5658 NWT LTD. AND THE
GOVERNMENT OF THE NORTHWEST TERRITORIES

5658 NWT Ltd.

Northwest Territories

PROJECT DESCRIPTION REPORT FOR CONSTRUCTION OF THE MACKENZIE VALLEY HIGHWAY TULITA DISTRICT, SAHTU SETTLEMENT AREA

OCTOBER 2011
ISSUED FOR USE

eba
A TETRA TECH COMPANY

ACRONYMS

AANDC	Aboriginal Affairs and Northern Development Canada
ARI	Aurora Research Institute
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWS	Canadian Wildlife Services
DFO	Fisheries and Oceans Canada
DIAND	Department of Indian and Northern Affairs
DOT	Department of Transportation
ENR	Department of Environment and Natural Resources
GDP	Gross Domestic Product
GNWT	Government of the Northwest Territories
HADD	Harmful Alteration, Disruption, or Destruction (of fish habitat)
HSE	Health, Safety, and Environment
HSS	health and social services
INAC	Indian and Northern Affairs Canada
MACA	Department of Municipal and Community Affairs
MGP	Mackenzie Gas Project
MOU	Memorandum of Understanding
MVEIRB	Mackenzie Valley Environmental Impact Review Board
MVLWB	Mackenzie Valley Land and Water Board
MVRMA	Mackenzie Valley Resource Management Act
NRCAN	Natural Resources Canada
NWPA	Navigable Waters Protection Act
PDR	Project Description Report
PWC	Public Works Canada
PWNHC	Prince of Wales Northern Heritage Centre
SARA	Species at Risk Act
SDMCLCA	Sahtu Dene and Metis Comprehensive Land Claim Agreement
SLUPB	Sahtu land Use Planning Board
SLWB	Sahtu Land and Water Board
SRRB	Sahtu Renewable Resources Board
SSA	Sahtu Settlement Area
VC	Valued Component

EXECUTIVE SUMMARY

E1.0 INTRODUCTION

The communities of the Central Mackenzie Valley are not linked to the rest of the Northwest Territories and Canada by all-weather road. Ground access to the Central Mackenzie Valley is only by winter road.

After Prime Minister John Diefenbaker first proposed the concept for the "Road to Resources" in the Northwest Territories in the late 1950s, the idea expanded in the 1960s to consider building an all-weather road through the Mackenzie Valley. The federal government, through Public Works Canada (PWC), did significant work in the 1970s on highway surveys, geotechnical investigations, environmental studies, bridge and culvert designs, some detailed design and even tender package preparation. This resulted in construction of 210 km of the south part of the Mackenzie Valley Highway between Fort Simpson and Wrigley, ending in the early 1980s just south of Wrigley.

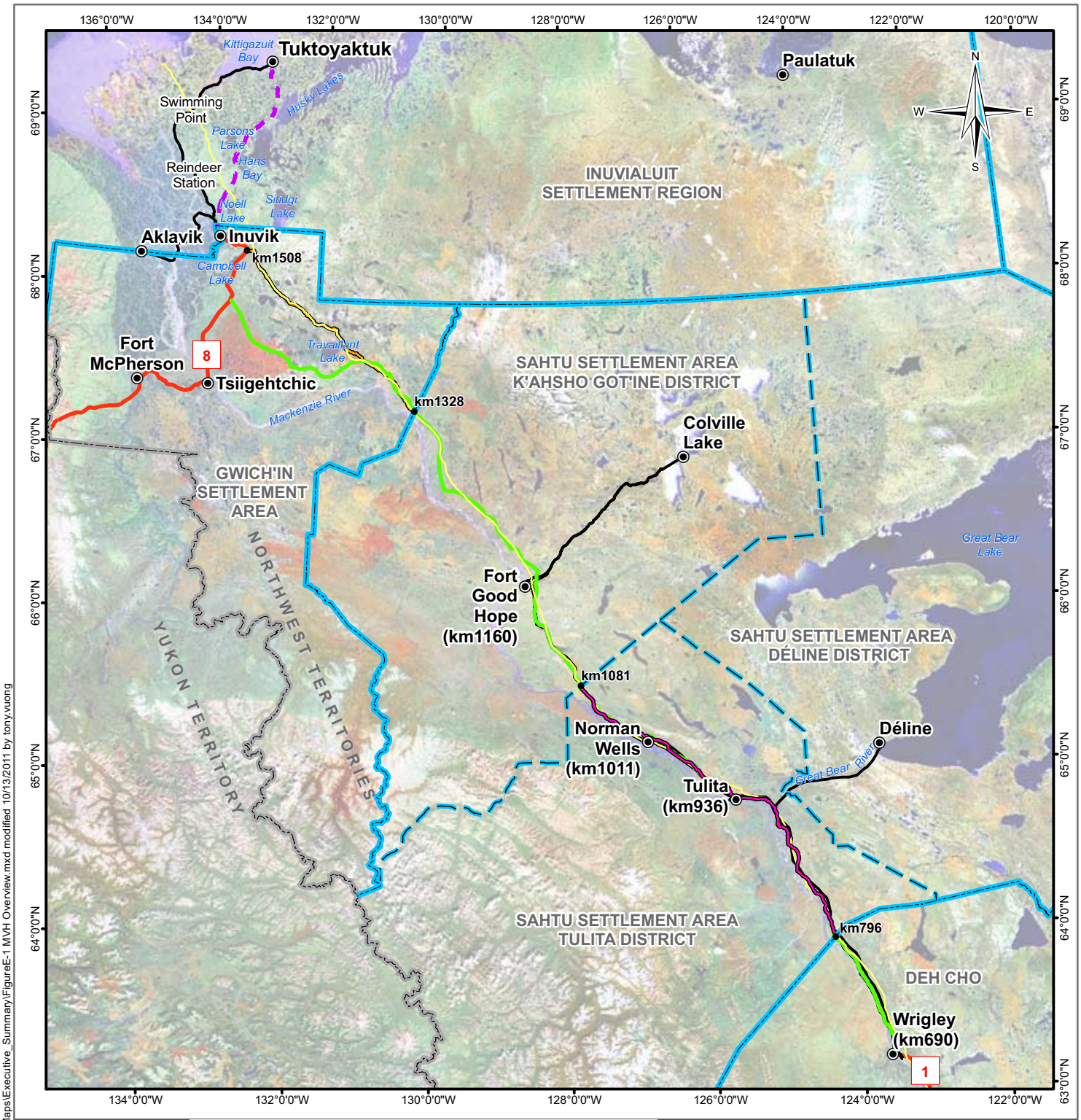
That section was completed with the development of a ferry crossing at N'Dulee Crossing (Camsell Bend) in the early 1990s and construction of a 210 m two-span bridge at Willow Lake River in 1994, after which the plans to construct the highway between Wrigley and Inuvik (over 800 km) were put on hold. With the completion of the all-weather Dempster Highway through Yukon in 1979, it was possible to reach Tsiigehtchic, Fort McPherson and Inuvik by road year-round.

Responsibility for the highway system was devolved by the federal government to the Government of the Northwest Territories (GNWT) in 1989. The same year, the Transportation Engineering Division of the Department of Transportation (DOT) prepared a report entitled "Mackenzie Highway, Wrigley to Inuvik Extension". Based primarily on the work done by Public Works Canada in the 1970s, the study changed the parameter for bridges from two-lane to single lane spans (DOT 1989).

Ten years later, in 1999, DOT updated the Highway strategy with three new studies: an engineering study to modify design standards to allow an operating speed of 60 km/hr to 90 km/hr depending on local conditions, an environmental scoping study and a benefit/cost analysis. Like the 1989 strategy, this update focused on community-based construction but extended the construction period to more than 10 years.

At the time the GNWT took over the highway system, it did not have the financial basis to undertake construction of major infrastructure projects such as the Mackenzie Valley Highway extension. Funding from the federal government was, and still is, required.

In 2010, a Memorandum of Understanding (MOU) was signed between DOT, as the Highway Proponent, and 5658 NWT Ltd., representing the Tulita Land Corporation, the Norman Wells Land Corporation, the Fort Norman Metis Land Corporation and the Tulita Dene Band. This agreement set the terms for the completion of a Project Description Report (PDR) for the construction of 285 km of all-weather, gravelled highway through the Tulita District, stretching from the northern boundary of Tulita District with K'ahsho Got'ine District to the southern boundary of the Tulita District, which is also the southern boundary of the Sahtu Settlement Area (SSA) (See Figure E-1).



LEGEND

- Communities
- PWC 1974 Highway Concept Route
- Mackenzie Gas Project Corridor
- MVH Concept - June 2011 (Preferred Alignment)
- Dempster Highway (NWT HWY 8)
- Public Winter Road
- Proposed Inuvik to Tuktoyaktuk Highway (2009)
- GSA Alignment
- Settlement Area Boundary
- District Boundary
- Territorial Boundary

NOTES

Base data source: ESRI
MGP & PWC 1974: GNWT
Boundaries: SLUPB
Alignment is considered preliminary and is subject to change

MACKENZIE VALLEY HIGHWAY TULITA DISTRICT

Mackenzie Valley Highway Overview

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:3,800,000
50 25 0 50
Kilometres

FILE NO. FigureE-1 MVH Overview.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y22101155	TV	MS	RM	0

OFFICE EBA-RIV
DATE October 14, 2011

5658 NWT Ltd.

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Figure E-1

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This agreement, and DOT's decision to form partnerships with each land claimant organization along the proposed route, has revived the idea of completing the Mackenzie Valley Highway.

This PDR covers the construction of the Highway through the Tulita District in the SSA, based on the nearly five decades of initiatives, studies, strategies, consultations and reports, and serves as the initial guiding document for the proposal to develop the Highway in the area. The PDR is subject to the terms of the *Sahtu Dene and Metis Comprehensive Land Claim Agreement (SDMCLCA)*. To the extent there is a conflict between the PDR and the *SDMCLCA*, the provisions of the *SDMCLCA* shall govern to the extent of the inconsistency.

E2.0 HIGHWAY CONCEPT

The overall Mackenzie Valley Highway from Wrigley to Inuvik has segments through the northern part of Deh Cho, the Tulita District and the K'ahsho Got'ine District, both in the SSA, and the Gwich'in Settlement Area. Similar PDRs are being prepared for the construction of the segments of the Highway in each area. When completed, all of the PDRs will be compiled into one overall PDR that will be submitted to the Mackenzie Valley Land and Water Board (MVLWB).

The Highway through the Tulita District is based on the consideration by 5658 NWT Ltd., DOT and the people of the Tulita District that the development of the route should take into account the location of the existing winter road, the route identified by Public Works Canada (PWC) in the 1970s and the proposed Mackenzie Gas Project (MGP). This effectively establishes a common Transportation Corridor to accommodate transportation (highway), utilities (pipeline), and communication infrastructure (fibre optic cable), thereby reducing the overall impact on the land, wildlife, habitat, traditional land use areas and cultural values in the SSA. Much of the information gathered in the past several years for the MGP is publically available and has proven useful for the preliminary design and preparation of the PDR.

The central Mackenzie Valley is currently served by a public winter road that extends from Wrigley to Fort Good Hope. This winter road has been in service for many years, and has many permanent bridges in place that are suitable for an all-weather highway. The main measure to minimize the impact on the environment from construction and operation of the Highway is to work within the footprint that has already been established for the public winter road. The preliminary design takes advantage of the existing winter road. Over half of the all-weather alignment is along the existing winter road, and, with a few exceptions, the existing bridge structures and crossing locations are incorporated. This minimizes the footprint and mitigates the impacts on traditional use, heritage value sites, and the overall environment.

E3.0 PARTNERSHIP IN PREPARATION OF THE PROJECT DESCRIPTION REPORT

In 2010, with federal government funding support, a Memorandum of Understanding (MOU) was signed between 5658 NWT Ltd. and DOT, the project Proponent, to set the terms for the completion of a Project Description Report (PDR) for the Construction of the Mackenzie Valley Highway (the Highway) in the Tulita District of the Sahtu Settlement Area (SSA). 5658 NWT Ltd. is the corporate entity representing the Norman Wells Land Corporation, the Tulita Land Corporation, the Fort Norman Metis Land Corporation and the Tulita Dene Band. 5658 NWT Ltd. has developed and delivered the PDR in conjunction with DOT

through the Management Committee and the Project Steering Committee. Management and Project Steering committee participants include:

- Management Committee:
  - Margaret McDonald, Norman Wells Land Corporation, (Chair Management Committee);
  - Edward MacCauley, Tulita Land Corporation;
  - Rocky Norwegian, Sr., Fort Norman Metis Land Corporation;
  - Frank Andrew, Tulita Dene Band; and
  - Robyn McGregor, EBA, A Tetra Tech Company
- Project Steering Committee:
  - Jim Stevens, Department of Transportation (Chair, Project Steering Committee);
  - Ed Hodgson, Norman Wells Land Corporation;
  - Wilfred Lennie, Fort Norman Metis Land Corporation;
  - Cecile MacCauley, Tulita Dene Band; and
  - Doug Yallee, Tulita Land Corporation.

The preparation of the PDR, along with the preliminary design, includes input from 5658 NWT Ltd. and its member groups: the Tulita Land Corporation, the Fort Norman Metis Land Corporation, the Norman Wells Land Corporation and the Tulita Dene Band; the Renewable Resource Councils, Sahtu regulatory authorities, the people of the Tulita District communities and DOT.

E4.0 PURPOSE OF THE PROJECT DESCRIPTION REPORT

The purpose of this PDR is to describe the construction of 285 km of all-weather, graveled highway, (the Highway) including an allowance for future installation of fibre optic cable within the highway right-of-way, through the Tulita District which is a part of the SSA in the Central Mackenzie Valley in the Northwest Territories. When completed, this section of the Mackenzie Valley Highway will be operated and maintained by DOT as part of the Northwest Territories public highway system.

The detailed design, construction and operation of the Highway will involve:

- refinement of the locations for the Highway alignment, stream and river crossings, material sources, and future installation of a communications fibre optic cable within the Highway right-of-way;
- developing supporting construction and maintenance infrastructure, including, material sources (long-term and temporary), temporary winter access roads, camps, and fuel, equipment and materials staging and storage locations;

- connecting proposed sections of the Highway extension from Wrigley in the Deh Cho to the section at the border between Tulita District and K'ahsho Got'ine District; and
- de-commissioning and restoring temporary material sources and access roads.

The reasons for building the Mackenzie Valley Highway through the SSA are the same as when first proposed in the 1960s, as follows:

- provide a year-round transportation link connecting the Central Mackenzie Valley with the rest of the Northwest Territories and Canada;
- decrease the cost of living by increasing access to good and services;
- significantly reduce transportation costs for Tulita District residents, businesses and industry;
- stimulate local workforce and business development in the resources sector;
- develop hospitality and tourism markets and other businesses;
- increase access to health care, education, training resources and employment opportunities;
- enable communities and families to share social, cultural, recreational and sports activities;
- support resource exploration, development, and production to increase viability in the Northwest Territories and stimulate the Sahtu economy;
- deliver governments' commitments for Northwest Territories regional economic development; and
- reduce the cost of delivering government services.

E5.0 ECONOMIC BENEFITS AND IMPACTS

E5.1 Economic Benefits

The "Mackenzie Valley All-weather Road Economic Analysis, September 2009" was prepared for DOT, and updated the socio-economic study that was included in the 1999 DOT Highway strategy. This economic analysis looked at the overall Mackenzie Valley Highway (Wrigley to Inuvik) and not its component parts in each region.

The analysis presented in the September 2009 report was based on cost estimates provided by DOT for the overall Mackenzie Valley Highway. The costs estimated at that time were:

- total construction cost, Wrigley to Inuvik: $1.67 billion, including $1.3 billion for road building, $223 million for bridge construction, and $178 million for engineering;
- total maintenance and operating costs of $13 million/year for the entire Highway; and
- construction costs for the Tulita District section at $599 million, including $467.3 million for road building, $60 million for the Great Bear River Bridge, $45.7 million for other bridges and $25.8 million for engineering.

E5.2 Economic Impacts

Economic impacts will be primarily felt in the Northwest Territories, but will also have some impact on the rest of Canada. The September 2009 study noted above provides estimates for the overall Mackenzie Valley Highway and the Tulita District can expect to see a proportion of them. A summary of the estimates provided in the 2009 report is as follows:

- Jobs – from construction and maintenance:
  - 7,785 construction jobs in the Northwest Territories;
  - 6,297 construction jobs in the rest of Canada; and
  - 128 permanent Northwest Territories jobs for ongoing maintenance, including for Tulita District.
- Reduction in the cost of living:
  - Tulita District residents can expect significant savings through reduced transportation costs year-round;
  - spin-off benefits for the rest of the Northwest Territories include $5.5 million in gross domestic product (GDP), 41 permanent jobs, $1.1 million increase in revenue for the GNWT (.6 million net); and
- Tourism:
  - expected to increase by 20%, with a corresponding increase in economic activity of $500,000 and in 10 new jobs;
  - increased average length of stay; and
  - tourists can drive "the Loop" formed by the Mackenzie Valley Highway and the Dempster Highway, thereby spending more time in the northern part of Northwest Territories and Yukon.
- Impact on resource development:
  - an all-weather Highway could extend winter drilling season, allowing for a faster pace of exploration and development;
  - the Highway provides greater access for oil and gas exploration and development should the people of the Tulita District choose to develop the resources.

E5.3 Other Benefits

The benefits listed below are difficult to quantify so a dollar value is not provided:

- End the sense of isolation for residents of the Tulita District by providing a year-round transportation link connecting the Central Mackenzie Valley with the rest of the Northwest Territories and Canada.
- Workforce development in the following areas:
  - management of Highway maintenance and operations;
  - land access management (enforcement, wildlife monitors, technical planning);

- tourism and associated community businesses (guides, environmental and wildlife monitors, communications and promotions specialists, business administrators, restaurant workers including owners and managers, expeditors, logistics specialists); and
- resource exploration and development in the petroleum and mining sectors (expeditors, logistics specialists, drillers and other rig workers, business administrators, camp managers and workers, miners, etc,).

There are two communities along the section of the Highway through the Tulita District: Norman Wells and Tulita, each of which will feel direct impacts from Highway construction and operation and maintenance. The Highway will have an impact on all SSA communities during construction through business and employment opportunities related to construction, and during operations, from business and employment opportunities related to the year-round operation and maintenance. Once completed, the Highway will provide a safer, year-round transportation link to other Northwest Territories communities, to Alberta cities such as Edmonton and Calgary, and to the rest of Canada.

E6.0 REGULATORY REVIEW AND APPROVALS

E6.1 Screening and Review

During consultations held in 2010 and 2011, Sahtu regulatory authorities, the Tulita District Land Corporation, and federal and territorial government representatives provided information about what the regulatory review process will likely look like for the project in the Tulita District.

The Highway within the Tulita District and the Sahtu is located within the Mackenzie Valley of the Northwest Territories. The main statutes governing the land and resource management in the Mackenzie Valley are:

- the *Mackenzie Valley Resources Management Act (MVRMA)*;
- the *Mackenzie Valley Land Use Regulations*;
- the *Northwest Territories Waters Act*; and
- the *Northwest Territories Waters Regulations*

In addition, the *SDMCLCA* applies in the Tulita District.

The *MVRMA* is the governing legislation for both the Mackenzie Valley Land and Water Board (MVLWB) and the Mackenzie Valley Environmental Impact Review Board (MVEIRB). As in other settled claim areas, the SSA has its own land and water board, set up under provisions of the *SDMCLCA* and given effect by the *MRVMA*. The Sahtu Land and Water Board functions as a regional panel of the MVLWB. Part of the MVLWB's mandate is to screen and regulate development projects that cover more than one region, as may prove to be the case for the overall Mackenzie Valley Highway.

The MVLWB will undertake preliminary screening of the Mackenzie Valley Highway based on the submission of an application for a land use permit and a water licence along with the PDR for the overall highway from Wrigley to Inuvik. Preliminary screening will likely find that the Mackenzie Valley Highway

might cause significant adverse environmental impact or public concern and would therefore be referred for an environmental assessment by the MVEIRB. Based on submitted project documentation and any public concerns about the project raised during scoping sessions, the MVEIRB could determine whether to conduct an environmental impact assessment or an environmental impact review, a more detailed examination and therefore longer process.

The Sahtu Land and Water Board (SLWB) may or may not participate in the preliminary screening or regulation or permitting of the project, depending on decisions made at the time the application is filed. The SLWB will; however, screen, regulate and permit any investigative activities that take place prior to construction (P. Dixon, SLWB, June 2009).

The following table shows the various permits, licences, authorizations or processes needed for pre-construction and construction activities for the Highway in the Tulita District.

Table E-1: Anticipated Authorizations, Permits, Licences or Other Approvals

Process, Authorization, Permit, Licence, Approval	Act and/or Regulation	Board, Agency, or Organization
Environmental Assessment Process		
Preliminary Screening	*MVRMA*	Mackenzie Valley Land and Water Board (MVLWB)
Environmental Assessment	*MVRMA*	Mackenzie Valley Environmental Impact Review Board (MVEIRB)
Land		
Land Use Permit	*Mackenzie Valley Land Use Regulations*	Pre-construction - SLWB Construction – MVLWB
Land Use - Commissioner's Lands - Reservation by Notification	*Commissioner's Lands Regulations (Commissioner's Land Act)*	Municipal and Community Affairs (MACA)
Quarry Permit – Crown Lands	*Territorial Quarrying Regulations (Territorial Lands Act)*	Aboriginal Affairs and Northern Development Canada (AANDC)
Quarry Permit - Commissioner's Lands - Reservation by Notification	*Commissioner's Lands Regulations (Commissioner's Land Act)*	MACA
Explosives Permit	*Explosives Act*	Natural Resources Canada (NRCAN)
Water		
Water Licence	*Northwest Territories Waters Regulations (Northwest Territories Waters Act)*	Pre-construction - SLWB Construction - MVLWB
Fisheries Authorization and/or Letter of Advice	*Fisheries Act*	Fisheries and Oceans Canada (DFO)
Navigable Waters Protection Approval	*Navigable Water Protection Act*	Transport Canada (TC)

Table E-1: Anticipated Authorizations, Permits, Licences or Other Approvals (Continued)

Process, Authorization, Permit, Licence, Approval	Act and/or Regulation	Board, Agency, or Organization
Other (Pre-construction investigations to support detailed design)		
NWT Scientific Research Licence	*NWT Scientists Act and Northwest Territories Act*	Aurora Research Institute (ARI)
NWT Archaeological Permit	*Northwest Territories Archaeological Sites Regulations (Northwest Territories Act)*	Prince of Wales Northern Heritage Centre (PWNHC)
NWT Wildlife Research Permit	*NWT Wildlife Act*	Department of Environment and Natural Resources (ENR)
Licence to Fish for Scientific Purposes; Letter of Advice or Authorization	*Fisheries Act*	DFO

A flow chart of the estimated permitting process is illustrated on Figure E-2.

E6.2 Co-management Boards and Settlement Land Owners in Tulita District

In addition to the regulatory and assessment bodies listed in the table above, the following Sahtu boards and organizations will play roles in regulating and permitting of the Highway.

E6.2.1 Sahtu Land and Water Board (SLWB)

The SLWB is a public co-management regulatory board established under the *SDMCLCA* and given effect by the *MVRMA* to provide an integrated and coordinated system of land and water use management in the Mackenzie Valley. The Board regulates the use of land and water to ensure that development activities in the settlement area do not have adverse impacts and issues, amends, renews and suspends land use permits and water licences throughout the Sahtu. This includes activities on Crown, Commissioner's, Sahtu settlement and privately-owned lands (SLWB 2004). The SLWB administers the Mackenzie Valley Land Use Regulations and the Northwest Territories Waters Act and Regulations in the Sahtu.

Depending on decisions made regarding the overall Mackenzie Valley Highway which is trans-boundary, the SLWB may or may not be involved in regulating and permitting the overall Mackenzie Valley Highway. They will however, be responsible for regulating and permitting pre-construction investigative activities such as survey, archaeological and geotechnical investigations.

E6.2.2 Sahtu Renewable Resources Board (SRRB)

The Sahtu Renewable Resources Board (SRRB) was established as a public co-management board by the *SDMCLCA* and given effect by the *MVRMA*, and is the main instrument for protection, conservation and management of wildlife and forest management in the SSA under s.13.8.1. The SRRB consults regularly with the community Renewable Resources Councils (formerly known as Hunters and Trappers Associations), which provide community-based knowledge and guidance about renewable resources.

The SRRB conducts research on renewable resources found in the Sahtu, and has supplied the research results to the Sahtu Land Use Planning Board (SLUPB) for use in the *Sahtu Land Use Plan* (*SLUP*). The SRRB provides informed opinions to the SLWB regarding all land use permit and water licence applications. This information serves as the basis for calculation of *SDMCLCA* Participants' compensation in the event of damage or loss to harvesting caused by development or disaster.

E6.2.3 Sahtu Land Use Planning Board (SLUPB)

The SLUPB is a public co-management established under the *SDMCLCA* and is given effect by the *MVRMA*. The SLUPB has developed the *SLUP,* completing Draft 3 in August 2010, which provides for the conservation, development and utilization of land, water and resources. The *SLUP* sets up Management Areas which allow for different levels of use and/or development. It applies to all Crown Land, Commissioner's Lands and Sahtu Settlement Lands in the SSA, including in the Tulita District, an area just under 57,000 sq. km. Land within community boundaries, national parks, historic sites and monuments are excepted from the land use plan (SLUPB 2010).

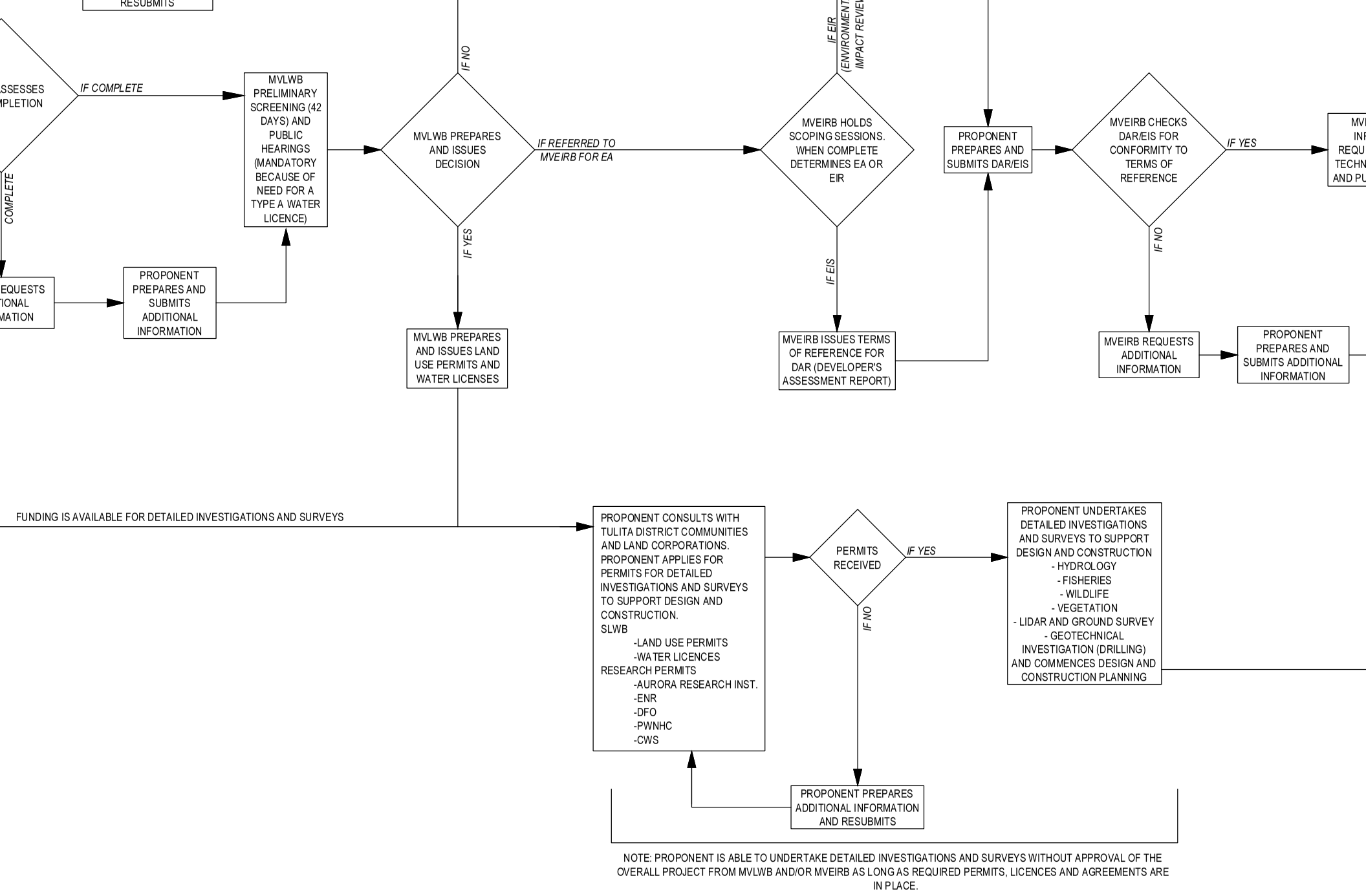
After the *SLUP* is approved, all licences, permits or other authorizations relating to the use of land, water or the deposit of waste in the SSA must conform to the land use plan.

E6.2.4 Tulita District Land Corporation

The Tulita District Land Corporation manages Sahtu Settlement Lands in the Tulita District on behalf of the three community land corporations in the region: Tulita Land Corporation, Fort Norman Metis Land Corporation and Norman Wells Land Corporation. The Board of Directors for the Tulita District Land Corporation includes the presidents of each of these community land corporations. The activities that will occur on Tulita District lands related to the Highway will include:

- research and investigative activities – material sources, archaeological assessments, fisheries assessments;
- establishing gravel pits and quarries (material sources); and
- Highway construction and associated infrastructure.

Proponents of any development project planned for the Tulita District must first receive approval to access Sahtu land from the Tulita District Land Corporation before proceeding through the regulatory and assessment process, usually in the form of a private access and benefits agreement. In this case, the Proponent, DOT, will negotiate access and tenure to Sahtu land with the Tulita District Land Corporation.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EQUESTS TIONAL MATION
PROPONENT PREPARES AND SUBMITS ADDITIONAL INFORMATION
MVLWB PRELIMINARY SCREENING (42 DAYS) AND PUBLIC HEARINGS (MANDATORY BECAUSE OF NEED FOR A TYPE A WATER LICENCE)
MVLWB PREPARES AND ISSUES DECISION
IF NO
IF YES
IF REFERRED TO MVEIRB FOR EA
IF EIR (ENVIRONMENT IMPACT REVIEW
MVEIRB HOLDS SCOPING SESSIONS. WHEN COMPLETE DETERMINES EA OR EIR
IF EIS
MVLWB PREPARES AND ISSUES LAND USE PERMITS AND WATER LICENSES
MVEIRB ISSUES TERMS OF REFERENCE FOR DAR (DEVELOPER'S ASSESSMENT REPORT)
PROPONENT PREPARES AND SUBMITS DAR/EIS
MVEIRB CHECKS DAR/EIS FOR CONFORMITY TO TERMS OF REFERENCE
IF YES
IF NO
MVEIRB REQUESTS ADDITIONAL INFORMATION
PROPONENT PREPARES AND SUBMITS ADDITIONAL INFORMATION
FUNDING IS AVAILABLE FOR DETAILED INVESTIGATIONS AND SURVEYS
PROPONENT CONSULTS WITH TULITA DISTRICT COMMUNITIES AND LAND CORPORATIONS. PROPONENT APPLIES FOR PERMITS FOR DETAILED INVESTIGATIONS AND SURVEYS TO SUPPORT DESIGN AND CONSTRUCTION.
SLWB
-LAND USE PERMITS
-WATER LICENCES
RESEARCH PERMITS
-AURORA RESEARCH INST.
-ENR
-DFO
-PWNHC
-CWS
PERMITS RECEIVED
IF YES
IF NO
PROPONENT UNDERTAKES DETAILED INVESTIGATIONS AND SURVEYS TO SUPPORT DESIGN AND CONSTRUCTION
- HYDROLOGY
- FISHERIES
- WILDLIFE
- VEGETATION
- LIDAR AND GROUND SURVEY
- GEOTECHNICAL INVESTIGATION (DRILLING)
AND COMMENCES DESIGN AND CONSTRUCTION PLANNING
PROPONENT PREPARES ADDITIONAL INFORMATION AND RESUBMITS
NOTE: PROPONENT IS ABLE TO UNDERTAKE DETAILED INVESTIGATIONS AND SURVEYS WITHOUT APPROVAL OF THE OVERALL PROJECT FROM MVLWB AND/OR MVEIRB AS LONG AS REQUIRED PERMITS, LICENCES AND AGREEMENTS ARE IN PLACE.

E7.0 COMMUNITY AND REGULATORY CONSULTATIONS

E7.1 Community Consultations

Public consultations took place in Norman Wells and Tulita in July 2010, March 2011, and October 2011. The consultations were led by 5658 NWT Ltd. and DOT and included representatives from the consultant team (EBA, a Tetra Tech Company). Consultations were conducted at the start of the PDR development to share the process and gather initial information. They were held again at the midpoint of the process to show progress, confirm some decisions about the Highway and to gather further information. A final round of consultations was held near the end of the process to present the PDR, to show how the input was used, identify the next steps for submission to the MVLWB, view the maps showing the Highway and answer remaining questions.

Table E-2: Consultation Summary

Consultation Location	Date	Format and Content of Meeting
Norman Wells	July 28, 2010	Community supper followed by community meeting. Project presentation and discussion around maps showing the preliminary corridor for the Highway.
	March 28, 2011	Community supper followed by community meeting. Project update presentation and discussion around large maps showing the preliminary alignment for the Highway. The discussion included Traditional Knowledge, environmental and socio-economic issues, among other topics.
	October 4, 2011	Mackenzie Mountain School. Interactive presentation and discussion about future Highway details, benefits, potential impacts and mitigative measures with students of grades 7 through 12.
	October 4, 2011	Community supper followed by community meeting. Project Description presentation and how community's input had been included in different sections of the document. Discussion included bridge details and next steps among other topics.
Tulita	July 29, 2010	Community supper followed by community meeting. Project presentation and discussion around maps showing the preliminary corridor for the Highway.
	March 29, 2011	Community supper followed by community meeting. Project update presentation and discussion around large maps showing the preliminary alignment for the Highway. The discussion included Traditional Knowledge, environmental and socio-economic issues among other topics.
	October 5, 2011	Chief Albert Wright School. Interactive presentation and discussion about future Highway details, benefits, potential impacts and mitigative measures with students of grades 6 through 12.
	October 5, 2011	Community supper followed by community meeting. Project Description Report presentation and how community's input had been included in different sections of the document. Discussion included bridge details and next steps among other topics.

In addition to the public community consultations, consultations were held with the following organizations in August, 2011:

- Hamlet of Tulita;
- Tulita Dene Band;
- Tulita Renewable Resource Council;
- Tulita Land Corporation;
- Tulita District Land Corporation;
- Fort Norman Metis Land Corporation;
- Town of Norman Wells;
- Norman Wells Land Corporation; and
- Norman Wells Renewable Resources Council.

Information meetings and/or telephone conversations with other organizations, regulatory agencies and government departments took place throughout the preparation of the PDR and included:

- Sahtu Land and Water Board;
- Sahtu Land Use Planning Board;
- Sahtu Renewable Resources Board;
- Aboriginal Affairs and Northern Development Canada;
- Department of Fisheries and Oceans;
- Environment and Natural Resources, GNWT;
- Aurora Research Institute;
- Municipal and Community Affairs, GNWT;
- Transport Canada;
- Prince of Wales Northern Heritage Centre;

- Sahtu Dene Council;
- Sahtu Secretariat Inc. (SSI); and
- Canadian Wildlife Service (CWS).

More information about consultations, including questions, answers, background information distributed at the meetings, attendance sheets and presentations can be found in Appendix C in this PDR.

E8.0 DEVELOPMENT OF THE HIGHWAY

This PDR and the preliminary design for the Highway builds on the previous work done by PWC and DOT, in consideration of the following alignment options:

- the alignment defined by the PWC between 1972 and 1976;
- the existing winter road, with an overall consideration of developing a common transportation corridor for linear infrastructure;
- the MGP alignment; and
- the routing study undertaken during the development of this PDR.

The preliminary design, location of the Highway, and location of potential granular material sources also consider avoiding areas of heritage value, traditional use, and environmental sensitivity. The preferred alignment for the Highway is shown on Figure E-3. The location of the Highway in the vicinity of Norman Wells and Tulita is shown on Figure E-4 and Figure E-5.

Highway development plans of the past 50 years estimated construction periods ranging from as few as four years to as many as 20 years in order to utilize local community labour and construction equipment. However, there is greater advantage to putting the Highway into operation sooner rather later. Local communities will benefit more from long-term sustainable management and operations and expected economic growth arising from Highway completion than from the relatively shorter term construction period. The long term opportunities beyond construction of the Highway include:

- highway management and operation (equipment operators, highway patrol, maintenance foreman, expeditors, engineering and technical staff, environmental monitors, etc.);
- land access management (enforcement, environmental and wildlife monitors, technical planning staff, etc.);
- tourism and associated community based service businesses (environmental and wildlife monitors, professional guides, communications and marketing specialists, business administrators, chefs, restaurant managers, hotel and bed and breakfast operators, expeditors, logistics specialists, etc.).
- resource and exploration opportunities and associated community based service businesses (environmental and wildlife monitors, technical and engineering specialists in exploration and production, surveyors, rig hands, geotechnical support workers, camp support staff, expeditors, logistics specialists, business administrators, etc.).

E8.1 Staged Design and Construction

In a traditional design and construction approach, the detailed design would be completed for the full 285 km of highway before the construction starts. The Highway can be completed sooner if components of the design are completed each year for specific Highway sections, staying just ahead of construction – a staged approach to design and construction. The work completed to date in the development of the preliminary design and the PDR provides sufficient information and guidance about the Highway to be able to proceed with detailed design, investigations and subsequent construction in this manner.

This approach results in an accelerated delivery schedule and delivers advantages and savings from innovations in design, construction, mobilization and staging. Significant resources are needed for accelerated design and construction. To the extent possible, all qualified and relevant resources in local communities will be used.

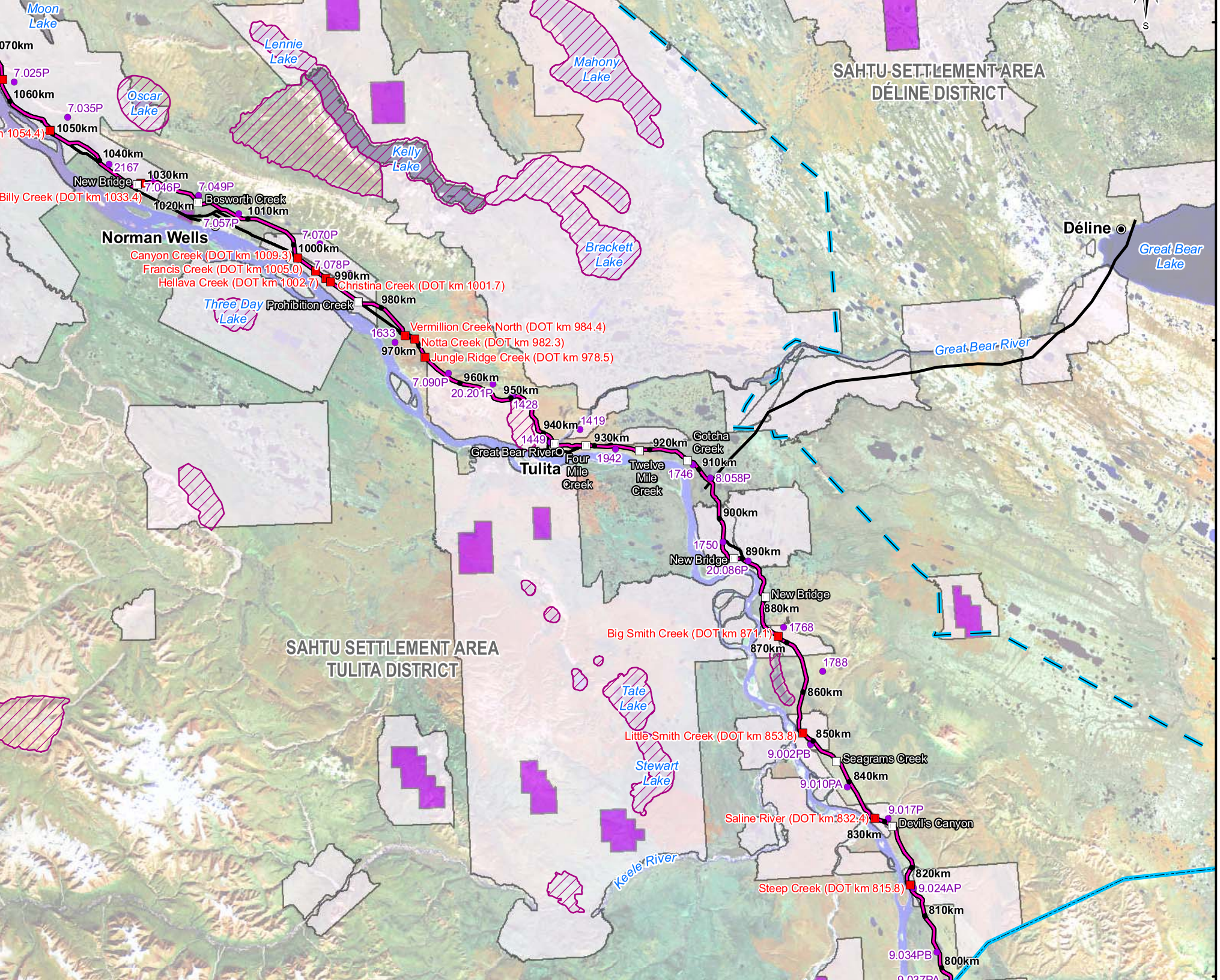
The construction process could also include "training segments" under the direction of each community. This will maximize training and construction opportunities in real time. Public Private Partnership (P3) approaches to significant components such as the Great Bear River Bridge may also be considered to accelerate delivery. Regardless of the approach, the design and measures invoked to mitigate the impact to the social and physical environment will be similar. The mechanism and speed of delivery is largely dependent on partnerships developed by the land claim and aboriginal organizations, and the availability of funding.

E8.2 Cost of the Highway

The Highway section through the Tulita District is estimated to cost $599 million, which includes the amount of $60 million for construction of the Great Bear River Bridge.

E8.3 Project Timetable

Using the staged design and construction approach described above, Highway construction through the Tulita District is estimated to take three winter seasons after receiving regulatory approval. Construction will begin in the first winter directly following approvals and the availability of funding. Assuming funding is available, the first stage of design would begin in the preceding spring.


Moon Lake
Lennie Lake
Mahony Lake
Oscar Lake
Kelly Lake
Brackett Lake
Three Day Lake
Tate Lake
Stewart Lake
Great Bear Lake
Great Bear River
Keele River
SAHTU SETTLEMENT AREA
DÉLINE DISTRICT
SAHTU SETTLEMENT AREA
TULITA DISTRICT
Déline
Norman Wells
Tulita
New Bridge
Bosworth Creek
Prohibition Creek
Four Mile Creek
Twelve Mile Creek
Gotcha Creek
Devil's Canyon
Billy Creek (DOT km 1033.4)
Canyon Creek (DOT km 1009.3)
Francis Creek (DOT km 1005.0)
Hellava Creek (DOT km 1002.7)
Christina Creek (DOT km 1001.7)
Vermillion Creek North (DOT km 984.4)
Notta Creek (DOT km 982.3)
Jungle Ridge Creek (DOT km 978.5)
Big Smith Creek (DOT km 871.1)
Little Smith Creek (DOT km 853.8)
Seagrams Creek
Saline River (DOT km 832.4)
Steep Creek (DOT km 815.8)
1060km
1050km
1040km
1030km
1020km
1010km
1000km
990km
980km
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960km
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890km
880km
870km
860km
850km
840km
830km
820km
810km
800km
7.025P
7.035P
2167
7.046P
7.049P
7.057P
7.070P
7.078P
1633
7.090P
20.201P
1428
1419
1449
1942
1746
8.058P
1750
20.086P
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1788
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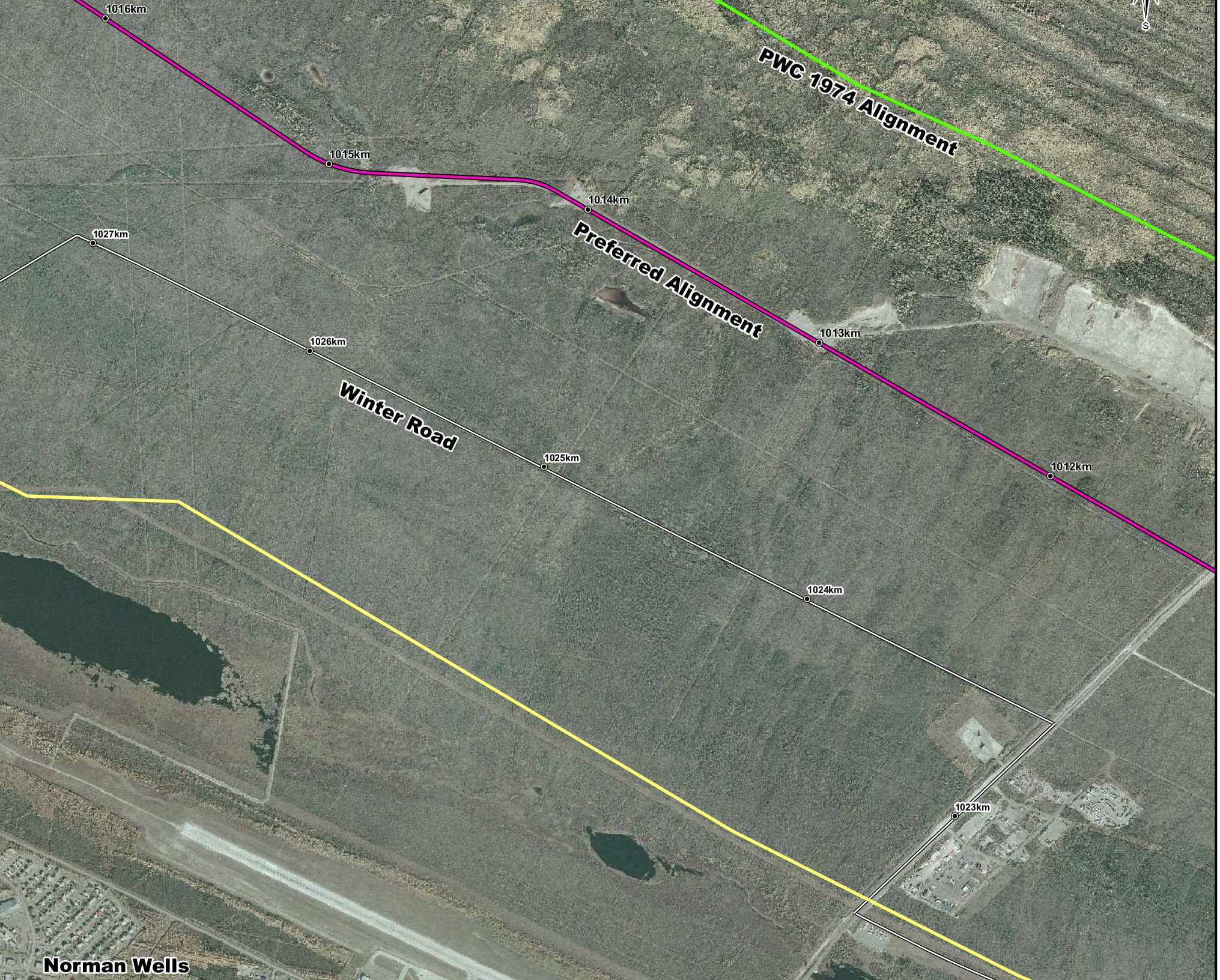

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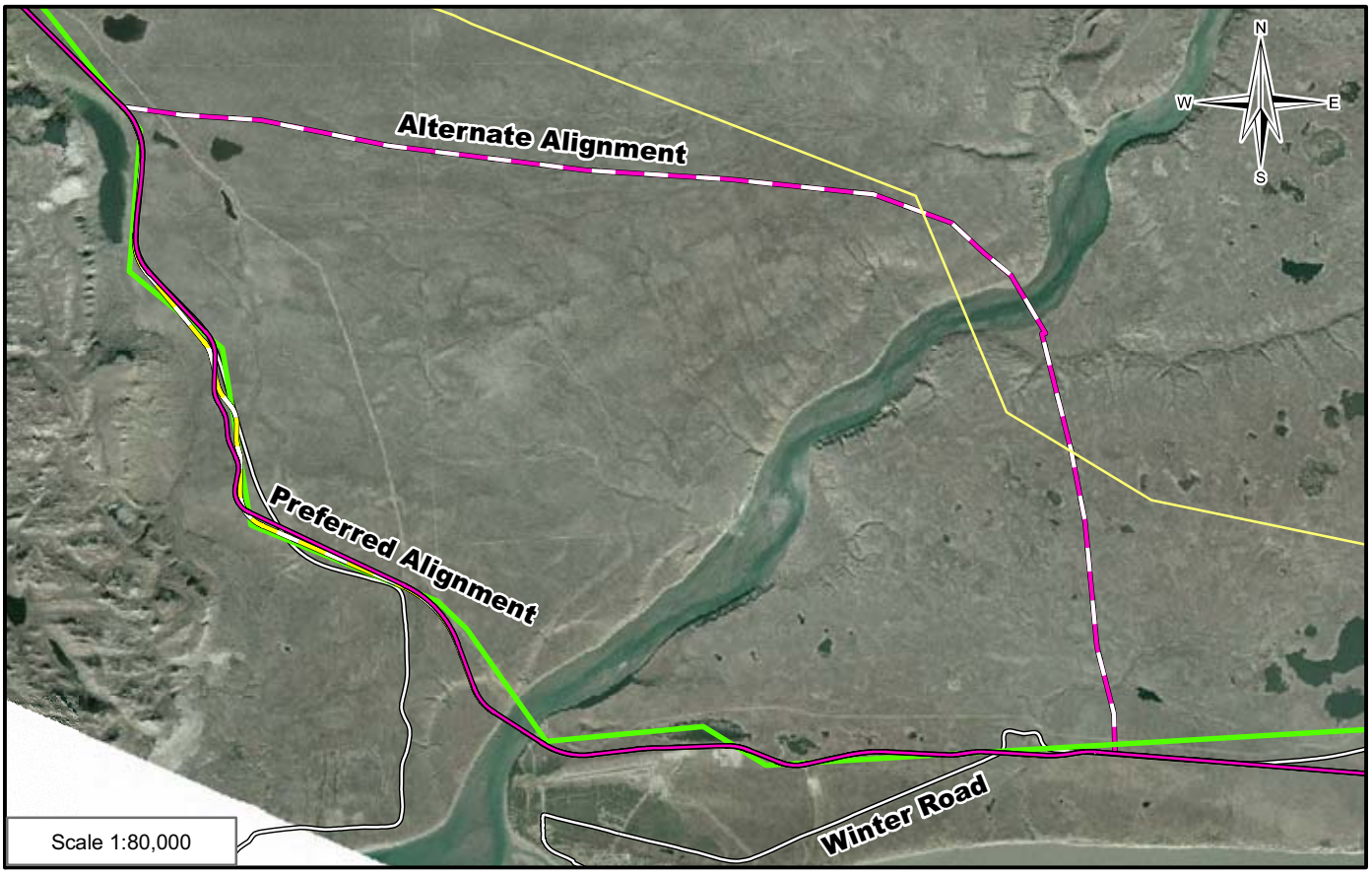

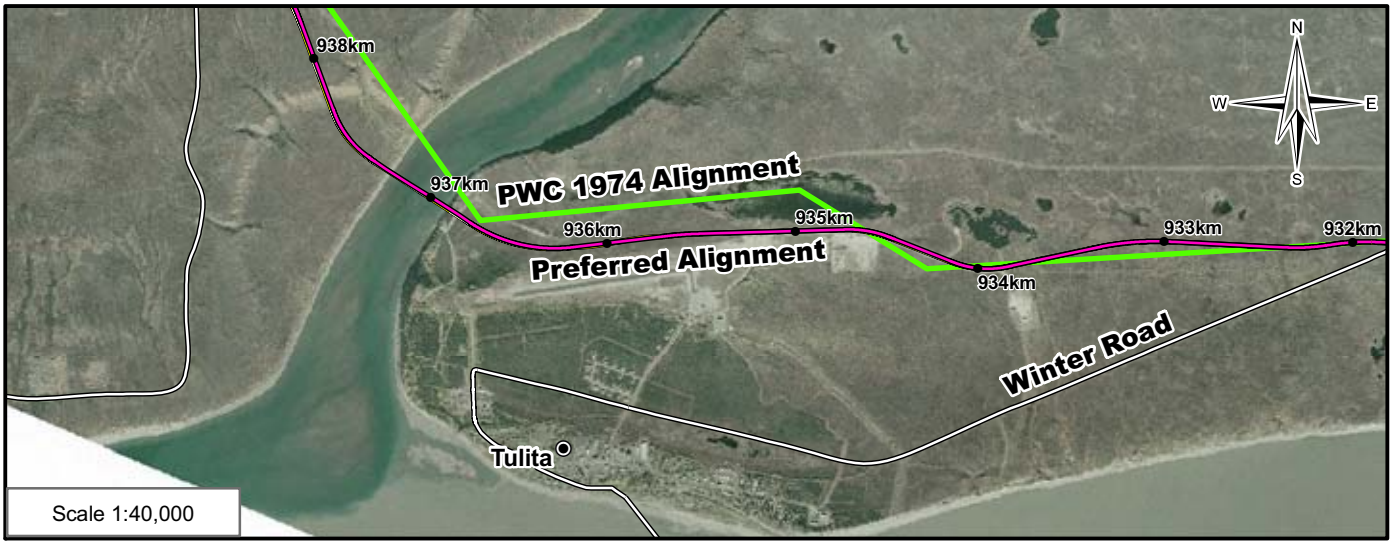

LEGEND

- Communities
- MVH Concept - June 2011 (Preferred Alignment)
- MVH Concept - EBA March 2011, Main
- MVH Concept - EBA March 2011, Alternative
- PWC 1974 Highway Concept Route
- Public Winter Road, Commissioner's Land
- Mackenzie Gas Project

NOTES

Base data source: ESRI
MGP & PWC 1974: GNWT
Alternate alignment: Great Bear River Bridge Project Description Report (EBA 2006)
Alignment is considered preliminary and is subject to change

MACKENZIE VALLEY HIGHWAY TULITA DISTRICT

Alignment Options in the Vicinity of Tulita

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:40,000
700 350 0 700
Metres

FILE NO. Y22101155_Figure E-5 Tulita.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y22101155	TV	MS	RM	0

OFFICE	DATE
EBA-RIV	October 14, 2011

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Figure E-5

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Table E-3: Proposed Schedule of Activities

Activities	Approximate Dates
Submission to MVLWB for Highway Construction Wrigley to Inuvik	January 2012
MVLWB Preliminary Screening Process	February through September 2012
MVEIRB Environmental Assessment Process	October 2012 through December 2013
Consultation and Permitting Required for Investigation and Survey Activities	October 2012 through May 2013
Investigation and Survey Activities to Support Design and Construction Permitting	June 2013 through March 2014
Additional Permitting Required for Construction	January 2013 through August 2014
Design	Commences April 2013 and is ongoing throughout the duration of the project staying ahead of fabrication and construction requirements.
Construction	August 2014 through Fall 2017
Estimated Opening of the Highway	Fall 2017

The estimated dates for construction start and completion could be earlier than those shown if the approval is provided through preliminary screening by the MVLWB, or if environmental assessment or review is completed earlier than estimated above. Estimated timelines for permitting and construction activities are shown in Table E-4 and Table E-5.

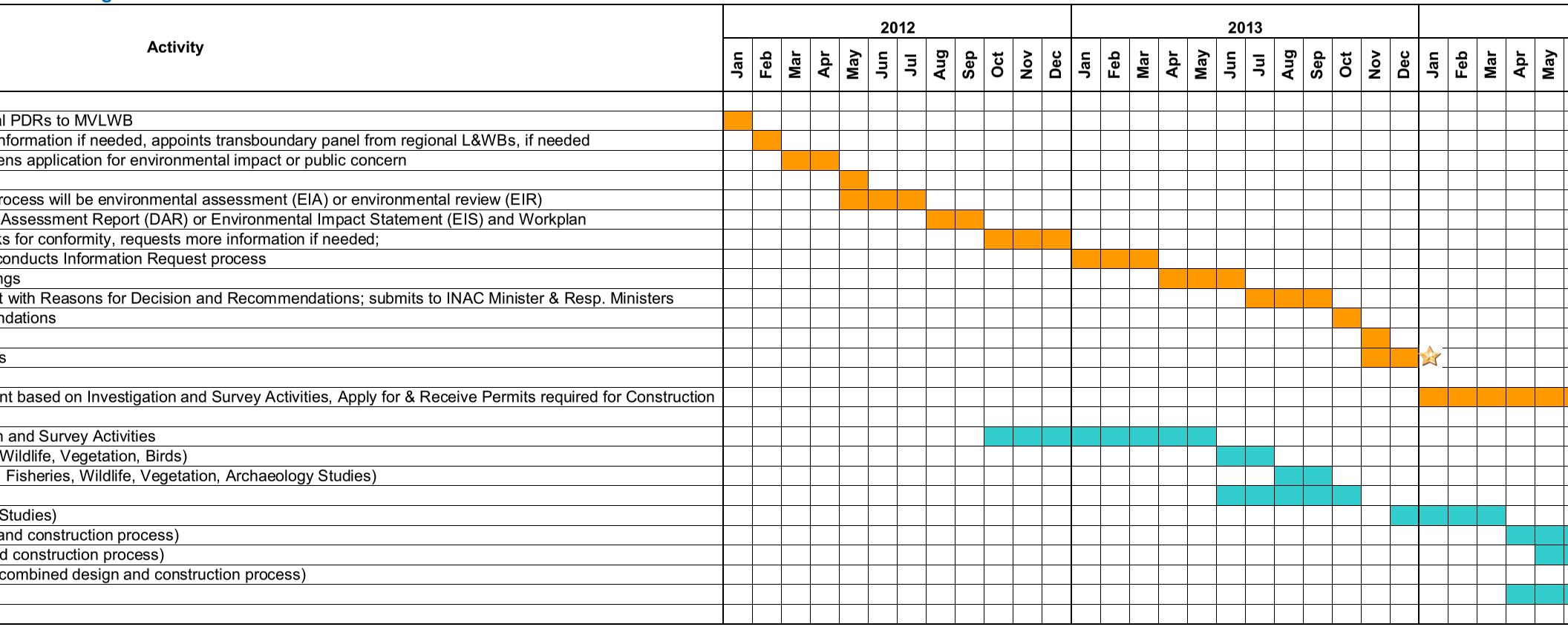
E8.4 Location

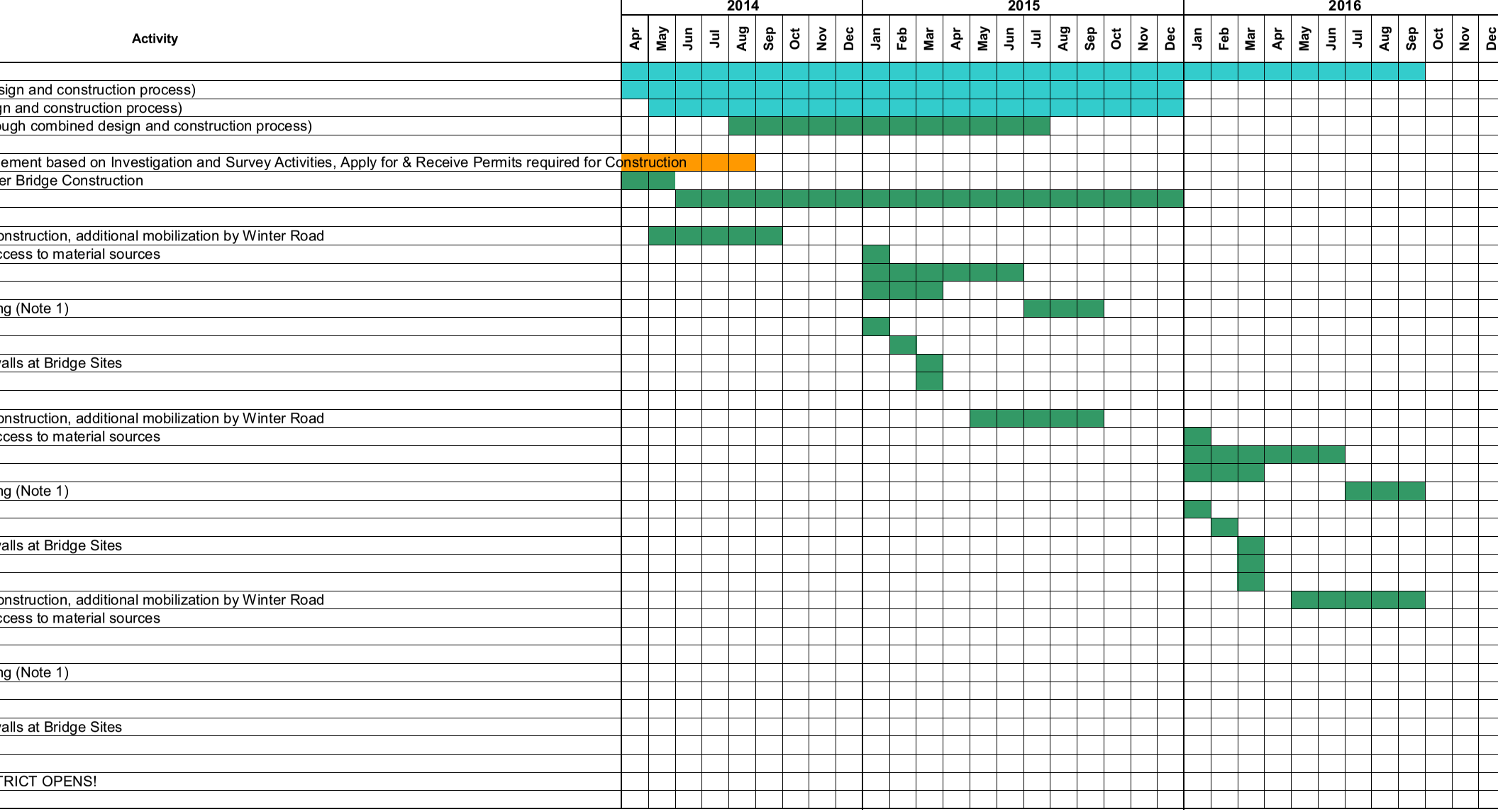
The Highway in the Tulita District starts in the south at the border with the Deh Cho, and stretches 285 km northwest, roughly aligned with the Mackenzie River, to the southern boundary of the K'ahsho Got'ine District, north of Norman Wells. The Highway through Tulita District follows closely to the MGP and utilizes much of the existing winter road, as follows:

- 149 km (52%) along the existing winter road; and
- 136 km (48%) on new alignment.

The Highway is located within two distinct physiographic regions: the Mackenzie Plain and the Franklin Mountains. The Mackenzie Plain is flat to gently undulating for the most part where it is underlain by fine-grained glaciolacustrine sediments. Terraced glaciofluvial and fluvial deposits flank the river locally and there are a few bedrock outcrops. The Franklin Mountains, located east of the Mackenzie Plain, comprise much steeper terrain. The mountains are discontinuously covered with either till or colluvial material. Fine tuning of the horizontal and vertical alignment for the Highway takes advantage of the flat areas and allows for avoidance of most of the steep and colluvial areas.

ns and Design Schedule





erial along or adjacent to completed embankment in previous winter.

The Highway lies entirely within the extensive discontinuous permafrost zone (50% to 90% of land area underlain by permafrost, Canada Permafrost Map, 1995). Ground temperatures are within the range of -1˚C to -3˚C.

Using topographic maps, air photo imagery, and other available information, the initial desktop routing study defined a preliminary highway alignment and minor alternatives, potential stream crossings and potential material sources. The initial routing development was based on the following constraints:

- avoid ice rich and unstable terrain;
- avoid steep grades and deep valleys;
- find locations to cross major streams to minimize bridge lengths;
- avoid locations with obvious wildlife nesting or denning areas;
- situate the Highway on or near potential material sources to minimize the length of temporary or permanent access roads;
- minimize the need to cross the MGP;
- minimize the infrastructure footprint while maintaining a sufficient tree or vegetation screen between the highway and a minimum 50 m from the pipeline alignment; and
- utilize existing winter road alignment and bridges where efficient.

The Highway will be positioned within a cleared right-of-way that is typically 60 m wide. In some locations, the right-of-way could be wider to accommodate the demands of the terrain and design. Additional right-of-way will also be required at major bridge crossings, maintenance camps, and in areas where pull-offs and chain-up areas are necessary to support safe travel. The total footprint of disturbance will also include temporary access roads and development of material sources. Right-of-way and footprint of disturbance will be determined at the detailed design stage.

The initial routing study was the basis for the September 2010 field program and the preliminary design and the identification of potential material sources. The Highway alignment and the selection of the material sources will be refined through more detailed investigations and design prior to the construction phase of the project development.

E8.5 Highway Design, Bridges and Culverts

Preliminary highway design incorporated constraints based on operational and safety considerations such as traffic volume (estimated at 50 vehicles per day, with 13% to 15% of that being heavy trucks), the type of vehicle to operate on the Highway, desired operating speed, accommodation and protection of permafrost and ice-rich terrain, avoiding or minimizing impact to sensitive environmental and heritage resource areas, and information gathered during consultations.

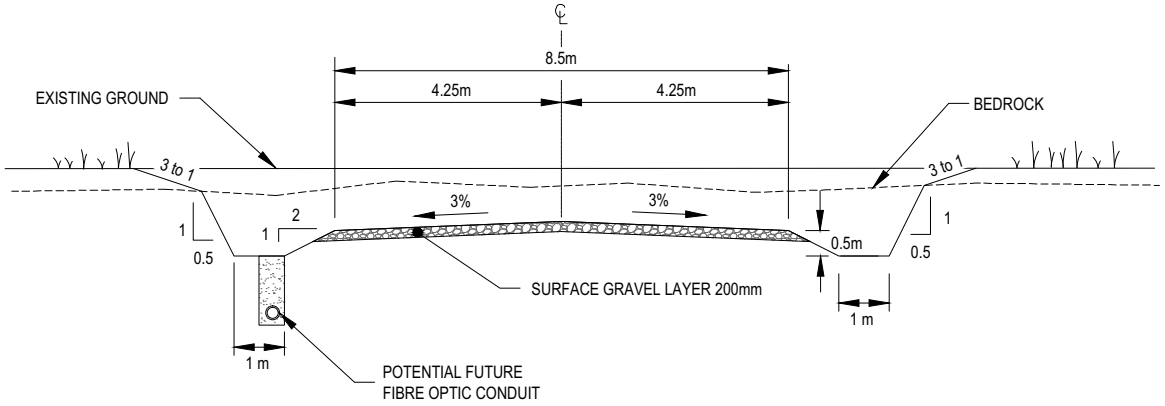
Design parameters are based on published and accepted guidelines and best practices for developing infrastructure in the Northwest Territories. DOT has reviewed and accepted the design parameters developed for the Highway. Working within a discontinuous permafrost region such as is found in the

Tulita District, and considering the potential for impact from climate change on permafrost, extensive consideration of past experience and adaptation of engineering principles and practices is required.

Table E-6: Design Parameters

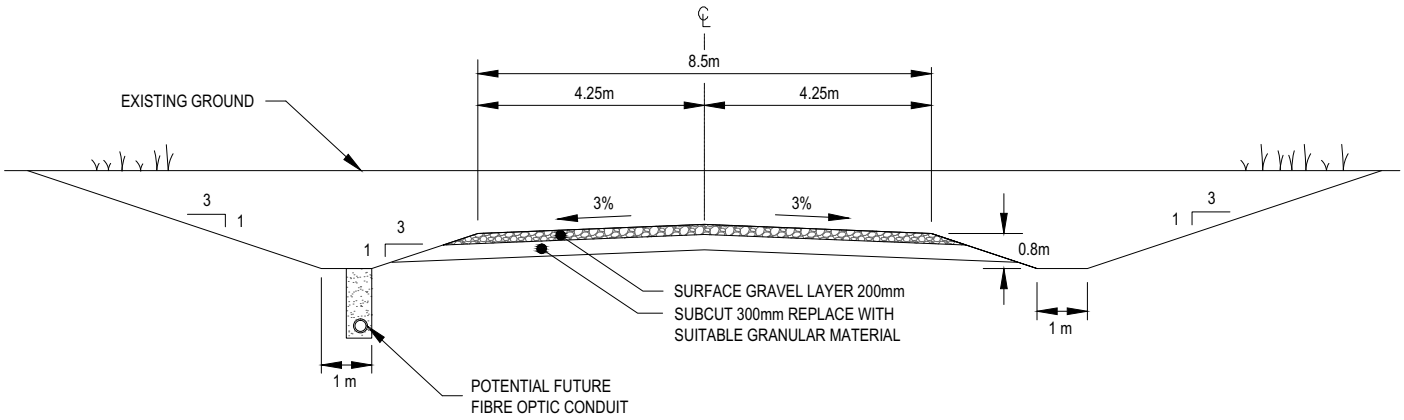
Mackenzie Highway – Tulita District	
Design Criteria	**Typical**
Desired Road Design Speed	90 km/hr
Posted Speed Limit (existing bridges may require a posted speed reduction to 50 km/hr)	80 km/hr
Horizontal Alignment	
Desired Curve Radius	340 m
Minimum Curve Radius (see notes)	250 m
Desired Sight Distance	n/a
Minimum Sight Distance	n/a
Length of Spiral (Radius 2000 to 360)	50 m
Length of Spiral (Radius 340 to 300)	60 m
Length of Spiral (Radius 290 to 260)	70 m
Length of Spiral (Radius 250)	80 m
Vertical Alignment	
Minimum Passing Sight Distance	n/a
Minimum Stopping Sight Distance	n/a
Minimum Sag K Value	13
Minimum Crest K Value	25
Minimum Lengths of Vertical Curves	80 m
Desired Maximum Grade	6%
Maximum Grade	8%
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 %
Side Slopes - All Sections	3:1
Ditch Bottom widths	1 m
Ditch depths from Shoulder Elevation	1 m
Embankment Height (except in cut or on bedrock)	
Dry (ice poor) Till and Outwash Deposits	1.4 m
Wet (ice medium to ice rich) Till and Outwash Deposits	1.4 m to 1.6 m
Wet Silts and Clays (ice rich)	1.6 m to 1.8 m
Thick Organic Peatlands and Ice Rich Permafrost	1.8 m
Thickness of Base Course Gravel	200 mm

Typical cross section for the Highway is illustrated on Figure E-6 and Figure E-7.



TYPICAL HIGHWAY CROSS SECTION

ROCK CUT SECTION



TYPICAL HIGHWAY CROSS SECTION

EARTH CUT SECTION

LEGEND

NOTES:
POTENTIAL FUTURE FIBRE OPTIC CONDUIT IS SHOWN FOR ILLUSTRATIVE PURPOSES ONLY. FIBRE OPTIC CABLE IS NOT PART OF THE MACKENZIE VALLEY HIGHWAY PROJECT.

MACKENZIE VALLEY HIGHWAY
TULITA DISTRICT

TYPICAL HIGHWAY
CROSS SECTION - CUT

PROJECTION	DATUM

Scale 1:150

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FILE NO.
Y22101155 Typical Section.dwg

PROJECT NO.	DWN	CKD	APVD	REV
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Figure E-6

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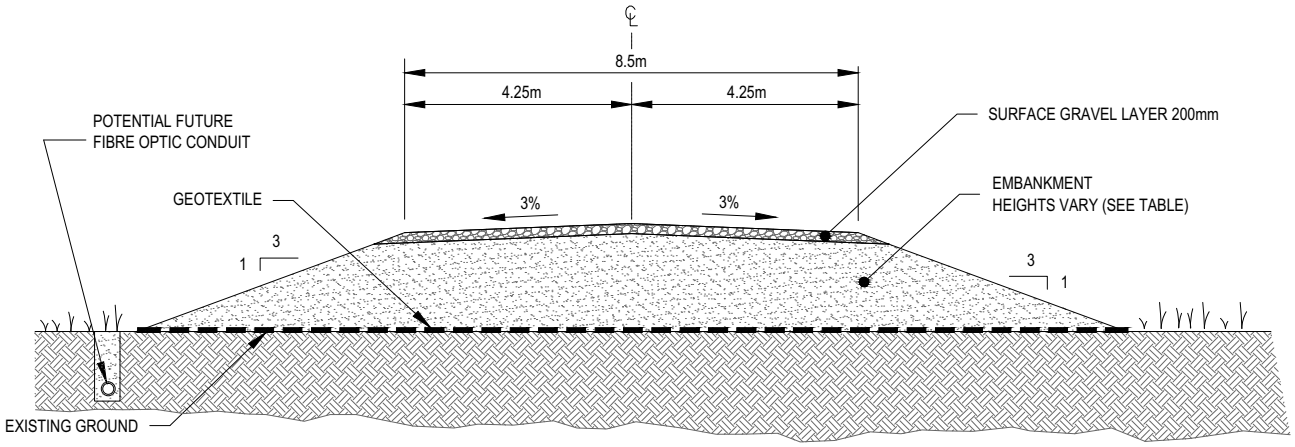

TYPICAL HIGHWAY CROSS SECTION
FILL SECTION

TERRAIN TYPE	DESCRIPTION	EMBANKMENT HEIGHTS
1	DRY (ICE POOR) TILL AND OUTWASH DEPOSITS	1.4 m
2	WET (ICE-MEDIUM TO ICE-RICH) TILL AND OUTWASH DEPOSITS	1.4 to 1.6 m
3	WET SILTS AND CLAYS (ICE-RICH)	1.6 to 1.8 m
4	THICK ORGANIC PEATLANDS AND ICE-RICH PERMAFROST	1.8 m

LEGEND

NOTES:
POTENTIAL FUTURE FIBRE OPTIC CONDUIT IS SHOWN FOR ILLUSTRATIVE PURPOSES ONLY. FIBRE OPTIC CABLE IS NOT PART OF THE MACKENZIE VALLEY HIGHWAY PROJECT.

MACKENZIE VALLEY HIGHWAY
TULITA DISTRICT

TYPICAL HIGHWAY
CROSS SECTION - FILL

PROJECTION	DATUM

Scale 1:150
1 0 1 3m

FILE NO.
Y22101155 Typical Section.dwg

PROJECT NO.	DWN	CKD	APVD	REV
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DATE: October 14, 2011

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Figure E-7

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There are many permanent bridge structures along the existing winter road that will be used in the new Highway. In some locations, new bridge crossing will be required. The table below provides a summary of the Bridge Structures along the Highway.

Table E-7: Summary of Bridge Structures

Bridge Name	No. of Spans	Preferred Alignment Km	Status
Steep Creek	1	816.5	Remain in use in present location, 64 m
Devil's Canyon	1	828.0	New longer bridge structure in current location (raise 3.5 m), 40 m
Saline River	2	831.8	Remain in use in present location, 128 m
Seagrams Creek	1	844.0	New longer bridge structure in new location, 25 m
Little Smith Creek	1	852.4	Remain in use in present location, 78 m
Big Smith Creek	1	872.0	Remain in use in present location, 67 m
"New Bridge"	1	881.0	New bridge in new location along preferred alignment, 35 m
"New Bridge"	2	890.0	New bridge in new location along preferred alignment, 70 m + 40 m
Gotcha Creek	1	912.0	New longer bridge structure in current location (raise 3 m), 40 m
Twelve Mile Creek	1	922.0	New bridge in new location along preferred alignment, 20 m
Four Mile Creek	2	931.0	New longer bridge structure in new location, 100 m + 40 m
No Name Creek	1	n/a	Not in use in preferred alignment.
Great Bear River Bridge	5	937.0	New bridge along preferred alignment, 460 m (2 lanes)
Jungle Ridge Creek	1	967.7	Remain in use in present location,19.6 m
Notta Creek	1	971.4	Remain in use in present location, 25.6 m
Vermillion Creek North	1	973.4	Remain in use in present location, 42.3 m
Prohibition Creek	1	983.0	New longer bridge structure in new location, 100 m
Christina Creek	1	990.3	Remain in use in present location, 19.6 m
Hellava Creek	1	991.3	Remain in use in present location, 19.6 m
Francis Creek	1	993.5	Remain in use in present location, 25.6 m
Canyon Creek	1	997.5	Remain in use in present location, 42 m
Bosworth Creek	1	1019.8	New bridge in new location along preferred alignment, 60 m
Billy Creek	1	1030.8	Remain in use in present location, 25.6 m
"New Bridge"	1	1031.6	New bridge in new location along preferred alignment, 60 m
Oscar Creek	1	1050.8	Use existing bridge that is not currently in service on the winter road, 67.6 m
Elliot Creek	1	1072.4	Remain in use in present location, 25.6 m

Highway alignment options in the vicinity of Tulita consider terrain and topography, the proximity to the Hamlet of Tulita and a suitable location to cross the Great Bear River. Alignment options and river crossing locations were considered in detail in the design and regulatory submission for the Great Bear River Bridge in 2006 (EBA 2006). In preliminary design for the Highway, the available information was reviewed, and the specification locations for the Great Bear River crossing were revisited during the September 2010 field program.

The location for the Great Bear River Bridge presented in 2006 is considered the most efficient and suitable location and is the alignment option included in the preferred alignment for the Highway (Figure 6-7). The two most important reasons that this location is selected are:

- It is downstream from the community's water intake, ensuring the security of the community's water supply if a vehicle collision or spill were to occur.
- The location requires a short bridge and short length of Highway, minimizing the foot print and reducing the impact on the land. The location also has better access for construction (i.e., near the barge landing and located nearer to the community to support construction), and the length of bridge and highway is shorter, making the incremental construction cost approximately $10 million less (EBA 2006). The location of the Highway along the north side of the airstrip takes into consideration the observed ground conditions as well as providing sufficient room for future expansion of the airstrip and the Highway. These items will be confirmed in the detailed design stage.

The location of the Bear River Bridge generates some concern among the residents of Tulita, and the topic was raised during community meetings. It was felt that the bridge location, and the section of highway leading to it from the south side of the Great Bear River was too close to the community, and suggestions were made to move the bridge further upstream. The locations of both the Bridge and the Highway can be re-examined during geotechnical and other in-depth studies during the next phase of the project.

In addition to the major bridge structures, there will be requirements for culverts at many smaller stream crossings. Thirty-five stream crossings have been identified through the field observations and the preliminary designs. Detailed hydrology and drainage studies to support culvert design and sizing will be done during later detailed design stages in the development of the project. At that time, decisions will also be made as to whether some of these minor crossings would be better served with a small bridge structure (10 m to 15 m span).

E8.6 Material Resources

The Highway requires an estimated 285 km of new highway construction. There is a scarcity of materials for road embankment construction along some sections of the Highway which will result in a road that is more expensive to construct in those sections due to longer haul distances.

The work done to date on material sources represents only preliminary information. Future work should include drilling of boreholes, analysis of samples and possibly application of ground penetrating radar to determine the quality and volume of these potential source areas.

The sources would be developed during the winter months when the ground is frozen and temporary winter access roads and work pads would be used.

The preliminary quantity estimates for embankment or fill material and surfacing material are:

- embankment or fill volume: 8.85 million m^3;
- cut volume1.56 million m^3; and
- surfacing gravel: 522,000 m^3.

These quantities are presented as compacted material in place, and do not account for "bulking" or swell of material as it is removed from the material source and hauled to placement in the Highway. As well, relatively minor amounts of additional fill material will be required at bridge sites, maintenance facilities, staging areas, and other locations. Preferred material sources are shown on Figure E-3 along the preferred highway alignment.

E8.7 Land Access and Tenure

In the Tulita District, the Highway crosses over Crown Land, Commissioner's Land and Sahtu Settlement Land. The goal is to have the surface right for the 60 m wide Highway right-of-way under the authority of the DOT.). Tenure to Crown land transfers to the GNWT when the Highway is completed. For Commissioner's Land, DOT, as part of the GNWT, advises the Department of Municipal and Community Affairs as to which parcels of Commissioner's lands are needed for the Highway. MACA, through a Registration by Notation, registers this use of the Commissioner's Land on the Land Registry.

Access and tenure to Sahtu Settlement land in the Tulita District will be negotiated by DOT with the Tulita District Land Corporation, under the terms of the *SDMCLCA*, Schedule XVII.

E8.8 Construction Aspects

E8.8.1 Deployment and Staging

The Highway segment in the Tulita District is accessible by the existing winter road and in summer by community barge landing facilities situated at Norman Wells and Tulita. Construction of the Highway in the Tulita District is therefore not reliant on construction of other segments of the overall Mackenzie Valley Highway.

Staging locations will be situated at the selected material sources along the Highway. Activities at these locations include:

- housing of workers;
- storage and maintenance of equipment;
- storage of fuel; and
- receipt of supplies, equipment, and materials by winter road.

Temporary facilities at these locations include:

- camp and maintenance buildings;
- equipment and material storage areas;
- fuel storage facilities;
- staging area;
- helicopter landing area;

- access road from shore; and
- waste c7ontainment facilities.

The specific location of these will be determined during the detailed design and construction planning phase.

E8.8.2 Winter Construction

Construction in winter is necessary when using heavy equipment for building the embankment or accessing areas within the right-of-way before the Highway is constructed. The advantages of winter construction are as follows:

- allows the use of temporary winter road access to granular material sources without the need to construct costly all-weather access roads.
- allows the placement of construction material directly onto frozen ground. This approach enables the establishment of a frozen core for the Highway and helps protect sensitive and ice rich terrain.
- minimizes potential effects on vegetation and soils adjacent to the actual roadway that might occur if working under snow-free or wet conditions.
- promotes initial stability of the Highway through the placement of frozen material directly onto frozen ground (with geotextile separation layer). In the first construction year, it is anticipated that the majority of construction settlements will occur in the top layers of the constructed embankment as it thaws, dries, and consolidates. The lower layers are not expected to thaw much, if at all, in the first years, leading to greater stability than has been the case with the placement of warm fill on thawed ground in summer construction. This will reduce maintenance problems in the future.

Winter construction does have disadvantages, including:

- work is difficult in the extremely cold temperatures common at the beginning of the construction season in late December and early January. This is challenging for both personnel and equipment;
- work could be delayed due to winter storms;
- construction operations are conducted in periods of minimal daylight;
- excavation of frozen material in material sources will likely require the use of drill and blast methods to be able to source the required volumes of material for construction; and
- excavation and placement of frozen material directly on top of geotextile placed on the natural ground makes it more difficult to achieve compaction of the embankment layers.

Some construction work can take place during the spring, summer, and fall of any given year provided that access over land to the particular area is not required, or that access can be achieved over an already completed portion of the Highway. The timing of construction activities will respect the sensitive nature of the management areas and conservation zones and will follow permit conditions.

E8.8.3 Waste Management, Water Use and Fuel Handling

The waste generated during construction will include sanitary waste, grey water, kitchen and paper waste, hazardous waste (i.e., batteries), recyclable metals, used oil from equipment, and other. Temporary maintenance shop facilities at construction camps will have incinerators in which used oil can be burned to produce heat for shop and camp facilities. Camps will have on-site treatment plants to process wastewater that can then be used to supplement the water use for the project. Kitchen waste, cardboard, and paper will be incinerated onsite and recyclable metals and hazardous wastes will be hauled to commercial waste disposal sites, likely in the south.

Overall daily water use for winter road construction is expected to range from 500 m^3/day to more than 1,000 m^3/day. An estimated 500 m^3/day of water will also be required during the later summer and fall months in support of compaction of the road base course and surfacing material. Camp operations will require approximately 200 L/person/day. A 150-person camp would, therefore, require approximately 30,000 L or 30 m^3/day.

The estimated fuel requirements for construction of the Highway are in the order of 40 million to 45 million litres. Fuel storage requirements at an individual camp facility will be determined when detailed design and construction planning steps are undertaken at later stages of the project. Fuel will be delivered in the winter from regional storage hubs to fuel tanks situated along the Highway in the staging and storage areas, in the material sources, and in the camps.

E8.8.4 Health, Safety, and Environment (HSE)

Completing the construction of the Highway in a safe manner to protect health of the project workers and to protect the environment will be paramount during the construction operations. The components of the Health, Safety, and Environment (HSE) requirements include:

- First Aid training and materials;
- spill prevention; and
- erosion control.

The personnel and facilities for the Highway construction will include the following First Aid services:

- personnel trained and qualified in Advanced First Aid;
- personnel trained and qualified as Emergency Medical Technician Paramedics;
- a mobile treatment centre; and
- an adequately-supplied First Aid room at each camp facility.

Spill prevention requirements are discussed in Section 11 of this PDR and include:

- double-walled fuel storage tanks;
- minor size spill kits on each vehicle;
- major size spill kits at fuel storage areas;

- major size spill kits at re-fuelling areas that can address spills on land and in water;
- adequate training of personnel involved with fuel handling; and
- a spill response trailer for the work area.

E9.0 ARCHAEOLOGY, TRADITIONAL KNOWLEDGE AND LAND USES

E9.1 Archaeology

The Tulita District has been occupied for several centuries by the Sahtu Dene. Traditionally, the Sahtu Dene occupied an area including Great Bear Lake and its borderlands, the Mackenzie Valley lowlands between Blackwater River and Travaillant River, large portions of the Anderson Plain north of the Mackenzie River and west of Great Bear Lake, and the Mackenzie Mountains and foothills, well into the Yukon Territory. The Sahtu Metis are descended from the intermarriage between Sahtu Dene and Euro-Canadians who began to move into the region with the fur trade in the early nineteenth century (SHPSJWG 2000).

The Great Bear River was occupied by Athapaskan speakers called Slave or Slavey at the time of contact, while north of the Great Bear River was the group known as Hare Indians (Asch 1981; Savishinsky and Hara 1981). Both groups were small and semi-nomadic and differentiated each other by geographic locations or some variation in behavior or cultural feature.

The limited availability of food resources required travelling to different parts of their range with changes in seasons via a network of well used interconnecting trails to take advantage of all available animals and plants. The Hare Indians were so called by the early explorers because of their heavy dependence on the snowshoe hare (Savishinsky and Hara 1981). 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 (Asch 1981).

Critical subsistence resources for Sahtu Dene and Metis included moose, woodland caribou, Dall sheep, beaver, marten, muskrats, waterfowl and other birds, fish, hare, and other small game. Caribou still are of prime importance and are a critical food source (SHPSJWG 2000).

Archaeological investigations have looked for evidence of timing and travel routes for the first people entering North America. The Mackenzie Valley was considered 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. Most of the prehistoric sites recorded in the Mackenzie Valley thus far appear to date to Late Prehistoric times (Pilon 1988).

The fur trade in the Mackenzie Valley began shortly after Alexander Mackenzie's river voyage in 1789. The first fur trade post in the Tulita area was reportedly Fort "Normand" (also referred to as Fort Norman I), built by the Northwest Company around 1809. In 1851, the Hudson's Bay Company built Fort Norman on the current site of Tulita (Usher 1971) and has operated continuously to the present time. In the 1850s, missionaries from both the Anglican and Catholic churches arrived in the Mackenzie District. Steamboats began to travel up and down the Mackenzie River in 1887. The RCMP arrived in the Mackenzie region in

1903 (Robinson and Robinson 1946) and established a post at Fort McPherson, and in Fort Norman in 1916.

Oil and gas exploration began in the vicinity of Norman Wells in the early 1900s. The first producing oil well was drilled in 1920 and a small refinery was built. During World War II, oil production at Norman Wells was considered to be strategic to war efforts and the CANOL pipeline from Norman Wells to Whitehorse was completed in late 1944. It operated only until the end of the war.

The 1930s saw the development of a winter road in the Mackenzie Valley to bring in construction supplies from Edmonton. This road was only built as needed in the next few decades and since the 1970s, it has been built and used annually.

E9.1.1 Previous Archaeological Studies

Archaeological investigations in the Mackenzie Valley began in the early 1950s (e.g., MacNeish 1953) as part of a search for the routes used by early colonizers of North America. 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).

In 1973, the first of a number of archaeological studies of potential pipeline corridors in the Mackenzie Valley was completed (Losey 1973) and was largely confined to a narrow band along the east bank with some examination short distances up major rivers at several localities between Fort Simpson and Fort Good Hope. The one area intensively examined within the current study area was the vicinity of Tulita and the first few miles upstream along the Great Bear River. Two prehistoric sites were discovered on the Mackenzie bank just below Tulita while one site was discovered on a ridge on the west side of the Great Bear River approximately 2.5 km upstream.

Two later archaeological investigations were completed relative to the overall Mackenzie Valley Highway. In 1999, archaeological studies were conducted of proposed upgrades to "the existing winter road" that comprised 17 proposed bridges and 12 potential culvert locations (Ronaghan 2000). No new archaeological sites were found. Seven of these bridges that fall within the current study area have since been built. In 2006, a study of a proposed bridge over the Great Bear River was completed (MacKay 2006). Four archeological sites were recorded.

Most archaeological investigations since the mid-1980s have been related to Mackenzie Valley oil and gas pipeline proposals. Over 150 archaeological sites have been recorded within or immediately adjacent to the Tulita District. Most of these sites have been recorded along the Mackenzie River at the mouths of creeks and rivers or short distances upstream from those confluences. Fifty-three of these sites are within approximately 1 km of the Highway and potential material sources. The known sites were primarily recorded during the surveys for the MGP in 2002 to 2006, as well as studies related to the original road and bridge assessments conducted in 1973, 1999, and 2006.

E9.2 Traditional Knowledge and Land Use

In July 2010, March 2011, and October 2011 consultations and discussions for this project were held with community residents in Norman Wells and Tulita, regulatory agencies, and community organizations. Traditional knowledge was incorporated from the third draft of the *SLUP*, issued by the SLUPB in August

2010, Rakekee Gok'e Godi: *Places We Take Care Of* (SHPSJWG 2000), *Spirit of the Mountains: Shuhtagot'ine Nene* and *Naats'ihch'oh Traditional Knowledge Study* (SENES 2009), and *Traditional Knowledge Study Report: Great Bear River Bridge* (EBA 2006). Although the Highway and the proposed MGP are completely separate projects but are intended to be developed in a common transportation corridor, the information contained in the MGP EIS (IOL et al. 2004) is applicable to the development of the PDR for the Highway.

Traditional knowledge, along with the information on current and historical land uses, is important information to review for a linear development that will pass across undeveloped land. The traditional knowledge, particularly regarding traditional land use such as trails, harvest areas, and cabin locations, was reviewed and incorporated as part of the Highway preliminary design so that potentially affected cultural sites and important natural areas can be protected when the Highway is constructed and operated (Figure E-8).

E9.2.1 Traditional Knowledge Gathered During Community Consultations

All of the comments and questions recorded at the community consultations for the Highway are provided in detail in the PDR. Some of the comments recorded at the consultation meetings make reference to the importance of the land and cultural values of the areas. Examples are presented below.

Selected comments from Norman Wells:

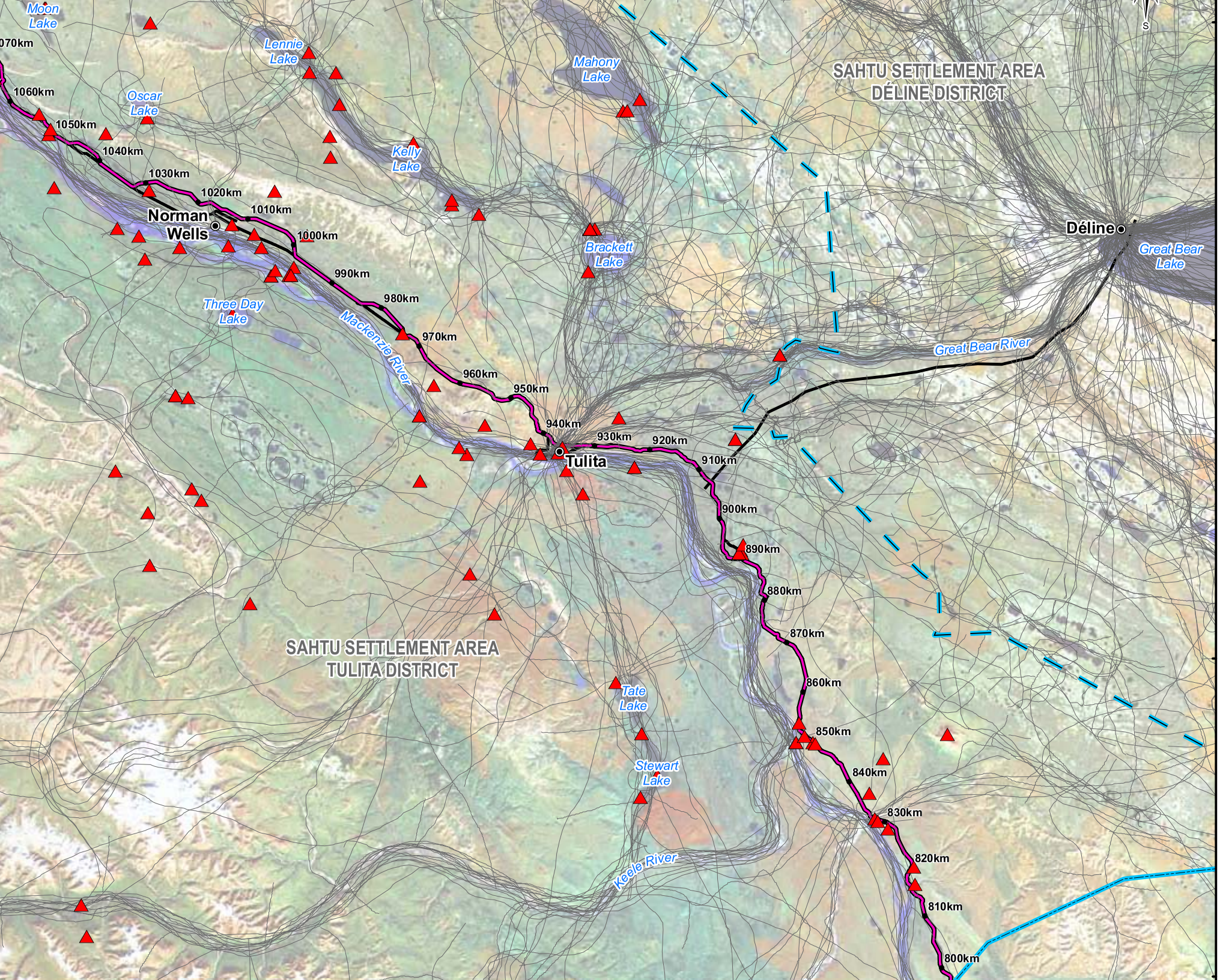
- *"The worst place to navigate along the road is a slide area by the water; it was recommended that the route go along the ridge."*
- *"Some of the permanent bridges were supposed to lengthen the winter road, but did not plan appropriately for freshet and as a result, some bridges are surrounded by water during freshet. New bridges may be needed."*
- *"The Winter Road is currently located on high ground and is a good starting pointfor a proposed route."*
- *"Not too many wildlife around the winter road, but some beaver dams and caribou."*
- *"The winter road provides easy access for hunting (which is good and bad)."*

Selected comments from Tulita:

- *"The close location of Great Bear Bridge to town has come up several times with Elders, it is a concern."*
- *"Is the Project Team considering land tenure and land rights?"*
- *"A comment we had in July 2010 session was looking at the sacred areas around Peel River."*
- *"There is a cabin close to the road around Jasper Lake, does Highway accommodate this?"*

E9.2.2 Traditional Knowledge near the Proposed Great Bear River Bridge

A traditional knowledge study was conducted by EBA Engineering Consultants Ltd. on behalf of DOT for the proposed Great Bear River Bridge near Tulita in 2006. The Great Bear River Bridge will form part of the Highway.


Moon Lake
070km
Lennie Lake
Mahony Lake
SAHTU SETTLEMENT AREA
DÉLINE DISTRICT
1060km
Oscar Lake
1050km
1040km
Kelly Lake
1030km
1020km
1010km
Norman Wells
1000km
Brackett Lake
Déline
Great Bear Lake
990km
980km
Three Day Lake
Mackenzie River
970km
Great Bear River
960km
950km
940km
930km
920km
Tulita
910km
900km
890km
880km
870km
SAHTU SETTLEMENT AREA
TULITA DISTRICT
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Stewart Lake
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Table E-8 provides a summary of the traditional knowledge collected during interviews. Additional information is presented in the PDR.

Table E-8 Summary of Interview Results for the Great Bear River Bridge

Category	Comments
Terrain	No major concerns were discussed around immediate cautions to crew and equipment working at the project site. No knowledge of earthquakes, landslides, etc. was presented. A number of community residents noted that the East approach to the proposed bridge location is known to be very muddy, because of water flow and clay/dirt-like terrain.
Climate	Bridge will be great [because] with the climate getting warmer each winter, resulting in shortened ice seasons, safety becomes a big concern for travellers.
Vegetation	A blueberry picking area is located on the West side of the proposed bridge.
Water	Concerned about the pressure that the ice will put on the piers. Concerns around ice breaking capabilities of the piers.
Wildlife	Moose habitat is located directly on the West side of the bridge.
Significant Sites	Grayling are commonly present in the Great Bear River.
Traditional Use	Many participants spoke of playing in and around the project site as children. There are several fish netting areas identified around the project site.

E9.2.3 Traditional Knowledge, Land Use and the Highway

The available traditional knowledge and local knowledge demonstrated at the community consultation meetings has influenced the preliminary design of the Highway and the general approach to the project as a whole. As the project progresses through the regulatory process, further consultation with the communities in the Tulita District will be undertaken.

Traditional land use sites have been found in close proximity to the Highway. The current location of the Highway is preliminary, and will be finalized during the detailed design which will help identify any potential effects on traditional land use sites with more certainty. Mitigation measures to minimize potential effects on traditional land use sites are presented in the PDR. In general, these sites have been avoided in the preliminary design.

E9.2.4 Land Use

E9.2.4.1 Land Use Identified in the Sahtu Land Use Plan (SLUP)

According to the *SLUP* (SLUPB 2010), the types of zoning that apply to the land along the Highway are:

- General Use Zones – allows all land use except bulk water removal.
- Special Management Zones – allows all types of land use other than bulk water removal, subject to the general use and special management conditions outlined in the *SLUP* to protect cultural and ecological values present in those zones.

- Conservation Zones – are significant traditional, cultural, heritage and ecological areas in which specified land uses are prohibited. Permitted land uses are subject to the general use of special management conditions outlined in the *SLUP*.
- Proposed Conservation Initiative – are areas for which formal legislated protection is proposed for conservation using formal legislated protection through the Protected Areas Strategy, or under the *Canada National Parks Act* or *Historical Sites and Monuments Act.* These areas have the same status as conservation zones under the *SLUP* until they are protected under other legislation.
- Transportation corridors and infrastructure development are suited to General Use and Special Management Zones, but are typically not compatible with the intent of Conservation Zones or Proposed Conservation Initiatives. The Highway is located within the Bear Rock Conservation Zone. Development within Conservation Zones and Proposed Conservation Initiatives may be allowed on a restricted basis, in accordance with Conformity Requirement #1.

Caution is needed with all land uses to reduce environmental effects by re-using existing disturbed areas and concentrating land use in existing corridors (SLUPB 2010).

E9.2.4.2 Non-traditional Land Use

The land in the Tulita District has been and is currently used for a number of purposes, including:

- Winter Access Trails – Snowmobiles are used for hunting, trapping, recreation and other activities including in the vicinity of the Highway.
- Oil and Gas Exploration and Production Activities – Oil has been produced at Norman Wells since the 1920s and since 1985 the Norman Wells pipeline has transported oil to southern Canada. There has been some exploration activity around Tulita, Norman Wells and at sites across the Mackenzie River.
- Material Sources – Several material sources have been identified as potential for construction of the Highway.
- Timber Resources – No major timber harvesting operations currently occur within the study area. Residents harvest wood along the winter road throughout the SSA for use as fuel.
- Mineral Resources – The Highway traverses in the vicinity of small mineral claims and coal exploration licenses, although the SLUPB rated them as having low potential;
- Communications Towers – Several towers are located along the Mackenzie River.
- Winter Road – The winter road extends from Wrigley to Fort Good Hope, and is typically open from December until March, depending on weather conditions.
- Barge Landing Sites – Barging typically occurs from mid-June to late September. There are community barge landing sites along the Mackenzie River at Tulita, Norman Wells, Fort Good Hope and an occasionally used site at Little Chicago.

- Tourism and Recreation – Residents use the Mackenzie and Great Bear Rivers to travel between communities in summer. Tourism activities include jet-boat tours on the Mackenzie River and its tributaries; the winter road and the Enbridge pipeline rights-of-way are used for recreation during all seasons.

Proposed future land use includes:

- MGP – A proposed natural gas pipeline to move gas from the Mackenzie Delta to southern markets. The project has regulatory approval, but a decision to construct is not expected until late 2013.
- Great Bear River Bridge – This will be the largest bridge of the Mackenzie Valley Winter Road Bridge Program. The residents of Tulita have long been concerned about the safety of the current winter road route across the Mackenzie River around the Great Bear River.
- Oil and Gas Exploration – New oil and gas exploration leases were awarded by AANDC in June, 2011, indicating that exploration will continue into the future. The all-weather Highway is expected to encourage exploration by significantly decreasing logistical costs.

E9.3 Natural Resources Harvesting

E9.3.1 Wildlife

Traditionally, wildlife has been harvested for subsistence, survival materials and for trade. Tradition based hunting for subsistence and trapping continues today. Animals harvested include barren ground and woodland caribou, moose, black and grizzly bears, furbearers such as beaver, muskrat, marten, snowshoe hare, red squirrel, red fox, wolf, wolverine, lynx, and porcupine, waterfowl and game birds including three species of grouse, one species of ptarmigan, thirteen species of ducks, and four species of geese.

The Sahtu Settlement Harvest Study, conducted by the SRRB (SRRB 2005) between 1998 and 2005, summarizes the annual harvest information for animals, fish and birds, by the Sahtu Dene and Metis Hunters. Harvest data is from this study can be found in Section 8 of this PDR.

E9.3.2 Berries

Berry harvesting is an important traditional harvesting activity in this region. Several species of berry-producing plants, such as bearberry, cranberry, blueberry, cloudberry, crowberry, raspberry, and black and red currant are found in the Tulita district.

The *SLUP* (SLUPB 2010) identifies the following Management Zones as important for berry picking:

- Mackenzie River (Deh Cho) Special Management Zone;
- Kelly and Lennie Lake Conservation Zone; and
- Kelly Lake Protected Area Conservation Zone.

E10.0 COMMUNITIES AND DEMOGRAPHICS

The socio-economic area for the Highway consists of those communities that are more likely to experience effects due to their proximity to the Highway, as well as their possible contributions to the Highway workforce. On this basis, the only two communities in the Tulita District, Norman Wells and Tulita, are in the closest proximity to the Highway and are therefore likely to experience the greatest impacts. Both Norman Wells and Tulita have a mixed population of Dene, Metis and non-aboriginals in varying number. Both communities have young populations, with a high percentage of residents aged 44 or younger. Employment rates have fluctuated, depending on locally available economic activity but since 1986, the general trend indicates an increase in employment and subsequent unemployment over time. Both communities have winter road access, and both are accessible by air. Norman Wells, as the largest community in Sahtu, has daily jet service from Yellowknife and Inuvik, while Tulita has daily air service from Norman Wells. Both are accessible by boat in summer and receive freight by barge in the summer.

As of 2010, the population of Norman Wells was 816, of which 38.6% was Aboriginal. Sixty-eight percent of the population was aged 44 or younger. In 2009, the employment rate in Norman Wells was 84.7% while the unemployment rate was 5.3%. The Town of Norman Wells is a commercial and service hub in the Tulita District and the SSA with more than twenty types of services offered by local businesses.

In Tulita, the population was 564 in 2010, of which approximately 89.9% was Aboriginal. Seventy-one percent of the population was aged 44 or younger. Of the 217 Tulita residents in the labour force, 52.9% were employed and 21.2% were unemployed.

E11.0 ENVIRONMENTAL OVERVIEW

E11.1 Climate

The general climate of the Central Mackenzie Valley is sub-arctic, characterized by long, cold winters, short, mild summers and extreme annual temperature variations. The Mackenzie Valley itself has a somewhat milder climate than adjacent areas to the east and west, while cooler temperatures remain longer over the more mountainous areas (Kokelj 2001). The average annual temperature is below zero with a very short frost-free season and insufficient summer warmth to melt prevalent permafrost areas. Snow and ice cover typically occur between October and May. Annual precipitation is usually low but sufficient for tree growth, and occurs more frequently in the warmer summer months than during the winter. A large portion of the annual precipitation is stored for several months in the form of snow and therefore snowmelt runoff in spring is a dominant feature of regional stream hydrographs.

E11.2 Terrain

Excluding Norman Wells, which has had producing oil wells for several decades, the Sahtu is largely undeveloped and has had little in the way of any industrial activity. There has been some oil and gas exploration near all Sahtu communities over the past 40 years, but most of the region is undisturbed.

The Highway crosses two distinct physiographic regions in the Tulita District, but predominantly lies within the Mackenzie Plain physiographic region and crosses the Franklin Mountains physiographic region.

The Mackenzie Plain encompasses both sides of the Mackenzie River. The Plain on the east side of the river is narrow relative to its counterpart west of the river. The eastern margin of the Plain is intersected by the Bear Rock massif northwest of Tulita on the north side of the Great Bear River.

The Franklin Mountains parallel the east side of the Mackenzie Plain. The Norman range represents the Franklin Mountains unit in the northern sector of the area. It begins west of Tulita with the prominent Bear Rock massif and continues in a northwesterly direction. The Franklin Mountains are composed of Middle Devonian unnamed and undivided carbonate strata with minor shale and anhydrite inclusions, as well as Ordovician and Silurian dolomite, anhydrite and shale. In general, the Franklin Mountains consist of rocks which are competent and represent a good source of construction materials.

The surficial deposits along the Highway are glacial and post-glacial in age. Surficial geology mapping for the Tulita District prepared by the Geological Survey of Canada (Duk-Rodkin 2002; Duk-Rodkin and Couch 2004), provides an overview of the terrain conditions along the Highway, which vary from relatively dry glacial till to wet, ice-rich glaciolacustrine and thick organic deposits.

The Highway crosses many seasonal watercourses, wet lowlands, peatlands and thermokarst lakes, which are remnants of glacial outwash channels. Organic deposits can overlie any of the various terrain types, but as a general rule are thin over relatively dry till deposits and thick over wet glaciolacustrine deposits.

North of Tulita, the Highway is within the Taiga Plains Ecozone. South of Tulita, the Highway lies within the Taiga Cordillera Ecozone. The Taiga Plains Ecozone is dominated by Canada's largest river, the Mackenzie, and its tributaries, and is characterized by distinctive regional ecological factors including climate, physiography, vegetation, soils, water, fauna and land use. The Mackenzie Valley forms one of North America's most travelled migratory corridors for waterfowl (duck, geese and swans) that breed along the Arctic Coast. Peatlands in the Taiga Plains Ecozone are extensive; the Mackenzie Valley is one of the major peatland areas of Canada (Robinson 2002).

Climate is highly variable throughout the Taiga Plains and is divided into four main climatic-physiographic divisions (Level III ecoregions) which are defined by vegetation and permafrost. The Highway lies within the Central Great Bear Plains Low Subarctic (LS) Ecoregion (Level III) which occupies the middle third of the Taiga Plains.

E11.3 Vegetation

As a result of recent fires, large areas are covered by dwarf birch (*Betula nana*), green alder (*Alnus viridis*) and Alaska paper birch (*Betula neoalaskana*), or regenerating mixed black and white spruce (*Picea glauca*) forests. Regenerating white and black spruce-Alaska paper birch–dwarf birch communities are dominant throughout this Ecoregion with Alaska paper birch being the most common deciduous species. Closed to open mixed spruce-shrub-moss-lichen stands are common in unburned areas. The northern limits of trembling aspen and mixed aspen-white spruce forests and jack pine forests are located at the Tulita gap. Peat plateaus are also scattered throughout the Ecoregion; however, they are found mainly in the north (Ecosystem Classification Group 2007).

During the September 2010 field program, seven broad vegetation communities were identified along the Highway:

- open black spruce;
- riparian shrub;
- upland mixed forest;
- upland tall spruce;
- regenerating forest;
- graminoid fen; and
- emergent.

Vegetation surveys done for MGP documented 19 species considered as rare plants in the Taiga Plains area and another 13 were found in graminoid or patterned fens along the pipeline route. These locations have been considered in the preliminary design for the Highway.

E11.4 Wildlife and Fish

A total of 31 species of mammals, 118 species of birds and two species of amphibians occur, or have the potential to occur, along the Highway (Cornell 2010; COSEWIC 2010; ENR 2010a; Government of Canada 2010; Banfield 1977; ENR 2005; National Geographic 2006; Wilson and Ruff 1999). Eight species are designated as having special conservation status. For the purposes of this PDR, special conservation status includes those species listed under the *Species at Risk Act* (*SARA*), and/or assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) to be endangered, threatened, or of special concern, and/or ranked by the Government of the Northwest Territories (GNWT).

The Highway will cross numerous ephemeral and permanent streams, and pass near many lakes along its route through the Tulita District. It is therefore important to identify the fish and fish habitat resources in these waterbodies so as to develop suitable avoidance and mitigation strategies designed to protect fish populations. Previous fish and fish habitat surveys have been conducted in streams along the Highway, which closely follows the route proposed for the MGP.

As the Highway alignment is close to that of the MGP, ecoregion data will be quite similar. Where the Highway alignment deviates from the MGP alignment there is no data available from prior studies, so site-specific vegetation surveys and assessments in the areas that have not previously been studied, must be completed before any disturbance takes place.

E11.5 Anticipated Effects and Mitigation

The Proponent is committed to constructing the Highway, material sources, and associated winter access roads in an environmentally responsible manner, based on a comprehensive environmental management framework as described in this PDR.

The existing framework for environmental management of Highway construction consists of:

- regulatory and other management instruments that define environmental terms and conditions;
- traditional knowledge, the *SLUP*, and information gathered from community consultations;
- hiring experienced local construction contractors;
- avoidance and protection of sensitive terrain and habitats;
- avoidance of identified heritage and traditional values and archeological sites; and
- hiring environmental and wildlife monitors with experience on the land and local knowledge.

Contractors hired for Highway construction will be required to comply with the following management plans:

- contractor health, safety and environment manuals including general spill contingency and emergency response plans;
- training for workers in health, safety, fuel handling and environmental procedures;
- contractor work procedure documents;
- site-specific health and safety plans; and
- site-specific spill contingency plans.

The Proponent considers key environmental management components for the Highway to include avoidance and/or protection of:

- sensitive terrain and habitats;
- species of concern;
- identified heritage and traditional values; and
- archaeological sites.

The potential effects of activities on terrain can be related to surface disturbance during construction that can cause damage to soils and permafrost, and that may cause erosion and alteration of landforms. Mitigation strategies to reduce effects on soils and landforms include:

- reducing surface disturbance;
- controlling potential erosion;
- stabilizing slopes, if required; and
- re-vegetation, if possible.

To minimize impacts on the existing terrain of the project area, the footprint of the Highway, the temporary construction camps, and the material sources will be minimized to the extent possible.

E11.5.1 Air Quality and Noise

Dust, air emissions and noise associated with Highway construction are expected to have limited, localized and temporary impacts in the vicinity of the Highway.

Dust is expected from heavy equipment movements, loading and unloading material, crushing, screening, blasting, erosion from stockpiles and other activities. Dust suppression, using water from nearby lakes as permitted under a Northwest Territories Water License and DFO water withdrawal criteria, will follow the GNWT Guideline for Dust Suppression (GNWT 1998). Dust suppressants such as calcium chloride may also have a negative impact on plants. Research is underway to find products other than calcium and magnesium chloride for dust control.

Noise will be associated with heavy equipment and truck movements and blasting during excavations. The use of heavy equipment, truck movements and explosives will be timed and located to avoid periods when wildlife species are in the area or to avoid potential harm to fish in local water bodies.

Contractors will be directed to maintain their equipment in proper working order, including mufflers, to reduce emissions and noise.

E11.5.2 Construction and Operation Effects and Mitigation

The Highway right-of-way will be 60 m and will be maintained cleared for the full width. The average width of the Highway footprint (from one toe of the embankment to the other) will be 20 m to 28 m along the entire 285 km route.

Highway construction will be by excavation and end-dumping of aggregate material. Activities that affect terrain directly include removal of overburden at material sources, excavation of Highway construction material at material sources, Highway construction, and re-contouring of construction sites and associated facilities. Monitors will be on site from the start of construction.

Several indirect effects from construction may occur including the introduction of non-native or invasive plant species, alteration of hydrology conditions and increased erosion or slumping which could also affect plant communities.

Operational activities, including road maintenance and vehicle traffic, have the potential to directly and indirectly impact vegetation.

Material sources have been selected to be as close to the Highway as possible to minimize haul distances and will be operated in accordance with quarry permit requirements and existing environmental standards and guidelines. Material sources will be accessed by temporary winter roads except in the case of those identified for maintenance and operations once the Highway is completed. All material sources will be permanently reclaimed or restored after use in accordance with the applicable reclamation plan.

Dust will be produced from the Highway during operation, and is expected to be local and seasonal. Dust can lead to early snow melt and a corresponding early green up. Dust could also reduce vegetation cover and change plants assemblages. Dust suppressants such as calcium chloride may also have a negative impact on plants. As noted above, products other than calcium and magnesium chloride are being considered for dust control.

Snow removal is necessary during winter operations. The build-up of snow in ditches along the Highway may result in additional vegetation or plant loss, and an increase in forest fires.

Mitigation measures will include:

- minimize project footprint wherever possible to reduce impacts;
- avoiding the locations of rare plants as identified in the MGP studies;
- design and install appropriate drainage culverts to maintain existing water flow conditions;
- monitor and maintain drainage culverts to ensure proper working order and mitigate standing water or ponding;
- remove snow from the roadway and sideslope to specific storage areas during winter maintenance;
- employ geotextile as an underlay, and use sufficient fill depths over the road bed to protect permafrost;
- minimize the number of material sources for the Highway construction and future maintenance requirements;
- reclaim all material sources (including re-contouring and re-vegetation) that are not needed for maintenance requirements; and
- restrict construction traffic to the planned Highway footprint.

E11.5.3 Effects on Communities and Mitigation

The Highway has the potential to have both positive and negative effects on the communities within the Tulita District and also on Deline due to its proximity to Tulita and the likelihood it will contribute to the Highway workforce. Any human activity or development has the potential to generate negative effects. Mitigation measures can be planned and implemented in advance to minimize detrimental effects. Likewise, some of the benefits associated with the Highway can be enhanced with similar foresight and planning.

Some of the positive effects on communities include:

- an anticipated reduction in the cost of living;
- an increase in employment and new business opportunities that are directly and indirectly associated with Highway construction and operations;
- easier access to health care, recreation and education facilities;
- an increase in community, family, cultural and sporting activities in other communities; and
- the delivery of government programs and services more cost-effectively.

Some of the negative effects on communities include:

- an increase in the availability of drugs and alcohol;

- an increase in drug and alcohol abuse and related social issues as a result of an increase in the number of people receiving wages from employment from Highway construction;
- an increase in hunting or in other land use in areas that are easy to access from the Highway and in areas not previously used for hunting which could have a negative effect on wildlife, wildlilfe habitat and traditional and sacred sites.

Concerns about these issues were raised during public community meetings and with community land corporations. One solution proposed during these meetings would be to establish a Transportation Corridor Management Group to manage land access through using monitoring and enforcement, environmental and wildlife monitors and technical planning staff. The Management Group could work with various government agencies and other organizations to monitor traffic and land use along the Highway to try to prevent the increase in drugs and alcohol availability and to prevent land use destructive to wildlife habitat or traditional and sacred sites. Establishment of such a management group could possibly allow some control over access to communities and the land in the Tulita District.

Such a management group, and other mitigations for community issues arising from Highway development, will require a co-operative approach from health and social services personnel, police personnel, community and territorial governments. (See Section 10 and Section 11 for more information.)

E11.5.4 Effects on Wildlife and Mitigation

All habitats adjacent to the Highway support wildlife, including species with special conservation status. The effects of roads on wildlife and wildlife populations are well known; however, negative effects typically increase with road widths, speed limits, and traffic volumes. The Highway is expected to have very low traffic volumes, less than 50 vehicles per day.

E11.5.4.1 Potential Effects on Wildlife and Wildlife Habitat

Potential direct and indirect effects on wildlife from the construction and operation of the Highway include:

- habitat loss and/or alteration;
- reduction in habitat connectivity;
- increase in habitat fragmentation;
- increased habitat disturbance by humans;
- increased hunting pressure from opening areas not previously accessed for hunting, including areas used for denning and nesting; and
- wildlife mortality.

Effects may occur at both the individual and population levels (Jalkotzy et al. 1997). Individual species, particularly grizzly bear, wolverine, and boreal caribou are more sensitive to human disturbances and may avoid roads as a result of repeated disturbances (Jalkotzy et al. 1997). However, Jalkotzy et al. (1997) indicated that avoidance behavior in areas without hunting is either nonexistent or very short term.

The objectives of wildlife management activities will be to mitigate potentially negative effects on wildlife in the following general ways:

- minimize loss or fragmentation of habitat through project design;
- minimize direct mortality due to collisions with vehicles;
- manage waste at construction camps and implement environmental awareness programs;
- reduce the volume, duration, and frequency of noise producing construction activities;
- time construction activities to avoid critical periods for wildlife;
- conformance with pre-determined setback distances from wildlife habitat along the right-of-way; and
- ensure construction crews have wildlife training and awareness, and understand the applicable regulations for fishing, hunting and land access.

DOT's highway operational policies are designed to mitigate potential impacts on wildlife and wildlife habitat. Applying these measures will potentially localize and limit effects on wildlife and wildlife habitat.

E11.5.4.2 Fish

The potential effects of the Highway on aquatic resources, fish and fish habitat, and the development of effective avoidance or mitigation measures are major components of the Highway's environmental assessment.

There are three categories of streams along the Highway alignment:

- non-fish bearing stream: not used by fish during any part if their life cycles;
- migratory channels: ephemeral and perennial streams, used by fish only for migration or that contribute to downstream habitat quality; and
- spawning/rearing/feeding streams: ephemeral and perennial streams, used for one or more life cycle stages in addition to migration.

Various Highway activities, including embankment construction, bridge construction, proper culvert sizing and installation, use of heavy equipment, quarry development, water extraction in winter and summer and public access after construction can have negative effects on water resources and fish. Constructions strategies to minimize impacts and disturbances include:

- erosion and sediment control best practices, including using protocols for culvert installation and on-going monitoring of culverts after installation to ensure erosion and sediment disturbance are controlled;
- employing DFO protocols for water withdrawal in winter and summer;
- route location to maintain sufficient distances of material sources and the Highway alignment from critical habitat, lakes and streams;
- employing DFO protocols for temporary stream crossings and clear span bridges;

- storing fuel and other chemicals a safe distance from water; and
- public education to minimize disturbances from Highway use.

E11.5.4.3 Birds

The Mackenzie River acts as a major flyway for Arctic breeding birds during spring and fall migrations. Numerous species, including waterfowl (swans, geese, ducks, loons and grebes) and waterbirds (cranes, shorebirds, gulls and terns), raptors and other upland birds use the Mackenzie River during migration and disband along the route to appropriate breeding habitat. Migration is influenced and governed by weather, as is the speed of the migration which varies among species.

Strategies to minimize impacts and disturbance have and will be used to mitigate effects on waterfowl, water birds, raptors and upland birds, as follows:

- remain as far from lakes and wetlands as possible;
- avoid all known raptor nests by 1 km if possible;
- avoid clearance and construction activities, including blasting and quarrying, during nesting and fledgling seasons (March to August) as per *Migratory Birds Convention Act* and *Northwest Territories Wildlife Act*; and
- aircraft must remain at a minimum 650 m altitude when flying over nesting areas.

E11.5.4.4 Cumulative Effects

With the application of proposed mitigation measures summarized here and included in the PDR, the residual effects associated with the construction and operation of the Highway within the Tulita District are anticipated to be of low magnitude and local in extent.

Individually, no significant residual effects are anticipated. A cumulative effects assessment will consider the potential additive and synergistic effects of overall residual effects, in combination with past, existing or known planned activities in the vicinity of the Highway through the SSA.

E12.0 CONCLUSION

The Mackenzie Valley Highway has been a long standing goal of the residents of the Tulita District, and the federal and territorial governments, along with the residents of the rest of the Mackenzie Valley. The section of Highway through the Tulita District is a key component of the Northwest Territories transportation system.

The Highway will have many positive impacts: reduce the cost of living, improve access to health care, education and training, provide employment and economic development opportunities and enable residents to travel by road year-round to the rest of the Northwest Territories and Canada.

Completing the Mackenzie Valley Highway will connect Canada from Coast to Coast to Coast and will address Canada's goal of establishing a year-round transportation link to the Arctic coastline.

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APPENDIX H Community Data
APPENDIX I Fuel Spill Contingency Plan Example

1.0 INTRODUCTION

The idea of building an all-weather highway through the Mackenzie Valley originated in the 1960s. In the 1970s the federal government, through Public Works Canada (PWC) did significant work on highway surveys, geotechnical investigations, environmental studies, bridge and culvert designs, some detailed design and tender package preparation. Some 200 km of the south portion of the Mackenzie Valley Highway, between Fort Simpson and Wrigley, were constructed in the mid-1970s, but construction came to an abrupt halt in 1977 just south of Wrigley. The remaining few kilometres to Wrigley were completed in the mid-1990s, but the plans to construct more than 800 km of highway between Wrigley and Inuvik were put on hold. With the completion of the Dempster Highway in 1979, an all-weather road through Yukon, it became possible to reach Tsiigehtchic, Fort McPherson and Inuvik by road year-round.

In 1989, the federal government devolved the authority over the highway system to the Government of the Northwest Territories (GNWT). The Department of Transportation (DOT) prepared the initial Highway Strategy along with a report entitled "*Mackenzie Highway, Wrigley to Inuvik Extension*" (DOT 1989). A decade later, as part of an update to the Highway Strategy, DOT undertook three companion studies to update the Mackenzie Valley Highway initiative: an engineering update, an environmental scoping study and a benefit/cost analysis. These studies contemplated what it would take to build the Mackenzie Valley Highway and evaluated whether the value of the Mackenzie Valley Highway would be worth the investment.

In 2010, with federal funding support, a Memorandum of Understanding (MOU) was signed between 5658 NWT Ltd. and DOT, the project Proponent, to set the terms for the completion of a Project Description Report (PDR) for the construction of the Mackenzie Valley Highway (the Highway) in the Tulita District of the Sahtu Settlement Area (SSA). 5658 NWT Ltd. is the corporate entity representing the Norman Wells Land Corporation, the Tulita Land Corporation, the Fort Norman Metis Land Corporation and the Tulita Dene Band. 5658 NWT Ltd. has developed and delivered the PDR in conjunction with DOT through the Management Committee and the Project Steering Committee. Management and Project Steering committee participants include:

- Management Committee:
  - Margaret McDonald, Norman Wells Land Corporation, (Chair, Management Committee);
  - Edward MacCauley, Tulita Land Corporation;
  - Rocky Norwegian, Sr., Fort Norman Metis Land Corporation;
  - Frank Andrew, Tulita Dene Band; and
  - Robyn McGregor, EBA, A Tetra Tech Company
- Project Steering Committee:
  - Jim Stevens, Department of Transportation (Chair, Project Steering Committee);
  - Ed Hodgson, Norman Wells Land Corporation;

- Wilfred Lennie, Fort Norman Metis Land Corporation;
- Cecile MacCauley, Tulita Dene Band; and
- Doug Yallee, Tulita Land Corporation.

The MOU, and DOT's determination to partner with each respective land claim group in the Mackenzie Valley, have re-invigorated the dream of building the Highway. This PDR provides a preliminary Highway design, assesses its effects and identifies appropriate mitigation to enable the Highway to be constructed. The PDR has been prepared specifically for submission, along with a Water Licence and Land Use permit application, to the Mackenzie Valley Land and Water Board (MVLWB) for preliminary screening – the first stage of the regulatory process, moving the Highway closer to becoming a reality.

The PDR marks the culmination of decades of initiatives, studies, consultations, and reports. The list of previous studies is included in the References section of this PDR. The PDR represents the 'project story' for the Highway in the Tulita District and a guiding document for the development proposal. Following this introduction, Section 2.0 identifies the project Proponent and Section 3.0 presents the rationale for constructing the Highway. Section 4.0 introduces the anticipated regulatory process and identifies the approvals that will be required to commence construction. Section 5.0, Section 6.0, and Section 7.0 illustrate the Highway location, and summarize the history of the federal and territorial governments' efforts toward constructing a highway through the Mackenzie Valley. These sections use available information from prior studies, and pertinent information from the Mackenzie Gas Project (MGP) [Imperial Oil Limited (IOL) 2004], to propose a preferred Highway alignment, design, and project schedule. The PDR identifies the necessary resources – particularly granular and embankment materials – that will be used to construct the Highway.

After putting in place this vision for the project, Section 8.0, Section 9.0, and Section 10.0 set the Highway in the environmental, social, and economic context of the Tulita District. The PDR describes the 2010 engineering, scientific, and archaeological field program activities and their findings. Of note, these studies did not aim to re-evaluate or update previous assessments nor add to the wealth of available bio-physical data that has been collected in this area. Instead, the field program focused on filling information gaps and clarifying specific questions that arose from the 1999 scoping study and the Tulita District's decision to adopt the 2010 highway design described herein.

The PDR relates specific detail from three rounds of consultation held in Norman Wells and Tulita in 2010 and 2011. DOT, as the project Proponent, and its technical team were participants in these meetings, during which they received direct feedback that shaped the concept of the Highway at the beginning, in the middle, and near the end of the preparation of this PDR. As a result, this PDR values and integrates knowledge shared by the communities and regulators during consultation and it integrates heritage resource information, traditional land use, and traditional knowledge.

With this understanding of the proposed development and a rich picture of the setting for the development, Section 11.0 and Section 12.0 of the PDR assess the potential environmental, social, and cumulative effects of constructing the Highway. In instances where there exists a potential for negative environmental or social effects to arise, mitigation actions are identified.

In closing, the PDR gives voice to the local, regional, and national desire to build the Highway. It describes the activities that establishment of the Highway and provision for the future installation of a communications fibre optic cable will entail. This landmark project will establish an envisioned infrastructure corridor through the Mackenzie Valley that will, simply stated, bring people together. 5658 NWT Ltd. and DOT are confident in the findings presented in the PDR. 5658 NWT Ltd. and DOT further believe that with the preliminary design for the Highway and the assessment of its potential effects, this project can proceed efficiently through the regulatory process to permitting, construction, and responsible long term operations and maintenance. The PDR is subject to the terms of the *Sahtu Dene and Metis Comprehensive Land Claim Agreement (SDMCLCA)* and to the extent there is a conflict between the PDR and the *SDMCLCA*, the provisions of the *SDMCLCA* shall govern to the extent of the inconsistency.

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2.0 CONTACT NAMES AND ADDRESSES

The contacts for the Highway in the Tulita District, SSA are 5658 NWT Ltd. and DOT. All communication regarding this PDR should be directed to the following contacts:

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F. 867-587-2049
E. ebamountaindene@theedge.ca

Mr. Jim Stevens
Director, Mackenzie Valley Highway
Department of Transportation
Government of the Northwest Territories
Highways Building, 2nd Floor
4510 – 50 Avenue
P.O. Box 1320
Yellowknife, NT X1A 2L9
T. 867-920-6247
F. 867-920-2565
E. Jim_Stevens@gov.nt.ca

The information contained in this PDR will be combined with similar PDRs for the other sections of the Mackenzie Valley Highway between Wrigley and Inuvik and submitted as one project to the MVLWB. The regulatory review and approvals process is discussed further in Section 4.0 of this PDR. At the time of submission, DOT will be the Proponent for the overall Mackenzie Valley Highway project. 5658 NWT Ltd. supports the information presented in this PDR and supports the submission of the overall project by DOT to the MVLWB for approval. As the Proponent for the Mackenzie Valley Highway project, DOT, with support of 5658 NWT Ltd., will take responsibility for mitigation commitments as presented in this PDR.

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3.0 PURPOSE OF THE PROPOSED PROJECT

The purpose of this Project is to construct approximately 285 km of highway within the Tulita District of the SSA, as one component of the proposed Mackenzie Valley Highway extension from Wrigley to Inuvik (approximately 800 km). On completion, the Mackenzie Valley Highway will be operated and maintained as part of the Northwest Territories Public Highway system. The detailed design, construction and operation of the Highway will involve:

- Refinement of the locations for:
  - the Highway alignment;
  - stream crossings;
  - borrow sources; and
  - future installation of communications fibre optic cable (buried along the toe of the embankment).
- Development of supporting construction and maintenance infrastructure, including:
  - borrow sources, long term and temporary;
  - temporary winter access roads;
  - camps; and
  - fuel, equipment and materials storage locations.
- Construction of the Highway and associated bridge structures and stream crossings to connect with existing and proposed highways:
  - the Mackenzie Valley Highway at the northern boundary of the Tulita District; and
  - the Mackenzie Valley Highway at the southern boundary of the Tulita District.
- Decommissioning and restoring temporary borrow sources, construction camps, and staging areas.
- Replacement or restoration and abandonment of components of the Highway (i.e., bridges, culverts, maintenance borrow sources, etc.) as they reach the end of useful life or as operational needs change (i.e., increased traffic volumes, changes in technology, etc.).

As is discussed in Section 6.1 of this PDR, over several decades a number of initiatives have been completed and decisions made in support of the Highway. Of paramount importance is the signing of the *SDMCLCA*. The *SDMCLCA* designates a highway corridor within the SSA. It includes a Notice of Intent for the Expropriation of Sahtu Lands for the Proposed Mackenzie Highway in Schedule XVII.

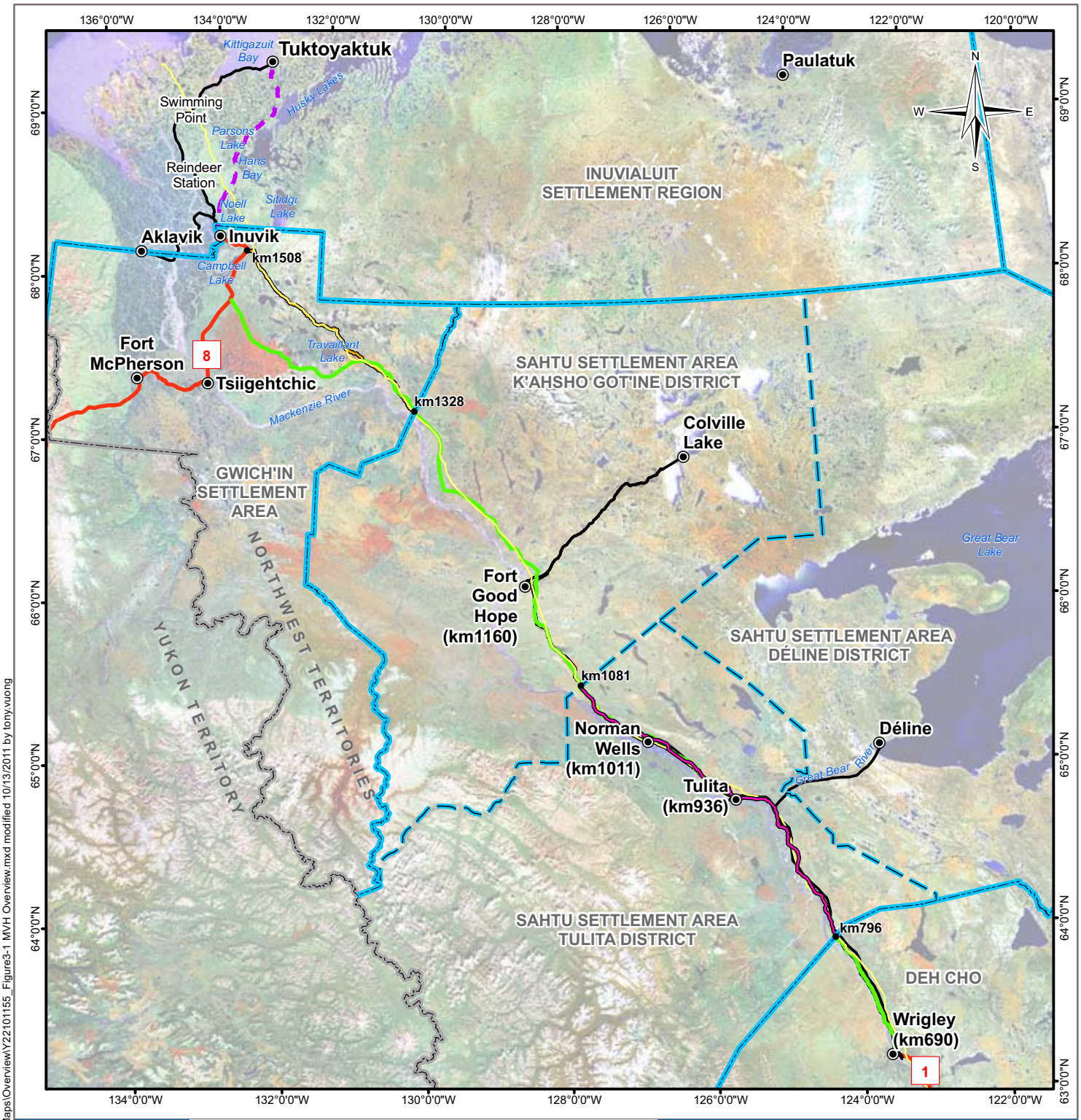
The partnership for the preparation of the PDR for the Highway in the Tulita District consists of 5658 NWT Ltd. and DOT. Decision making for the preliminary design and the development of the PDR is by the Project Steering Committee which is represented by the President of 5658 NWT Ltd., the Director, Mackenzie Valley Highway, DOT and representatives of the four organizations that make up 5658 NWT Ltd. (Fort Norman Metis Land Corporation, Norman Wells Land Corporation, Tulita Land Corporation and the Tulita Dene Band). The preparation of the preliminary design and the development of the PDR included input from 5658 NWT Ltd., DOT and the people of the Tulita District.

Figure 3-1 presents an overview of the proposed route for the Mackenzie Valley Highway between Inuvik and Wrigley, including the proposed section in the Tulita District. The reasons for constructing a highway through Mackenzie Valley include:

- establishing a year round transportation corridor connecting the Mackenzie Delta and Mackenzie Valley with the rest of the Northwest Territories and southern Canada;
- decreasing the cost of living for residents by increasing access to good and services;
- increasing access to health care, educational resources, and employment opportunities;
- enabling opportunities for remote communities and families to interact and share social and cultural connections;
- increasing tourism and hospitality opportunities in the region;
- increasing opportunities for recreational and sporting activities;
- supporting resource exploration, development, and production to stimulate the regional economy;
- stimulating the regional economy with highway construction and operations jobs;
- enhancing communications and development in the North with the future provision of a fibre optic cable;
- reducing the cost of delivering government services; and
- delivering government's commitment to economic development in the Northwest Territories.

The preferred alignment, shown on Figure 3-2, establishes a common infrastructure or transportation corridor (referred to as a Transportation Corridor) to accommodate separate projects in transportation (Highway), utility (Mackenzie Gas Project or transmission lines), and communication infrastructure (fibre optic cable). Consolidating development has the benefit of reducing the overall effect on the land, wildlife, habitat, traditional land use areas, and cultural values in the Tulita District. As well, the decision to pursue a common Transportation Corridor makes best use of the extensive information gathered during the MGP environmental assessments, consultations, and review. A wealth of recent environmental, social, and economic information and consultation commentary was gathered and closely scrutinized with the prospect of building the pipeline. Much of that information has proven useful for designing and building the Highway and preparing this PDR for the Mackenzie Valley Highway in the Tulita District.

The purpose of this PDR is to show where the highway will be built, how it will be built, the benefits it will bring and how various impacts to the social and physical environment will be mitigated. The Highway will serve to reduce the cost of living and attract development to the Tulita District through easier access. Many more months each year will be available for working rather than just the two to three months now available through the existing winter road. This will in turn, serve to build the economy. The Sahtu is rich in resources that are yet untapped. The Highway provides support for the people of the Tulita District to choose to develop those resources and this will benefit the residents of the area as well as the rest of Canada. In addition to supporting economic development the Highway will also provide a solid transportation and communication network that will provide support to sovereignty and national security.



LEGEND

- Communities
- PWC 1974 Highway Concept Route
- Mackenzie Gas Project Corridor
- MVH Concept - June 2011 (Preferred Alignment)
- Dempster Highway (NWT HWY 8)
- Public Winter Road
- Proposed Inuvik to Tuktoyaktuk Highway (2009)
- GSA Alignment
- Settlement Area Boundary
- District Boundary
- Territorial Boundary

NOTES

Base data source: ESRI
MGP & PWC 1974: GNWT
Boundaries: SLUPB
Alignment is considered preliminary and is subject to change

MACKENZIE VALLEY HIGHWAY TULITA DISTRICT

Mackenzie Valley Highway Overview

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:3,800,000
50 25 0 50
Kilometres

FILE NO. Y22101155_Figure3-1 MVH Overview.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y22101155	TV	MS	RM	0

OFFICE EBA-RIV
DATE October 14, 2011

5658 NWT Ltd.

eba A TETRA TECH COMPANY

Figure 3-1

M:\TRANSPORTATION\NWT_Mackenzie_Highway\Y22101155_TulitaMaps\Overview\Y22101155_Figure3-1 MVH Overview.mxd modified 10/13/2011 by tony.vuong

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NOTE
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UTM Z

65°30'0"N
65°0'0"N
64°30'0"N
64°0'0"N

Great Bear Lake
Déline
SAHTU SETTLEMENT AREA
DÉLINE DISTRICT
Great Bear River
km796
Mahony Lake
Brackett Lake
Tulita
(km936)
Tate Lake
Stewart Lake
Keele River
Kelly Lake
Mackenzie River
SAHTU SETTLEMENT AREA
TULITA DISTRICT
Lennie Lake
Three Day Lake
Norman Wells
(km1011)
Oscar Lake
Moon Lake

4.0 ENVIRONMENTAL ASSESSMENT AND REGULATORY APPROVALS

This section provides an overview of the environmental assessment and regulatory approval processes that are anticipated for the portion of the Highway in the Tulita District. The basis for this overview includes the primary applicable Acts, [*Northwest Territories Act, Mackenzie Valley Resource Management Act (MVRMA), SDMCLCA, Northwest Territories Waters Act*], and regulations (*Mackenzie Valley Land Use Regulations, Northwest Territories Waters Regulations*), guidelines, operational procedures, consultation with regulatory authorities and organizations, the *Mackenzie Valley Highway Extension Environmental Scoping Report* (GeoNorth Limited and Golder Associates 1999) and *Regulatory Roadmaps Project: Oil and Gas Approvals in the Northwest Territories – Sahtu Settlement Area* (Erlandson and Associates Consulting 2002).

It is intended that this PDR will subsequently be combined with similar PDRs from the K'ahsho Got'ine District in the Sahtu, the Gwich'in Settlement Area and the Deh Cho, and then be submitted to the MVLWB under an umbrella document for the Mackenzie Valley Highway extension from Wrigley to Inuvik. The objective with these PDRs is to prepare a Highway description that honours the rights of each respective land claimant group and respects local interests and values while describing long-awaited key infrastructure that will also serve territorial and federal interests.

In the SSA, the *SDMCLCA* was approved in 1993 by the Sahtu Dene and Metis (Participants) and by the territorial and federal governments. It was brought into force in 1994 by settlement legislation passed by the federal government.

The SSA covers 280,238 km^2 and includes Great Bear Lake and five communities: Tulita, Norman Wells, Fort Good Hope, Colville Lake and Deline. The *SDMCLCA* provides certainty to Participants regarding rights to ownership and use of the land and resources, and provides Participants with harvesting rights and the right to participate in decisions concerning wildlife harvesting and management as well as conservation and management of land, water, and resources.

To that end, the *SDMCLCA* established three districts in the SSA – Tulita, K'ahsho Got'ine and Deline, each with a district land corporation holding the ownership in that district's land on behalf of Participants and which oversees the local land corporations set up in each community. The Tulita District Land Corporation is comprised of three community land corporations: Norman Wells Land Corporation, Tulita Land Corporation and the Fort Norman Metis Land Corporation.

The *SDMCLCA* establishes three co-management boards as institutions of public government to regulate, permit, license and manage land, water and resources in the SSA. Two of them, the Sahtu Land and Water Board (SLWB) and the Sahtu Land Use Planning Board (SLUPB) work within and are given effect by the broader Northwest Territories regulatory regime established under the *MVRMA*. The third, the Sahtu Renewable Resources Board (SRRB), as set out in the *SDMCLCA*, advises the SLWB on wildlife and forestry resources and management issues.

In addition to the *SDMCLCA*, the main statutes governing land and resource management in the Mackenzie Valley and in the Sahtu are the *MVRMA*, the *Mackenzie Valley Land Use Regulations*, the *Northwest*

Territories Waters Act, and the *Northwest Territories Waters Regulations*. The *MVRMA* establishes two other institutions of public government having effect in the Sahtu: The MVLWB and the Mackenzie Valley Environmental Impact Review Board (MVEIRB).

In 2010 and 2011, consultations with regulatory authorities and Tulita District organizations provided the Proponent with feedback and suggestions about the most likely regulatory review process that will be used for the Tulita District component of the Mackenzie Valley Highway. Discussions focused on the Tulita District and, at the same time, acknowledged that this is one part of a larger endeavor to create an all-weather transportation link between Inuvik and Wrigley.

4.1 Anticipated Environmental Assessment and Regulatory Permitting Processes

The main environmental assessment and regulatory permitting process will involve submission of the consolidated PDR (a document combining the four regional PDRs) along with applications for a Water Licence and Land Use Permit for preliminary screening by the MVLWB. It is anticipated that the overall Mackenzie Valley Highway project will subsequently be referred to the MVEIRB for environmental assessment. A Developer's Assessment Report giving more detailed information about the entire project will then be prepared in conformance with the Terms of Reference to be specified by the MVEIRB.

Following completion of the environmental assessment and a positive report of Environmental Assessment by the MVEIRB, followed by approval by the Minister for Aboriginal Affairs and Northern Development Canada (AANDC) and other Responsible Ministers, the Project will then be referred back to the MVLWB for regulation and processing of the necessary land use permits and water licences.

Depending on the decisions made to regulate and permit the staged design and construction process for the Highway, permits and licences for construction and operation could be issued by the MVLWB or by the SLWB. For this PDR, it is anticipated the Board issuing permits and licenses for construction of the Highway project will be the MVLWB, although, based on the decisions made at the time of application, this could change. Permits and licenses for any Highway-related work in advance of construction would be managed and issued by the SLWB (P. Dixon, SLWB. July 2011).

Concurrent with processing of the necessary land use permits and water licences, various other applications will be prepared and submitted as appropriate to other regulatory agencies with responsibility for regulating certain aspects of the overall highway construction program. These will include:

- Quarry Permits to be issued by AANDC for Crown lands;
- Fisheries Authorizations or Letters of Advice to be issued by Fisheries and Oceans Canada (DFO);
- Navigable Waters Permits to be issued by Transport Canada;
- Reservation by Notation to be recorded for the Highway and material sources by Municipal and Community Affairs (MACA) that are situated upon Commissioner's Lands;
- Explosives Permit(s) to be issued by Natural Resources Canada (NRCAN); and
- Incidental Use of Forests Licence to be issued by Forest Management, Department of Environment and Natural Resources (ENR), GNWT.

Other permits and approvals required to conduct ongoing pre-construction field investigations and surveys needed to support the design of the Highway and/or for subsequent construction-related regulatory approvals can and will be obtained as needed on an annual basis. These will include:

- Northwest Territories Scientific Research Licence issued by the Aurora Research Institute (ARI);
- Northwest Territories Archaeological Permits issued by the Prince of Wales Northern Heritage Centre (PWNHC);
- Northwest Territories Wildlife Research Permit to be issued by ENR;
- Licences to Fish for Scientific Purposes to be issued by DFO; and
- Letter of Advice from Proponent to Forest Management, ENR, GNWT, regarding Use of Forests during field investigations. (To be replaced by Licence requirement in 2012.)

Table 4-1 summarizes the regulatory permitting process, including permits, licences, authorizations, letters of advice and other approvals required for the pre-construction activities for the Highway in the Tulita District of the SSA.

It should be noted that the design and construction for the Highway will be a staged process where design will precede major segments of construction. Some licences and permits for pre-construction investigations will need to be renewed annually to ensure that all needed information is gathered for the regulatory permitting for the each phase of construction. The expectation is that as one phase is being constructed, the investigative work, application and permitting process will be underway in advance of the next phase.

Table 4-2 summarizes the regulatory permitting process, including permits, licences and other approvals required for construction activities for the Highway. Figure 4-1 provides an illustrative flow chart.

4.2 Environmental Assessment and Regulatory Organizations

4.2.1 Mackenzie Valley Land and Water Board (MVLWB)

The MVLWB is a co-management board mandated under the *MVRMA* to regulate the use of land and waters and the deposit of waste so as to provide for the conservation, development and utilization of land and water resources in a manner that will provide the optimum benefit to the residents of the SSA, of the Mackenzie Valley and to all Canadians (MVLWB 2010).

The MVLWB ensures consistency in the application of the *MVRMA* throughout the Mackenzie Valley. It screens and regulates proposed development projects in areas where a land claim has not yet been settled or where projects cross one or more regional boundaries in the Northwest Territories. As noted earlier in this section, this is expected to be the case for the Highway (R. Batchelor, DOT. June 2011).

As identified in Section 4.1, the preliminary screening process by the MVLWB under the *MVRMA* will begin upon submission of the consolidated PDR for construction of the Mackenzie Valley Highway Project, along with Water Licence and Land Use Permit applications.

The purpose of preliminary screening is to assess whether the proposed activity, in this case the construction of the Highway, might have a significant adverse impact on the environment or might be a cause of public concern as defined under the *MVRMA* (s. 125 (1)(a)). To make this determination, the MVLWB will use the Proponent's description of the proposed development, the environmental context, and community consultation records as provided in this PDR.

As noted in Section 4.1, it is expected that the entire Mackenzie Valley Highway project will subsequently be referred to the MVEIRB for environmental assessment. Following completion of the environmental assessment process, a positive Report of Environmental Assessment and approval by the Minister for AANDC and other Responsible Ministers, the project will then be referred back to either the MVLWB or the SLWB for regulation and processing of the necessary land use permits and water licences. This will depend on the decisions made by the regulators at the time of application.

For this PDR, it is anticipated the Board issuing permits and licences for construction of the Highway project will be the MVLWB. Permits and licences for any Highway-related work in advance of construction would be managed and issued by the SLWB. (P. Dixon, SLWB. July 2011).

Although the overall Mackenzie Valley Highway from Wrigley to Inuvik will be treated as one project for the purposes of the *MVRMA* process, permitting and licensing will not occur all at once. In each region, including in the Tulita District, the design and construction of the Highway will be staged, meaning the detailed information needed for permit and licence applications will be available prior to construction of each stage of the Highway. Applications will be made well in advance of the commencement of each stage.

4.2.2 Sahtu Land and Water Board (SLWB)

The SLWB is one of three regional, co-management boards of public government that were established by the *SDMCLCA*, and which, along with the SLUPB, was given effect under the *MVRMA*. Along with the MVLWB and the MVEIRB, these boards provide for an integrated and coordinated system of land and water management in the Sahtu.

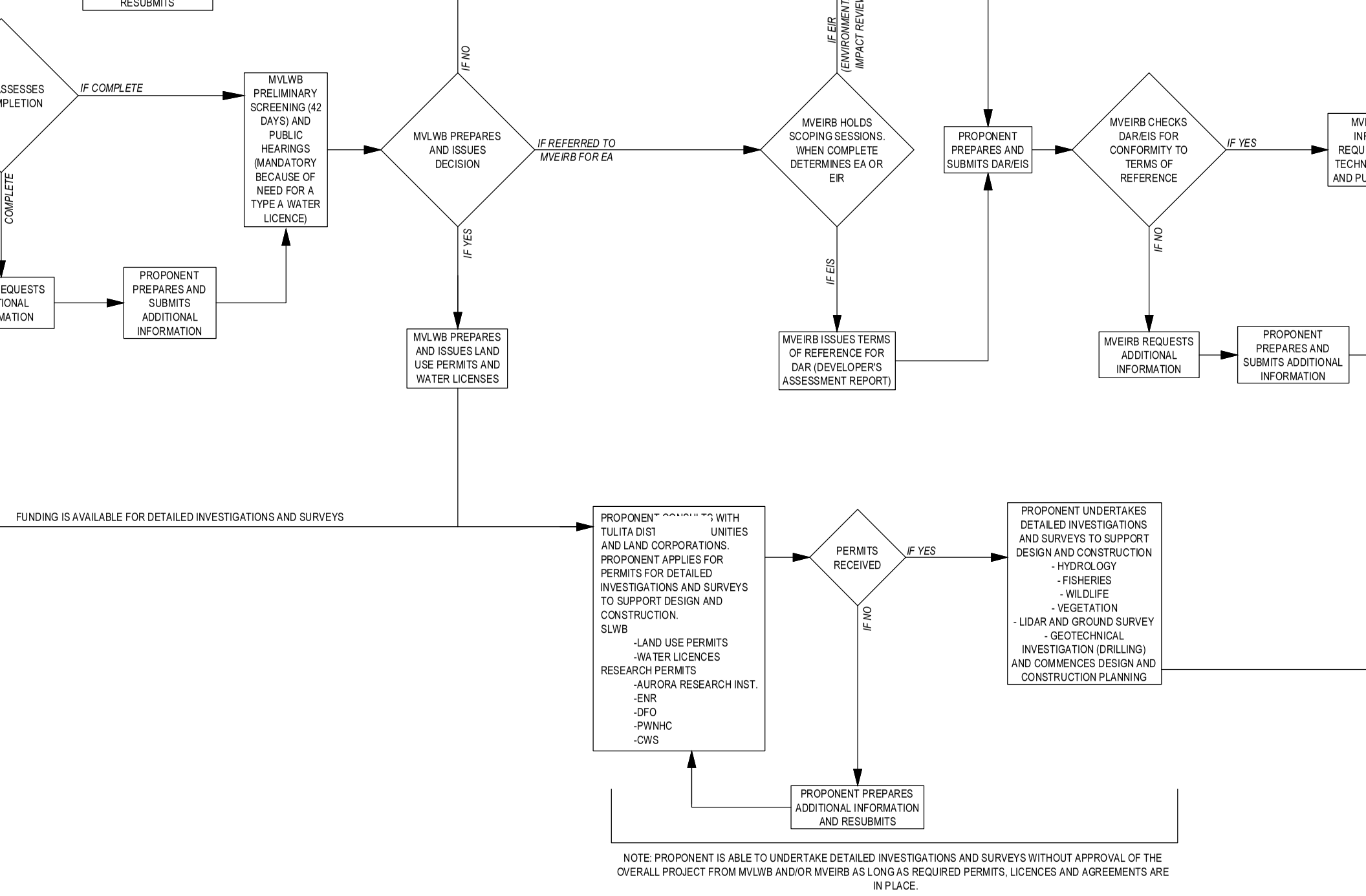
Under the *MVRMA*, the SLWB regulates the use of land and water by issuing, amending, renewing and suspending and closing land use permits and water licences on all Crown lands, Sahtu lands, Commissioner's Lands and private lands within the SSA. The *Mackenzie Valley Land Use Regulations*, the *Northwest Territories Waters Act* and *Northwest Territories Waters Regulations* are administered by the SLWB.

In instances where a project is located solely within the SSA, the SLWB screens the project, renders its decision, and issues the necessary land use permits and water licences with associated terms and conditions.

As noted above, the MVLWB will issue the necessary land use permits and water licences for construction of the Highway through the Tulita District. The SLWB will screen, review and issue permits and licenses for any needed geophysical or other investigative work done prior to construction (see Table 4-2 and Figure 4-1).

rown, ner's Private)	AANDC	Corporation	ENR	Environmental site assessment permit)	PWNHC	BPC	Councils Corps, Fe GNW
ns prior)	Compliance monitoring	Proof of consultation and permission to access		Research Permit		Letter of Advice or Authorization, depending on amount of disturbance	Reviews Appli
ns prior)	Compliance monitoring	Proof of consultation and permission to access					Reviews Appli
		Proof of consultation and permission to access		Research Permit		Scientific Licence	
		Proof of consultation and permission to access	Wildlife Research Permit	Research Permit (if interviewing people about hunting and Traditional Knowledge)			Consult with S local RRCs.
ns prior)	Quarry permit; Compliance monitoring	Proof of consultation and permission to access	Letter of Advice to ENR Norman Wells re: clearing	Research Permit		Notification form for winter water withdrawal associated with temporary winter road construction	Reviews Appli
		Proof of consultation and permission to access			Archaeological Permit		
		Proof of consultation and permission to access	Wildlife Research Permit (if wildlife food source)	Research Permit			
s prior)	Compliance monitoring	Proof of consultation and permission to access					Reviews Appli
s prior)	Compliance monitoring	Proof of consultation and permission to access					Reviews Appli
s prior, includes	Quarry permit; Compliance monitoring	Proof of consultation and permission to access				Notification form for winter water withdrawal	Reviews Appli

AANDC	Tulita DLC	MVEIRB	for pre-construction activities renewed as needed)	Transport Canada	ENR	for pre-construction activities renewed as needed)	for pre-construction activities renewed as needed)	Commissioner's Land)	
Ministerial approval (2 - 36 months)	Access permission from 5658 NWT Ltd. members' resolution	Environmental Assessment & Recommendation for Approval (2 years)					Notification form for winter water withdrawal		
Compliance monitoring	Access permission from 5658 NWT Ltd. members' resolution				Incidental Use of Forests Licence (new 2012)				
Quarry Permit; Compliance monitoring	Access permission from 5658 NWT Ltd. members' resolution							Reservation by notation for quarry/borrow	
Compliance monitoring	Access permission from 5658 NWT Ltd. members' resolution								
				Navigable Waters Permits (3-6 months)					
Compliance monitoring	Access permission from 5658 NWT Ltd. members' resolution						Notification form for winter water withdrawal associated with temporary winter road construction		
Compliance monitoring	Access permission from 5658 NWT Ltd. members' resolution			Navigable Waters Permits (3-6 months)			Letter of Advice or Authorization, based on disturbance amount		
Compliance monitoring	Access permission from 5658 NWT Ltd. members' resolution			Navigable Waters Permits (3-6 months)			Notification form referencing culvert installation protocol		
Compliance monitoring	Access permission from 5658 NWT Ltd. members' resolution								
Compliance monitoring	Access permission from 5658 NWT Ltd. members' resolution								
Compliance monitoring	Access permission from 5658 NWT Ltd. members' resolution								
Quarry permit; Compliance monitoring	Access permission from 5658 NWT Ltd. members' resolution						Notification form for winter water withdrawal		
After HWY	DOT negotiates tenure							Reservation by	


RESUBMITS
ASSESSES MPLETION
IF COMPLETE
IF NOT COMPLETE
EQUESTS TIONAL MATION
PROPONENT PREPARES AND SUBMITS ADDITIONAL INFORMATION
MVLWB PRELIMINARY SCREENING (42 DAYS) AND PUBLIC HEARINGS (MANDATORY BECAUSE OF NEED FOR A TYPE A WATER LICENCE)
MVLWB PREPARES AND ISSUES DECISION
IF NO
IF YES
IF REFERRED TO MVEIRB FOR EA
IF EIR (ENVIRONMENTAL IMPACT REVIEW)
MVEIRB HOLDS SCOPING SESSIONS. WHEN COMPLETE DETERMINES EA OR EIR
IF EIS
MVEIRB ISSUES TERMS OF REFERENCE FOR DAR (DEVELOPER'S ASSESSMENT REPORT)
PROPONENT PREPARES AND SUBMITS DAR/EIS
MVEIRB CHECKS DAR/EIS FOR CONFORMITY TO TERMS OF REFERENCE
IF YES
IF NO
MVEIRB REQUESTS ADDITIONAL INFORMATION
PROPONENT PREPARES AND SUBMITS ADDITIONAL INFORMATION
MVLWB PREPARES AND ISSUES LAND USE PERMITS AND WATER LICENSES
FUNDING IS AVAILABLE FOR DETAILED INVESTIGATIONS AND SURVEYS
PROPONENT CONSULTS WITH TULITA DIST UNITIES AND LAND CORPORATIONS.
PROPONENT APPLIES FOR PERMITS FOR DETAILED INVESTIGATIONS AND SURVEYS TO SUPPORT DESIGN AND CONSTRUCTION.
SLWB
-LAND USE PERMITS
-WATER LICENCES
RESEARCH PERMITS
-AURORA RESEARCH INST.
-ENR
-DFO
-PWNHC
-CWS
PERMITS RECEIVED
IF YES
IF NO
PROPONENT UNDERTAKES DETAILED INVESTIGATIONS AND SURVEYS TO SUPPORT DESIGN AND CONSTRUCTION
- HYDROLOGY
- FISHERIES
- WILDLIFE
- VEGETATION
- LIDAR AND GROUND SURVEY
- GEOTECHNICAL INVESTIGATION (DRILLING)
AND COMMENCES DESIGN AND CONSTRUCTION PLANNING
PROPONENT PREPARES ADDITIONAL INFORMATION AND RESUBMITS
NOTE: PROPONENT IS ABLE TO UNDERTAKE DETAILED INVESTIGATIONS AND SURVEYS WITHOUT APPROVAL OF THE OVERALL PROJECT FROM MVLWB AND/OR MVEIRB AS LONG AS REQUIRED PERMITS, LICENCES AND AGREEMENTS ARE IN PLACE.

In parallel with the *MVRMA* process, for the portions of the Highway that do not follow the existing winter road right-of-way, the right to access land for the Highway construction will need to be obtained from the district land corporations for Sahtu land. For the portion of the Highway in the Tulita District, permission to access Sahtu land would come from the Tulita District Land Corporation. Access to Crown lands is coincident with the issuance of a land use permit from the SLWB. Because the Proponent for this project is DOT, access and tenure for Commissioner's Land will come through a Reservation by Notation registered by MACA upon receiving advice from DOT. (B. Chamberlin, MACA, June 2011).

Land use permits are anticipated to be required for the following activities:

- geotechnical and other investigative work done prior to construction to locate material sources, refine the alignment, confirm bridge placement or to determine other elements necessary for design and logistical planning;
- clearing and construction within the Highway right-of-way;
- temporary winter road construction for winter Highway-related activities;
- accessing material sources;
- gaining temporary access to temporary material sources;
- use of explosives;
- material source investigations (depending upon equipment used); and
- establishing temporary campsites, fuel and supply storage sites.

Based on the activity thresholds set out in the Mackenzie Valley Land Use Regulations, the construction of the Highway will require one or more Type A land use permits due to the type of construction equipment that is proposed to be used to clear land; the proposed land clearing that will exceed 1.5 m in width and 4 hectares (ha) in area; and the quantities of fuel that may be stored (containers exceeding fuel capacity of 4,000 litres (L) or a fuel storage facility with a capacity of 80,000 L or more), and other project elements. Additional thresholds may apply, but the ones stated above indicate that a Type A land use permit will be required for construction.

One or more Type A water licences are anticipated to be required for the following project elements:

- major and minor water course crossings, including bridges and culverts;
- direct water use for road construction, dust suppression, winter road construction, etc.;
- water use and deposit of waste water by camps; and/or
- handling and storage of petroleum and/or hazardous materials.

The specifics of each of these activities for the Highway will be determined after detailed investigations are completed in the next stages of the project development. The main factor influencing the project's requirement for a Type A water licence is the volume of 'direct water use' per day. The estimated maximum daily water volumes over the lifespan of the water licence will be 500 m^3 to more than 1,000 m^3

per day at peak usage and encompass the full range of seasonal activities (see Section 6.0). Based on this, a Type A water licence will be required to allow for the necessary daily direct water use, deposition of waste, construction of watercourse crossings, and other regulated activities.

4.2.3 Other Sahtu Boards

Although the entities listed below are not directly involved in permitting or regulating proposed development projects in the way the SLWB is, each has an important and contributing advisory role to play in the process.

4.2.3.1 Sahtu Land Use Planning Board (SLUPB)

The SLUPB is one of three regional, co-management boards of public government that were established by the *SDMCLCA*, and, as with the SLWB, given effect under the *MVRMA*. Working with the MVLWB and the MVEIRB, these boards provide for an integrated and coordinated system of land and water management in the Sahtu.

The SLUPB is mandated to develop and implement a land use plan for the SSA. The Plan will take effect upon approval by the Sahtu Secretariat Incorporated, the GNWT and the Government of Canada. The Plan will be reviewed every five years after approval to ensure its relevance and effectiveness in the future. The board is authorized to develop procedures for exceptions and amendments to the plan.

In July 2010, the third draft to the Plan was issued for comments to Sahtu boards, government agencies and departments and Sahtu stakeholders. This PDR, and any subsequent documents submitted to regulatory authorities for the Highway through the SSA, will refer to the *SLUP*.

4.2.3.2 Sahtu Renewable Resources Board (SRRB)

The SRRB is one of three regional, co-management boards of public government that were established by the *SDMCLCA*, along with the SLUPB and the SLWB. The SRRB is the main instrument of wildlife and forestry management in the SSA, and gathers information through consultation with the Regional Renewable Resources Committees and the community-based Renewable Resources Councils (formerly the Hunters and Trappers Associations) which provide guidance about local renewable resources.

The SRRB conducts research on renewable resources and Renewable Resources Councils participate in the research projects conducted in or near their respective communities, including wildlife and fish population studies, distribution and migration patterns studies, and cumulative effects studies, among others. From this research, the SRRB can provide information to the SLWB regarding land use permits and water licenses which provides the basis for the calculation of compensation in the event of damage or loss caused by development or disaster. The SRRB also supplies information to and works closely with the SLUPB in the development of the SLUP.

4.2.3.3 Tulita District Land Corporation

For any development on Sahtu private lands, the project Proponent must get the permission of the land owner, in this case, the Tulita District Land Corporation, before any land use or water use application is considered complete by the SLWB. For a private developer, the permission takes the form of an access and benefits agreement which includes hiring commitments, business opportunities, royalties or any land

access and use fees charged as compensation for land use. These agreements are private between a project proponent and the TDLC, which acts on behalf of the Norman Wells Land Corp., the Tulita Land Corp., and the Fort Norman Metis Land Corp.

In the case of the Highway, some sections of the alignment occur on Sahtu land. The Proponent will negotiate with the Tulita District Land Corporation, as the landowner, to secure the needed permission for access and tenure, under Schedule XVII of the *SDMCLCA*. (R. Batchelor, DOT and B. Chamberlin, MACA. June 2011.)

4.2.3.4 Sahtu Secretariat, Inc.

The Sahtu Secretariat serves as the coordinating body for all seven Sahtu community land corporations, including the three in the Tulita District: Norman Wells Land Corporation, Tulita Land Corporation, and Fort Norman Metis Land Corporation. It operates as a contact point for government departments and agencies and deals with matters such as health, education, environment and economic development.

The Secretariat's mandate is to facilitate the implementation of services and programs for the benefit of Sahtu people according to the *SDMCLCA*.

4.2.4 Mackenzie Valley Environmental Impact Review Board (MVEIRB)

The MVEIRB is the co-management board responsible for the environmental impact assessment process in the Mackenzie Valley. In 1998, the *MVRMA* established the Review Board as an independent administrative tribunal. Although the federal government enacted this piece of legislation, the Act itself resulted from the completed land claims in the Northwest Territories. This legislation gives the aboriginal people of the Mackenzie Valley a greater say in resource development and management.

The MVEIRB is authorized by Section 126 of the *MVRMA* to conduct an environmental assessment if the project is referred by a Land and Water Board, and may also proceed based on a referral from a government department, agency, or local government, or on its own motion.

It is anticipated that following screening by the MVLWB, the overall Mackenzie Valley Highway project will be referred to the MVEIRB for environmental assessment. This will trigger the need for a Developer's Assessment Report to be prepared in conformance with the Terms of Reference to be specified by the MVEIRB.

The environmental assessment process will serve to determine if the development being assessed is likely to have significant adverse effects on the environment, or is likely to cause public concern. Based on the outcome of the assessment, MVEIRB can recommend to the federal Minister for AANDC one of the following:

- the project can proceed to regulatory permitting and licensing as is;
- the project can proceed to regulatory permitting and licensing provided some mitigative measures recommended by the MVEIRB as a result of the assessment are in place; or
- the project should be rejected.

Alternatively, the MVEIRB or the federal and responsible ministers may order an environmental impact review for a much more detailed review by an independent panel appointed by MVEIRB.

4.2.5 Aboriginal Affairs and Northern Development Canada (AANDC)

AANDC is responsible for managing and issuing permits for granular and rock resources on Crown lands (quarry permits), negotiating access to Crown lands, inspecting and monitoring land use permit and water licence compliance, and providing guidelines for land use in northern Canada.

AANDC is responsible for the management of granular resources on Crown lands under the Territorial Quarrying Regulations. This includes balancing among proposed activities, community needs, and anticipated future needs. Current needs and reasonably foreseeable future interests in granular resources must be identified and managed.

This PDR will estimate the anticipated material sources for Highway construction material and project material quantity requirements to enable AANDC's review of the project in the context of total known and estimated material resources in the Tulita District. Note that the Proponent has yet to assess the planned material sources for material quality, quantity, ice content, and other critical characteristics. This information will be submitted to AANDC when quarry permit applications are made, and will also be submitted to SLWB and/or MVLWB as part of the land use permit application. A land use permit and a quarry permit are required for use of material sources.

Some sections of the Highway through Tulita District will be located on Crown lands. The Proponent will advise AANDC which parcels of Crown land will be needed for the Highway and land use permits and water licences for pre-construction or construction activities on these lands will be issued by the SLWB and/or the MVLWB. No permits for land use will be issued by AANDC for the Highway, with the exception of quarry permits which authorize permanent roads to permanent material sources or temporary winter roads to temporary material sources on Crown land. These quarry permits are issued after the MVLWB/SLWB land use permit is issued.

Following completion of construction, tenure for the section of the Highway on Crown land automatically reverts to the GNWT under section 44(2) of the *Northwest Territories Act*, which, under section 44(1)(c), also gives the GNWT responsibility for all roads and highways on public lands.

Working with the SLWB, AANDC's second key responsibility is to manage compliance with land or water authorizations issued under the *Mackenzie Valley Land Use Regulations* and *Northwest Territories Waters Regulations*, respectively. The Proponent will notify AANDC in advance of activities on the project. As well, AANDC's Operations Branch will conduct inspections of right-of-way clearing, water crossings, material sources, and temporary winter access roads to ensure the methods and approaches employed are being applied in accordance with the project-specific terms and conditions.

4.2.6 Department of Municipal and Community Affairs (MACA)

The GNWT MACA serves to support capable, accountable and self-directed community governments in order to provide a safe, sustainable and healthy environment for community residents. The Department works with community governments and other partners in supporting community residents as they organize and manage democratic, responsible and accountable community governments (MACA 2011).

MACA's Lands Administration Division manages public land that is under the administration and control of the Commissioner of the Northwest Territories (Commissioner's Lands), to assist community governments in the development of their communities, and to fairly and equitably value the assessment base in the Northwest Territories.

Commissioner's Lands are generally situated within or near the municipal boundaries of the communities in the SSA. Administration and control of surface rights on these lands are administered by MACA pursuant to the Commissioner's Lands Act and Commissioner's Lands Regulations. In addition, under an arrangement with the federal government, MACA processes lease applications on land within municipal boundaries that is not Commissioner's Land. For activities on these and Commissioner's lands, MACA issues Land Use Permits, Quarry Permits, Easements and Rights-of-Way. In the SSA, such permits are issued by the MACA office in Norman Wells.

MACA is not a regulator so does not issue permits with regulatory conditions such as those issued by the SLWB. Rather, MACA, as the land administrator for Commissioner's Land in the Northwest Territories, issues permission for a Proponent to use the land for a specific stated purpose under the regulatory conditions prescribed by the SLWB. For the Highway, where the Proponent is the DOT, MACA will register a "Reservation by Notation" on the land registry which sets aside the Commissioner's Land and gives tenure to the DOT for the Highway and for quarries. (B. Chamberlin, MACA, June 2011.)

4.2.7 Fisheries and Oceans Canada (DFO)

DFO is the regulator for the *Fisheries Act* in the Tulita District. The DFO review of the project will focus on the potential effects of construction activities on fish habitat, which is protected under Section 35 of the *Fisheries Act*, as follows:

- Section 35(1) prohibits the Harmful Alteration, Disruption, or Destruction (HADD) of fish habitat; and
- Section 35(2) allows the Minister to Authorize a HADD of fish habitat.

The *Fisheries Act* defines fish habitat to mean "...spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes."

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, does provide 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 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 Proponent and DFO for compensation that will achieve no net loss. Authorizations or Letters of Advice are intended to assist the Proponent with 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. 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.

The various stream crossings that are part of this project will be sited and designed to avoid or mitigate adverse effects 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 can be submitted.

DFO will also be involved in the initial pre-construction Highway development and planning stages, through the issuance of the necessary Licences to Fish for Scientific Purposes, required to conduct fish and fish habitat surveys of the streams to be crossed by the Highway. Early consultations with DFO will be beneficial to assist in the design and implementation of the necessary fish and fish habitat surveys and to ensure that all of the appropriate data are collected.

4.2.8 Transport Canada

Transport Canada is responsible for issuing permits under the *Navigable Waters Protection Act* (NWPA). Under the *NWPA* and Regulations, the project will require approval for the construction of some of the larger stream crossings (e.g., bridges) across navigable waters. More specifically, the *NWPA* requires approvals to be obtained for any structure that may interfere with navigation if it is constructed in, on, over, under, through or across any navigable water bodies. Applications will be submitted to Transport Canada after bridge design reaches the necessary level of completeness for the assessment of the proposed structures at each potentially navigable stream crossing.

4.2.9 Natural Resources Canada (NRCAN)

NRCAN administers the storage and use of explosives at a work site under the *Explosives Act*. Explosives are expected to be required to access material at select material sources along the Highway. Appropriate approvals (Permits) will be sought to enable the transportation and use of explosives for material site development and highway construction materials extraction as and when required.

4.2.10 Aurora Research Institute (ARI)

The ARI is responsible for scientific research licencing in the Northwest Territories under the Northwest Territories Scientists Act and the Northwest Territories Act. Archaeological research is managed and permitted by the PWNHC and wildlife research, while requiring a scientific research licence from ARI, also requires a Wildlife Research Permit from the GNWT ENR and consultations with the SRRB and the appropriate Sahtu RRC.

ARI's purview includes work with the physical, social, and biological sciences as well as indigenous knowledge. Through the research licensing process, information about research work in the NWT is shared with other researchers and northern residents. Part of the mandate of ARI is to distribute or make available research summaries to community organizations, media, and other researchers. In addition, research information is added to existing and developing scientific databases (ARI 2011). As development of the Highway progresses through the stages of design and construction, additional fieldwork is anticipated. The appropriate research licences, land use permits and water licences will be applied for and obtained prior to the conduct of field programs including detailed fisheries assessments at major stream crossings, geotechnical investigations at borrow sources and along the alignment, and studies with sampling and ground-based activities beyond the scope of September 2010 field program.

4.2.11 GNWT Department of Environment and Natural Resources

GNWT ENR is responsible for issuing Wildlife Research Permits under the *Northwest Territories Wildlife Act*. As a result, ENR will be involved in the initial pre-construction Highway development and planning stages, through the issuance of the necessary Wildlife Research Permit(s) required to conduct wildlife and wildlife habitat, including wetlands, surveys of the Highway and general wildlife study area. Early consultations with ENR will be beneficial to assist in the design and implementation of the appropriate wildlife and wildlife habitat surveys.

4.2.12 Prince of Wales Northern Heritage Centre (PWNHC)

The PWNHC administers the Northwest Territories Archaeological Sites Regulations under the *Northwest Territories Act*. Archaeological permits are required to conduct archaeological studies in the Northwest Territories. This permitting and reporting requirement is in effect at the preliminary reconnaissance stage, as in 2010, and at the pre-construction and construction stages that are yet to come.

One aspect of the information sharing involved in Northwest Territories archaeological work is that Highway project archaeologists are given privileged access to information about heritage and archaeological resources in order that they can use the information to guide development for the protection of these resources during the initial Highway planning stage.

4.3 Land Access and Tenure

There are three types of land ownership in the Tulita District, and the Proponent will obtain some form of permission for access and tenure from each owner. Because the Proponent is DOT, for the portions of the Highway that do not follow the existing winter road right-of-way, permission for access and tenure will take the following forms:

For those sections of the Highway that occur on Sahtu land, permission for access will come in the form of the resolution passed by the groups making up 5658 NWT Ltd. that supports DOT, as the Proponent, in going forward with the project as described in the PDR. 5658 NWT Ltd. represents the Tulita Land Corporation, the Norman Wells Land Corporation, the Fort Norman Metis Land Corporation, and the Tulita District Land Corporation. Tenure on Tulita District lands will come through negotiations between DOT and the Tulita District Land Corporation under the terms of Schedule XVII of the *SDMCLCA*.

For those sections of the Highway that occur on Crown lands, permission for access is coincident with the issuance of a land use permit from the MVLWB/SLWB. The Proponent will advise AANDC which parcels of Crown land will be needed for the Highway and land use permits and water licences for pre-construction or construction activities on these lands will be issued by the SLWB and/or the MVLWB, after the appropriate applications have been made. No permits for land use will be issued by AANDC for the Highway, with the exception of quarry permits which authorize permanent roads to permanent material sources or temporary winter roads to temporary material sources on Crown land.

Because the Proponent for this project is DOT, following completion of construction, tenure for the Highway automatically reverts to the GNWT under section 44(2) of the Northwest Territories Act, which, under section 44(1)(c), also gives the GNWT responsibility for all roads and highways on public lands.

For those sections of the Highway that occur on Commissioner's Land, which, under the Commissioner's Lands Act is controlled and administered by MACA, GNWT, tenure will come through a Reservation by Notation registered by MACA upon receiving advice from DOT regarding which sections of land are required for the Highway. (B. Chamberlin, MACA, June 2011.)

5.0 LOCATION

The general location of the Highway is shown on Figure 3-1 and Figure 3-2. The proposed overall Mackenzie Valley Highway extends from Wrigley to Inuvik. The Highway presented in this PDR extends through the Tulita District of the SSA, from the north boundary of the district to the south boundary and connecting the Town of Norman Wells and Hamlet of Tulita. The Highway in the Tulita District is approximately 285 km.

The latitude and longitude coordinates for where the Highway meets the district boundaries are:

- North District Boundary: 127°48'19"W, 65°38'19"N; and
- South District Boundary: 124°16'26"W, 64°1'10"N.

The Highway within the Tulita District forms one of four sections of the overall extension of the Mackenzie Valley Highway (NWT Hwy 1) from just south of Inuvik (a junction with the Dempster Highway) to the existing all-weather highway at Wrigley, Northwest Territories.

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6.0 DEVELOPMENT SUMMARY

This section presents an overall discussion of the development of the Highway in the Tulita District. Historical or background information on the earlier work from the 1970s, 1980s, and 1990s is outlined to provide an understanding of the history of development. A discussion of the alignment options is presented to demonstrate that the historical work has been useful in the current development of the Highway. Design parameters, a description of the physical infrastructure, quantity and cost estimates and construction approach are also presented. To summarize:

- The work undertaken in the development of the preliminary design for the Highway and the PDR builds on the previous work that has been undertaken since the early 1970s.
- The physical infrastructure includes an average of 8.5 m wide gravel driving surface with a horizontal and vertical alignment designed to support an operating speed of 80 km/hr (posted speed limit). The design approach is one of mostly fill only, but includes sections of cut to obtain the vertical alignment and where thaw-sensitive ground is not apparent. This approach has been undertaken to protect the permafrost from thawing and mitigate future operational challenges that could result.
- Over 50% of the new alignment follows the existing winter road. This minimizes the footprint and the impact to areas of traditional use, heritage values, and the overall environment. A majority of the permanent bridges on the winter road will be used in their present location. There are 11 new bridge crossings, including the Great Bear River Bridge, and a number of smaller stream crossings that have been identified for either culverts or small bridges. Single lane bridges meet the requirements for traffic volumes and safety.
- The preliminary design also considers the potential for future installation of fibre optic cable. Maintenance camps and emergency shelters will be included. The specific location of these permanent facilities along the Highway will be determined in the detailed design stages of the project development.
- The alignment options considered in the preliminary design include the alignment defined by the federal government in the early 1970s, a new and separate routing study undertaken in the development of this PDR, the MGP alignment, and the existing winter road with an overall consideration of developing a common Transportation Corridor for linear infrastructure. The preliminary design, location of the Highway, and location of potential material sources also consider avoiding areas of heritage value, traditional use, and environmental sensitivity.
- The preliminary estimate for material required for construction of the Highway is over eight million cubic metres. Twenty-seven potential material sources have been identified along the Highway and sixteen of these are on Sahtu lands. All of the potential material sources, bridge crossings, and the Highway alignment will require geotechnical investigation and surveys to support the detailed design, material source management, and construction planning in the next steps in the project development.
- The preliminary cost estimate for the Highway is $599 million, and this includes engineering, design, construction administration, environmental monitoring, and construction.

- Most of the embankment and bridge construction will take place in the winter months. Summer activities will include compaction of the embankment, and placing of surfacing gravel. Construction will be mobilized from a number of points along the alignment. Once approvals are in place, construction will occur with an accelerated approach with large scale plant and multiple spreads, with design staying just ahead of construction. Construction of the Highway in the Tulita District is anticipated to take place at the same time as construction in the other regions. The estimate for overall completion is three and a half years to four years after funding and regulatory approvals for construction are in place.

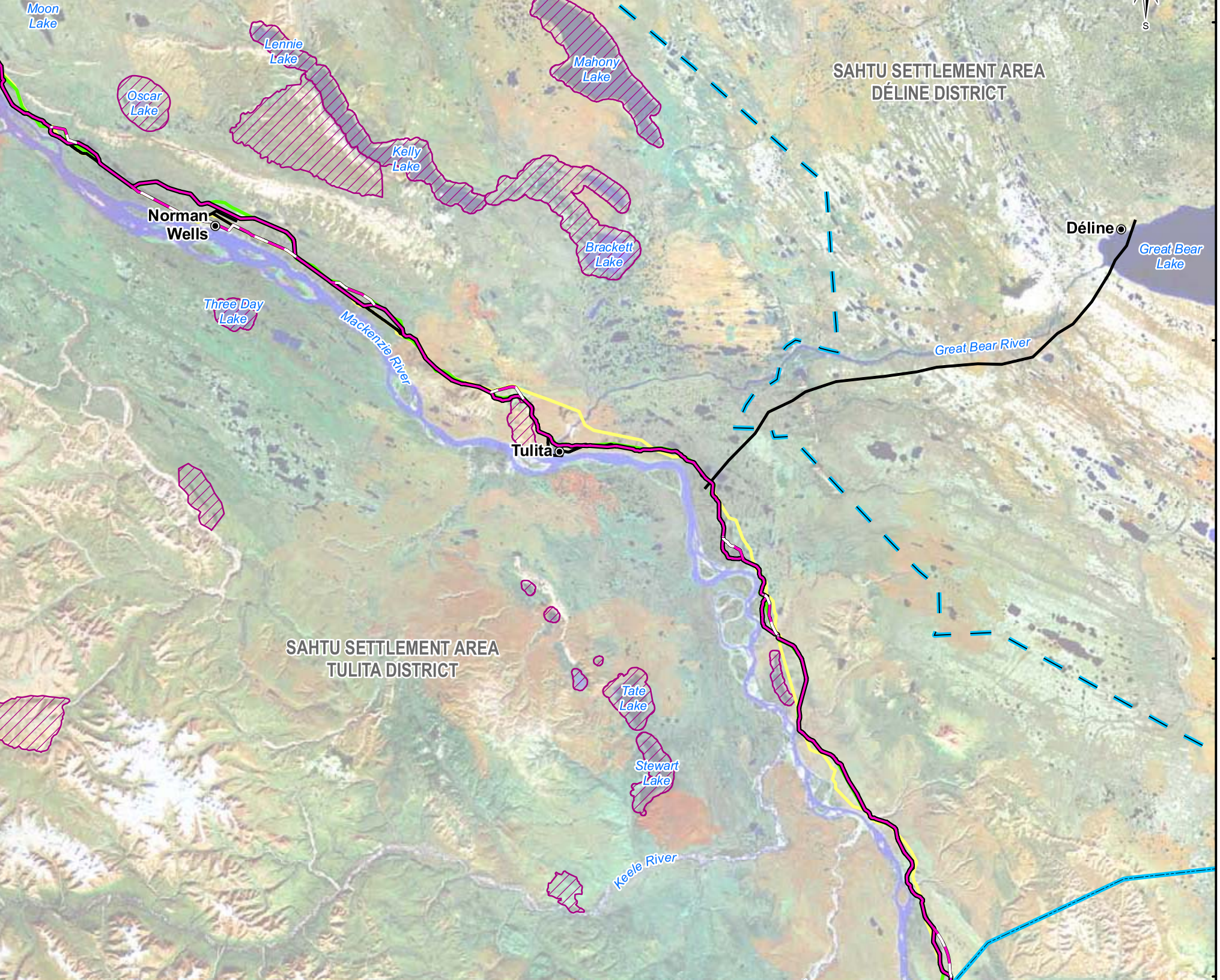
6.1 Historical Development of the Mackenzie Valley Highway

6.1.1 Federal Government and the 1970s

The overall highway concept through the Mackenzie Valley is shown on Figure 3-1. In 1972, Public Works Canada (PWC) began steps towards the development of an all-weather highway from Fort Simpson (the terminus of the all-weather highway in 1972) to the Dempster Highway. At the time, an ambitious schedule of preliminary engineering, design, and construction to be undertaken over a four-year period was proposed for the extension of the Highway north from Fort Simpson. Survey, geotechnical investigation, environmental studies, bridge and culvert designs, and for some sections, detailed design and tender package preparation were undertaken, but actual construction of the highway ceased in 1977 just south of Wrigley. Thus, only a 210 km extension from Fort Simpson to south of Wrigley was constructed by the federal government before the transfer of the NWT highway system to the GNWT. The highway to Wrigley was completed by DOT in the mid 1990's with a ferry at N'Dullee Crossing (Camsell Bend) and the Willow Lake River Bridge (DOT 1989).

The highway alignment that was proposed and studied in the 1970s by PWC is shown on Figure 6-1. Provisional grading contract packages for grading and concept designs for major bridge structures were developed in the 1970s. Although the desire in the 1970s was a four-year period for design and construction, when the grading contract packages were developed, the estimates for construction were revised to eight years for the full highway from Fort Simpson to the Dempster and relied on construction resources from both northern and western Canada.

The basic design parameters that were considered in the 1970s were for a 60 mile per hour (mph) or 100 km/hr gravel surfaced highway with double lane bridges. The design and construction approach was one of embankment overlay or fill in most places to avoid cuts in permafrost and ground of high ice content. This is a design and construction approach that is intended to mitigate thawing of unstable ground and is a best practice that is carried forward today. In the design, both in the 1970s and today in the Tulita District, the permafrost and ice conditions of some sections of the natural ground are such that cuts can be safely used to obtain the desired vertical alignment.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DÉLINE DISTRICT
Norman Wells
Brackett Lake
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Mackenzie River
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6.1.2 Department of Transportation, Government of the Northwest Territories, and 1980s and 1990s

In the early 1980s, still under the authority of the federal government, the highway grade was completed to Wrigley, but an all-weather connection was still not in place given that N'Dulee Crossing (Camsell Bend) did not have a ferry (winter crossing only) and a major bridge crossing was not in place at Willow Lake River just south of Wrigley (DOT 1989).

In 1989, the federal government devolved the authority over the highway system to the GNWT and an overall Transportation Strategy was developed for the Northwest Territories. The Transportation Strategy set out the priorities for the Northwest Territories in the coming years, including the extension of the Mackenzie Highway. As input to this strategy, the Transportation Engineering Division of DOT prepared a report entitled "Mackenzie Highway, Wrigley to Inuvik Extension" (DOT 1989). This report outlines the previous work on the highway completed by the federal government in the 1970s and provides an updated cost estimate. For the most part, the alignment, design standards, and construction approach for the highway were unchanged with the exception of consideration of single lane bridges (rather than two lane bridges) and a tender/construction approach that shortens the estimated eight years to six or seven years by increasing the number of grading contracts that are underway at any one time, or combining shorter single year contract segments into larger multi-year contract segments. The approach in the 1990s still focused on delivery by available local forces.

At the time of devolution of responsibility for the highway system, and as is still the case, DOT does not have the financial basis to undertake construction of new infrastructure. Federal funding was, and is, still required.
The additional development work on the Highway that was completed in this period was the installation of a ferry camp and vessel at N'Dulee Crossing in the early 1990s and the completion of the 210 m, two-span Willow Lake River Bridge in 1994. This connected the community of Wrigley to Fort Simpson on an all-weather basis, but did not serve to connect the communities in the Sahtu. During this period, DOT also undertook to review the implementation plan for the Mackenzie Highway Extension and in 1992, published a report entitled "Implementation Plan for the Mackenzie Highway Extension". This report focused on construction by local forces and proposed a 20-year time frame to optimize local economic benefits.

In 1999, as part of an update to the Highway Strategy, DOT undertook three companion studies to update the Mackenzie Valley Highway initiative. The three studies were an engineering update, an environmental scoping study, and a benefit/cost analysis. The engineering update focused on the proposed highway alignment from the 1970s, but proposed a modification to the design standards. For the most part, the highway would be designed to allow an operating speed of 80 km/hr to 90 km/hr, but some sections would be designed to only allow for a 60 km/hr operating speed to compensate for some of the challenges associated with the local relief (DOT GNWT 1999). The 1999 report provided an updated cost estimate but still focused on a community based construction approach over a time period that could likely extend beyond 10 years.

6.1.3 Department of Transportation, Government of the Northwest Territories and 5658 NWT Ltd.

In 2010, a MOU was signed between 5658 NWT Ltd. and DOT to set the terms for the completion of a PDR to construct the section of the Highway that goes through the Tulita District, SSA. In launching this new chapter in development of the Highway, the work completed in 1970s and 1990s has been reconsidered by leadership in the Tulita District and DOT. 5658 NWT Ltd. and DOT began the process by looking at route options in 2010 that follow the proposed MGP route, the existing winter road and the route put forward by the federal government in the 1970s. Ultimately, the view of the people of the Tulita District is to establish a single Transportation Corridor that reduces the overall environmental impact to the land. This approach results in transportation, utility, and communication infrastructure (highway, pipeline, fibre optic cable) in a single development corridor that protects the land, wildlife habitat, traditional land use, and cultural values.

During the MGP studies, information was gathered and closely scrutinized for the prospect of building the pipeline. Much of the information that is publically available from the MGP studies is transferrable to the Highway project and has been useful for undertaking the preliminary or conceptual design for the Highway as presented in this PDR.

6.2 Alignments Considered in 2010/2011

The alignment options considered in the preliminary design for the Highway are illustrated on Figure 6-1. These are:

- PWC 1970s alignment;
- the existing Winter Road;
- MGP alignment; and
- alignment options for specific segments identified in the 2010 routing study and field program.

These options and how they are considered in the preliminary design for the Highway are discussed below.

6.2.1 Public Works Canada 1970s Alignment

The PWC alignment from the 1970s is noted as PWC 1974 Highway Concept Route on Figure 6-1. As noted above, a considerable amount of survey, geotechnical investigation, and preliminary design was undertaken along this proposed alignment in the period between 1972 and 1976.

At the time of the development of the original alignment, the SLUP was not yet in place and the Special Management Zone along the Mackenzie River was not identified. Most of the PWC 1974 highway concept route, as well as the existing winter road, is located within the Special Management Zone.

Section 17 of the *SDMLCA* identifies the PWC 1974 highway concept route as the future alignment for the all-weather highway, but also provides the process by which the location of the future highway is to be confirmed through engineering studies. The preliminary design and this PDR form those engineering studies to advance the PWC 1974 highway concept route to an all-weather highway alignment that meets the needs and design considerations of the present day.

This alignment was one of the three starting alignments that were used in the development of this preliminary design and project description.

6.2.2 Existing Winter Road

The existing winter road is shown on Figure 6-1. This road has been in place on a seasonal basis for many years. In the last 10 to 15 years, DOT has made efforts to improve the alignment (straightening some segments, widening the cleared right-of-way) for safety reasons, and has upgraded or replaced temporary stream crossings with permanent bridge structures. These bridges are single lane structures that have been designed and located with a future all-weather highway alignment in mind. The initial routing study and preliminary design for the current all-weather highway alignment has considered as much as is practical the existing winter road alignment and the existing bridge structures.

6.2.3 Mackenzie Gas Project Alignment

The MGP alignment that is currently identified in the available public information is shown on Figure 6-1. The pipeline within the Tulita District follows a path similar to the PWC 1974 highway alignment.

The MGP alignment and the available information was the second of the two starting alignments used in the development of this preliminary design and project description.

6.2.4 Transportation Corridor and Initial Routing Study

As noted above in Section 6.1, the view of the people of the Tulita District is to establish a single Transportation Corridor that reduces the overall environmental impact to the land. This approach results in a transportation, utility, and communication infrastructure (highway, pipeline, fibre optic cable) in a single development corridor that protects the land, wildlife habitat, traditional land use, and cultural values. With this in mind, initial routing studies were undertaken to identify a preliminary alignment and minor options that were in the general vicinity of the MGP and utilized as much of the existing winter road as practical.

Using available topographic maps, air photo imagery, and other available information, an initial desktop routing study was undertaken to define a preliminary highway alignment and minor alternatives, potential stream crossing locations, and potential material sources. The development of the initial routing was based on the following constraints:

- avoid ice rich and unstable terrain;
- avoid steep grades and deep valleys;
- find locations to cross major streams to minimize bridge lengths;
- avoid locations that are obvious nesting or denning areas for wildlife;
- avoid locations that have obvious cultural or heritage potential;
- situate the route on or near potential material sources to minimize the need and/or length of temporary or permanent access roads;

- minimize need to cross the MGP;
- minimize infrastructure footprint by selecting a route near the MGP while maintaining sufficient tree or vegetation screen between the Highway and the pipeline (minimum 50 m from the pipeline alignment); and
- utilize as much of the existing winter road alignment and bridge structures as practical.

The initial routing study was the basis for the June 2010 field program and the preliminary design. The outcome of the routing study was the preliminary highway alignment and minor alternatives that is shown on Figure 6-1. This information was used as the basis of the field program undertaken in September 2010 by environmental, engineering, and archaeology specialists. The field program produced observations along the preliminary highway alignment and minor alternatives that were then used for the environmental and heritage resources overviews. These overviews are documented in other sections of this PDR. The overviews, the observations by the engineering specialists on the field program and the information received in the initial consultations were then used to commence the preliminary design and refine the alignment further.

6.3 Design Approach for the Highway

6.3.1 Design Parameters

The preliminary design begins with further development of the constraints outlined above in the initial routing studies into specific design parameters. These are based on operational and safety considerations for the Highway (traffic volumes, types of vehicles expected to use the highway, desired operating speed), accommodation and protection of permafrost and ice rich terrain, avoiding or minimizing impact to areas described as sensitive in the environmental and heritage resources overviews, and respect for questions and comments raised in the consultations.

Design parameters are based on published and accepted guidelines and best practices for developing infrastructure in the Northwest Territories. DOT has reviewed and accepted the design parameters developed for the Highway. Working within a permafrost region such as this, particularly in the face of the impacts of climate change on permafrost, requires extensive consideration of past experience (both good and bad) and adaptation of engineering principles and practices. The specific impacts of climate change and the adaptation in the preliminary design is discussed in a later section of this PDR; however, it is important to note that a recently published guideline entitled "Development and Management of Transportation Infrastructure in Permafrost Regions" (Transportation Association of Canada 2010) was referred to in the development of the preliminary design and construction approach for the Highway in the Tulita District.

The design parameters considered in this preliminary design are based on estimated traffic volumes and other operational considerations on public highways in the Northwest Territories. The estimated traffic volumes for the Highway are 50 vehicles per day (very low) with an estimated 13% to 15% of those as heavy truck traffic. Using this and the accepted design practices in the Northwest Territories for public highways, the specific design parameters have been obtained from the Geometric Design Guidelines published by the Transportation Association of Canada (TAC). The estimated traffic volumes take into account future increases due to development and tourism, and the proposed design parameters will serve

foreseeable future traffic increases. The embankment height is specific to the terrain conditions in the Mackenzie Valley and is based on the need to protect permafrost and ice rich soils from degradation under traffic loading and the presence of the highway infrastructure.

The following table presents a summary of the design parameters used in the preliminary design for the Highway.

Table 6-1: Design Parameters

Mackenzie Highway – Tulita District	
Design Criteria	**Typical**
Desired Road Design Speed	90 km/hr
Posted Speed Limit (reduce to 50 km/hr at bridge crossings)	80 km/hr
Horizontal Alignment	
Desired Curve Radius	340 m
Minimum Curve Radius (see notes)	250 m
Desired Sight Distance	n/a
Minimum Sight Distance	n/a
Length of Spiral (Radius 2000 to 360)	50 m
Length of Spiral (Radius 340 to 300)	60 m
Length of Spiral (Radius 290 to 260)	70 m
Length of Spiral (Radius 250)	80 m
Vertical Alignment	
Minimum Passing Sight Distance	n/a
Minimum Stopping Sight Distance	n/a
Minimum Sag K Value	13
Minimum Crest K Value	25
Minimum Lengths of Vertical Curves	80 m
Desired Maximum Grade	6 %
Maximum Grade	8 %
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 %
Side Slopes - All Sections	3:1
Ditch Bottom widths	1 m
Ditch depths from Shoulder Elevation	1 m
Embankment Height	
Dry (ice poor) Till and Outwash Deposits	1.4 m
Wet (ice medium to ice rich) Till and Outwash Deposits	1.4 m to 1.6 m
Wet Silts and Clays (ice rich)	1.6 m to 1.8 m
Thick Organic Peatlands and Ice Rich Permafrost	1.8 m
Thickness of Base Course Gravel	200 mm

6.3.2 Design Approach and Considerations

The typical highway cross-sections for cut and fill are illustrated on Figure 6-2 and Figure 6-3.

In general, the approach taken to this section of the Mackenzie Valley Highway is to construct a 'fill only' embankment, in the great majority of the overall roadway. Approximately 93% or 263 km of the proposed 285 km of highway uses this method of construction. Not all locations require a fill only approach, and indeed some areas benefit from a local 'cut and fill' design and construction approach.

There are three basic types of locations where such a cut/fill approach could be utilized:

- Type 1 – areas of near surface bedrock impacting the road's vertical or horizontal alignment;
- Type 2 – areas where non-ice rich soils would allow cuts to be carried out without long term negative impacts; and
- Type 3 – areas where ice rich soils would require any cuts made to be insulated in some manner, and then regularly maintained and filled in areas of subsidence.

The first locations are found near the north end of the section, near Gibson's Gap (1,079 km), and crossing the ridgeline just north of Tulita (949 km). In those locations, near surface bedrock would be excavated to both improve alignments, and to provide quarried material for roadbed construction.

The second type of locations are often found at approaches to bridge locations, where the use of cut and fill allows much lower bridge embankment heights and shorter bridge lengths. In many of these locations, existing cuts, without long term subsidence show that there is no ice rich material to degrade when exposed.

Existing bridge approach vertical grades are quite steep, in the 12% to 20% range at several of the bridge sites, and would benefit from additional excavation to lessen approach grades. Erosion is also evident at these locations in the ditch lines as well as at the bridge abutments. Erosion control measures such as ditch blocks and rip-rap slope protection would be utilized to mitigate erosion issues.

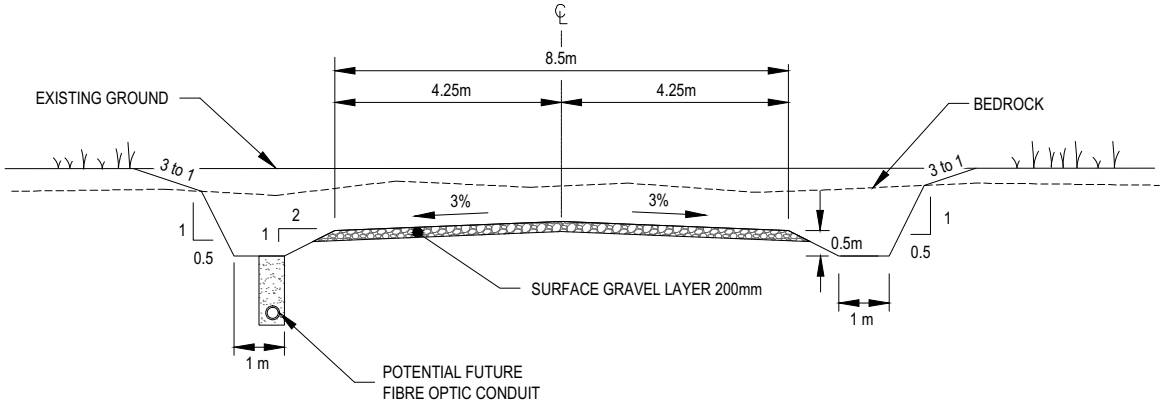
There are a number of locations where new bridge locations do not provide any history of performance with cuts in the location of the proposed new bridge.

In these areas geotechnical drill programs must be carried out prior to finalizing detailed design for the road and bridge in that location, to determine whether or not ice rich ground would be encountered at the location of the bridge and the bridge approach road cuts.

If ice rich material is encountered, the first option would be to change the location of the crossing or the grade line of the approach road to avoid cutting in ice rich material. If such a relocation was not practical, the third type of cut/fill approach would be taken.

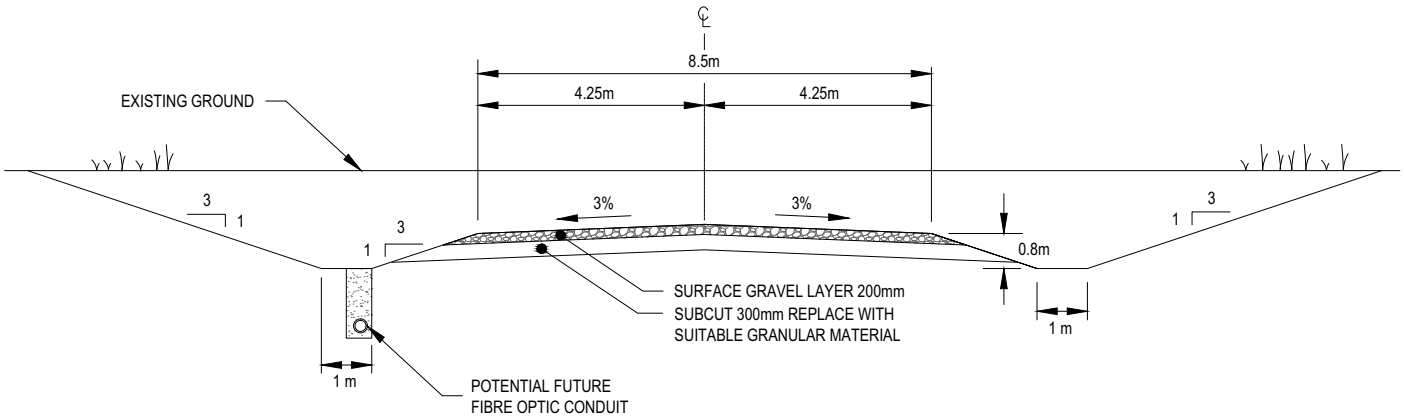
The cut slopes would be cut back and insulated with imported non frost susceptible material, and possibly synthetic insulation as well, and the maintenance approach would assume yearly rehabilitation of the approach roads.

This is the less desirable option and it is therefore imperative to carry out a comprehensive geotechnical investigation of subsurface conditions in all areas of potential roadway cut situations to try to avoid this option.



TYPICAL HIGHWAY CROSS SECTION

ROCK CUT SECTION



TYPICAL HIGHWAY CROSS SECTION

EARTH CUT SECTION

LEGEND

NOTES:
POTENTIAL FUTURE FIBRE OPTIC CONDUIT IS SHOWN FOR ILLUSTRATIVE PURPOSES ONLY. FIBRE OPTIC CABLE IS NOT PART OF THE MACKENZIE VALLEY HIGHWAY PROJECT.

MACKENZIE VALLEY HIGHWAY
TULITA DISTRICT

TYPICAL HIGHWAY
CROSS SECTION - CUT

PROJECTION	DATUM

Scale 1:150
1 0 1 3m

FILE NO.
Y22101155 Typical Section.dwg

PROJECT NO.	DWN	CKD	APVD	REV
Y22101155	SM	RM	RM	0

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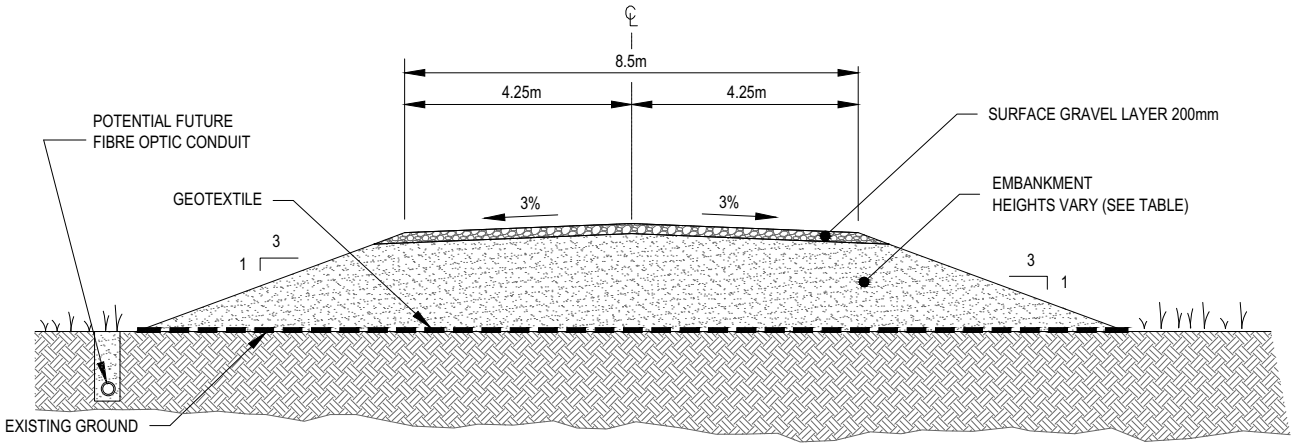
Figure 6-2

Q:\Vancouver\Drafting\Environmental\Y221\Y22101155\CADD\Preliminary Design\Y22101155-Typical Section.dwg [FIGURE 6-2 CUT] October 11, 2011 - 1:53pm andrew.deepwell



TYPICAL HIGHWAY CROSS SECTION
FILL SECTION

TERRAIN TYPE	DESCRIPTION	EMBANKMENT HEIGHTS
1	DRY (ICE POOR) TILL AND OUTWASH DEPOSITS	1.4 m
2	WET (ICE-MEDIUM TO ICE-RICH) TILL AND OUTWASH DEPOSITS	1.4 to 1.6 m
3	WET SILTS AND CLAYS (ICE-RICH)	1.6 to 1.8 m
4	THICK ORGANIC PEATLANDS AND ICE-RICH PERMAFROST	1.8 m

LEGEND

NOTES:
POTENTIAL FUTURE FIBRE OPTIC CONDUIT IS SHOWN FOR ILLUSTRATIVE PURPOSES ONLY. FIBRE OPTIC CABLE IS NOT PART OF THE MACKENZIE VALLEY HIGHWAY PROJECT.

MACKENZIE VALLEY HIGHWAY
TULITA DISTRICT

TYPICAL HIGHWAY
CROSS SECTION - FILL

PROJECTION	DATUM

Scale 1:150
1 0 1 3m

FILE NO.
Y22101155 Typical Section.dwg

PROJECT NO.	DWN	CKD	APVD	REV
Y22101155	SM	RM	RM	0

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Figure 6-3

Q:\Vancouver\Drafting\Environmental\Y221\Y22101155\CADD\Preliminary Design\Y22101155-Typical Section.dwg [FIGURE 6-3 FILL] October 11, 2011 - 1:53pm andrew.deepwell

6.4 Comparison of Alignment Options and the Preferred Alignment

6.4.1 Comparison of Alignment Options

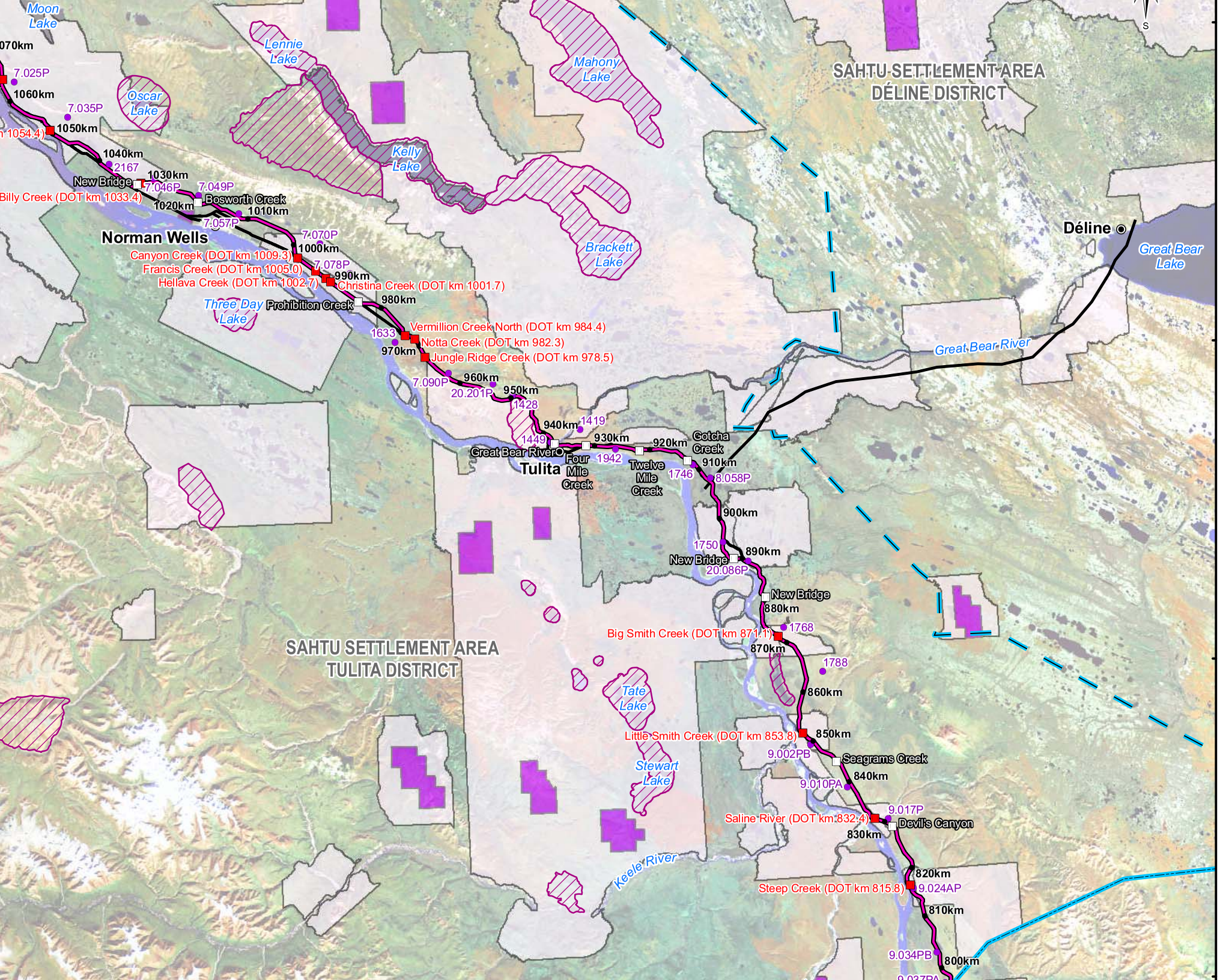
Typically, major alignment options would be developed and compared based on community need, constructability, cost, operating conditions, and minimization of impact to the land and the environment. The desire to develop a Transportation Corridor in the vicinity of the currently proposed MGP alignment to minimize development footprint eliminated the need to look for major alignment options outside of the general vicinity of the main alignments noted above.

The preliminary alignment and the minor alignment options prepared in the fall of 2010, based on the initial routing studies, were developed and refined based on the design parameters, the outcomes of the field studies, the outcome of the overview studies, attempts to minimize footprint size and construction material requirements, and suggestions provided in the three rounds of consultation to obtain the preferred alignment. The preferred alignment for the Highway is shown on Figure 6-4. Detailed map sheets at a scale of 1:25,000 are included in Appendix A.

Minor alignment options were considered and confirmed at various locations where suitable terrain, topography, stream/river crossing opportunities and protection of sensitive areas (i.e., traditional use, values at risk, heritage resources, environmental sensitivity, etc.) could be improved from the existing winter road alignment. For example:

- Oscar Creek: DOT has installed a permanent stream crossing at Oscar Creek that is not currently in use on the existing winter road. An option for realignment of this stream crossing further upstream was considered in the preliminary design. In considering the terrain, topography, length of bridge required, and overall cost, it was confirmed that the permanent stream crossing at Oscar Creek is preferred and included in the preliminary design for the Highway. At the time of detailed design and construction, stream training to minimize erosion potential on the south abutment will be required (Figure 6-5).
- In the Vicinity of Norman Wells: Four alignment options have been considered in the preliminary design for the Highway in the vicinity of Norman Wells: through town; along the existing winter road; straight along the foot of the north hills; and following the topography along the foot of the north hills. The preferred alignment follows the topography along the foot of the north hills. This is preferred because it does not increase heavy truck traffic through town, it is dryer and more stable terrain than the existing winter road alignment, the topography is suitable with only minor grading to meet the design parameters, it is near a suitable material source and it is within the lands that are accessible and could be further developed near Norman Wells (Figure 6-6).

- In the Vicinity of Tulita: Alignment options in the vicinity of Tulita consider terrain and topography as well as proximity to the Hamlet of Tulita and a suitable location to cross the Great Bear River. Alignment options and river crossing locations were considered in detail in the design and regulatory submission for the Great Bear River Bridge in 2006 (EBA 2006). In preliminary design for the Highway, the available information has been reviewed, and the specification locations for the crossing revisited during the September field program. The location for the Great Bear River Bridge presented in 2006 is considered the most efficient and suitable location and is the alignment option included in the preferred alignment for the Highway (Figure 6-7). The two most important reasons that this location is selected are a) it is downstream from the community's water intake, ensuring the security of the community's water supply if a vehicle collision or spill were to occur; and b) the location requires a short bridge and short length of Highway, minimizing the foot print and reducing the impact on the land. The location also has better access for construction (i.e., near the barge landing and located nearer to the community to support construction), and the length of bridge and highway is less making the incremental construction cost approximately $10M less (EBA 2006). The location of the Highway along the north side of the airstrip takes into consideration the observed ground conditions as well as providing sufficient room for future expansion of the airstrip and the Highway. These items will be confirmed in the detailed design stage.
- Realignment Approximately 45 km East of Tulita: Approximately 45 km east of Tulita the preferred alignment diverges from the existing winter road (at approximately km 890), extends west and then north to rejoin the existing winter road at approximately km 896 (see Appendix A, Maps 38 and 39). The preferred alignment in this area follows more closely to the PWC 1974 alignment than the existing winter road. This choice was made in the preliminary design for two reasons a) to avoid impact to existing cabins (noted as Heritage Value Sites on Maps 38 and 29, Appendix A), and b) to gain direct access to a potential material source near km 893. In the next stages of detailed design, one-on-one interviews with the owners of the cabins will be undertaken to discuss and refine the alignment to ensure desired access is maintained and impact is minimized.


Moon Lake
Lennie Lake
Mahony Lake
Oscar Lake
Kelly Lake
Brackett Lake
Three Day Lake
Tate Lake
Stewart Lake
Great Bear Lake
Great Bear River
Keele River
SAHTU SETTLEMENT AREA
DÉLINE DISTRICT
SAHTU SETTLEMENT AREA
TULITA DISTRICT
Déline
Norman Wells
Tulita
New Bridge
Bosworth Creek
Prohibition Creek
Four Mile Creek
Twelve Mile Creek
Gotcha Creek
Seagrams Creek
Devil's Canyon
7.025P
1060km
7.035P
1050km
1040km
2167
1030km
7.046P
7.049P
1020km
1010km
7.057P
7.070P
1000km
7.078P
990km
980km
1633
970km
7.090P
960km
20.201P
950km
1428
940km
1419
1449
930km
920km
1942
910km
1746
8.058P
900km
1750
890km
20.086P
880km
1768
870km
1788
860km
850km
9.002PB
840km
9.010PA
9.017P
830km
820km
9.024AP
810km
9.034PB
800km
Billy Creek (DOT km 1033.4)
Canyon Creek (DOT km 1009.3)
Francis Creek (DOT km 1005.0)
Hellava Creek (DOT km 1002.7)
Christina Creek (DOT km 1001.7)
Vermillion Creek North (DOT km 984.4)
Notta Creek (DOT km 982.3)
Jungle Ridge Creek (DOT km 978.5)
Great Bear River
Big Smith Creek (DOT km 871.1)
Little Smith Creek (DOT km 853.8)
Saline River (DOT km 832.4)
Steep Creek (DOT km 815.8)
65°30'0"N
65°0'0"N
64°30'0"N

6.4.2 Description of the Preferred Alignment

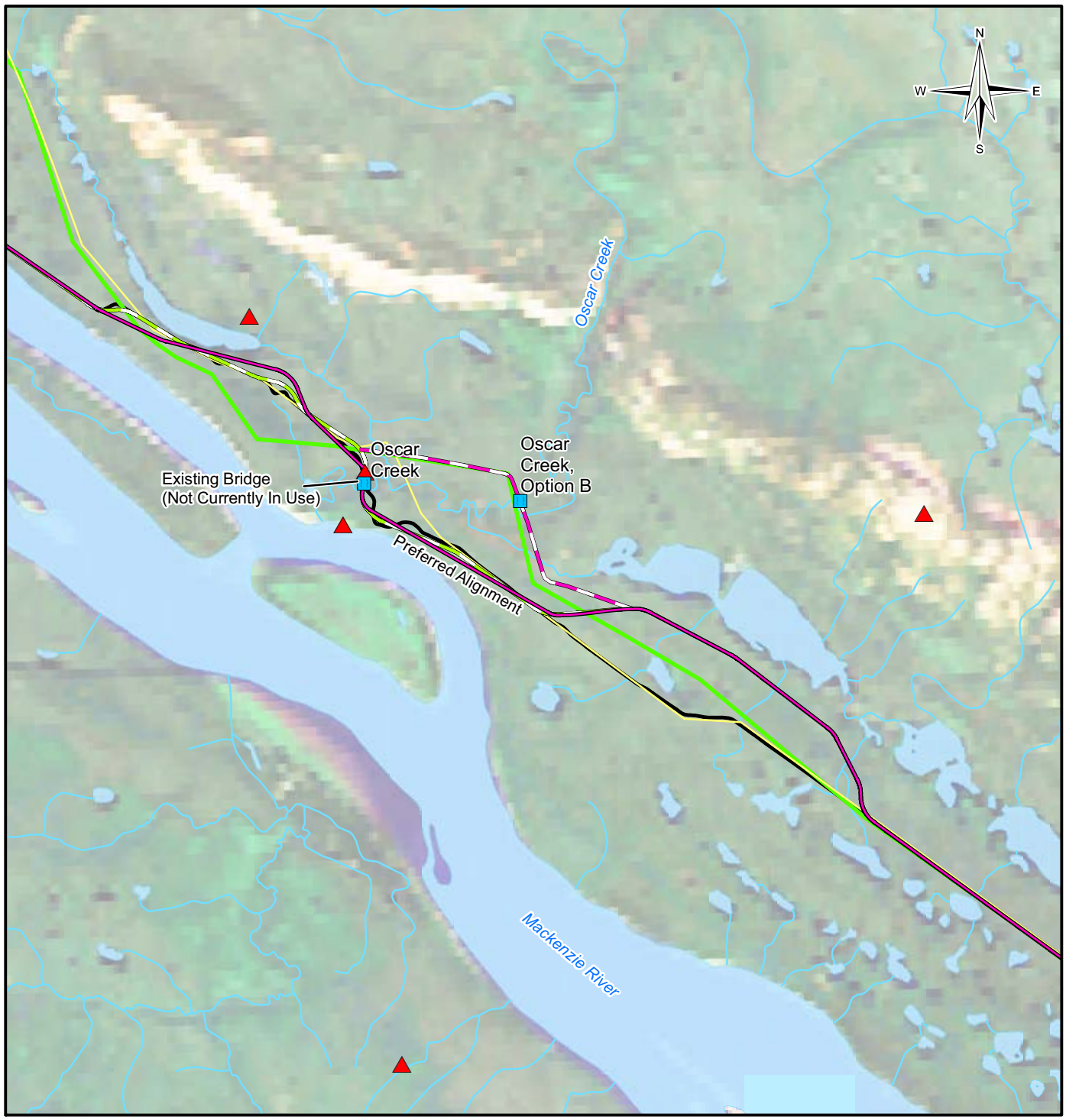
As noted above, the preferred alignment is shown on Figure 6-4. The design parameters presented above are desirable. It is not cost effective to meet the desirable design parameters in all cases; however, an appropriate level of safety on the Highway can still be maintained by putting appropriate operational controls in place.

These design parameters are recognized as desirable. For the most part, the preliminary design meets or exceeds the design parameters. It is not unusual for there to be design exceptions introduced into a highway design, if it is understood that operational controls can be introduced and reductions in operational level of service over short distances are acceptable. An example of an operational control is a reduced speed limit through a tighter curve and an example of a reduction in operational level of service is a larger vehicle travelling slower over a short but steeper hill.

The exceptions to the design parameters and associated operational controls include:

- 100 m horizontal curve radii on approach to Steep Creek, 50 km/hr design speed, 40 km/hr posted speed limit;
- 10% grade at pipeline crossings, posted with appropriate warning signs;
- shorter than desirable vertical curves on approach to Devil's Canyon, 50 km/hr design speed, 40 km/hr posted speed limit;
- 150 m horizontal curve radii and 10% grade on approach to Saline River, 50 km/hr design speed, 40 km/hr posted speed limit;
- shorter than desirable vertical curves on approach to Seagram's Creek and 10% grades, 50 km/hr design speed, 40 km/hr posted speed;
- shorter than desirable vertical curves on approach to Little Smith Creek, 50 km/hr design speed, 40 km/hr posted speed limit; and
- 100 m horizontal curve radii on approach to Oscar Creek, 50 km/hr design speed, 40 km/hr posted speed limit.

The Highway will be positioned within a cleared right-of-way that is typically 60 m wide. In some locations, where the height of the Highway to be constructed is quite high relative to the natural ground and the toe of the slope of the embankment extends more than 30 m from the centreline of the Highway on either side, then the right-of-way through these segments will be wider to accommodate the infrastructure. Additional right-of-way will also be required at major bridge crossings, maintenance camps, and in areas where pull-offs and chain up areas are necessary to support safe travel. The total footprint of disturbance will also include temporary access roads and development of material sources. Right-of-way and footprint of disturbance will be determined at the detailed design stage. The estimate for right-of-way and footprint is approximately 250 ha based on the preliminary design undertaken for this PDR. Over half of that is area that is already disturbed as part of the footprint of the existing winter road. It is not anticipated that the full width of a Transportation Corridor as discussed earlier would be cleared, but it is possible that in the future, rights-of-way for parallel developments (i.e., Highway and pipeline) may overlap within that Transportation Corridor.



LEGEND

- Heritage Value Site
- Bridge
- MVH Concept - June 2011 (Preferred Alignment)
- MVH Concept - EBA March 2011, Main
- MVH Concept - EBA March 2011, Alternative
- PWC 1974 Highway Concept Route
- Mackenzie Gas Project Corridor
- Public Winter Road, Commissioner's Land
- Water Body

NOTES
Base data source: ESRI
MGP & PWC 1974: GNWT
Heritage Sites: ENR
Alignment is considered preliminary and is subject to change

MACKENZIE VALLEY HIGHWAY TULITA DISTRICT

Alignment Options Near Oscar Creek

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:100,000
2 1 0 2
Kilometers

FILE NO. Y22101155_Figure 6-5 Oscar Creek.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y22101155	TV	MS	RM	0

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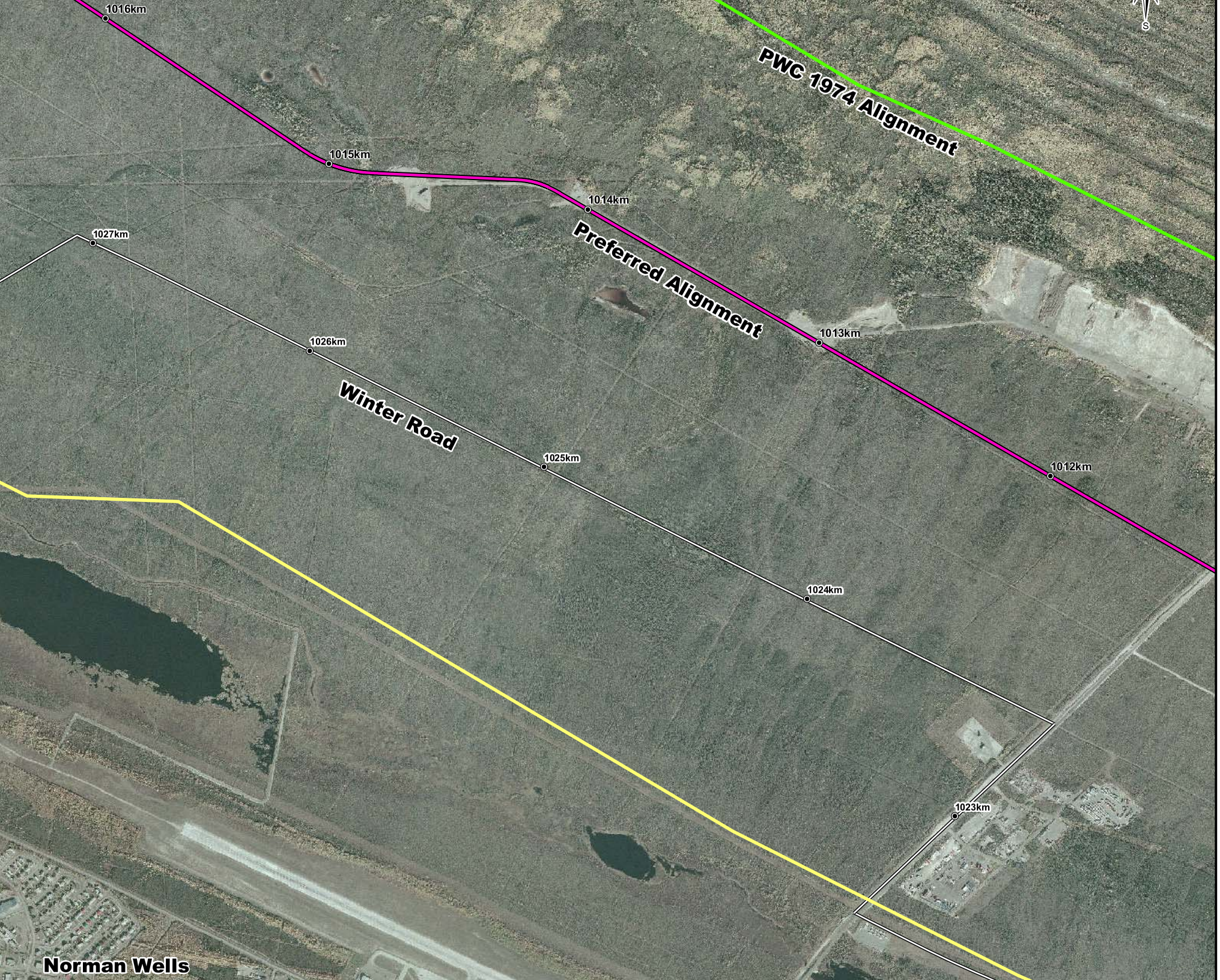
Figure 6-5

M:\TRANSPORTATION\NWT_Mackenzie_Highway\Y22101155_TulitaMaps\Overview\Y22101155_Figure 6-5 Oscar Creek.mxd modified 10/13/2011 by tony.vuong



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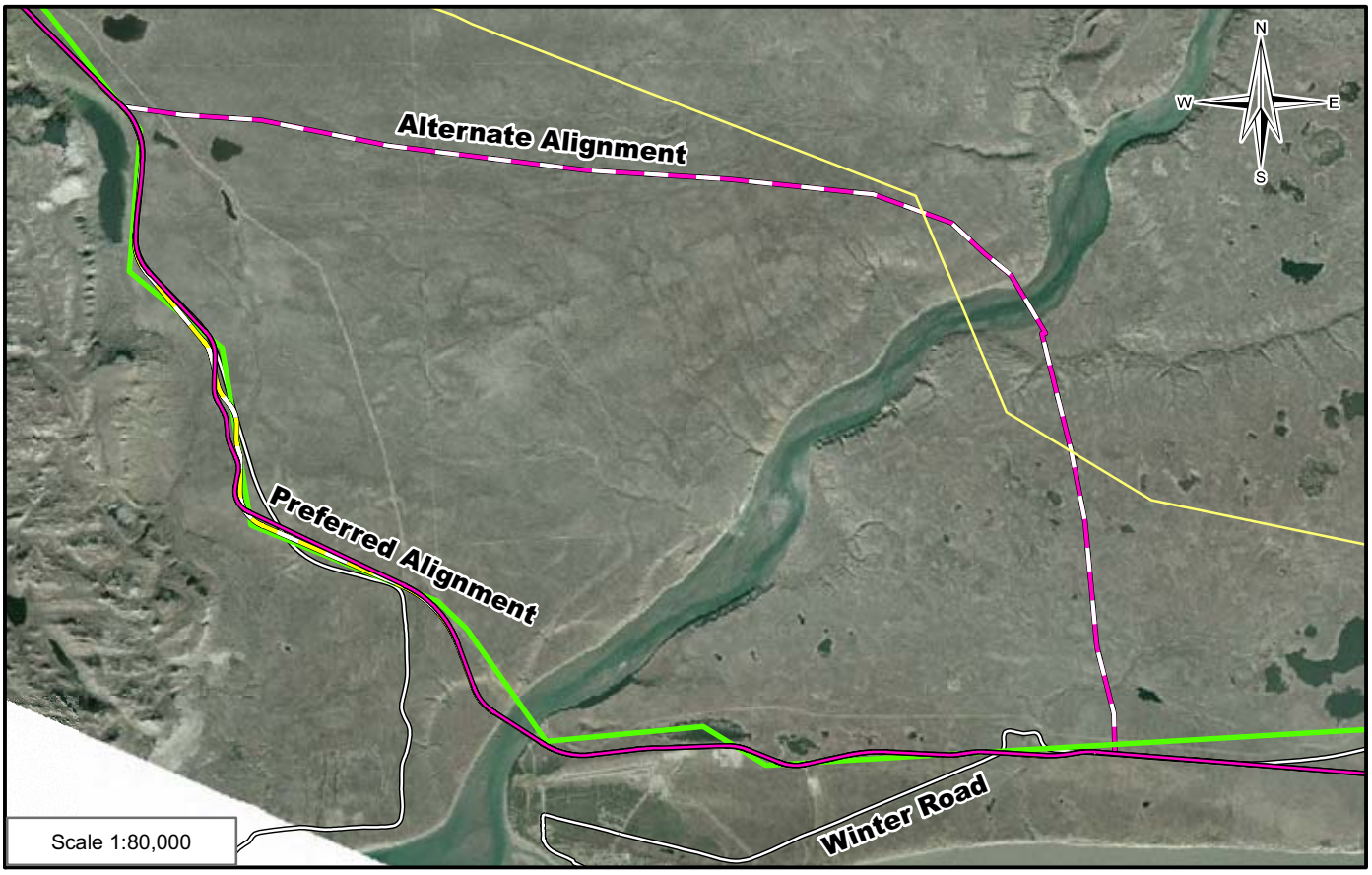

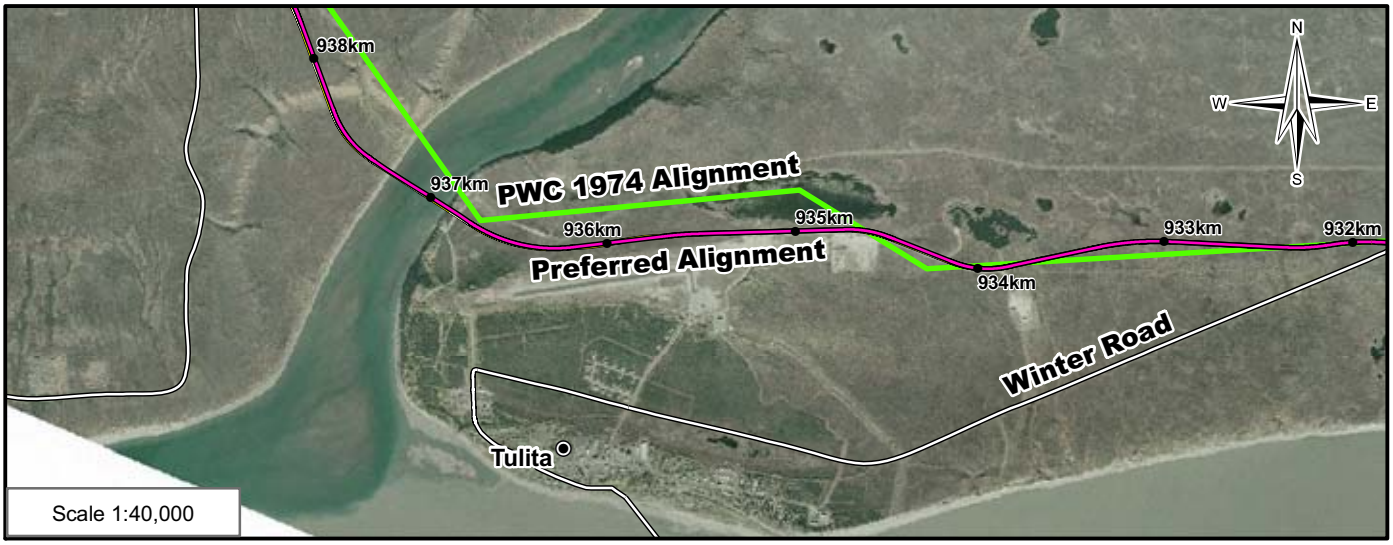

LEGEND

- Communities
- MVH Concept - June 2011 (Preferred Alignment)
- MVH Concept - EBA March 2011, Main
- MVH Concept - EBA March 2011, Alternative
- PWC 1974 Highway Concept Route
- Public Winter Road, Commissioner's Land
- Mackenzie Gas Project

NOTES

Base data source: ESRI
MGP & PWC 1974: GNWT
Alternate alignment: Great Bear River Bridge Project Description Report (EBA 2006)
Alignment is considered preliminary and is subject to change

MACKENZIE VALLEY HIGHWAY TULITA DISTRICT

Alignment Options in the Vicinity of Tulita

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:40,000

700 350 0 700

Metres

FILE NO. Y22101155_Figure 6-7 Tulita.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y22101155	TV	MS	RM	0

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Figure 6-7

M:\TRANSPORTATION\NWT_Mackenzie_Highway\Y22101155_TulitaMaps\Overview\Y22101155_Figure 6-7 Tulita.mxd modified 10/13/2011 by tony.vuong

Estimated footprint widths greater than 60 m wide:

- Great Bear River Bridge North approach cut (150 m wide);
- Great Bear River Bridge South approach cut (85 m wide);
- Saline River North approach cut (102 m wide);
- Seagrams Creek North approach cut (82 m wide);
- Steep Creek North approach cut (75 m wide); and
- five areas bridge approach cuts (60 m to 65 m wide). Overall, the preferred alignment for the Highway is described as:
- 264 km (92.6%) in fill;
- 18.5 km (6.5%) cut in earth;
- 2.5 km (0.9%) cut in bedrock;
- 285 km total road length;
- 149 km (52%) along the existing winter road alignment;
- 136 km (48%) along new alignment;
- max fill height 10 m;
- max cut height 19 m at Bear River Bridge approach; and
- max grade 10%.

6.5 Terrain, General Topography and Permafrost Along Preferred Alignment

The terrain and general topography along the preferred alignment are discussed in detail in the Section 10, Environmental Overview of this PDR. The key elements that are considered in the preliminary design are discussed below.

The Highway is located within two distinct physiographic regions: the Mackenzie Plain and the Franklin Mountains. The Mackenzie Plain is flat to gently undulating for the most part where it is underlain by fine-grained glaciolacustrine sediments. Terraced glaciofluvial and fluvial deposits flank the river locally and there are a few bedrock outcrops. The Franklin Mountains, located east of the Mackenzie Plain, comprise much steeper terrain. The mountains are discontinuously covered with either till or colluvial material. Fine tuning of the horizontal and vertical alignment of the route would take advantage of the flat areas and allow for avoidance of most of the steep and colluvial areas.

The section of the proposed Mackenzie Highway within the Tulita District lies entirely within the extensive discontinuous permafrost zone (50% to 90% of land area underlain by permafrost, Canada Permafrost Map, 1995). Ground temperatures are within the range of -1˚C to -3˚C.

The term "permafrost" describes a ground thermal condition where the soil or rock remains below 0˚C for two or more years, regardless of material type, ground ice distribution, or thermal stability. The two-year minimum stipulation is meant to exclude from the definition the overlying ground surface layer which freezes every winter and thaws every summer (called the "active layer" or "seasonal frost"). In undisturbed areas, the active layer generally ranges from 1 m to 1.5 m thick in the south and less than 1 m thick in the north; however, it is dependent on many variables including soil type, thickness of organic cover, exposure, etc.

Along the Highway alignment, permafrost is present in the fine-grained and organic materials and to a lesser extent within the coarser granular deposits. The fine-grained glaciolacustrine sediments tend to be ice rich. Permafrost-related features include locally occurring discrete ground ice bodies, thermokarst landforms, and thaw-induced unstable slopes. Engineering controls and highway routing (horizontal alignment) consider these problematic areas and either provide solutions for them (e.g., thicker embankments) or re-route the proposed highway to avoid them.

6.6 Bridge and Culvert Structures along the Preferred Alignment

6.6.1 Bridge Summary and Use of Existing Structures

There are 19 permanent bridge structures in current use along the existing winter road. Thirteen of these will be used in the existing locations for the Highway. There is a new bridge at Oscar Creek that is not yet in use. It will be used in the new Highway. The bridge at No Name Creek along the existing winter road will be taken out of service as the Highway does not cross this creek. Other bridges will be removed and replaced in the present location with longer structures at higher elevation or new bridges will be installed where the preferred alignment crosses these water bodies. Five new bridge crossings will be required including the Great Bear River Bridge. Existing and new bridges are shown on Figure 6-4 and summarized in the table below.

Table 6-2: Summary of Bridge Structures along the Preferred Alignment

Bridge Name	Winter Road Km	Year Installed	No. of Spans	Preferred Alignment Km	Status
Steep Creek	815.8	2001	1	816.5	Remain in use in present location, 64 m
Devil's Canyon	828.4	1989	1	828.0	New longer bridge structure in current location (raise 3.5 m), 40 m
Saline River	832.4	2001	2	831.8	Remain in use in present location, 128 m
Seagrams Creek	844.9	1986	1	844.0	New longer bridge structure in new location, 25 m
Little Smith Creek	853.8	2009	1	852.4	Remain in use in present location, 78 m
Big Smith Creek	871.1	2008	1	872.0	Remain in use in present location, 67 m
"New Bridge"	n/a	n/a	1	881.0	New bridge in new location along preferred alignment, 35 m
"New Bridge"	n/a	n/a	2	890.0	New bridge in new location along preferred alignment, 70 m + 40 m
Gotcha Creek	913.7	1989	1	912.0	New longer bridge structure in current location (raise 3 m), 40 m
Twelve Mile Creek	n/a	n/a	1	922.0	New bridge in new location along preferred alignment, 20 m
Four Mile Creek	932.2	1996	2	931.0	New longer bridge structure in new location, 100 m + 40 m
No Name Creek	944.0	1995	1	n/a	Not in use in preferred alignment.
Great Bear River Bridge	n/a	n/a	5	937.0	New bridge along preferred alignment, 460 m (two lanes)
Jungle Ridge Creek	978.5	2004	1	967.7	Remain in use in present location,19.6 m
Notta Creek	982.3	2004	1	971.4	Remain in use in present location, 25.6 m
Vermillion Creek North	984.4	1994	1	973.4	Remain in use in present location, 42.3 m
Prohibition Creek B	995.3	1991	1	983.0	New longer bridge structure in new location, 100 m
Prohibition Creek A	995.3	1991			
Christina Creek	1001.7	2004	1	990.3	Remain in use in present location, 19.6 m
Hellava Creek	1002.7	2005	1	991.3	Remain in use in present location, 19.6 m
Francis Creek	1005.0	2005	1	993.5	Remain in use in present location, 25.6 m
Canyon Creek	1009.3	1999	1	997.5	Remain in use in present location, 42 m
Bosworth Creek	n/a	n/a	1	1019.8	New bridge in new location along preferred alignment, 60 m
Billy Creek	1033.4	2004	1	1030.8	Remain in use in present location, 25.6 m
"New Bridge"	n/a	n/a	1	1031.6	New bridge in new location along preferred alignment, 60 m
Oscar Creek	1054.4	2005	1	1050.8	Use existing bridge that is not currently in service on the winter road, 67.6 m
Elliot Creek	1072.4	2005	1	1072.4	Remain in use in present location, 25.6 m

Thirty-five additional crossings along the preferred alignment have been identified for short span bridges (10 m to 15 m) or large diameter culverts. These are also shown on Figure 6-4. The detailed design to be completed in the next stages of development of the Highway will identify where additional small diameter culverts will be required to maintain surface water flow. It is anticipated that two to three of these culverts will be required for each km of highway construction.

6.6.2 Description of New Bridge Structures

The bridge concepts were developed with consideration given to constructability requirements in remote areas and the utilization of standardized span lengths and substructure components to minimize structural fabrication and erection costs. In addition, the bridge concepts were selected to meet the requirement of minimizing environmental impacts by ensuring that the bridge structures were set back from the edges of the riparian vegetation and banks at the crossing locations. Varying site constraints were also accounted for, including the road alignments and profiles, river and creek alignments and bank widths, embankment fill heights, and existing ground contours.

Details for the new bridge structures are summarized in Table 6-3 and concept sketches are included in the appendix. These conceptual bridge layouts provided in this PDR are based on limited data from field investigation. Specific layouts will be subjected to geotechnical investigation, survey, hydrology studies, detailed design, etc. at later stages in the project development.

Approach fills at each bridge abutment are able to be contained utilizing precast concrete backwalls and return walls designed integral with the bridge superstructure to resist the lateral soil pressures. The proposed bridge design will reduce the overall length of the bridges without requiring a mechanically stabilized earth wall retaining system and associated select granular backfill material. In some cases, the optimal bridge concept may require high approach fills and in these locations, a combined lower retaining wall system utilizing metal bin walls or H-pile retaining walls combined with the typical precast concrete abutment backwalls and return walls. The type of piles (either driven or ad-freeze piles) will be confirmed in the detailed design stage when the geotechnical information at each bridge site is available.

In addition to minimizing the total lengths of the bridges through the use of relatively high approach fills, the use of common spans and precast elements is proposed to simplify fabrication and construction and to achieve additional cost saving. The proposed bridge superstructures will consist of simply supported steel plate girders with composite precast concrete deck panels and either timber or steel guardrail alternatives. Common superstructure span lengths of 30 m, 40 m, 50 m, and 65 m have been used in the conceptual bridge designs. The proposed substructures consisting of steel pipe pile supporting precast concrete pile caps, precast backwalls, and return walls are typical at the abutments. It is anticipated that all steel and precast components on these bridges shall be prefabricated off site to ensure quality of work and to expedite the construction. The use of common details and geometry shall reduce fabrication costs and provide ease in the procurement process and flexibility in the construction schedule.

The design criteria used in the preliminary design of the seven major bridges are summarized as follows:

- Can/Canadian Standards Association (CSA)-S6-06 Canadian Highway Bridge Design Code;
- Live Load: CSA CL625, Class C Highway (250 Average Daily Truck Traffic);

- Overload Truck: Permitted Overload Vehicles only;
- Climatic Loads: Site Specific (will be determined in detailed design stage);
- steel for girder flanges, webs, splice plates, stiffeners, sole plates, and all material welded to girders shall be CSA G40.21M-350 AT Category 3;
- all other steel shall be CSA G40.21M-350A; and
- single lane bridges.

Other minor stream crossings will utilize common culvert design and installation or minor bridges. The decision to use a culvert or a minor bridge structure is generally dependent on ground and soil conditions, availability of fill material, cost, and most importantly, requirements to protect fish habitat. Where large diameter culverts (greater than 1,400 mm dia.) are considered for minor crossings, the culverts will be traditional circular or arch culverts with closed bottoms as these are known to have better performance in permafrost regions than open bottom arch culverts. As the cost of shipping large diameter corrugated steel pipe culverts is prohibitive, structural plate corrugated steel pipe culverts will be considered.

Designs for major and minor culverts will include requirements for bedding materials, geotextile, and insulation to provide strength in foundation and to protect the surrounding permafrost and ice rich soils from thaw. Detailed geotechnical information will be collected in field investigations in the next steps in development of the Highway and detailed design stages will incorporate the bedding and foundation requirements for culverts.

Rip-rap and other erosion protection materials incorporated into bridge and culvert designs are not likely to be readily available in any of the material sources. Cost effective pre-manufactured products, such as A-Jacks concrete rip-rap modules and Armorflex articulated concrete block “mats” (both manufactured by Armortec Canada Inc.) will be included in the detailed design stage of the development of the Highway.

The practicality of constructing bridge foundations (piling, abutments, and piers) to accommodate widening of the superstructure (girders and deck) to two lanes in the future has been considered. This is a practical and cost effective solution to minimize or eliminate in-stream work in the future should it be necessary to widen the single lane bridges to two lanes. As well, the cost of including this relative to the overall estimated cost of the construction of the Highway is quite small. The need for widening to two lanes will be based on growth in traffic volumes to a point where any delays and waiting times at bridge crossings become intolerable. The estimated traffic volume for the Highway is 50 vehicles per day and growth in that traffic is not anticipated in the foreseeable future. With such low traffic volume, the likelihood of two vehicles travelling in the opposite direction meeting at a bridge structure is very low and the need for two lane bridges is not anticipated in the future. This may not be the case when overweight or over-dimension loads are being hauled on the Highway under permit, or during isolated periods when other construction activities within the corridor are underway (i.e., construction of the MGP), but these are expected to be tolerable given that the conditions are infrequent or temporary in nature. In the preliminary design for this PDR, all bridge structures are considered as single lane, with the exception of Great Bear River Bridge.

Table 6-3: Summary of New Bridge Structures

Bridge Name	No. of Spans	Preferred Alignment Km	Description	Length (m)
Devil's Canyon	1	828.0	New longer bridge structure in current location (raise 3.5 m).	40
Seagrams Creek	1	844.0	New longer bridge structure in new location.	25
"New Bridge"	1	881.0	New bridge in new location along preferred alignment.	35
"New Bridge"	2	890.0	New bridge in new location along preferred alignment.	110
Gotcha Creek	1	912.0	New longer bridge structure in current location (raise 3	40
Twelve Mile Creek	1	922.0	New bridge in new location along preferred alignment.	20
Four Mile Creek	2	931.0	New longer bridge structure in new location.	140
Great Bear River Bridge	5	937.0	New bridge along preferred alignment.	460
Prohibition Creek	1	983.0	New longer bridge structure in new location.	100
Bosworth Creek	1	1019.8	New bridge in new location along preferred alignment.	60
"New Bridge"	1	1031.6	New bridge in new location along preferred alignment.	60

6.7 Information on Material Sources in the Area

Material sources are required to provide the materials needed to construct the proposed Highway.

The early work in the investigation and evaluation of granular material resources in the Mackenzie Valley Region was carried out by Aboriginal Affairs and Northern Development Canada (AANDC), PWC, and various consultants. In the 1970's, PWC conducted its own fieldwork during planning of an all-weather road including investigating granular and rock material sources along the route. In addition, surficial geology and terrain mapping has been compiled for the Study Area by the Geological Survey of Canada (GSC).

In the 1970's, numerous and extensive granular material investigations were undertaken by private industry resource development groups and government agencies, primarily under the direction of the DIAND. Many industry groups had significant interests in the development of energy resources in the Mackenzie Valley Region with parallel demands for granular materials. Granular material investigations were completed by various consultants including PEMCAN, EBA, and R.M Hardy, for AANDC. More recent investigations by EBA have provided further ground-truthing and confirmation of selected granular material sources and quarry sites near Tulita and Norman Wells.

Nearly 40 years later, most of these sources have not been further investigated except for a few sources in close proximity to the communities of Tulita and Norman Wells. In 2005 and 2007, the MGP investigated a number of material sources during their investigative work in support of the pipeline project. The MGP sources that were investigated had been previously identified by others as sources of material.

The available and prospective sources identified within the Tulita District have been compiled by AANDC and are found in a Granular Materials database. This dataset is too large to be reproduced for this report.

However, available information, including some estimated volumes, on select sources along the proposed alignment is presented in Table 6-4. These sources are considered to be adequate from a quality and quantity standpoint. The preliminary material volume estimates are based on a preliminary horizontal and vertical geometric design using the embankment cross section presented in this section. The historical estimates show that there appears to be sufficient construction material in the area for the Highway and for other developments.

6.7.1 Location of Construction Materials

Known potential material sources in the general area are shown in the map book in Appendix A. Many sources that are not near the preferred alignment will not be considered for use in the construction as it is inefficient to haul from these locations due to their distance from the alignment. Material sources proposed for construction of the Highway are highlighted on Figure 6-4 and estimated quantities that may be required from these sources are presented in Table 6-5.

There is little unfrozen material available for construction purposes. Competent materials with low enough ice contents are relatively scarce along the alignments and as a whole throughout the project area.

The project area has been extensively studied over the years and the likelihood of locating new sources of quality granular material near the alignment is considered unlikely. Additional work could be completed to better delineate areas and firm up material quantity and quality estimates.

6.7.2 Material/Quarry Development

Material and quarry pits are a necessity in highway construction. Well-planned development is therefore, required so as not to detract from the appearance of the landscape. Even if pits are hidden from the motorist's view, they will remain visible to those flying overhead.

It should be feasible to design material areas which will provide the needed construction material, yet will still blend into the landscape. Some material areas may be used for other purposes after highway construction. They may serve as parking areas for rest stops, as emergency pull offs and recreational areas, as interpretive features depicting natural vegetation, or as wildlife viewing areas. The shape, size and contours of a material pit must be determined by the amount of material to be taken, location and shape of suitable deposits, local topography and drainage and potential use of the material area. Material areas will take one of two very general shapes: linear where the material lies in ridges, or amoeboid where the material is found in irregular deposits below flat or undulating terrain.

The sources would be developed during the winter months when the ground is frozen and temporary winter access roads and work pads would be used. Drill and blast methods may be used to excavate the required volumes of material for construction from frozen material sources.

-4 Potential Material Sources

Post Field Alignment Station (KP)	Offset Distance from Alignment (km)	Direction from Alignment	Terrain Features	Material Description	Reference Literature	Estimated Volume (m3)
1079.0	0.75	E	Till veneer, patches of colluvium, underlain bedrock	Quarry		N/A
1078.0	0.30	NE	Till veneer, patches of colluvium, underlain bedrock	Quarry	1	N/A
1077.5	0.20	SW	Till veneer, patches of colluvium, underlain bedrock	Quarry		N/A
1077.0	0.90	SW	Till veneer, patches of colluvium, underlain bedrock	Quarry		N/A
1078.5	0.15	SW	Till veneer, patches of colluvium, underlain bedrock	Quarry		N/A
1077.0	0.45	SW	Till veneer, patches of colluvium, underlain bedrock	Quarry		N/A
1077.0	0.00	NE/SW	Till veneer, patches of colluvium, underlain bedrock	Quarry		N/A
1076.5	0.00	W/E	Till veneer, patches of colluvium, underlain bedrock	Quarry		N/A
1079.0	1.10	E	Till veneer, patches of colluvium, underlain bedrock	Quarry		N/A
1077.5	0.10	E	Till veneer, patches of colluvium, underlain bedrock	Quarry	1	N/A
1078.3	0.00	E/W	Till veneer, patches of colluvium, underlain bedrock	Quarry	1	N/A
1077.7	0.05	E	Till veneer, patches of colluvium, underlain bedrock	Quarry	1	N/A
1077.8	0.40	NE	Till veneer and till blanket underlain by bedrock	Quarry	1	N/A
1075.0	0.70	E				
1073.5	0.10	E				
1075.0	1.00	E				
1074.0	1.00	E				
1073.0	1.25	E				
1071.7	0.60	NE				
1071.7	1.10	NE				
1068.4	0.00					
1070.0	0.00					
1068.0	0.00					
1040.0	1.00	NE				
1070.0	0.80	E				
1067.0	0.00					
1067.0	0.25	E				
1068.0	1.60	W				
1068.0	1.70	W		Granular	1	
1067.0	1.50	W		Granular	1	
1069.0	1.50	SW	Shoreline ridge - transitional glaciofluvial & glaciolacustrine	Granular	1	N/A
1064.5	0.50	E				
1065.0	0.20	E				
1063.0	2.10	E				
1062.0	2.10	E				
1061.0	1.60	E				
1064.5	0.60	E				
1065.4	0.80	E				
1062.0	0.00					
1062.3	0.20	NE				
1063.0	0.50	W				
1062.5	0.10	E				
1063.0	1.90	E	Outwash plain with patches of colluvium.	Gravel		10,000,000
1056.5	0.80	E				
1062.0	2.60	E				
1059.8	0.25	E				
1055.0	0.10	N				
1054.0	0.00					
1059.0	3.80	E				
1056.0	0.20	SE				
1056.0	0.10	W				
1054.0	0.00					
1052.0	0.80	SW				
1050.5	0.80	E				
1053.0	0.00					
1050.0	0.00					
1047.0	2.30	N				
1048.0	App. 2.5	NE	Oscar Creek valley incised into the outwash plain.	Sand and Gravel		7,000,000
1048.0	1.50	NE				
1046.0	0.00					
1045.0	0.20	E				
1044.0	0.50	S				
1044.0	0.90	S				
1044.0	1.00	S				

Source No.	Post Field Alignment Station (KP)	Offset Distance from Alignment (km)	Direction from Alignment	Terrain Features	Material Description	Reference Literature
1317	1048.0	2.30	NE			
1218	1048.0	2.50	NE			
2104	1041.0	0.30	SW			
2165	1041.0	0.40	SW			
2166	1041.0	0.70	SE			
2404	1043.0	0.80	S			
2405	1041.0	0.10	S			
1314	1041.0	2.30	E			
1315	1041.0	1.70	NE			
2167	1038.0	0.90	E			
2168	1035.0	1.00	SW			
2169	1035.0	0.30	SW			
2170	1034.0	0.20	SW			
2171	1032.0	0.20	NE			
2172	1029.0	0.70	S			
2173	1029.0	0.80	SE			
1532	1029.0	1.20	NE			
1533	1029.0	1.00	NE			
2409	1025.0	0.40	E			
2410	1025.0	0.75	NE			
1527	1025.0	0.80	E			
109B	1026.0	0.25	NE			
7.046P	1028.0	0.40	N	A patch of glaciofluvial deposits within glacial till	Granular	1, 2
2407	1028.0	0.50	NE			
2408	1028.0	0.30	N			
109A	1027.0	0.75	NE			
1531	1028.0	0.50	NE			
1526	1027.0	0.70	NE			
1527	1026.0	0.70	NE			
2174	1019.0	0.70	W			
2378	1019.0	0.40	N			
2379	1020.0	0.50	E			
2380	1020.0	0.50	E			
2381	1020.0	0.00				
2382	1020.0	0.10	S			
2384	1020.0	1.00	W			
2385	1022.0	0.00				
1482	1019.0	0.10	N			
1513	1022.0	0.50	E			
1514	1022.0	0.00				
1515	1021.0	0.10	S			
1516	1020.0	0.20	N			
1518	1020.0	0.25	NE			
1519	1020.0	0.25	NE			
1520	1020.0	0.50	E			
1522	1019.0	0.50	E			
1524	1020.0	0.70	E			
1525	1019.0	0.00				
1527	1023.0	0.50	N	7.049P = Low relief gentle to flat benches, elongated rounded ridges and hillocks composed of glaciofluvial deposits with patches of colluvium		
7.049P	1020.0	0.75	NE		Sand and Gravel	
7.054P	1020.0	0.50	S	7.054P = A patch of glaciofluvial deposits: uniform terrace with a gentle gradient slope.	Sand and Gravel	
1482	1019.0	0.20	E		Granular	1
1483	1019.0	2.00	S		Granular	1
1521	1019.0	0.40	N			
1523	1018.0	0.75	N			
1507	1015.0	0.10	SE			
1508	1015.0	0.40	SE			
1481	1011.0	3.00	S			
1484	1010.0	0.60	N			
1509	1014.0	0.40	SE			
1510	1014.0	0.50	SE			
1511	1013.0	0.40	SE			
1512	1013.0	0.40	NW			
1535	1012.0	1.80	NE	7.057P = Bedrock-controlled, benched and ridged slope. The		

-4 Potential Material Sources

Post Field Alignment Station (KP)	Offset Distance from Alignment (km)	Direction from Alignment	Terrain Features	Material Description	Reference Literature	Estimated Volume (m3)
1002.0	1.30	NE				
1002.0	0.30	S				
1000.0	0.10	NW				
1000.0	0.00					
999.0	0.10	N				
999.0	0.40	E				
999.0	0.70	E				
998.0	0.60	E				
997.0	0.25	SW				
997.0	0.40	SE				
994.0	1.00	E				
996.0	0.00					
996.0	0.60	NE				
995.2	4.50	NE	Gentle gradient outwash fan	Sand and Grave	1, 6	1,000,000
993.0	0.00					
992.0	App. 2.5	NE	Gentle gradient outwash fan	Granular		800,000
992.0	App. 2.5	NE	Gentle gradient outwash fan	Granular		N/A
992.0	1.80	NE				
991.0	3.00	NE				
990.0	0.40	N				
990.0	0.30	NE				
990.0	0.20	E				
990.0	0.30	SW				
990.0	1.00	NE				
990.0	1.00	NE				
989.0	1.00	NE				
989.0	0.80	NE				
989.0	0.70	NE				
988.0	1.40	SW				
987.0	2.40	NE				
986.7	2.70	NE	Gentle gradient outwash fan	Sand and Grave	1, 6	900,000
986.0	2.40	NE				
988.0	1.00	NE				
987.0	0.70	NE				
987.0	1.00	NE				
986.0	1.25	NE				
984.0	0.10	S				
982.0	0.15	E				
979.0	0.10	NE				
975.0	2.50	NE				
971.2	0.50	NE				
972.5	0.00					
972.5	0.60	SW				
972.5	2.40	SW				
977.0	0.00		7.090P = Glacial till ranging in thickness from a veneer to blanket underlain by bedrock, which is exposed in some locations			
962.0	0.60	NE		Quarry		
950.0	0.10	S				
953.8	1.40	NE	20.201 = A bedrock-controlled low relief narrow ridge with colluvium-covered gentle gradient slopes.	Quarry		
949.0	0.00					
947.0	0.50	S				
944.5	0.30	E				
				Granular		180,000
				Quarry: limestone		N/A
939.0	0.00					
938.5	0.25	NE				
935.0	2.50	SW				
937.0	0.00					
939.5	1.10	SW				
939.5	1.70	SW				
939.5	2.80	SW				
934.0	1.00	N				
934.8	0.25	S				
935.5	0.90	S				
			7.155AP = A glaciofluvial and fluvial complex of terraces,	Granular	4	

Source No.	Post Field Alignment Station (KP)	Offset Distance from Alignment (km)	Direction from Alignment	Terrain Features	Material Description	Reference Literature
FN20x					Granular (expecte	4
1429	930.0	0.75	S			
1942	925.0	0.00				
1432						
1746	911.0	0.00				
1747	906.4	0.00				
8.058P	906.3	0.50	NE	Ridged beach deposits within glaciolacustrine plain	Sand and gravel	1
1748	901.0	0.75				
1749	897.1	0.30				
1750	897.0	0.00				
1751	899.0	2.25				
1762	889.0	0.00				
1763	892.0	0.00				
20.086P	888.0	0.25	N	Glaciolacustrine plain	Sand	
1764	875.0	0.00				
1768	871.0	0.00				7
1769	871.0	0.40	SW			
1770	866.0	0.00				
1782	865.0	1.50	E			
1784	865.0	2.25	E			
1788	862.0	2.50	E			
1789	851.0	0.00				
1791	851.0	0.75	NE		Sand and Gravel	1
1792	850.0	0.00	0			
9.002PA	850.7	1.00	NE	Glaciofluvial complex of eskers, kames and terraces	Sand and Gravel	1
9.002PB	849.2	0.80	SW	Glaciofluvial terrace	Sand and Gravel	1
1803	837.0	0.50	SE		Quarry	1
1812	837.0	0.50	E			
1813	838.0	0.80	E			
1814	836.0	0.90	E			
9.010PA	838.2	0.70	SW	9.010PA = Bedrock ridge partially covered with a veneer of till. Steep east-facing slope.	Quarry	1
1816	830.5	0.50	NE			
1817	830.5	0.00			Fluvial deposit	3
1818	828.0	0.00			Sand and Gravel	1
9.017P	828.0	0.80	N	Glaciofluvial terrace	Sand and Gravel	1
1827	824.0	2.50	NE			
1834	822.0	1.60	NE			
1835	821.0	1.60	NE			
1836	820.0	1.60	NE			
1837	820.0	1.60	NE			
1832	814.5	0.00			Fluvial deposit	3
1833	818.0	1.80	SE			
9.024AP	814.0	0.40	NE	Glaciofluvial terrace	Sand and Gravel	1
1831	810.0	0.00				
1885	802.0	0.00			Sand and Gravel	1
9.034PB	801.2	0.25	W	Glaciofluvial terrace	Sand and Gravel	1
1887	797.0	0.00			Granular	1
9.034PA	797.8	0.20	W	Glaciofluvial terrace	Sand and Gravel	1
9.037PA	794.8	0.90	W	Glaciofluvial terrace	Sand and Gravel	1
9.037PB	794.0	2.40	SW	Glaciofluvial terrace	Sand and Gravel	1
9.038PA	794.0	4.00	S	Glaciofluvial terrace	Sand and Gravel	
9.038PB	794.0	2.80	S	Glaciofluvial terrace	Sand and Gravel	

Note 1: Distances from alignment were measured at approximate right angles from the centreline.

Note 2: Distances and locations of borrow sites were taken from the approximate centre of the borrow.

Note 3: Estimated volume is based on information in the available literature.

Reference Literature:

1. Base Case for Class III Estimate
2. INAC - Granular Resources
3. EBA Map Book. August 2010.
4. Geotechnical Investigation Plans, Subusrface Evaluation of Granular Resources, Tulita, NT. October 2007.
5. Figure ID: 107-0000-012-004 021 (map)
6. Mackenzie Gas Project. Index Maps.
7. Geotechnical Investigations, Mackenzie Highway, Mile 544 to Mile 635, April 20, 1973

6.7.3 Further Investigation of Material Sources

The work done to date on material sources represents only preliminary information. Future work should include drilling of boreholes, analysis of samples and possibly application of ground penetrating radar to determine the quality and volume of these potential source areas.

6.7.4 Scarcity of Construction Materials in Some Areas

There is a scarcity of granular materials for road embankment construction along certain sections of the proposed alignment, which will result in a road that is more expensive to construct in these sections due to longer haul distances.

There is a scarcity of granular materials between Little Smith Creek and Tulita as the route travels along an extensive glaciolacustrine plain, particularly between an area north of Big Smith Creek and Tulita. Also, there is a scarcity of quality granular materials from an area north of Bear Rock massif to Vermillion Creek.

In general, the section of the route north of Saline River to Big Smith Creek is considered marginal with respect to availability of good quality granular materials, although some good quality materials are available between Saline River and Little Smith Creek. There is also little quality material east of the Bear Rock massif.

Better materials are available in the glaciofluvial deposits along the western slopes between Prohibition Creek and Canyon Creek, and the glaciofluvial delta deposits adjacent to the upstream portions of Oscar Creek and Elliot Creek. Some good quality granular materials of varying proven resource are available between an area north of Vermillion Creek and Norman Wells and also between an area north of Oscar and the northern Tulita district boundary.

6.7.5 Embankment Performance

The performance of an embankment is dependent on many variables and cannot be generalized for preliminary design purposes. Consideration must be given by the designer to each of the following for every proposed use of fine-grained moraine (clay, silt, and sand) in embankments:

- the zone in which the embankment is to be constructed;
- the physical properties of the material;
- the frozen/unfrozen state;
- the moisture content or ice content of the material;
- proposed timing for construction (winter vs. summer); and
- anticipated density of the embankment.

Satisfactory performance should be expected under conditions where fine-grained materials having moisture contents near optimum are excavated in the unfrozen state and placed during the summer months with controlled compaction. Less satisfactory performance would be expected from frozen high ice content silt and clay excavated and placed in the winter months with no meaningful compaction possible.

From Tulita to Norman Wells, it will be advantageous to use rock materials for construction of the embankments. Quarries, which can be used for the embankment construction, were identified at the following locations along the preferred alignment:

- km 951;
- from km 956.3 to km 963 (limestone with 2 m of overburden);
- from km 966 to km 975 (high plastic clay shale);
- from km 996 to km 1,011 (shale with 2 m of clay till overburden); and
- from km 1,011 to km 1,016 (cuts through limestone and shale along this section will provide a balanced cut and fill through this section).

6.8 Preliminary Quantity Estimates for the Preferred Alignment

6.8.1 Total Estimated Length of New Highway Construction

The preferred highway alignment requires an estimated 285 km of highway construction and is detailed as follows:

- 149 km (52%) along the existing winter road; and
- 136 km (48%) on new alignment.

6.8.2 Estimate of Embankment (Fill) and Surfacing Material

The preliminary quantity estimates for embankment or fill material and surfacing material are:

- Embankment or fill volume: 8.85 million m^3
- Cut volume: 1.56 million m^3
- Surfacing gravel: 522,000 m^3

Quantity breakdown by design segment is presented in Table 6-5. These quantities are presented as compacted material in place, and do not account for "bulking" or swell of material as it is removed from the material source and hauled to placement in the Highway. As well, relatively minor amounts of additional fill material will be required at bridge sites, maintenance facilities, staging areas, and other locations.

Table 6-5: Preliminary Quantity Estimates for Embankment and Surfacing Material

Station (km)	Section Length (m)	Fill Volume per km (m^3)	Cut Volume per km (m^3)	Total Fill Volume (m^3)	Total Cut Volume (m^3)	Total Surface Gravel (m^3)	Total Subcut Gravel (m^3)
795+915	4,880	37,024	1	180,676	0	8,940	
800+805	5,180	34,008	0	176,507	0	9,508	
806+005	5,400	28,746	0	155,918	0	9,929	
811+415	6,030	40,862	15,212	246,741	91,727	11,065	4,787
817+455	5,660	57,863	10,553	327,851	59,731	10,387	3,761
823+165	5,460	32,800	6,798	180,811	37,117	10,094	1,880
828+675	5,370	28,071	30,039	152,463	161,309	9,929	6,154
834+085	4,380	40,097	0	177,003	0	8,097	
838+495	4,320	34,264	0	149,055	0	7,969	
842+835	5,840	26,919	16,776	157,898	97,972	10,736	2,906
848+695	5,230	33,868	7,333	177,820	38,352	9,618	3,419
853+935	5,160	30,249	0	156,432	0	9,471	
859+115	5,190	37,074	0	193,105	0	9,545	
864+320	5,390	44,093	0	238,941	0	9,943	
869+747	5,490	33,197	10	183,286	0	10,113	
875+262	4,090	34,985	0	143,700	0	7,525	
879+370	4,690	43,223	0	203,406	0	8,629	
884+080	5,020	40,878	4,541	206,240	22,797	9,252	1,710
889+130	6,030	38,230	22,262	231,176	134,237	11,081	8,240
895+177	5,170	34,932	0	180,943	0	9,490	
900+357	5,320	34,936	0	186,548	0	9,783	
905+697	4,850	29,438	273	143,464	1,326	8,922	205
910+567	5,280	25,486	9,205	135,256	48,603	9,710	2,735
915+867	5,090	26,529	46	135,377	234	9,343	
920+967	5,250	25,701	18,172	135,236	95,405	9,634	2,325
926+226	6,030	28,922	0	174,745	0	11,065	
932+279	6,841	27,810	52,363	190,242	358,204	12,532	15,249
939+200	5,658	65,892	60	372,817	342	11,645	
944+858	7,806	34,467	15,758	269,052	123,007	14,050	7,550
952+664	12,884	24,722	12	318,515	149	23,775	
965+548	11,585	17,666	152	204,658	1,765	21,382	118
977+133	7,606	19,228	9,295	146,248	70,694	14,059	4,339
984+739	6,642	17,037	1,104	113,160	7,333	12,266	450
991+381	9,042	16,413	1,769	148,406	15,996	16,574	981
1000+423	16,177	22,194	232	359,040	3,749	29,865	194
1016+600	14,404	31,590	2,609	455,025	37,583	26,581	2,020
1031+004	9,383	36,811	0	345,396	0	17,315	
1040+387	9,372	28,265	112	264,895	1,045	17,254	
1049+759	6,515	23,658	13,898	154,134	90,544	11,168	3,071
1056+274	9,731	35,303	384	343,537	3,741	17,913	250
1066+005	7,459	29,873	10	222,826	77	13,769	
1073+464	6,196	32,722	8,956	202,745	55,490	11,437	3,406
1079+660	233	6,288	0	1,465	0	396	
TOTALS				**8,842,761**	**1,558,531**	**521,761**	**75,750**

6.8.3 Major Bridge Structures

Table 6-6: Major Bridge Structures

Bridge Name	No. of Spans	Preferred Alignment Km	Width (m)	Total Bridge Length (m)	Total Deck Area (m^2)
Devil's Canyon	1	828.0	5	40	200
Seagrams Creek	1	844.0	5	25	125
"New Bridge"	1	881.0	5	35	175
"New Bridge"	2	890.0	5	110	550
Gotcha Creek	1	912.0	5	40	200
Twelve Mile Creek	1	922.0	5	20	100
Four Mile Creek	2	931.0	5	140	700
Great Bear River Bridge	5	937.0	8.5	460	3910
Prohibition Creek	1	983.0	5	100	500
Bosworth Creek	1	1019.8	5	60	300
"New Bridge"	1	1031.6	5	60	300

6.8.4 Culverts

In addition to the major bridge structures, there will be requirements for culverts at many smaller stream crossings. Thirty-five stream crossings have been identified through the field observations and the preliminary designs. Detailed hydrology and drainage studies to support culvert design and sizing will be done during later detailed design stages in the development of the project. At that time, decisions will also be made as to whether some of these minor crossings would be served better with a small bridge structure (10 m to 15 m span). A nominal size of 1,200 mm and nominal length of 30 m is estimated at this preliminary stage in the development of the project. Smaller diametre centreline or equalization culverts may also be required. A nominal size of 900 mm, nominal length of 30 m, and estimated frequency of two per km is estimated. The summary of estimated culvert quantities is presented in Table 6-7.

Table 6-7: Culverts

Culvert Diameter (mm)	Culvert Length (m)	Number of Culverts	Total Estimated Length (m)
1,200	30	35	1,050
900	30	852	25,560

6.8.5 Quantity Estimates from Each Potential Material Source

Table 6-8: Estimated Quantities from Individual Material Sources

Source No.	Offset from Alignment (km)	Direction from Alignment	Station	Fill and Gravel Required per Source (m^3)	Estimated Volume of Source (m^3)
9.037PA	0.90	W	796+400	150,901	4,600,000
9.034PB	0.25	W	803+000	321,783	N/A
9.024AP	0.40	NE	815+700	485,386	1,000,000
9.017P	0.80	N	829+600	225,288	2,700,000
9.010PA	0.70	SW	839+300	332,425	N/A
9.002PB	0.80	SW	850+200	303,614	N/A
1788	2.50	E	863+000	460,754	Unknown
1768	0.00		872+400	483,538	Unknown
20.086P	0.25	N	888+800	511,724	11,700,000
1750	0.00		897+000	209,562	Unknown
8.058P	0.50	NE	907+400	262,669	N/A
1746	0.00		912+000	219,553	Unknown
1942	0.00		926+100	277,138	Unknown
1419	1.00	N	934+800	117,065	
1449	0.00		937+700	14,208	Unknown
1428	0.50	S	949+400	415,500	Unknown
7.090P	0.60	NE	962+700	316,333	N/A
1633	0.00		973+600	181,466	Unknown
7.078P	2.70	NE	988+100	239,458	900,000
7.070P	4.50	NE	996+100	219,467	1,000,000
7.057P	0.50	NE	1011+900	299,369	N/A
7.049P	0.75	NE	1020+500	222,845	850,000
7.046P	0.40	N	1028+700	279,050	350,000
2167	0.90	E	1038+000	377,745	Unknown
7.035P	2.50	NE	1049+000	304,298	7,000,000
7.025P	1.90	E	1062+800	482,061	10,000,000
7.018P	0.40	NE	1078+600	303,762	N/A

6.9 Highway Construction

6.9.1 Proposed Construction Methodology

The proposed construction methodology for the various road type scenarios is as follows:

- Fill Only Scenario – Winter Construction
  - Clear right of way of trees.
  - Remove snow within roadway toes.
  - No stripping of organic material would take place.
  - Place non-woven geotextile within the embankment toes.
  - Place uncompacted embankment fill of 1.4 m to 1.8 m in height.
  - Install culverts, anticipating settlement in summer.
  - Compact the embankment the following summer and re-grade road to appropriate subgrade elevation.
  - Haul, place, and compacted granular base gravel in summer.
- Cut Scenario – Type 1 – Cuts in Bedrock – Winter and/or Summer Construction
  - Clear right of way of trees in winter.
  - Strip organic material within the roadway prism.
  - Remove overburden to expose bedrock, and use overburden material as embankment fill, if suitable.
  - Bedrock would be drilled and blasted to limits of roadway sub-grade.
  - Excavated bedrock material to be used as riprap slope protection material or low lying drainage concern areas.
  - Haul, place, and compacted granular base gravel in summer.
- Cut Scenario – Type 2 – Cuts in Non-ice Rich Ground – Summer Construction - Clear right of way of trees in winter.
  - Strip organic material within the roadway prism.
  - Excavate material and use as embankment fill if suitable.
  - These areas will require additional excavation (included in cut quantities currently designed at 300 mm depth) and replaced with non-frost susceptible sub-base gravels or pit-run. This depth will be increased if poor subsoil conditions are encountered.
  - Haul, place, and compacted granular base gravels in summer.
- Cut Scenario – Type 2 – Cuts in Non-ice Rich Ground – Summer Construction - Clear right of way of trees in winter.

- Strip organic material within the roadway prism.
- Excavate material and use as embankment fill if suitable.
- These areas will require additional excavation (included in cut quantities currently designed at 300 mm depth) and replaced with non-frost susceptible sub-base gravels or pit-run. This depth will be increased if poor subsoil conditions are encountered.
- Haul, place, and compacted granular base gravels in summer.
- - Install erosion protection measures in all ditches greater than 3% gradient.

- Cut Scenario – Type 3 - Cuts in Ice Rich Ground – Summer Construction
  - Same as Type 2, but if ice rich ground is encountered, raise roadway grade or move alignment if possible.
  - Flatten ditch slopes if possible.
  - Widen ditches if possible.
  - Insulate slopes with non-frost susceptible material or synthetic material. - Anticipate annual maintenance and road reconstruction/rehabilitation in localized problem areas.

6.9.2 Combining Design and Construction

As noted above in Section 6.1, the historical implementation plans for the Highway have included both "accelerated design and construction approaches over a short term" and "extended construction time frames building short sections each year with local forces". Economic benefits of the Highway are discussed in later sections of this PDR, but it is relevant to note here that the greater economic benefits to the people of the local communities come from the long-term sustainable management and operation of the Highway compared to any benefits achieved from employment during the initial construction. In other words, there is greater advantage to put the Highway into operation sooner rather than later and an approach that accelerates design and construction over a short term is therefore preferable.

In a traditional design and construction approach, the detailed design would be completed for the full 285 km of highway before the construction starts. The design will take from one to two years. Completion of the Highway can be achieved much sooner if components of the design (segment by segment) are completed each year, staying just ahead of construction. The work that has been completed in the development of the preliminary design for this PDR provides sufficient information and knowledge about the Highway to be able to proceed with design and construction in this manner. This approach will result in an accelerated delivery schedule, as well as advantages and savings from innovations in design, construction, mobilization, and staging than a traditional design and public tender construction approach. Significant engineering design, contracting, logistics and support resources are needed for accelerated design and construction. To the extent possible, all qualified and relevant resources in local communities will be used.

Using this approach, construction of the 285 km of the Highway through the Tulita District is likely to take three winter seasons. Detailed investigation, engineering, and design are necessary in advance of

construction of the initial segments of the Highway, but not for the entire 285 km at once. This can be done in advance of starting construction on each segment. Start of construction on the initial segments of the Highway within the Tulita District is expected in the first winter following regulatory approvals, assuming funding for the Highway within the Tulita District is available.

The contracting and construction approach could also include "training segments" under the direction of each community that will maximize training and construction opportunities in real time. Public Private Partnership (P3) approaches to significant components such as the Great Bear River Bridge may also be considered to accelerate delivery. Regardless of the approach, the design and measures invoked to mitigate the impact to the social and physical environment will be similar. The mechanism and speed of delivery is largely dependent on partnerships developed by the land claim and aboriginal organizations, and the availability of funding.

6.9.3 Construction Activities and Assumptions

6.9.3.1 Reliance on Construction of Other Segments of the Highway

The Highway segment in the Tulita District is accessible by the existing winter road and community barge landing facilities. Construction of the Highway in the Tulita District is therefore not reliant on construction of other segments of the overall Mackenzie Valley Highway segments north and south of it and can proceed independently.

6.9.3.2 Staging Locations

Staging locations will be near the selected material sources along the Highway. Activities at these locations include:

- housing of workers;
- storage and maintenance of equipment;
- storage of fuel; and
- receipt of supplies, equipment, and materials by barge.

Temporary facilities at these locations include:

- camp and maintenance buildings;
- equipment and material storage areas;
- fuel storage facilities;
- staging area;
- helicopter landing area;
- barge landing area;
- access road from shore; and
- waste containment facilities.

The specific location of these will be determined during the detailed design and construction planning phase.

6.9.3.3 Winter Approach to Embankment Construction

A fundamental concept of the proposed construction methodology is to utilize winter construction techniques for building the embankment or accessing areas within the right-of-way before the Highway is constructed, rather than the more typical summer construction as used in southern parts of Canada.

The advantages of winter construction are as follows:

- Winter construction allows the use of temporary winter access to material sources without the need to construct costly all-weather access roads.
- Winter construction allows the placement of construction material directly on to frozen ground. This approach enables the establishment of a frozen core for the Highway and helps protect sensitive and ice rich terrain.
- Winter construction minimizes potential effects on vegetation and soils adjacent to the actual roadway that might occur if working under snow-free or wet conditions.
- Winter construction promotes initial stability of the Highway through the placement of frozen borrow material directly onto frozen ground (with geotextile separation layer). In the first construction year, it is anticipated that the majority of construction settlements will occur in the top layers of the constructed embankment as it thaws, dries, and consolidates. The lower layers are not expected to thaw much, if at all, in the first years, leading to greater stability than has been the case with the placement of warm fill on thawed ground in summer construction. This will reduce maintenance problems in the future.

Winter construction does have disadvantages, including the following:

- Work is difficult, with extreme cold temperatures common at the beginning of the construction season in late December and early January. This is challenging for both personnel and equipment.
- Operations are conducted in periods of minimal daylight.
- Excavation of frozen material in material sources will likely require the use of drill and blast methods to be able to source the required volumes of material for construction.
- Excavating and placing frozen material directly on top of geotextile placed on the natural ground makes it more difficult to achieve compaction of the embankment layers.

6.9.3.4 Summary of Activities by Season

When specific components of the work can be done is largely based on the season as moving equipment on the native ground is limited to the winter months when the ground is frozen. Other activities can take place during the spring, summer, and fall of any given year provided that access over land to the particular area is not required, or that access can be achieved over a portion of the Highway that has previously been constructed. The timing of construction activities will respect the sensitive nature of the management areas and conservation zones and will follow permit conditions.

The construction schedule presented in the next section is based on the following basic factors for construction in the area:

- Equipment and bridge components can be mobilized to staging areas via the winter road.
- Equipment and bridge components can be mobilized to key locations by barge from either Hay River or Fort Simpson as early as June or July, provided the equipment and bridge components are arrive in Hay River or Fort Simpson in May.
- Where construction of the Highway is not yet complete, bridge sites and material sources will be accessed via winter road. Clearing of the right-of-way and winter road construction could start in December, but the actual full operation of the winter road for the purpose of moving equipment, hauling material, and construction of the embankment would not start in earnest until January.
- Although overland access to material sources to move equipment to them is by winter road, once equipment is positioned in a material source, material production and stockpiling can be undertaken all year long. For this purpose, the workers will be transported to the sites by helicopter.
- In some cases, it will be necessary to construct all-weather access roads to selected material sources as they may be used for significant volumes of material during construction, or for ongoing long-term use into the operation of the Highway.

Any given construction year on the Highway can be broken down into the following time periods and activities:

- December – clearing of right-of-way and construction of winter roads;
- January/February/March – hauling and placing of embankment material; mobilization to bridge sites and piling for bridge abutments; erection of bridge piers and abutments;
- April/May/June – no activities other than production and stockpiling of material assuming equipment has been mobilized to the particular material source;
- July/August/September – finishing and compaction of previously constructed embankment and placement of surfacing material;
- August/September – launching of bridge girders and deck components; and
- October/November – any activity that does not require overland access or can be accessed by previously constructed segments of the Highway.

6.9.4 Construction Schedule

Construction of the Highway within the Tulita District is estimated to take three to three and a half years from approval. Detailed investigation, engineering, and design are necessary in advance of construction, but in a combined design and construction approach, it is not necessary to complete this for the entire 285 km of highway in advance of starting construction. The investigation, engineering, and design components need only to stay in advance of the next segment or bridge to be constructed. The initial start of construction will begin in the first winter directly following approvals and funding being available. Assuming funding is available, the first stage of design would begin in the preceding spring.

A more detailed discussion and presentation of the construction schedule is included in Section 7.0, Project Timetable and Construction Schedule.

6.10 Discussion of Elements Related to Construction

Basic factors for construction in the area are presented above. The following provides a further discussion of some key elements related to construction of the Highway. These are also discussed in greater detail in Section 10.0 and Section 11.0 of this PDR.

6.10.1 Anticipated Equipment and Personnel

In any given winter construction season, four spreads will be in operation for embankment construction.

Typical equipment is listed in Table 6-9.

Table 6-9: Typical Equipment

Equipment	Typical Equipment Type
Typical Equipment in Each Spread	Compactors, Dozers, Drills, Cranes, Excavators, Graders, Haul Trucks, Mulchers, Wheel Loaders
Support Equipment	Deck Trucks, Fuel Trucks, Service Trucks, Vacuum Trucks, Water Trucks
Summer Operations	Wheel Loaders, Compactors, Graders, Water Trucks

Opportunities for training and employment of personnel are discussed in Section 12.0 of this PDR. Personnel that will be required will include equipment operators, carpenters and labourers for bridge construction and culvert installation, and engineering/survey/environmental monitoring staff. It is currently estimated that there will be four spreads working at peak times in the construction of the Highway and each spread would likely require 150 to 180 people. This is a substantial workforce. Delivery of the project will initially look to the local work force for qualified and relevant personnel, but will also need to look to other communities in the Northwest Territories, then Yukon and Nunavut, followed by southern Canada.

6.10.2 Camp and Stockpile Areas

Areas will be required for construction camps and stockpile or staging of equipment and materials (e.g., culverts, geotextiles, and bridge component). Temporary construction camps will be situated within the confines of the material sources to minimize development footprint. They will be spaced no more than 50 km apart, allowing a maximum driving distance of approximately 25 km for project workers. Individual camp sizes are likely to be 150 person, but will be temporary in set up. They may need to be mobilized on winter trails, ahead of the construction.

Stockpile sites and staging areas will be constructed parallel to the Highway and just ahead of material delivery to work areas by truck.

Camp and stockpile or staging areas that are not identified for the ongoing operation of the Highway will be reclaimed in accordance with the appropriate guidelines and permit conditions.

6.10.3 Access/Haul Roads and Material Sources

Temporary winter roads will be constructed for access and hauling material sources. In most cases, access will be by winter road or over the constructed portion of the Highway. The exception would be access to material sources that are selected for permanent or long-term use in the future operation of the Highway. In those cases, permanent all-weather access roads will be constructed. The specific alignment and type of all access roads will be confirmed in the early stages of detailed design in the development of the Highway project.

The driving surface width of any access or haul road will likely be 10 m to 11 m. The cleared width required would be approximately 50 m.

Material site or pit management plans will be developed by the Proponent for each selected source when the next stages of investigation are complete and as a requirement for land use and quarry permit applications for construction. The management plans will be in accordance with the appropriate guidelines, as noted in previous sections. Generally, material sources will include a minimum of 10 m cleared area beyond the edge of the excavation and stockpile areas, and there will be allowance for areas to be used for staging equipment, storage, stockpiles of organic materials, and wasting of ice rich materials.

6.10.4 Construction Access Along the Highway

Construction access along and ahead of the Highway will be by winter road along the embankment and within the right-of-way. These winter roads will be constructed during the initial clearing operations in December of each construction year. At small stream crossings, snow bridges will be used to cross the stream valleys, while at larger river crossing, ice bridges will be constructed. For larger river crossings with steeper banks, construction of shoo-flies may be required to reduce the grade from the top of the river bank to the ice crossing. Plans for and design of these shoo-flies, if required, will be undertaken at the detailed design stage.

Winter roads and ice crossings will be constructed and operated in accordance with applicable guidelines. Two such guidelines are:

- A Field Guide to Ice Construction Safety, Department of Transportation, GNWT, 2007; and
- Best Practice for Building and Working Safely on Ice Covers in Alberta, Government of Alberta, 2009.

The Transportation Association of Canada will also be publishing an applicable guide later in 2011 entitled "Best Practices for Operation and Construction of Winter Roads".

6.10.5 Waste Management

The waste generated during construction will include sanitary waste, grey water, kitchen and paper waste, used oils, hazardous waste (i.e., batteries), recyclable metals, used oil from equipment, and other. Temporary maintenance shop facilities at construction camps will have incinerators in which used oil can be burned to produce heat for shop and camp facilities. Camps will have on-site treatment plants that process wastewater that can then be used to supplement the water use as discussed in the next section. Kitchen waste, cardboard, and paper will be incinerated on site and recyclable metals and hazardous wastes will be hauled to commercial waste disposal sites, likely in the south.

6.10.6 Water Use

Overall daily water use for winter road construction is expected to range from at least 500 m^3/day to more than 1,000 m^3/day (each spread). Water will also be required during the later summer and fall months to place on the road in support of compaction of the base course and surfacing material. The volume is estimated at 500 m^3/day. The estimates for water use are based on the experience obtained from similar construction projects. Camp operations will require approximately 200 L/person/day. A 150 person camp would, therefore, require approximately 30,000 L or 30 m^3/day.

6.10.7 Fuel Delivery, Storage, and Use

The estimated fuel requirements for construction of the Highway are in the order of 40M to 45M litres. Fuel storage requirements at an individual camp facility will be determined when detailed design and construction planning steps are undertaken at later stages of the project. Major fuel suppliers will likely require advance notice and financial commitment to stockpile fuel at regional fuel hubs of Hay River, Norman Wells, and Tulita prior to commencement of the construction. This will be necessary as demands for fuel for this project will compete with other significant operations in the Northwest Territories (i.e., community and mining requirements).

Fuel will be delivered in the winter from regional storage hubs to fuel tanks situated along the Highway in the staging and storage areas, in the material sources, and in the camps.

Fuel storage and handling is discussed in Section 11.0 of this PDR.

6.10.8 Health, Safety, and Environment

Undertaking the construction in a safe manner to protect health of the project workers and to protect the environment will be paramount during the construction operations. The components of the Health, Safety and Environment (HSE) requirements include:

- First Aid requirements;
- spill prevention; and
- erosion control.

The personnel and facilities for the construction of the Highway will include the following First Aid services:

- personnel trained and qualified as Advanced First Aiders;
- personnel trained and qualified as Emergency Medical Technician Paramedics;
- mobile treatment centre; and
- First Aid room at each camp facility.

Spill prevention requirements are discussed in Section 11 of this PDR and include:

- double walled fuel storage tanks;
- minor size spill kits on each vehicle;
- major size spill kits at fuel storage areas;
- major size spill kits at re-fuelling areas;
- appropriate training for all personnel involved with fuel handling; and
- spill response trailer for the work area.

Sediment and erosion control requirements are discussed in Section 11 of this PDR. Erosion Control requirements as a key element of HSE include:

- silt fencing at temporary storage areas and material areas;
- silt fencing at inlet and outlets of minor culverts;
- sediment and silt ponds at material sources;
- erosion control matting at major water crossings; and
- pre-fabricated rip-rap at major water crossings.

6.10.9 Temporary Airstrips and Helipads

Temporary airstrips and helipads will be required during construction for light fixed wing aircraft (Twin Otter, Cessna) and helicopters. Evacuation of personnel for medical emergencies is preferred by helicopter, but during inclement weather and non-daylight conditions, accessibility by fixed wing aircraft will provide greater reliability. Fixed wing aircraft or helicopter will also be used for resupply of consumables (food, small parts, etc.) and rotation of personnel to the more isolated sections of the project (material sources during summer and late fall).

Temporary airstrips during construction could consist of:

- winter airstrips constructed on frozen lakes and/or cleared sections of the right-of-way; and
- summer airstrips constructed on tangent sections of the Highway embankment.

Specific details of temporary airstrips and helipads will be confirmed at the detailed design stage of the project development.

6.10.10 Explosives

Drilling and blasting operations in the material sources will be required as the material will be frozen. Explosives used will be primarily ammonium nitrate and diesel fuel (ANFO) with commercial products for "wet" holes. Storage of ammonium nitrate prills will be on site in a secured location and in accordance with the appropriate legislation and guidelines.

Timing and control of drilling and blasting operations relative to local fisheries, wildlife, and the environment are discussed in Section 10.0 and Section 11.0 of this PDR.

6.10.11 Mobilization

Timing of mobilization to the project area has seasonal and modal restrictions. Staging of camps, equipment, and fuel will be required and the selection or limitation of mobilization route or mode will increase costs as equipment could become stranded during the mobilization period.

The construction schedule presented in this section and the project time table presented in Section 7.0 are based on an estimated timing of issuance of approvals such that mobilization can be undertaken and not delay project start up. Key seasonal and modal factors to consider in mobilization to the project area are as follows:

- The 10-year average of opening and closing dates for the Mackenzie Valley Winter Road (NWT Hwy 1) from Norman Wells to Fort Good Hope is January 1 to March 30 (DOT Website 2010).
- The 10-year average of opening and closing dates for the river crossings on the Mackenzie Highway are shown in Table 6-10.

Table 6-10: Opening and Closing Dates for River Crossings on the Mackenzie Highway (10-year average) (DOT Website)

Mode	Fort Simpson (Liard River)		N'Dulee Crossing (Mackenzie River)	
	Opening	Closing	Opening	Closing
Ferry	May 13	Nov 4	May 23	Oct 30
Ice Bridge	Nov 28	Apr 21	Dec 19	Apr 21

- Available sailing season for barges on the Mackenzie River from Hay River is generally from May to September.
- Seasonal weight limits (i.e., Spring Weight Restrictions) on Provincial and Territorial Highways can limit the hauling of heavier loads (i.e., large equipment and/or bridge components). This is a limitation to be considered when hauling to Hay River to meet a barge sailing. Spring Weight Restrictions in Alberta, British Columbia, Yukon and the Northwest Territories are condition-based (i.e., they start when the temperature conditions have been such to forecast the timing of when the frost is starting to come out of the highway embankment), but generally start in March in Alberta, April/May in northern British Columbia, and May in the Northwest Territories.

6.10.12 Material Source Evaluation and Site Development Plans

The preferred material sources have been selected based on available information about the source and the proximity to the preferred alignment. The selections and the estimate of the materials to be used from this source are preliminary at this stage. Further evaluation of the preferred material sources will be required at the detailed design stage and will include geotechnical investigation to confirm quantity and quality of material available.

6.10.13 Site Development Plans or Pit Management Plans

Selection of materials and development of material sources is of high importance in permafrost regions. On one hand, it is important to select materials that are suitable for the development of infrastructure over frozen and thaw sensitive ground. On the other hand, it is important to select and develop material sources with minimal or no impact to historical resources, traditional use areas, and the environment.

In the next stages of the project development, material sites will be investigated with techniques that minimize impact. These include winter only access to the sites, and the use of advanced and non-destructive technologies, such as Ground Penetrating Radar in initial investigations to allow for a well-planned and selected drilling program.

Site development and operation will be effectively organized while minimizing the impact on the environment and the permafrost. Considerations will include:

- minimizing the use of valuable non-renewable resources;
- minimizing the footprint around the material site;
- minimizing the impact of the operation on the permafrost, and on all waterbodies and watercourses;
- adapting the site operations and selecting equipment that is appropriate to frozen ground conditions; and
- minimizing the impact of the exploration and operational activities on the landscape, traditional activities, and archaeological sites.

Most of the sites will be temporary sites for construction only. However, during the detailed design stage, approximately three of the sites will be selected based on location relative to permanent maintenance facilities and volume, quality, and type of material available to remain as permanent or at least, long-term material sources for future maintenance and preservation requirements for the Highway. These sources may be considered for development of other future infrastructure as well, and during the next stages of the Highway project development will include all-weather access to these few selected sources.

Whether a material source is considered for construction only, or for long-term use, a development plan for each site is an effective tool to manage the source. Site development plans will be prepared in accordance with environmental guidelines and policies, as well as local experience and best practices. The most relevant guidelines to the Highway are:

- “Environmental Guidelines, Pits and Quarries”, Land Resources, Northern Affairs Program, INAC 1982; and
- “Guidelines for Development and Management of Transportation Infrastructure in Permafrost Regions”, Transportation Association of Canada 2010.

6.11 Design/Construction Costs

The estimated design and construction costs for the Highway are presented in Table 6-11 and are based on a combined design and construction approach, the construction schedule discussed in detailed in Section 7,

and general knowledge and experience from the construction industry. Estimates are budgetary or planning level cost estimates, and include the cost of the Great Bear River Bridge ($60M).

Table 6-11: Estimated Design/Construction Costs ($2011)

Item	Quantity	Subtotal
Highway Construction (including mobilization, winter road construction, camp operation, bridges, etc.)		$572.9M
Engineering, Design, Construction Administration at 4.5% of Estimated Construction Cost		$25.9M
Total Estimated Design and Construction Costs		**$598.8M**

The estimated costs included in the above table do not include royalties or administrative fees associated with granular and embankment materials taken from sources that are on Sahtu private lands. These royalties or administrative fees are to be negotiated between the Sahtu and DOT.

6.12 Operation and Maintenance

This PDR is intended to focus on the construction of the Highway, but questions regarding the future operation and in particular dust control, were raised during the consultations. Operation and maintenance of the Highway will require maintenance camps or facilities located at approximately 100 km intervals along the Highway. Specific locations for the facilities will be confirmed during the detailed design phases of the development of the Highway and will be dependent on the final design alignment, the location of material sources, and other factors. These will be permanent facilities, operated all year long. There are expected to be three to four maintenance facilities in the Tulita District. Maintenance facilities are anticipated to include a small camp, a shop, fuel and other storage facilities, waste disposal facilities, and a small staging area. The maintenance facilities will be part of the Highway infrastructure and be operated under the authority of DOT.

Winter maintenance activities will include ploughing and ice control. Summer maintenance activities will include grading, blading, replacement of surface gravel, and dust control at selected locations where sight distance may be limited.

Chemicals commonly used for dust control on gravel highways include calcium and magnesium chloride or road salts. When stored and used properly, these road salts have minimal impact on the surrounding environment. However, other cost effective materials and technologies for roadway surfacing are being marketed and tested in northern environments. Some of these include polymer modified cold mix materials that are reported to withstand colder temperatures without ravelling, and are not a chemical that can become water or airborne after application on the road surface. An example of such is “E Z Street” which the vendors report to have used in other cold climate countries and is currently being tested in the Yellowknife area. Another example is “InfraCrete” which is an enhanced soil cement made with natural minerals and used in stabilizing road surfaces. At the present time, there are few practical applications in northern environments, but vendors report that test applications are underway. These types of surfacing materials will be further reviewed for application and effectiveness in the next stages of development of the project.

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7.0 PROJECT TIME TABLE

The summary of overall project activities through permitting, investigation, design, and construction is presented in the table and discussion below. The detailed schedule for activities leading up to construction (detailed field investigation, design, and permitting) and the construction schedule for the Highway is presented in Table 7-2 and Table 7-3.

Table 7-1: Proposed Schedule of Activities

Activities	Approximate Dates
Submission to MVLWB for Highway Construction Wrigley to Inuvik (See Section 7.1)	January 2012
MVLWB Preliminary Screening Process (See Section 7.2)	February 2012 through September 2012
MVEIRB Environmental Assessment Process (See Section 7.3)	October 2012 through December 2013
Consultation and Permitting Required for Investigation and Survey Activities (See Section 7.4)	October 2012 through May 2013
Investigation and Survey Activities to Support Design and Construction Permitting (See Section 7.5)	June 2013 through March 2014
Additional Permitting Required for Construction (See Section 7.6)	January 2014 through August 2014
Design	Commences April 2014 and is ongoing throughout the duration of the project, staying ahead of fabrication and construction requirements.
Construction (including fabrication of bridge components off site and planning for mobilization)	August 2014 through Fall 2017
Estimated Opening of the Highway	Fall 2017

7.1 Submission to Mackenzie Valley Land and Water Board (MVLWB)

DOT will prepare an overall PDR for the Mackenzie Valley Highway from Wrigley to Inuvik using information in this PDR and similar PDRs prepared for the other three highway segments. Then DOT will submit the overall PDR for approval to the MVLWB. The estimated submission date and the overall schedule is based on the assumption that the work completed to date and the information presented in this PDR is sufficient for purposes of the MVLWB Preliminary Screening, and that additional field investigations (engineering and environmental) and a more fully developed design are not required at this stage.

7.2 Time Estimated for the Preliminary Screening Process

The schedule provides an estimate of time that may be required for the:

- the MVLWB to assess the submission for completeness;
- the MVLWB to request the Proponent to provide additional information;
- the Proponent to prepare and submit additional information;

- the MVLWB to conduct preliminary screening, which could take a minimum of 42 days, (the MVLWB could request longer in accordance with the MVRMA);
- the MVLWB to conduct public hearings that are mandatory because of the need for a Type A Water Licence and the timing of which includes a required 35 days of public notice of the hearings; and
- the MVLWB to prepare and issue a decision.

In estimating the schedule, the assumption with this step is that the request for additional information will be relative to clarification of information presented in this PDR, that the additional information can be readily prepared from data already available in the project files, and that additional field investigations (engineering and environmental) and design work will not be required at this stage.

7.3 Time Estimated for Environmental Assessment Process

The schedule shows the estimated time required for the Environmental Assessment Process assuming the decision made by the MVLWB is to refer the project to the MVEIRB. Specifically, the schedule accounts for:

- the MVEIRB to hold community scoping sessions, develop the terms of reference, work plan, for the environmental impact statement;
- the Proponent to prepare the environmental impact statement;
- the MVEIRB to conduct the conformance review of the environmental impact statement and to request the Proponent to provide additional information, if needed;
- the Proponent to provide additional information; MVEIRB to hold Information Request process for parties to the assessment;
- the MVEIRB to hold technical sessions and public hearings for the environmental assessment process; and
- the MVEIRB to prepare and issue a recommendation to the Minister for AANDC; Minister to make the decision.

In estimating the schedule, the assumptions at this stage are that preparing the environmental impact statement and responding to requests for additional information will be undertaken based on data already available in the project files and additional field investigations and design will not be required to support the preparation of the environmental impact statement. It is assumed that the MVEIRB would not refer the project to a panel.

7.4 Time Estimated for Consultations and Permitting Required for Investigations and Survey Activities

While the preliminary screening and environmental assessment are underway, the next steps of field investigation and survey activities can be undertaken to support design and construction requirements once the overall project is approved. Consultation within the Tulita District will be required at this stage. The detailed discussion of permitting and the associated authorities is discussed in Section 4.0.

Time estimated in the schedule considers consultations, meetings, and preparation of individual permit applications, as well as time for the appropriate agencies to process the application.

7.5 Investigations and Survey Activities to Support Design and Construction

The intensive investigations and survey activities required to support design and construction are seasonally restricted but can be undertaken while preliminary screening and environmental assessment are underway. These activities are identified on the project schedule and include:

- spring investigations for hydrology, fisheries, wildlife, vegetation, and birds;
- late summer/fall investigations for hydrology, fisheries, wildlife, vegetation, and archaeology;
- supplementary ground survey; and
- winter investigations for geotechnical (highway alignment and material sources, including construction of winter access trails) and wildlife.

7.6 Additional Permitting Required for Construction

Additional permitting will be required subsequent to the Minister's decision for approval. Details of the permitting and the authorities are discussed in Section 4.0.

Preparation of the necessary applications will require the completion of the investigations and survey activities noted above and the design/planning requirements for winter construction access and pit management.

7.7 Construction Schedule

The approach to construction and the seasonality of specific activities is discussed in Section 6.0. The construction schedule is presented in Table 7-3.

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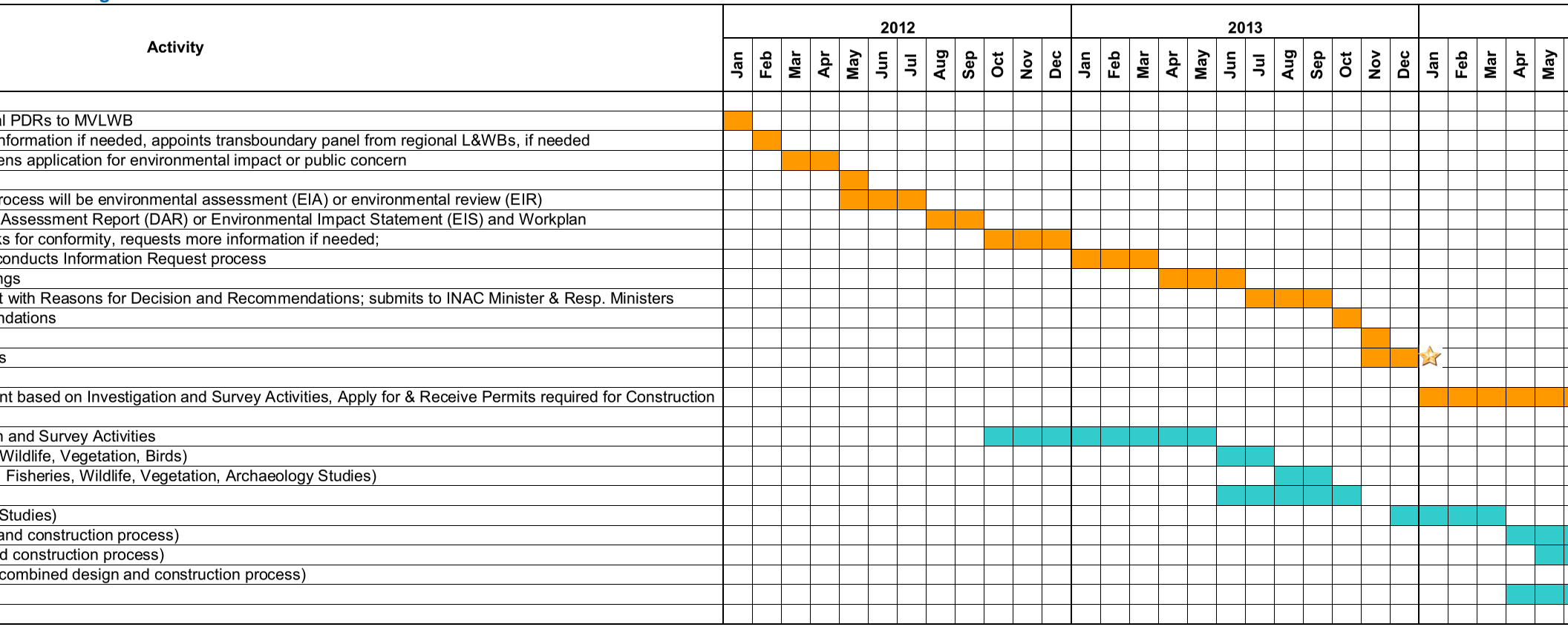
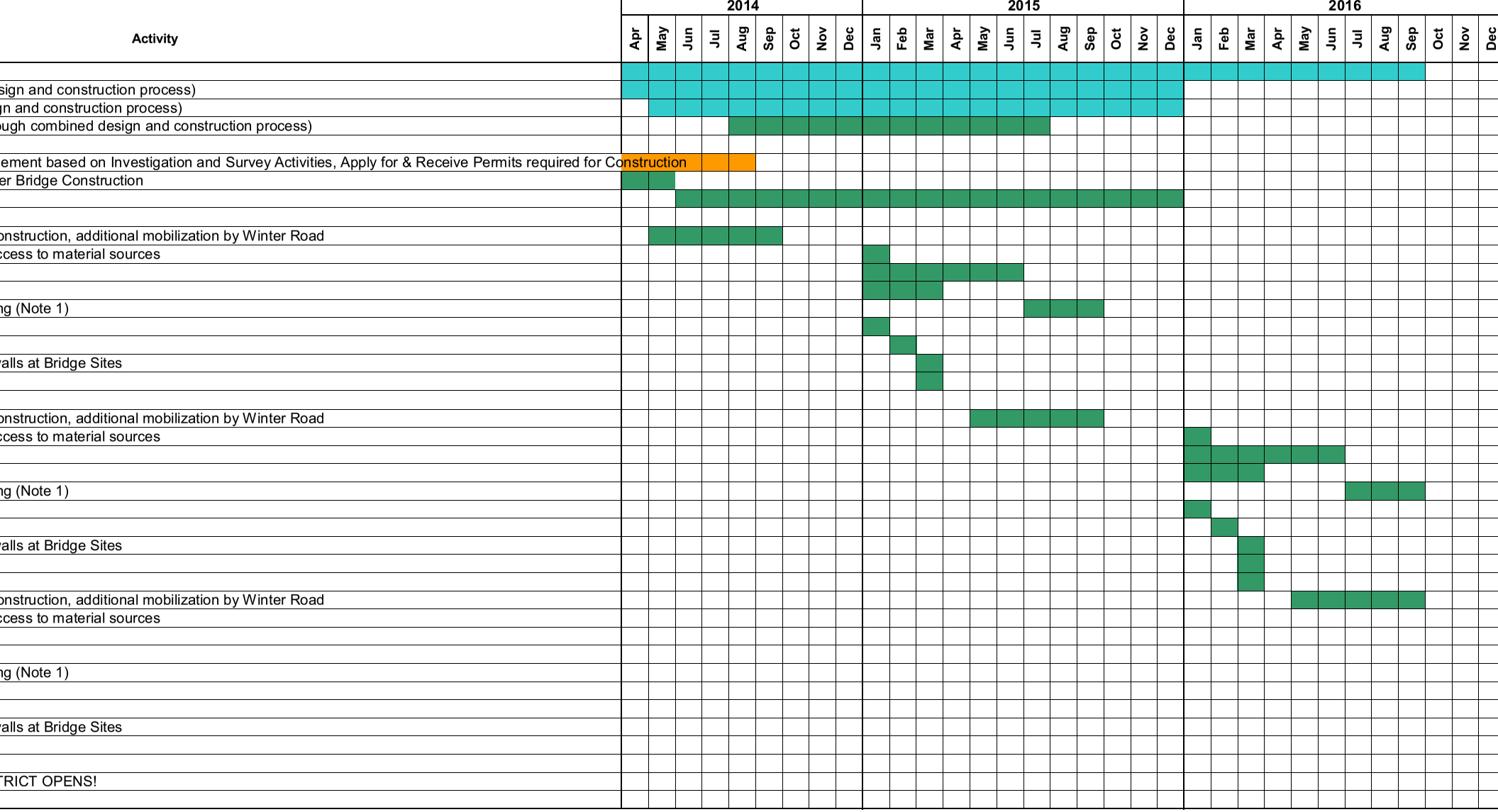
ns and Design Schedule





erial along or adjacent to completed embankment in previous winter.

8.0 TRADITIONAL AND OTHER LAND USES

8.1 General Overview of Traditional and Other Land Uses

The Tulita District in the SSA has been occupied for several centuries by the Sahtu Dene. Traditionally, the Sahtu Dene occupied an area including Great Bear Lake and its borderlands, the Mackenzie Valley lowlands between Blackwater River and Travaillant River, large portions of the Anderson Plain north of the Mackenzie River and west of Great Bear Lake, and the Mackenzie Mountains and foothills, well into the Yukon Territory. The Sahtu Metis are descended from the intermarriage between Sahtu Dene and Euro-Canadians who began to move into the region with the fur trade in the early nineteenth century (SHPSJWG 2000).

For centuries, the Sahtu Dene and Metis have travelled and used the resources within the Sahtu. Critical subsistence resources include moose, woodland caribou, Dall's sheep, beaver, marten, muskrats, waterfowl and other birds, fish, hare, and other small game. Caribou are of prime importance and are a critical food source (SHPSJWG 2000).

Several areas within the SSA have traditional land use significance and are specially managed. Due to the rich natural resources in the area, non-traditional land uses such as transportation infrastructure, industry and recreation are either existing or proposed for development.

8.2 Heritage and Archaeological Resources

Heritage resources are non-renewable and finite. They are important sources of historical knowledge and cultural identity. They are considered of value to local communities, scientists and the Governments of the Northwest Territories and Canada. 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. According to Northwest Territories Regulations, in order for remains to be considered archaeological, they must be greater than 50 years old. By definition, archaeological sites must have physical remains, while traditional or cultural sites do not need physical evidence. All these types of cultural sites can be included within the heritage resources classification.

8.2.1 Human History Summary

The following summary is based on extensive research of 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, available traditional knowledge studies, and reports on past archaeological studies. Pertinent topographic, palaeogeological and paleoenvironmental information will be incorporated to form a detailed knowledge base in order to assess the potential for heritage resources.

The Regional Study Area for background information research is necessarily large so as to place the Highway in context. Past people used the area in the vicinity of the Highway as part of a larger regional exploitation pattern. Therefore, for this overview, the Regional Study Area is essentially all of the SSA.

8.2.2 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 culture history of the Mackenzie Valley is not well defined. Below is a preliminary culture history sequence that has not been substantially revised in two decades.

The early Prehistoric Period [~10,000-6,000 years B.P. (before present)] is not well represented in the Mackenzie Basin. The Paleoarctic Tradition has been dated as early as 11,000 years B.P. in the Yukon and Alaska west of the Mackenzie, to as late as 4,500 years B.P. in other areas. Distinguishing characteristics in 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. Within the Mackenzie Valley, several tools recovered from Chick Lake, just west of the Highway, are very similar to the Acasta Lake complex found east of Great Bear Lake dated to about 7,000 years old (Millar and Fedirchuk 1974).

The Middle Prehistoric Period (6,000-2,000 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. Tenlen Lake north of the Highway may have Middle Prehistoric remains (Pilon 1988).

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. 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).

8.2.2.1 Historic Period

Since Alexander Mackenzie's historic journey up the river that bears his name in 1789 (Mackenzie 1801), numerous explorers and adventurers have travelled the Mackenzie River and recorded observations of the environment and of their encounters with aboriginal people they met. These include Sir John Franklin on his second polar expedition (Franklin 1828), Thomas Simpson (Simpson 1970), Sir John Richardson (Richardson 1851), and Frank Russell (Russell 1898), among many others. 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 the Mackenzie River. 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 beginning in 1795 with the establishment of Trout River Post by the Northwest Company 80 miles downstream from that river's outlet (Keith 2001). From this post, some trading expeditions occasionally travelled some distance downriver to meet and trade with other Slavey and Hare groups. Fort Good Hope, first established in 1804 (Voorhis 1930), was moved upstream twice after 1821 to provide easier access for the "Loucheux" people (Gwichya Gwich'in).

The first fur trade post in the area was reportedly Fort "Normand" (also referred to as Fort Norman I), built by the Northwest Company around 1809. It was said to have been located on the right bank of the Mackenzie River opposite the Redstone River mouth and operated at that location until 1815 (Keith 2001) or perhaps as late as 1823 (Smythe 1968). This could be in the vicinity of the Saline River. Old Fort Point, on the west bank of the Mackenzie about 35 km upstream from Tulita, may be the second site of Fort Norman; according to Voorhis (1930), Fort Norman was at Old Fort Point between 1844 and 1851. Fort Norman was built on the current site of Tulita by the Hudson's Bay Company in 1851 (Usher 1971) and has operated continuously to the present time. From 1900 to 1962, upwards of a dozen independent traders opened posts for between two and twenty years duration in the vicinity of the Great Bear River-Mackenzie River confluence (Usher 1971).

In the 1850s, missionaries from both the Anglican and Catholic churches arrived in the Mackenzie District. Steamboats began to travel up and down the Mackenzie River in 1887. The RCMP arrived in the Mackenzie region in 1903 (Robinson and Robinson 1946) and established a post at Fort McPherson. In 1916, a detachment was established at Fort Norman (ibid:13), now Tulita.

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) as early as 1789. The first productive oil well was drilled in 1920 and a small refinery was built. During World War II, oil production at Norman Wells was increased by American interests and a pipeline from Norman Wells to Whitehorse (the Canol line) was built in record time. The 1930s saw the development of a winter road in the Mackenzie Valley to bring in construction supplies from Edmonton. This road was occasionally built as needed in the next few decades. Since the 1970s, it has been built and used annually.

8.2.3 Ethnography

The southern part of the Highway to the vicinity of the Great Bear River was occupied at the time of contact by a group of Athapaskan speakers called Slave or Slavey while north of the Great Bear River was the group known as Hare Indians (Asch 1981; Savishinsky and Hara 1981). Neither group was traditionally organized into any cohesive unit such as a tribe; rather they were small semi-nomadic groups who differentiated each other by geographic locations or some variation in behavior or cultural feature (Asch 1981). Membership was fluid and all groups had access to the entire Sahtu land use area (T'Seleie et al. 2000). It may be more reasonable to refer to all the people making use of the area in the vicinity of the Highway 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; Savishinsky and Hara 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. June Helm spent much of 1951 and 1952 with a group of people at Jean Marie River on the Mackenzie River.

Mackenzie Basin Dene were necessarily semi-nomadic; the limited availability of food resources required travelling to different parts of their range with changes in seasons via a network of well used interconnecting trails to take advantage of all available animals and plants. The Hare Indians were so called by the early explorers because their heavy dependence on the snowshoe hare (Savishinsky and Hara 1981). 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 (Asch 1981).

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 water fowl. Longer hunting trips were also conducted at this time since people had often depleted all their preserved foods. In summer, Mackenzie Basin people in the vicinity of the Highway congregated at the larger river mouths on the Mackenzie River or, in later times, at the fur trade fort of Fort Norman at the mouth of the Great Bear River. This was when intensive fishing and fish drying was done. It was also a time for visiting and dancing. Other important activities carried out at this time included making and repairing tools, boats, fish nets, 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 caribou, moose and fish (Savishinsky and Hara 1981). Large mammals were hunted at any time of the year. Hunting caribou or moose was most commonly done by individual or pairs of hunters since the animals are typically solitary, except in the northeast portions of the Highway. There, barren ground caribou could be found in larger groups during winter since this was part of their winter range (Savishinsky and Hara 1981).

Large game 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 Athapaskans and was used for all animals" (Janes 1983). 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 in summer and snowshoes in winter. 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 most tools and implements. Snares, snowshoes and fish nets 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.

8.2.4 Previous Archaeological Studies

Archaeological investigations in the Mackenzie Valley began in the early 1950s (e.g., MacNeish 1953) as part of a search for the routes used by early colonizers of North America. 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).

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 fairly closely, only deviating where necessary to use more favourable terrain or tributary drainage crossings. As a result of this survey, 19 archaeological and historic sites were recorded within the Tulita District. The project included some construction monitoring in the southern section. It was not clarified whether this was to be an all season road or the winter road that was subsequently developed. In 1981, several of these sites were further investigated (Fedirchuk 1981).

In 1973, the first of a number of archaeological studies of potential pipeline corridors in the Mackenzie Valley was completed (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 major rivers at several localities between Fort Simpson and Fort Good Hope. The one area intensively examined in the vicinity of the Highway was the vicinity of Tulita and the first few miles upstream along the Great Bear River. Two prehistoric sites were discovered on the Mackenzie bank just below Tulita while one site was discovered on a ridge on the west side of the Great Bear River approximately 2.5 km upstream.

Two later archaeological investigations were completed relative to the Mackenzie Valley Highway Project. In 1999, archaeological studies were conducted of proposed upgrades to "the existing winter road" that comprised 17 proposed bridges and 12 potential culvert locations (Ronaghan 2000). No new sites were found. Seven of these bridges that are along the Highway have since been built. In 2006, a study of a proposed bridge over the Great Bear River was completed (MacKay 2006). Four sites were recorded.

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 excavations. 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 these projects to date.

Beginning in 2002, four field seasons of archaeological investigations were completed for the 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 material sources and infrastructure

locations. Approximately 22 archaeological sites and 14 traditional sites were recorded within the Tulita District. Numerous previously recorded sites 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, several large lakes, and, outside of these areas, specific development zones. Such focus has left substantial portions of the region unexamined.

8.2.5 Recorded Heritage Resources

Over 150 archaeological sites have been previously recorded within or immediately adjacent to the Tulita District (Figure 8-1). Most of these sites have been recorded along the Mackenzie River at the mouths of creeks and rivers or short distances upstream from those confluences. The majority of these sites have only been recorded to a preliminary level, and several have been subjected to some subsurface testing. Fifty-three of these sites are within approximately 1 km of the highway alignment options and material sources. The known sites were primarily recorded during the surveys noted above for the MGP in 2002 to 2006, as well as studies related to the original road and bridge assessments conducted in 1973, 1999, and 2006.

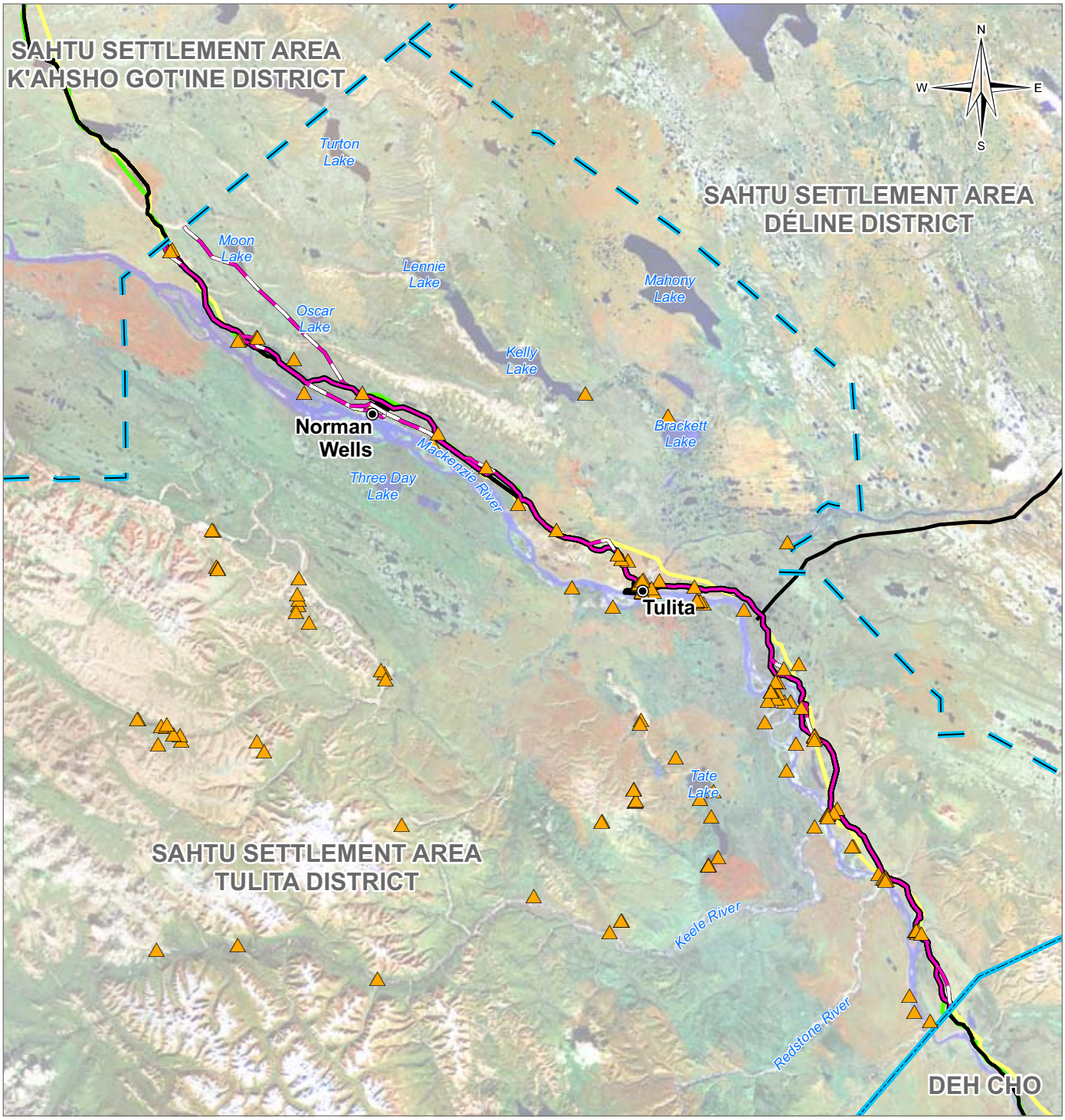
The site types recorded in this site assemblage are representative of the full range of culture history postulated for this Mackenzie region. They include prehistoric stone tool making sites, prehistoric camps, historic aboriginal camps, cabins, trails, graves and recent camps/cabins.

8.2.6 Archaeological Overview Assessment

The primary method used to rate archaeological potential was visual assessment by low and slow helicopter overflight. Coordinates digitized from maps were loaded in GPS units and used to follow the Highway and alternatives. The Highway, alternatives and a few nearby material sources were depicted on topographic base maps at a scale of 1:25,000. Several of those material sources were also overflown, with the boundaries roughly approximated using topographic maps. It must be emphasized that material sources were not finalized at the time of the field visit and, therefore, the overview assessments included here must be considered preliminary.

8.2.6.1 Terrain Potential

The terrain in the vicinity of the Highway is characterized by generally level to undulating ground. The section south of Tulita is more regular and at higher elevation than toward the north, up to an area near the south edge of the Highway. There the elevation drops and the ground becomes wetter. Water courses are often incised, and therefore typically exhibit terracing. Between Norman Wells and Tulita, elevation drops somewhat, more peatlands are evident and creek banks are lower, although the more easterly alignment option in this section crosses hillier ground. North of Norman Wells, the ground is more irregular, terrain variations at creek crossings more gradual, and patches of wet ground occur periodically. Significant portions of the area in the vicinity of the Highway have been burned, thus, large areas of aspen and young spruce are present.



LEGEND

- Communities
- Recorded Archaeological Site
- MVH Concept - EBA September 2010
- MVH Concept - EBA September 2010, Alternative
- Mackenzie Gas Project, Proposed Alignment
- PWC 1974 Highway Concept Route
- Public Winter Road
- Settlement Area Boundary
- District Boundary

NOTES
Base data source: ESRI

MACKENZIE VALLEY HIGHWAY TULITA DISTRICT

Previously Recorded Archaeological Sites

PROJECTION	DATUM
UTM Zone 9	NAD83

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Kilometres

FILE NO. Archaeological_Figure8-1.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y22101155	TV	MS	GP	0

OFFICE	DATE
EBA-RIV	October 14, 2011

5658 NWT Ltd.

eba A TETRA TECH COMPANY

Figure 8-1

M:\TRANSPORTATION\NWT_Mackenzie_Highway\Y22101155_TulitaMaps\Archaeological\Archaeological_Figure8-1.mxd modified 10/12/2011 by tony.vuong

Most of the Highway follows the existing winter road which is already disturbed. In general, creek and river crossings represent the best archaeological potential, but virtually all the bridges for the Highway have been built as part of the winter road, although a few may be relocated. Consequently, most of the best archaeological potential areas have already been impacted. Not all of those specific bridge locations were assessed for archaeological resources prior to construction and indeed, it is virtually certain that no archaeological assessments were conducted prior to the use of these crossings for the winter road beginning in the 1930s. Therefore, with regard to the drainage crossings, it is likely that new archaeological impacts could occur only in those instances where it may be necessary to revise the approaches to a bridge or to relocate a bridge.

Besides water crossings, there are several sections of the Highway that traverse terrain with good archaeological potential, that is, level, elevated, dry ground with a defined landform edge or other feature. Of particular interest, are sections close to the Mackenzie River upper terrace edge. Good potential terrain occurs at:

- km 815;
- km 876 to km 879;
- km 926;
- km 1,061.5; and
- km 1,075 to km 1,076.

The material sources assessed thus far are by and large rated moderate to high potential (Table 8-1). All new material sources are likely to require some archaeological ground reconnaissance, once they are identified.

Table 8-1: Potential Material Sources Assessed for Archaeological Potential

Material Source ID	Location*	Assessment	Archaeological Potential Rating
9.037PA	km 797	slightly elevated; dry looking ridge; aspen, pine	low-moderate
9.034PA	km 800	only slightly elevated; dry looking; aspen, pine	low
9.034PB	km 803	not visibly elevated but near pond; pine, aspen; dry looking	low-moderate
1831	km 812	sandy soil, pine forest, east terrain edge	moderate
9.024AP	km 816	Steep Creek; well defined terrace edges N&W	high
9.017P	km 830	Saline River; terrace edge	moderate-high
9.010PA	km 839	bedrock knob, gravel bench	moderate
9.002PB	km 850	already developed	n/a
9.002PA	km 8 53	upper Little Smith Creek terrace, arch site present	high
20.086P	km 890	hill edge, overlooking ponds	moderate
1750	km 894/km 896	elevated ridge; defined edge	moderate
1747	km 907	slightly elevated ridge; possible edge	low-moderate

Table 8-1: Potential Material Sources Assessed for Archaeological Potential (continued)

Material Source ID	Location*	Assessment	Archaeological Potential Rating
1746	km 911	mostly low, wet bog; terrace edge on Gotcha Creek	moderate
1942	km 926	on Mackenzie R. upper terrace edge	high
1429	km 930	on Mackenzie R. upper terrace edge; to Four Mile Creek mouth	high
1449	km 950	Great Bear River second terrace	high
1456	km 960	Bear Rock	High
7.090P	km 975	well defined ridge; arch site present	high
1505	km 1,000	nice ridge- west Canyon Creek	moderate
1572/1573	km 1,003	Helava Creek - nice hill, terrain edge?	moderate
7.057P	km 1,023	existing quarry	n/a
7.049P	km 1,020	Bosworth Creek terrace edge, contains site	high
7.054P	km 1,020	slight hill, tall spruce, aspen, birch	moderate
1527	km 1,025	nice ridge	moderate
109B	km 1,027	nice ridge	moderate
1329	km 1,081	saw-backed ridge; steep cliff face	low-moderate
7.021P	km 1,083	broad, rounded moderate ridge	moderate
7.018P	km 1,092	high knoll, arch sites present	high

*Location relative to existing winter road

8.2.6.2 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. Because the alignment is not yet finalized, it is not certain how many of the recorded archaeological sites are in the vicinity of the Highway. This is further compounded by the fact that some site coordinates may not be accurate (see discussion below). However, some preliminary statements on the potential for impact can be made.

Of the 53 sites recorded within 1 km, 32 sites appear to fall within approximately 250 m of the Highway or within material sources (Table 8-2), and 16 sites are 30 m or less. Those sites stated to be within 30 m may already be disturbed or destroyed by the ongoing maintenance and use of the winter road or by past construction of nearby utility lines. This was reported to be the case for two sites (LdRo-2, LdRo-4) at Big Smith Creek (Hanna 2004). It is possible that two or three historic trails may be crossed, since they generally follow the drainage valleys. One recorded trail appears to head northeast from Tulita, along the Bear Rock and probably was used to travel to Willow (also known as Brackett) Lake. It is necessary to relocate all sites in close proximity in order to confirm their status. Investigation of potential material sources, infrastructure such as construction camps and staging areas, and associated access roads will likely provide additional archaeological resources.

Archaeological sites have been recorded in material sources located near:

- km 852.5;
- km 975;
- km 1,019.5; and
- km 1,092.

These sites will need to be revisited and assessed. It may be possible to slightly revise the material source boundaries so as to avoid them.

Archaeological sites were previously recorded at the following locations (most sites are some distance from the current used/proposed crossings, except where noted):

- Oscar Creek: four sites;
- Billy Creek: one site;
- Bosworth Creek: one site in a material source along the Highway;
- Canyon Creek: three sites;
- Vermilion/Nota Creeks: one site at confluence;
- Great Bear River: eight sites, all near crossing;
- Big Smith Creek: six sites, all near crossing;
- Little Smith Creek: five sites, one near crossing;
- Saline River: five sites; and
- Steep Creek: four sites, two on or near alignment.

Research of published Sahtu Dene traditional knowledge has indicated that Bear Rock is an important heritage resource. This large rock ridge west of the Great Bear River has significant cultural values for local Sahtu Dene (T'Seleie et al. 2000). It is described as one of the most important sacred sites (ibid:94). The entire length of the Great Bear River is also considered an important heritage resource to the Sahtu Dene who have many stories about it (ibid:104). It is, furthermore, clear that Great Bear River has been a well used travel route between Great Bear Lake and the Mackenzie River for a considerable period of time. Tulita was an important summer gathering locale where visiting and feasting occurred (Blondin 1990). The chain of lakes comprising Brackett (called Willow by Dene) Lake, Kelly Lake and Mahony Lake were of key importance in the Sahtu Dene people's seasonal round. A group of people who regularly camped at Willow Lake were known as "the Willow Lakers" (Janes 1983), and they typically travelled to Willow Lake from Tulita along the Great Bear River and the Willow (now called Brackett) River; in past times, they also ranged north to Mahony Lake or sometimes to Great Bear Lake (Janes 1983). One of the sites recorded west of the Great Bear River is a trail which was probably one of the routes travelled by the Willow Lakers (Janes 1983).

Table 8-2: Recorded Archaeological Sites near Highway Components

Site	Location	Component/Distance	Type
LbRn-1	Steep Creek lower terrace	HWY*/within 30 m	historic camp
LbRn-2	Steep Creek upper terrace	HWY/within 30 m	cabin
LbRn-3	Saline River upper terrace	HWY/more than 250 m	lithic scatter
LbRn-4	Saline River upper terrace	HWY/more than 500 m	grave
LbRn-5	Saline River lower terrace	HWY/400 m	cabin
LbRn-6	Saline River lower terrace	HWY/250 m	prehistoric lithic
LbRn-7	Steep Creek/Mackenzie	on HWY	prehistoric lithic
LbRn-8	Steep Creek upper terrace	HWY/500 m	cabin/grave
LbRn-9	Steep Creek upper terrace	in material source	prehistoric lithic
LbRn-10	Steep Creek/ Mackenzie confluence	HWY/> 30 m	historic camp
LcRo-1	Little Smith Creek upper terrace	in material source	lithic scatter
LcRo-3	Little Smith Creek/Mackenzie confluence	HWY/>1 km	cabins
LcRo-5	Little Smith Creek/Mackenzie confluence	HWY/>1 km	cabin
LcRo-6	Little Smith Creek/Mackenzie confluence	HWY/>1 km	lithic scatter
LcRo-7	Little Smith Creek lower terrace	on HWY	lithic scatter
LdRo-2	Big Smith Creek upper terrace	HWY/<30 m/92 m N of bridge	lithic scatter
LdRo-3	Big Smith Creek upper terrace	HWY/<30 m/24 m N of bridge	prehistoric lithic
LdRo-4	Big Smith Creek upper terrace	HWY/48 m N of bridge	lithic scatter
LdRo-5	Big Smith Creek upper terrace	on HWY/>400 m S of bridge	prehistoric lithic
LdRo-7	Big Smith Creek upper terrace	on HWY?/NE of bridge	prehistoric lithic
LdRo-8	Big Smith Creek upper terrace	HWY	lithic scatter
LdRo-9	Mio Creek	HWY/>250 m	prehistoric lithic
LdRo-15	unnamed creek upper terrace	HWY/400 m	camp
LeRo-4	unnamed lake	HWY/50 m to 125 m	camp/Rosie's cabin
LfRp-7	unnamed lake	on HWY	camp/trail
LfRq-1	in Tulita	HWY/>40 m	lithic scatter
LfRq-3	unnamed lake	HWY/125 m	camp
LfRq-6	Great Bear River	HWY/>100 m	lithic scatter
LfRq-9	Great Bear River	HWY/>800 m	lithic scatter
LfRq-10	Great Bear River	HWY/0 to 30 m	trail
LfRq-11	Great Bear River	HWY/>400 m	camp/trail
LfRq-12	Great Bear River	HWY/>800 m	historic camp
LfRq-13	Great Bear River/Bear Rock	In material source	camp
LfRq-15	Great Bear River	HWY/>100 m	historic camp
LfRq-16	Great Bear River	HWY/>300 m	prehistoric camp
LfRq-17	Great Bear River	HWY/200 m	prehistoric camp
LfRq-18	Great Bear River	HWY/300 m	prehistoric camp
LfRq-19	Great Bear River	HWY/0 to 80 m	prehistoric lithic
LfRr-1	Bear Rock lake	HWY/40 m	cache/cut stumps/ trail
LfRr-2	Bear Rock lake	HWY/300 m	historic camp
LfRr-5	Bear Rock lake	HWY/240 m	historic camp
LgRr-1	Jungle Ridge creek	HWY/140 m/in material source	historic camp
LgRs-1	Vermilion Creek	HWY option/>150 m	prehistoric lithic

Table 8-2: Recorded Archaeological Sites near Highway Components (continued)

Site	Location	Component/Distance	Type
LgRs-2	Prohibition Creek	HWY option/>150 m	historic feature
LhRt-1	Canyon Creek	HWY, bridge/>1 km	cabins
LhRt-2	Canyon Creek	HWY, bridge/>1 km	cabin
LhRt-3	Canyon Creek	HWY, bridge/>1 km	fossils
LhRu-1	Bosworth Creek	HWY, bridge/800 m/ in	cabin
LiRw-1	Oscar Creek	HWY, bridge/900 m	cabin
LiRw-3	Oscar Creek	HWY/600 m	fossils
LiRw-4	Oscar Creek	HWY/0 to 700 m	trail
LjRx-2	South of Hanna River	within material source	lithic scatter
LjRx-3	South of Hanna River	in material source/HWY 200 m	prehistoric lithic tool

*HWY refers to the Highway and alternatives.

8.2.7 Heritage Site Locations and Types

The combination of visual assessment of the specific terrain in close proximity to the Highway and material sources with the background research results provides the basis for some preliminary statements on expected heritage resources and possible conflicts with known sites.

The Mackenzie Valley understandably has a large number of recorded archaeological sites and more sites can be expected. Potential for archaeological resources generally decreases as one moves away from the river, except along specific drainage systems, such as the Great Bear River, and associated networks of connected lakes. Based on the distribution of recorded archaeological sites as well as traditional knowledge and ethnographic 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 lakes.

Background research indicates that the types of sites to be expected could include various types of structural remains, stone tools and flakes, a variety of bone and wood artifacts, and bone concentrations. The organic materials in the tool kit would decompose quickly in this forest environment; thus, a high proportion of the tools would not be evident. Depending on their size, pits could represent semi-subterranean houses or caches for food or belongings or cooking pits. Because 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. Historic trails may be identified by blazes, cut stumps or lobsticks.

8.2.8 Heritage Resources Conclusions

The combination of background documentary data, traditional knowledge and overview terrain assessment for potential for archaeological remains has resulted in the identification of key areas where the likelihood of encountering heritage remains is judged high. Specific areas have been identified that are suggestive of sufficient potential for archaeological resources so that ground reconnaissance is recommended.

The following locations along the Highway as currently sited may have conflicts with recorded archaeological sites:

- Prohibition Creek, Option B;

- "Trout" Lake, km 956.5 to km 958.5;
- Great Bear River crossing;
- Big Smith Creek;
- Little Smith Creek;
- Steep Creek; and
- Lake near km 892 to km 893.

Four of the material sources contain archaeological sites (see Table 8-1). These sources have been identified as not for use in the preliminary design.

Intensive archaeological inventory survey will be completed along the Highway in the next stages of the project development. Boundaries of all associated components such as material sources, work staging areas, construction camps and access roads must be identified prior to field work.

Due to dense ground cover typical over most of the footprint of the Highway and the buried nature of some types of archaeological resources in this area, intensive systematic subsurface testing will be required in most areas judged to be suggestive of good archaeological potential. In areas already disturbed by past bridge construction, exposed soils should be carefully examined for any archaeological evidence.

Mitigation measures will be designed as appropriate for each individual site. These may include avoidance (the preferred mitigation), temporary site protection, or systematic data recovery. It is expected that most archaeological sites found will be small and could be readily avoided with a minor realignment or footprint adjustment. In the unlikely event that relocation of the Highway 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 ensure a representative sample of the site contents is obtained. This ensures that knowledge of that site is available for future generations. The archaeological terrain assessment which identified areas of archaeological potential is illustrated in Figure 8-2A through 8-2D.

8.3 Traditional Land Use and Traditional Knowledge

This section describes the traditional use of the land located along the Highway and the surrounding area. Information regarding traditional and other land uses in the area of interest along the Highway within the Tulita District has been drawn from a number of sources. In July 2010, March 2011, and October 2011 consultations and discussions were held with community residents, regulatory agencies, and community organizations for the Highway, as described in Section 9.0 of this PDR. Further traditional knowledge information was incorporated from the draft *SLUP* (SLUPB 2010), Rakekee Gok'e Godi: Places We Take Care Of (SHPSJWG 2000), Spirit of the Mountains: Shuhtagot'ine Nene and Naats'ihch'oh Traditional Knowledge Study (SENES 2009), and Traditional Knowledge Study Report: Great Bear River Bridge (EBA 2006). Although the document Rakekee Gok'e Godi: Places We Take Care Of (SHPSJWG 2000) is largely focused on the area around Fort Good Hope, there is still information that is relevant and useful to the development of the Highway in the Tulita District. The Highway and the MGP are located in the same vicinity and are intended to be developed in a common transportation corridor. The information contained in the MGP EIS (IOL et al. 2004) was, therefore, applicable to the development of the PDR for the Highway.

Traditional knowledge, along with the information on current and historical land uses, is important information to review for a linear development that will pass across undeveloped land. The traditional knowledge, particularly the information regarding traditional trails, harvest areas, and cabin locations, was reviewed as part of the Highway preliminary design so that potentially affected cultural sites and important natural areas can be protected when the Highway is constructed and operated (See Figure 8-3 through Figure 8-8 inc.).

8.3.1 Traditional Knowledge Gathered During Community Consultations

All of the comments and questions recorded at the community consultations for the Highway are referenced in Section 9.0 this PDR. However, some of the comments recorded at the consultation meetings make reference to the importance of the land and cultural values of the areas and examples are presented below because of their relevance to traditional land use.

Selected comments from Norman Wells:

- *"The worst place to navigate along the road is a slide area by the water; it was recommended that the route go along the ridge."*
- *"Some of the permanent bridges were supposed to lengthen the winter road, but did not plan appropriately for freshet and as a result, some bridges are surrounded by water during freshet. New bridges may be needed."*
- *"The Winter Road is currently located on high ground and is a good starting point for a proposed route."*
- *"Not too many wildlife around the winter road, but some beaver dams and caribou."*
- *"The winter road provides easy access for hunting (which is good and bad)."*

Selected comments from Tulita:

- "*The close location of Great Bear Bridge to town has come up several times with Elders, it is a concern."*
- *"Is the Project Team considering land tenure and land rights?"*
- *"People depend on fish lakes, historical sites, etc. Need to start the project with collecting traditional knowledge from Elders."*
- *"A comment we had in July 2010 session was looking at the sacred areas around Peel River."*
- *"There is a cabin close to the road around Jasper Lake, does Highway accommodate this?"*

8.3.2 Traditional Knowledge Near the Proposed Great Bear River Bridge

A traditional knowledge study was conducted by EBA Engineering Consultants Ltd. on behalf of DOT for the proposed Great Bear River Bridge near Tulita in 2006. The Great Bear River Bridge will form part of the Highway.

Table 8-3 provides a summary of the traditional knowledge collected during interviews. Additional information is found in the figures contained in this section.

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Christina Creek (DOT km 1001.7)
Prohibition Creek Alternate Bridge Location
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Vermillion Creek North (DOT km 984.4)
Notta Creek (DOT km 982.3)
Jungle Ridge Creek (DOT km 978.5)
Mackenzie River
Four Mile Creek Alternate Bridge Location
Great Bear River
No Name Creek (DOT km 944.0)
Tulita
Four Mile Creek (DOT km 932.2)
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Figure 8-2B
Figure 8-2C

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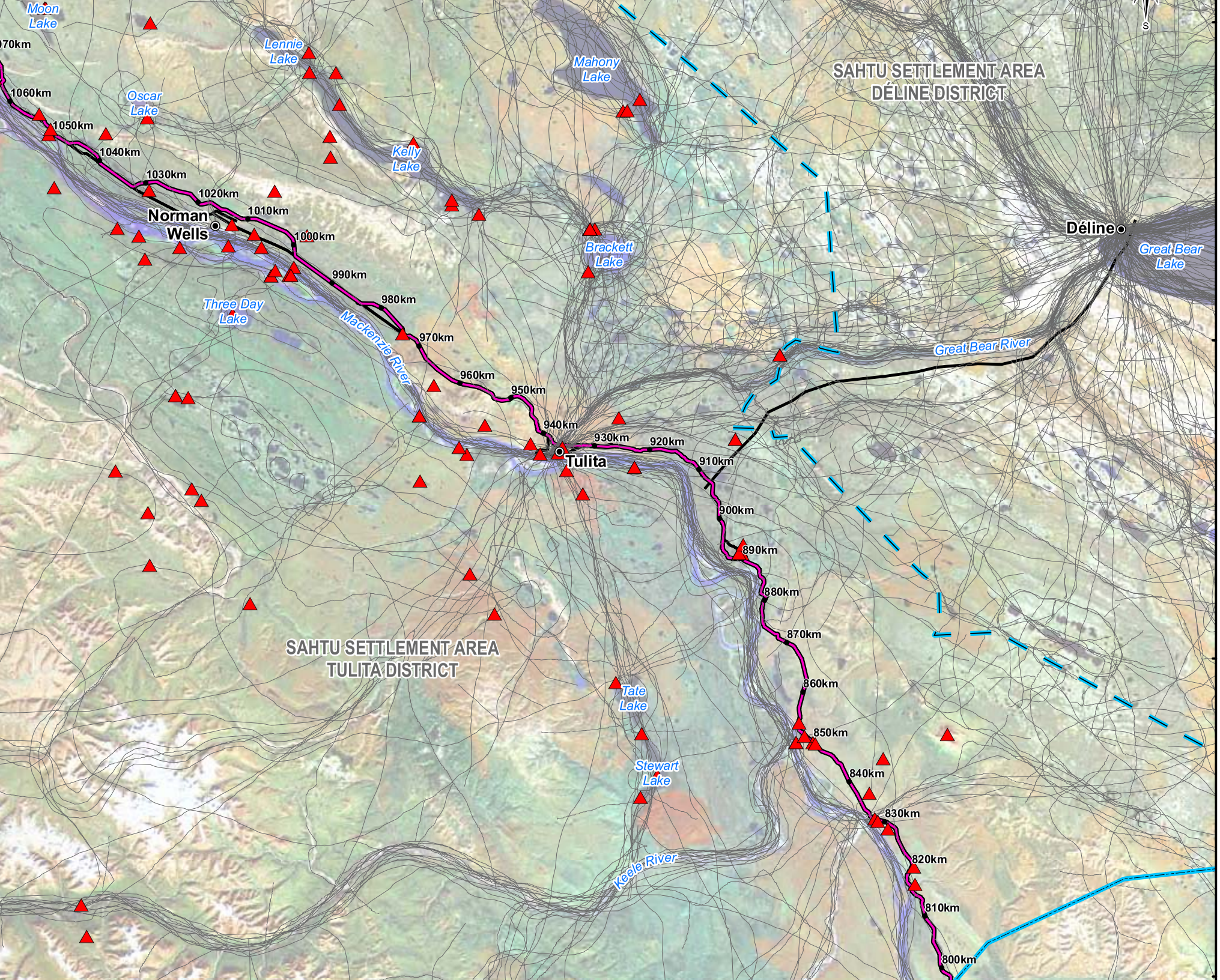
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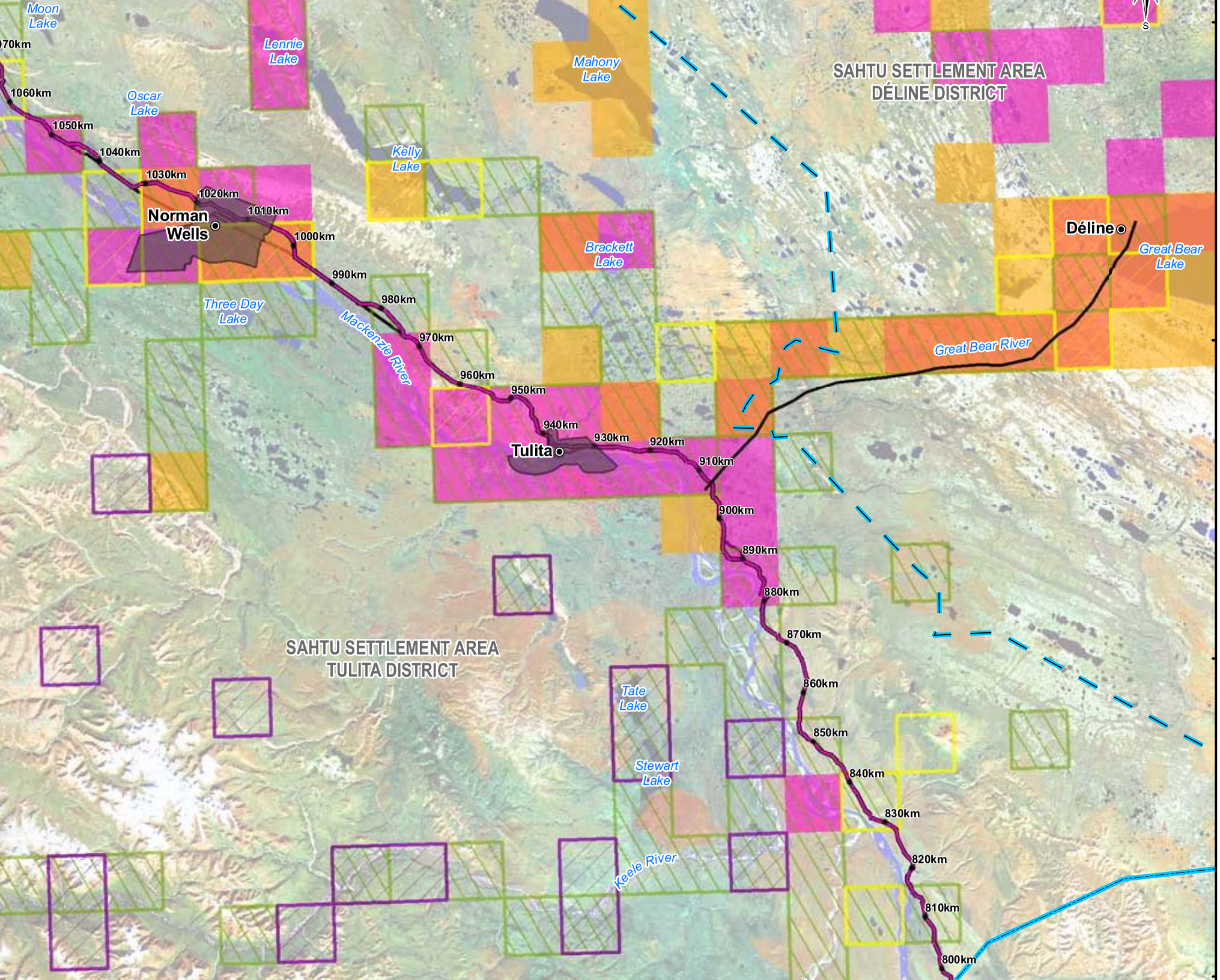
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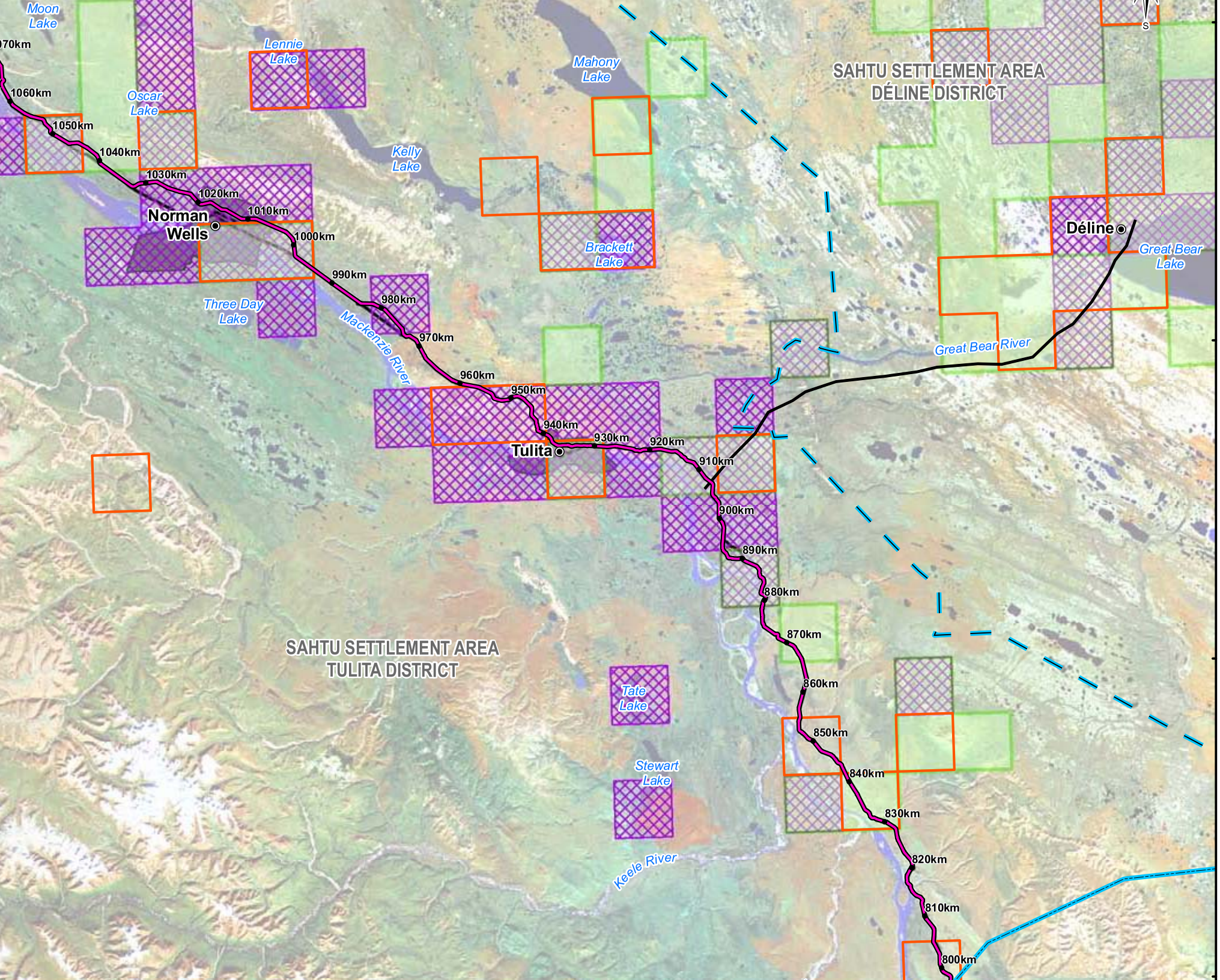
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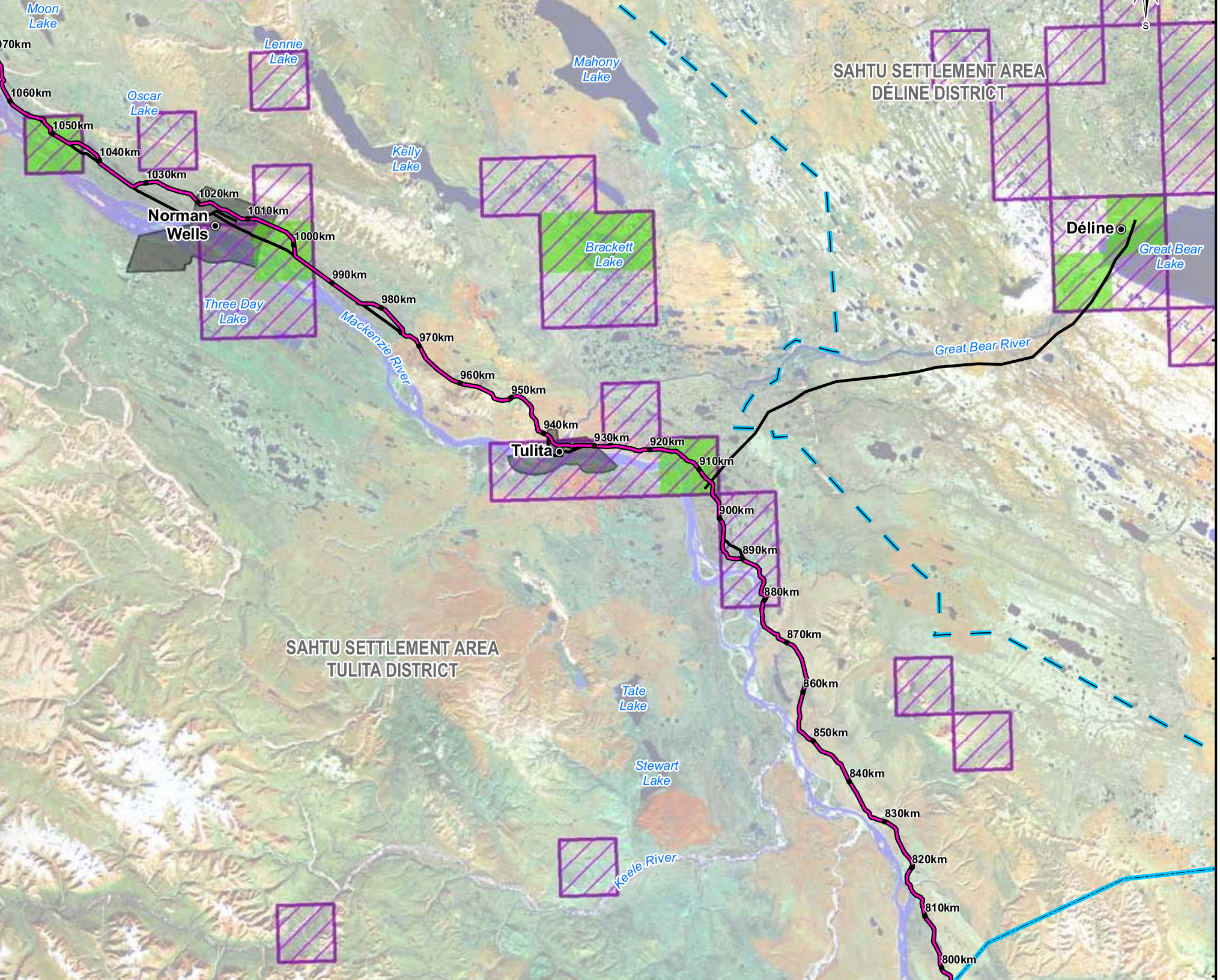
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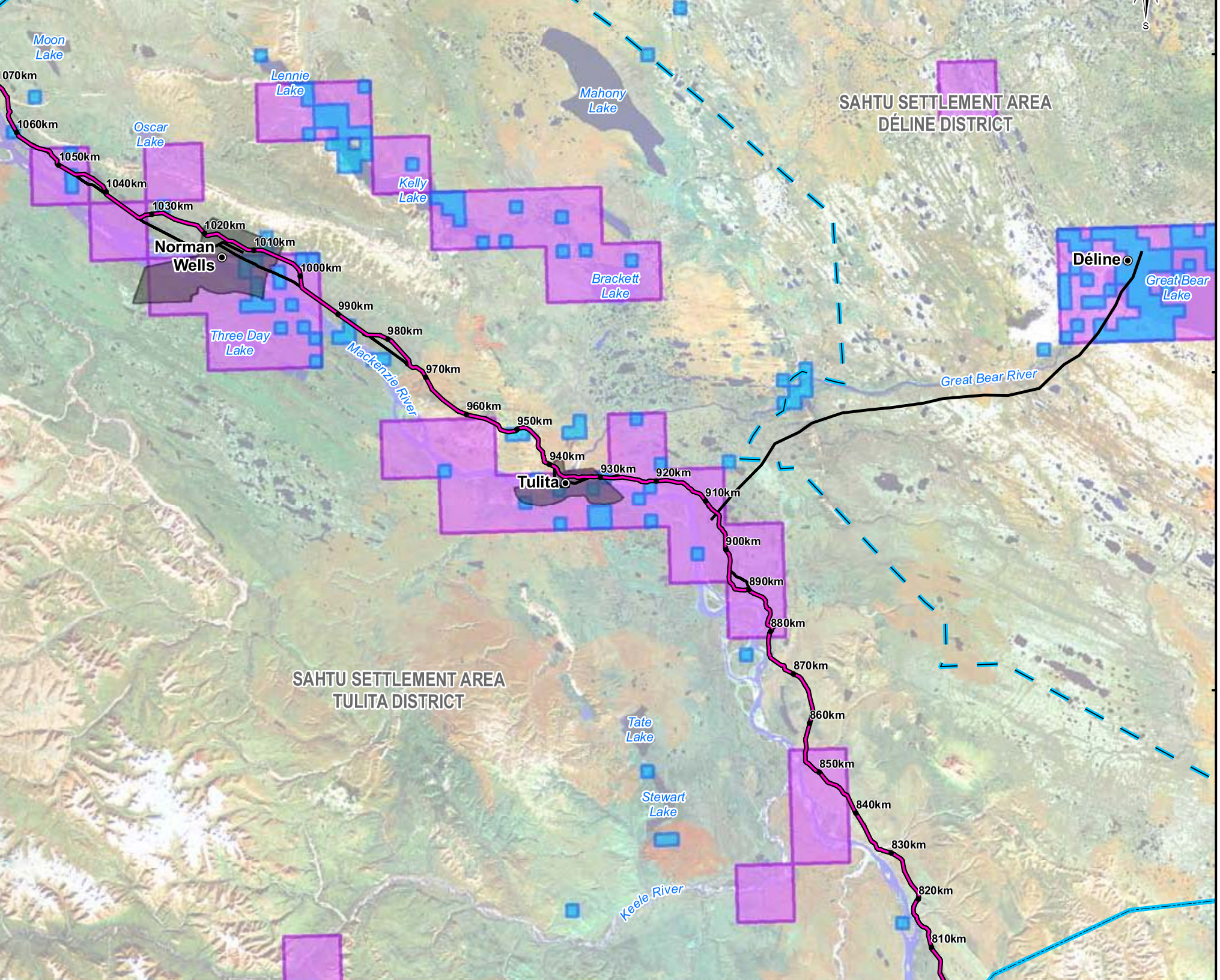
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Mackenzie River

Tulita

940km

Table 8-3: Summary of Interview Results for the Great Bear River Bridge

Category	Comments
Terrain	No major concerns were discussed around immediate cautions to crew and equipment working at the project site. No knowledge of earthquakes, landslides, etc. was presented. A number of community residents noted that the East approach to the proposed bridge location is known to be very muddy, because of water flow and clay/ dirt-like terrain.
Climate	Bridge will be great [because] with the climate getting warmer each winter, resulting in shortened ice seasons, safety becomes a big concern for travellers.
Vegetation	A blueberry picking area is located on the West side of the proposed bridge.
Water	Concerned about the pressure that the ice will put on the piers. Concerns around ice breaking capabilities of the piers.
Wildlife	Moose habitat is located directly on the West side of the bridge.
Significant Sites	Grayling are commonly present in the Great Bear River.
Traditional Use	Many participants spoke of playing in and around the project site as children. There are several fish netting areas identified around the project site.

8.3.3 Development Concerns

Specific concerns related to the construction of the Great Bear River Bridge and future development were identified in the Great Bear River Bridge Traditional Knowledge Study (EBA 2006) and the draft *SLUP* (SLUPB 2010). Additional development concerns are not identified specifically within any of the other reports; however, potential concerns were inferred based on the text and results of community consultations.

General Environment

According to the *Places We Take Care Of* (SHPSJWG 2000), the land itself is of particular importance in transmitting knowledge from one generation to the next.

Often, "culture-heroes" are associated with landscape features or locations where important events took place. The names and the narratives convey knowledge and tie the Sahtu Dene and Metis culture to the landscape, and also become powerful memory tools for recalling the significance of the location. The narratives provide information about access to harvesting areas, trails, and named places, and are also records of land use overtime and culture (SHPSJWG 2000).

For the Dene, the landscape is a living thing, inhabited by entities or powers (SHPSJWG 2000). At many special places, offerings are left to respect the entities that inhabit the land.

Caution is needed with all land uses to reduce environmental effects by re-using existing disturbed areas and concentrating land use in existing corridors (SLUPB 2010).

Cabins and Traditional Camps (Modern and Archaeological)

Camps and cabins should be left for Sahtu use and areas with cabins and camps should be avoided. Available information on camps and cabins both modern and archaeological has been considered in the preliminary design for the Highway. These areas have been avoided.

Heritage, Archaeological and Burial Sites

Sites have been identified, through existing research and the archaeological overview. Known sites have been avoided in the preliminary design. Potential sites will be considered for more detailed stages of the development of the project, and the design will be refined to avoid any new sites that are found. Burial grounds are always considered sacred places and are accorded great respect. According to the draft *SLUP* (SLUPB 2010), a land use activity shall not take place within 500 m of suspected or known burial sites, historical sites or archaeological sites. Several sites have been inventoried and listed in Schedule XIII of the *SDMCLCA*. These sites and any new sites identified during development will be avoided.

Natural Landscapes with Ecological and Socio-Cultural Significance

Several special management areas are proposed in the draft *SLUP* within the Tulita District to preserve natural landscapes and features due to their ecological or socio-cultural significance, including harvest areas. These areas will be avoided where possible or seasonal timing should be considered during development scheduling.

Traditional Trails

Trails are used year-round to provide access to a vast harvesting region. The trails link thousands of place names, each with a story, to the place. Traditional trails will be avoided during construction, where possible. Many of these trails are within areas proposed for special management and conservation zones. The Highway will consolidate access to these trails such that new trails are not likely to develop.

Harvest Areas

Concerns were expressed about the increased access to areas used by Elders, trappers and hunters once the Great Bear Bridge and the Highway are constructed. The concerns specifically relate to accessing these areas during summer periods when there is typically limited access (EBA 2006).

It was identified that moose habitat would not be affected by the Great Bear River Bridge as calving areas are located away from the proposed site (EBA 2006).

Wildlife

Wildlife are a source of country foods and are integral to the local culture. Appropriate measures will be implemented to mitigate long-term effects from the Highway. Land use activities will not occur around known habitat sites during sensitive periods and should adhere to the horizontal setbacks and minimum flight altitudes identified in the draft *SLUP* (SLUPB 2010).

Water

Under the authority of the *SDMCLCA*, the draft *SLUP* creates several conservation zones for the purpose of protecting water quality. Water is considered a fundamental requirement of life, providing drinking water for communities, habitat for fish and wildlife, and travel and shipping routes (SLUPB 2010). Many lakes and rivers have spiritual significance to the Sahtu Dene and Metis. The Highway development will mitigate any potential effects to water quality and provide water quality monitoring.

Climate Change

Warmer temperatures, melting permafrost and other environmental changes create concerns related to the environment. The Highway development will take into account climate change factors, including preventing and mitigating adverse effects resulting in the degradation or aggradation of permafrost (SLUPB 2010).

Society

The community is concerned about the potential number of people involved in the construction of the Great Bear River Bridge and the proximity of the work camps to the community. Work camps will be located away from the communities to avoid negative social effects (EBA 2006).

8.3.4 Traditional Knowledge, Land Use and the Highway

The available traditional knowledge and local knowledge demonstrated at the community consultation meetings has influenced the preliminary design of the Highway and the general approach to the project as a whole. As the project progresses through the regulatory process, further consultation with the communities in the Tulita District will be required. However, examples of where information collected to date has influenced the project include dust control, water quality and settling issues.

Research on dust control products other than calcium chloride or magnesium chloride is underway, particularly for bridge approaches and for use on the portions of the Highway closest to waterbodies to maintain water quality. Dust control is discussed previously in Section 6.0 of this PDR.

Additional maintenance efforts will be considered for the first year or two after construction to deal with settling and compaction of materials, given the initial construction with frozen material.

8.3.5 Traditional Knowledge, Land Use Conclusions

Through a review of the available traditional knowledge and land use information, traditional land use sites are found within close proximity to the Highway. The alignment passes through areas used seasonally for traditional pursuits by the Sahtu; however, the alignment for the Highway is preliminary and future detailed design will help identify any potential effects on traditional knowledge and traditional land use sites with more certainty. Traditional and local knowledge collected to date has influenced the preliminary design of the Highway and the general approach to the project. Mitigation measures to minimize potential effects on traditional land use sites are discussed further in Section 11.0 of this PDR.

8.4 Protected Areas and Management Zones

8.4.1 The *Sahtu Land Use Plan* (*SLUP*)

The SSA was established under the *SDMCLCA*. Within the SSA, land ownership is divided into Crown Land, Commissioner's Land, private land and Sahtu Settlement Lands. Most of the lands traversed by the Highway in the Tulita District are either federal Crown lands, administered by AANDC, or are on Sahtu Settlement Lands, administered by the Tulita District Land Corporation. Lands for Highway use within Norman Wells and Tulita are municipal lands, while any land parcels immediately outside of municipal areas are Commissioner's Lands are administered by the Town, Hamlet, or GNWT's Municipal and Community Affairs respectively (Figure 8-9).

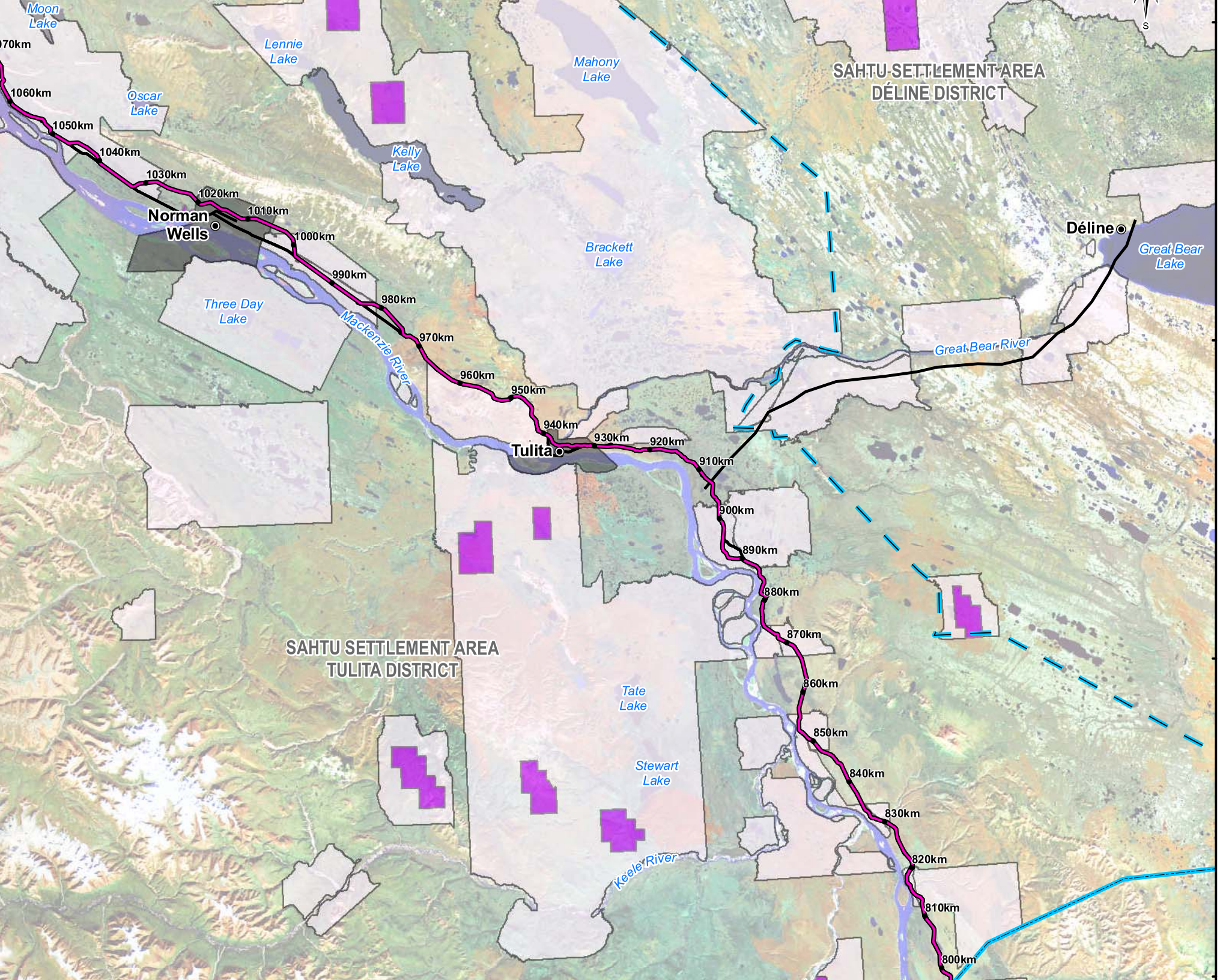
Under the authority of the *SDMCLCA* and the *MVRMA*, the SLUPB is in the process of developing the *SLUP*. Under the *SDMCLCA*, the "purpose of land use planning is to protect and promote the existing and future well-being of the residents and communities of the settlement area having regard to the interest of all Canadians"(*SDMCLCA* s.25.2.4). In particular, land use planning should protect and promote "the existing and future social, cultural and economic well-being of the participants; lands used by participants for harvesting and other uses of resources; and the rights of participants under [their] agreement" (*SDMCLCA* s.25.2.4).

In July 2010, the SLUPB issued the third draft of the *SLUP* for review. For the purposes of the PDR, the draft version has been referenced to represent the most current information concerning land use in the SSA. Application of the *SLUP* is not affected by land ownership and applies to all activities carried out on Crown Land, Commissioner's Land, and Sahtu Settlement Lands.

8.4.2 Zoning and Permissible Uses

The vision for the SSA, according to the draft *SLUP* (SLUPB 2010), is as follows:

> The region has cultural integrity. People use the land as they always have for hunting, trapping, fishing, gathering, spiritual renewal and healing. Elders are respected and play a central role in passing down the language, traditional skills, knowledge, stories and importance of the land to community leaders and the youth, strengthening cultural and spiritual connections to the land. Elders work with teachers to teach both traditional and modern skills in schools, which equip the youth to thrive and adapt in a changing environment.
>
> The ecological integrity of the region is maintained. The land, water and natural resources on which people depend are clean, healthy and abundant. There is a balance of industrial development and vast wilderness areas, a model of development hand in hand with environmental protection. Conservation Zones and legislated protected areas protect the most important places and values for future generations, while careful management allows sustainable development to proceed in all other areas.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According to the draft *SLUP* (SLUPB 2010), four types of zoning apply to the land along the Highway (Figure 8-10):

- General Use Zone – allows all land use except bulk water removal.
- Special Management Zone – allows all types of land use other than bulk water removal, subject to the general use and special management conditions outlined in the draft *SLUP* to protect cultural and ecological values present in those zones. Special management conditions may differ between special management zones.
- Conservation Zone – are significant traditional, cultural, heritage and ecological areas in which specified land uses are prohibited. Permitted land uses are subject to the general use of special management conditions outlined in the draft *SLUP*.
- Proposed Conservation Initiative – are areas for which formal legislated protection is proposed for conservation using formal legislated protection through the Protected Areas Strategy, or under the *Canada National Parks Act or Historical Sites and Monuments Act*. These areas have the same status as conservation zones under the *SLUP* until they are protected under other legislation.

Transportation corridors and infrastructure development are suited to General Use and Special Management Zones, but are typically not compatible with the intent of Conservation Zones or Proposed Conservation Initiatives. The Highway is located within the Bear Rock Conservation Zone. Development within Conservation Zones and Proposed Conservation Initiatives may be allowed on a restricted basis, in accordance with Conformity Requirement #1.

8.4.3 Management Areas Near the Highway

According to the draft *SLUP*, the majority of the Highway alignment is located within areas zoned for special management and/or conservation (Figure 8-10 and Figure 8-11). Summaries of the special management and conservation zones identified in the draft *SLUP* and protected areas in the vicinity of the Highway are as follows:

- **Bear Rock Conservation Zone (Zone #56)** – lies within the Mackenzie River Special Management Zone. It is located at the confluence of the Great Bear and Mackenzie Rivers, northwest of Tulita. Bear Rock is one of the most sacred sites and is of cultural value to Dene groups within and outside of the SSA (SHPSJWG 2000; SLUPB 2010). It is the location of a well-known story about Yamouria, a legendary hero who made the land safe for the Dene by chasing away and killing giant beavers that were causing harm to people. This zoning designation prohibits bulk water removal, mining, oil and gas, power development, forestry, and quarrying, and has general and special management conditions (SLUPB 2010).

  Bear Rock is also listed in the Tulita Conservation Initiative as an area of interest under Step 1 of the Protected Area Strategy (NWT PAS 2009).

- **Canol Heritage Trail Proposed Conservation Initiative (Zone #21)** – conservation is being sought through formal legislated protection under the Proposed Conservation Initiatives (SLUPB 2010). The trail was constructed during the World War II by the United States Army Corps of Engineers to build

and service a pipeline bringing oil from Norman Wells to a refinery in Whitehorse, Yukon, but was abandoned a few months after completion due to the end of the war. Now used primarily for hiking, the Canol Heritage Trail begins on the west side of the Mackenzie River.

- **Great Bear River Special Management Zone (Zone #14)** – is a buffer around the river from Great Bear Lake, near Deline, to its terminus at the Mackenzie River, near Tulita. The Great Bear River is used for traditional and cultural purposes including recreation, fishing, wildlife harvesting and is an important travel route. Ecologically, the area provides moose, furbearer, caribou, and breeding duck habitat. The Bluenose-East caribou herd traverses the area during the fall post-rut in November, and from December through to March. This area also provides moose habitat. Socio-cultural features include traditional trails, fish, bird, waterfowl and wildlife harvesting areas, timber log harvest, berry and plant harvesting, recreation sites, burial sites, cabins and camp sites, and archaeological sites. The buffer will ensure community access to the shoreline and will help protect water quality (SLUPB 2010).

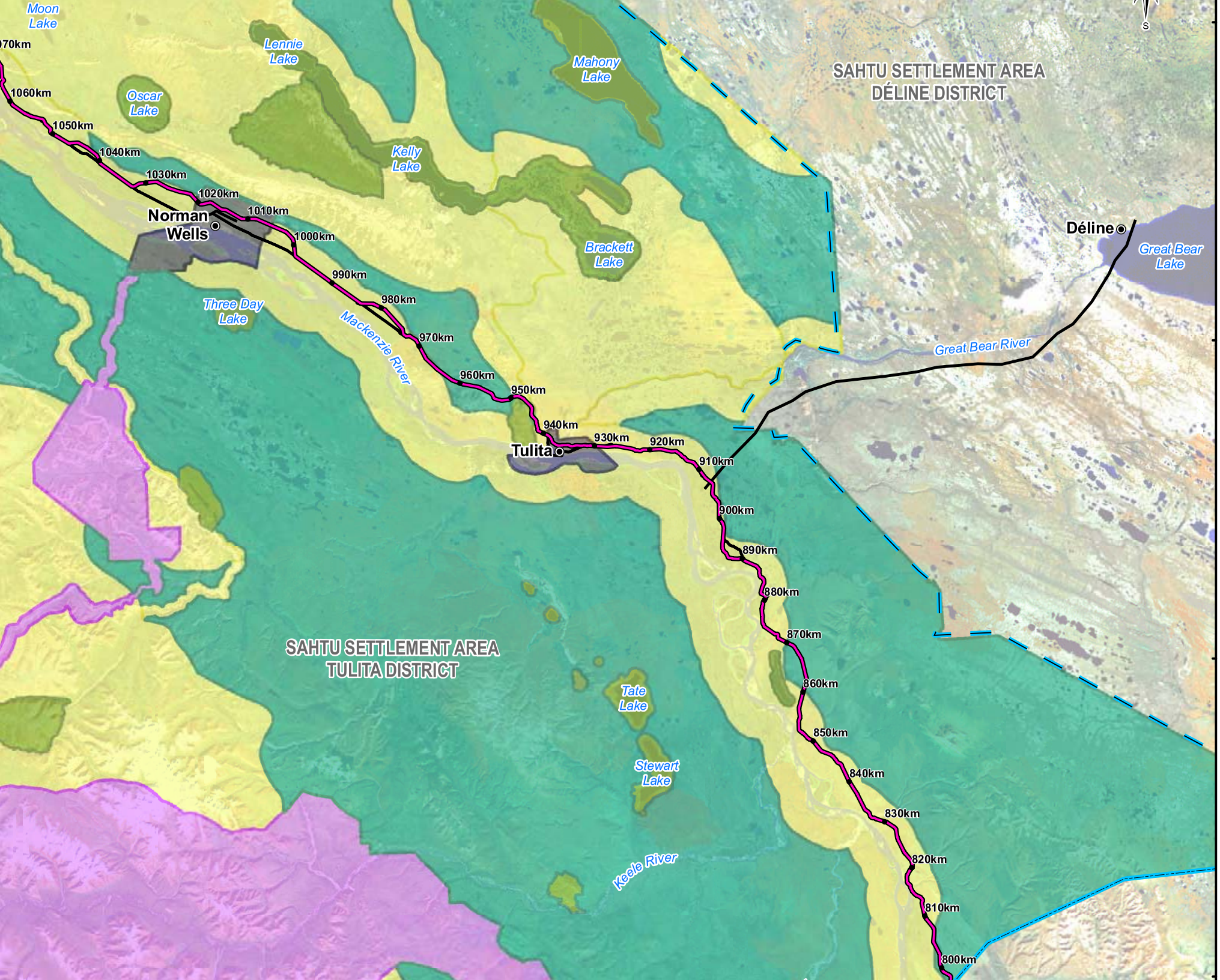
  According to the *Places We Take Care Of* (SHPSJWG 2000), oral tradition records many stories of the importance of this river. In ancient times, it was the route that Yamoria took while chasing the giant beavers from Great Bear Lake. The river is used to ferry supplies between Tulita and Deline and for fish harvesting.

- **Kelly Lake Protected Area (Land Claim) Conservation Zone (Zone #46)** – this conservation zone is located within the larger Norman Range Special Management Zone. The Kelly Lake Protected Area is a parcel of lake around the western bank of Kelly Lake that is protected under the *SDMCLCA* for continued traditional and cultural use. The ecological features contained in this area includes caribou, muskoxen, moose, furbearer, waterfowl, breeding duck, and fish habitat, raptor nesting sites, and migratory bird harvesting areas. Kelly Lake Protected Area is located east of the Highway (SLUPB 2010).

  Kelly Lake Protected Area is also listed in the Tulita Conservation Initiative as an area of interest under Step 1 of the Protected Area Strategy (NWT PAS 2009).

- **Mackenzie River (Deh Cho) Special Management Zone (Zone #3**) - is a 5 km buffer that applies to the entire length of the Mackenzie River, within the SSA, except for land within the community boundaries of Norman Wells and Tulita, which are exempt from the *SLUP*. This zoning designation provides protection for cultural heritage areas such as grave sites and archaeological sites, recreation and subsistence use areas such as community gathering places, and harvest locations. The zoning also offers added ecological protection to the river by way of protecting its shoreline, and providing for continued use for transportation (barge traffic, landing sites, and winter road). The special management zone has general and special management conditions, but no prohibited land uses (SLUPB 2010).

  According to the *Places We Take Care Of* (SHPSJWG 2000), the Mackenzie River has been a very important travel route for Sahtu Dene and Metis. There are many sacred, historical and cultural sites along the river, which also provides domestic fisheries, moose and waterfowl harvesting areas. The Mackenzie River is associated with numerous legends, including stories of Yamoria.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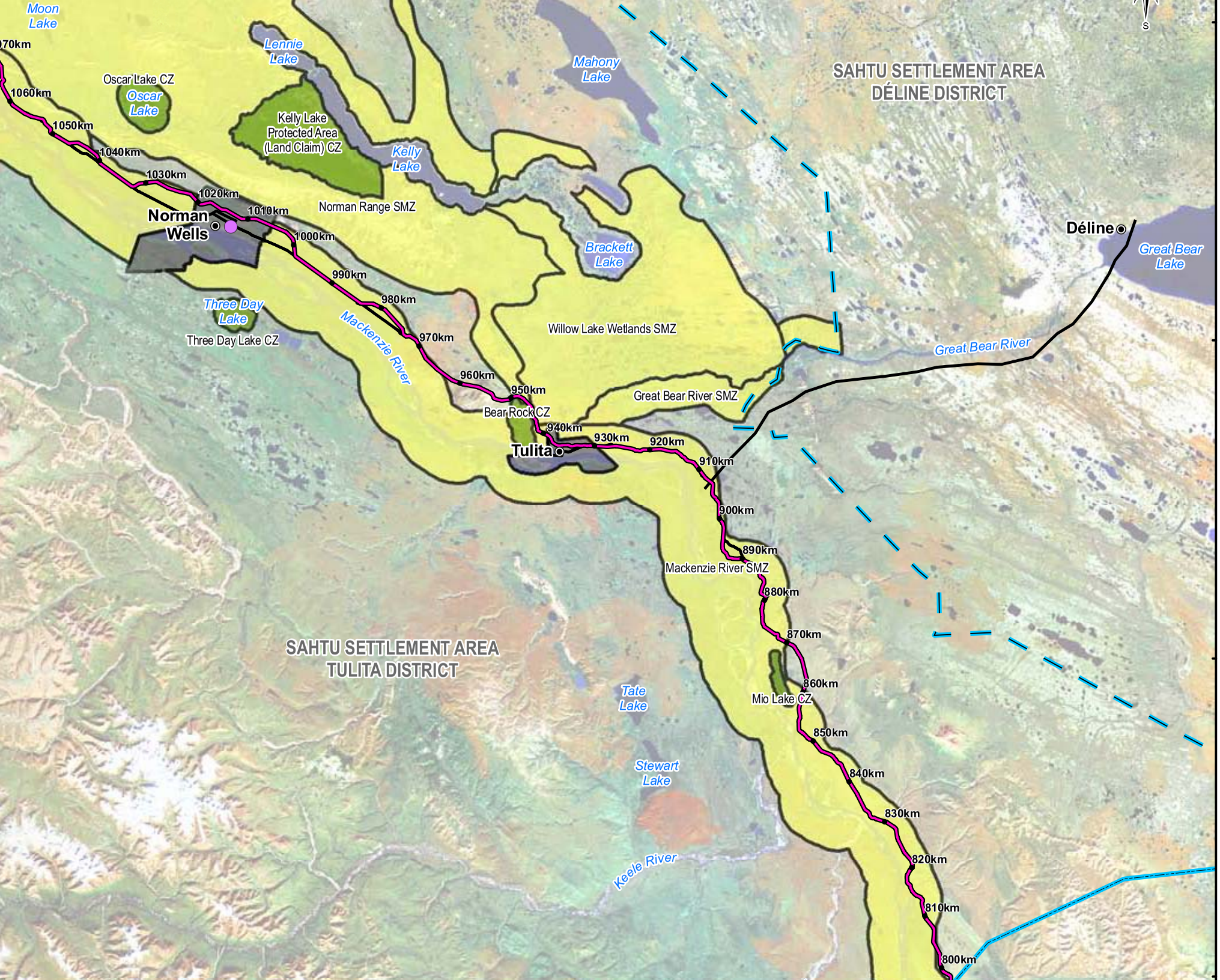
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Three Day Lake CZ
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Willow Lake Wetlands SMZ
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- **Mio Lake Conservation Zone (Zone #54)** – is a 500 m buffer around Mio Lake, which is located on the eastern banks of the Mackenzie River, south of Tulita, within the Mackenzie River Special Management Zone. The area has valuable waterfowl and bird habitat. The purpose of this conservation zone is to protect and to ensure continued subsistence use of the lake for harvesting of wildlife such as moose, waterfowl and birds. This zoning designation prohibits bulk water removal, mining, oil and gas, power development, forestry, and quarrying, and has general and special management conditions (SLUPB 2010).
- **Norman Range Special Management Zone (Zone #10)** – includes the entire Level IV Norman Range Ecoregion as its zone boundary to protect wildlife habitat and harvest locations. The zone also encompasses a number of traditional and cultural use areas. It is intended to ensure continued enjoyment of subsistence uses and practices on the land and to protect cultural sites such as archaeological and burial sites. The special management zone allows for the protection of specific values while allowing for the development of a range of economic development opportunities. This zoning designation has general and special management conditions, but no prohibited land uses (SLUPB 2010).
- **Oscar Lake Conservation Zone (Zone #47)** – is a 2.5 km buffer around Oscar Lake, located within the Norman Range Special Management Zone. The buffer encompasses the wetland area and smaller waterbodies adjacent to the lake. This zoning designation prohibits bulk water removal, mining, oil and gas, power development, forestry, and quarrying, and has general and special management conditions (SLUPB 2010).
- **The Smokes** – are located near Tulita and Bear Rock and its land features are tied to legends of Yamoria, a Dene culture hero. Under the Tulita Conservation Initiative, the Smokes are listed as an area of interest under Step 1 of the Protected Area Strategy (NWT PAS 2009). However, the Smokes are not a proposed management area under the draft *SLUP* (SLUPB 2010).
- **Three Day Lake Conservation Zone (Zone #48)** - is a 500 m buffer to provide for traditional and cultural uses and to protect the shoreline, water quality and habitat. Ecological features contained in this zone include moose, furbearer, bear, waterfowl, bird and breeding bird habitat. Socio-cultural features include traditional trails, berry picking sites, cabin and camp sites, and furbearer, bear, moose, waterfowl, bird and fish harvesting sites. Three Day Lake is located west of the Mackenzie River (SLUPB 2010).

Other important areas near the Highway recorded in *Places We Take Care Of* (SHPSJWG 2000), but are not proposed for management in the draft *SLUP* include the following:

- **Mountain Dene Trail to the Mountains** – starts on the Mackenzie River west of Tulita, crosses the Mackenzie Lowlands and Keele drainage area and terminates at Drum Lake in the Mackenzie Mountains. It is used as a walking trail in the fall and by dog team or snowmachine in the winter. Families would walk to the mountains, camp over winter and harvest moose, caribou and sheep. The trail was recommended for protection in *Places We Take Care Of* (SHPSJWG 2000); however, the Mountain Dene Trail is not a proposed management area under the draft *SLUP* (SLUPB 2010).

- **Old Fort Point** – the remains of a former fort located on the west bank and island in the Mackenzie River, approximately 48 km upstream of Tulita. The area was recommended for protection in *Places We Take Care Of* (SHPSJWG 2000). Although not a separate management area, it is included within the Mackenzie River Special Management Zone under the draft *SLUP* (SLUPB 2010).
- In addition to the management areas described in the draft *SLUP*, McKinnon Territorial Park is located within the Town of Norman Wells, on the bank of the Mackenzie River.
- **McKinnon Territorial Park** – is open from May 15 to September 15. It has eight non-serviced campsites, day-use and picnic facilities, and toilets. Although camping is permitted, residents use the park as a day-use area (IOL et al. 2004; GNWT ITI 2010).

8.5 Past and Existing Land Uses

The land in the Tulita District of the SSA has been and is currently used for a variety of purposes, which are described in this section (Figure 8-12) identifies the location of existing land uses.

8.5.1 Winter Access Trails

Since the introduction of snowmachines, winter access trails have been developed each winter as needed to allow pursuit of traditional hunting, trapping, recreational, and other activities, including in the general area of the Highway.

8.5.2 Oil and Gas Activities

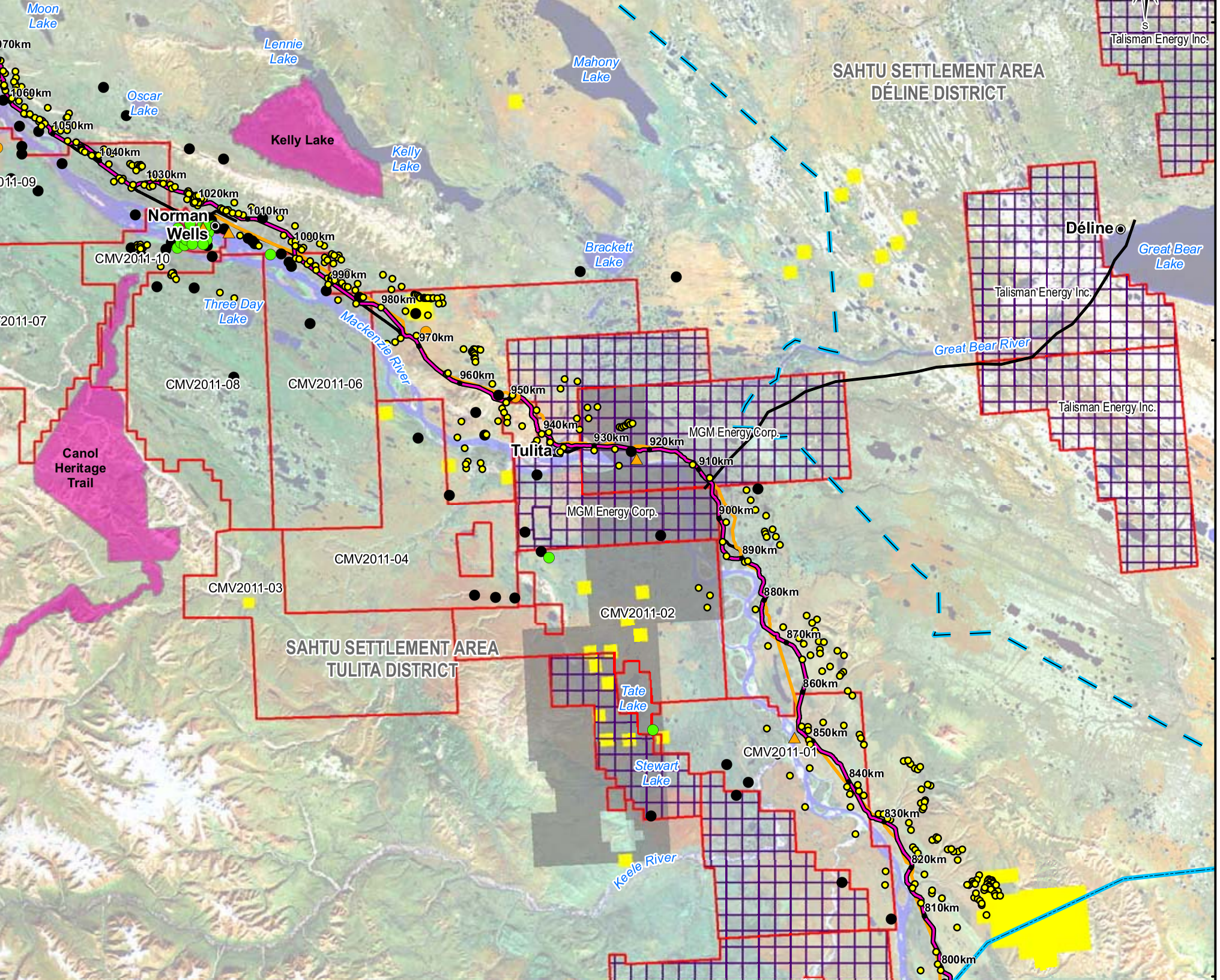
The Norman Wells Oilfield and Compressor Station, operating under the Norman Wells Production Area Agreement, is the most prominent petroleum industry activity within the SSA. Imperial Oil Resources Limited operates this site and Enbridge Pipelines (NW) Inc. operates the associated pipeline.

Norman Wells exists as a result of Canadian Government encouragement of oil exploration in the 1880s. In 1920, Imperial Oil found oil near the current site of Norman Wells (Norman Wells Historical Society 2009). The company produced oil for nearly six decades, and operated a small refinery for part of that time before deciding to expand production in the late 1970s. Construction of the Norman Wells Oilfield Expansion and Pipeline Project, including construction of six artificial drilling/production islands in the Mackenzie River and a 324 mm, 870 km pipeline to Zama, Alberta, was undertaken during the period 1982 to 1985. Over the past 90 years, Imperial Oil's Norman Wells oilfield has produced more than 226 million barrels of sweet crude oil. Since start-up of the pipeline in mid-1985, all production has been shipped to southern Canada (Norman Wells Historical Society 2009).

The Norman Wells Pipeline was the first, and remains the only, completely buried oil pipeline located in discontinuous permafrost terrain in Canada (NRCan 2011).

The Enbridge pipeline right-of-way extends south from Norman Wells through to and beyond the southern boundary of the Tulita District and is situated in the overall Transportation Corridor envisioned for the overall Mackenzie Valley Highway and the MGP.

Several oil and gas exploration licenses are located near Tulita. There are several active, abandoned or suspended wells located along the Highway (Figure 8-12).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8.5.3 Material Resources/ Material Sites

Several material sites are located within the SSA. These sites provide granular resources to communities for maintaining roads and other infrastructure. Some of the existing sites also provide support to petroleum operations in the Norman Wells area (IOL et al. 2004). For the Highway, several material sites have been identified for potential highway construction purposes. Those sites are noted in the discussion of material sources in Section 6.0 of this PDR.

8.5.4 Timber Resources

No major timber harvesting operations occur in the vicinity of the Highway. Former timber harvesting facilities were located at Fort Good Hope (i.e., Little Chicago and Grandview) in the K'ahsho Got'ine District (IOL et al. 2004). Norman Wells and Tulita each has a small lumber mill, typically consisting of a gas-powered band saw, to process timber for local use (IOL et al. 2004). Residents harvest wood for use as fuel along the winter road throughout the SSA.

8.5.5 Mineral Resources

The Highway traverses in the vicinity of small mineral claims and coal exploration licenses (pending) (Figure 8-12; SLUPB 2010). The MGP, which the Highway generally parallels, was rated as having low mineral potential by the Sahtu Land Use and Planning Board in 2001 (IOL et al. 2004).

8.5.6 Communications Line

Several communication towers are located along the Mackenzie River.

8.5.7 Winter Road

During the winter months, the Mackenzie Highway is extended through the Tulita District via a winter road from Wrigley to Fort Good Hope. The winter road provides access for trucks carrying goods to the communities and is typically open from December until March, depending on weather conditions. Over the past several years, DOT has installed permanent bridge infrastructure on several stream crossings for the winter road.

8.5.8 Barge Landing Sites

The Mackenzie River is important for barges and other boats delivering goods to many of the communities along its banks. Barging activities typically occur from mid-June to September. There are several barge landing sites along the Mackenzie River at strategic locations, and in Tulita District community barge landing sites can be found at Tulita and Norman Wells.

8.5.9 Tourism and Recreation

Residents use a variety of waterways in the SSA for transportation and recreation. In particular, the Mackenzie and Great Bear Rivers are used to travel between communities during the summer months, and

the Great Bear River is also a popular canoeing destination, primarily for local residents (IOL et al. 2004). Tourism activities include:

- jet-boat tours on the Mackenzie River and its tributaries; and
- tourism opportunities on Kelly Lake during the summer.

The winter road and the Enbridge pipeline rights-of-way are used for recreation during all seasons. In Norman Wells, outdoor recreational users include members of a local birders' club, cross-country skiers, hikers and mountain bikers. The Canol Road and TransCanada hiking trails are accessible from Norman Wells (IOL et al. 2004).

8.5.10 Visual and Aesthetic Resources

The Tulita District's predominant visual features include its forested uplands and rocky ridges. There are also rolling plains with trees, shrubs, bogs and fens. Bear Rock, near Tulita, is a prominent feature.

Several historic seismic or utility cutlines exist along the Mackenzie River valley, particularly near Norman Wells. In the northern portion of the Tulita District, the cutlines occur on both sides of the river, but south of Tulita, the cutlines occur primarily to the west of the river (IOL et al. 2004).

Oil production activity is prominent around Norman Wells.

8.6 Proposed Future Land Uses

Figure 8-13 identifies the locations of known proposed future projects that may be developed in the region.

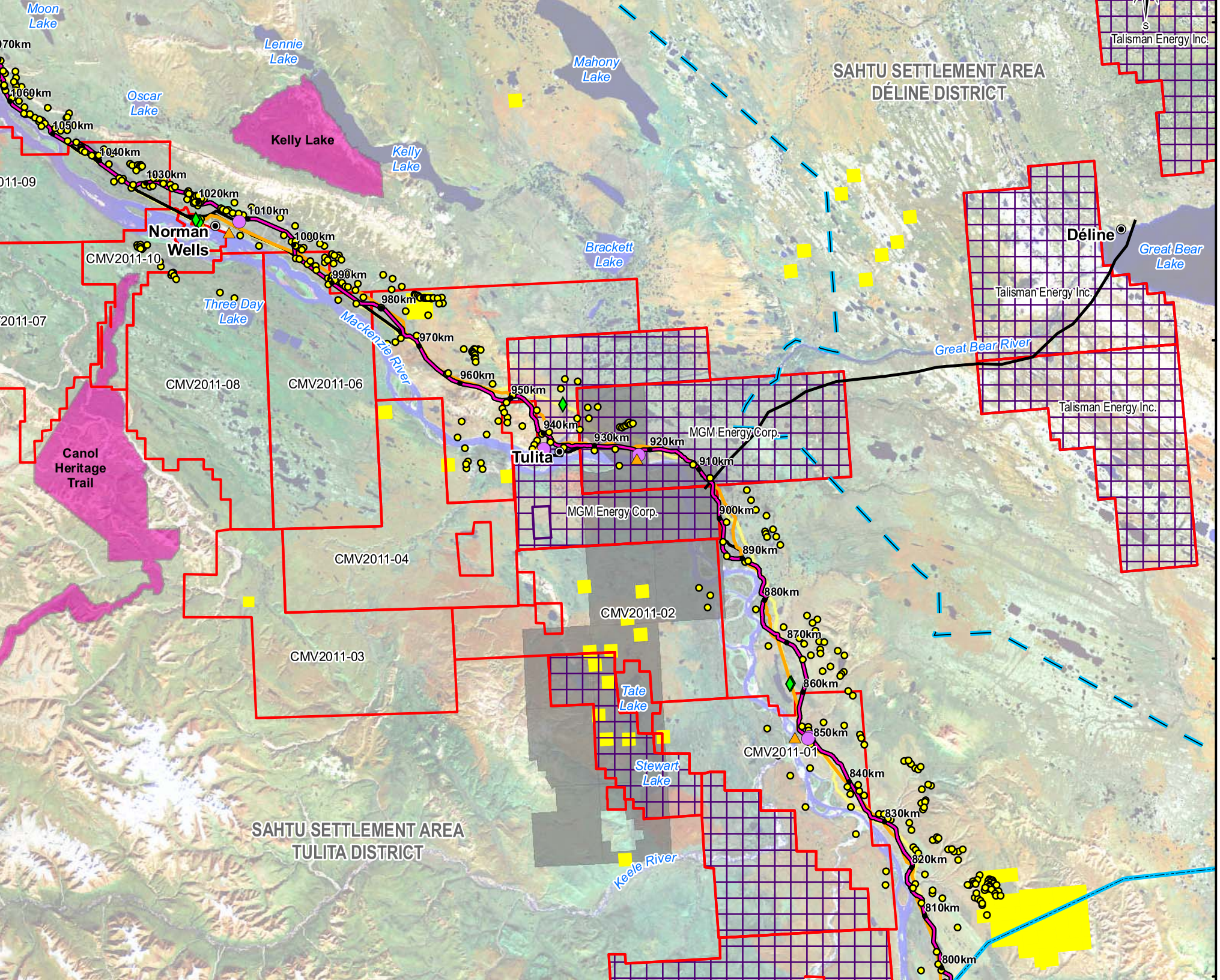
8.6.1 Mackenzie Gas Project (MGP)

Developing a natural gas pipeline from the Mackenzie Delta through the Northwest Territories to southern markets has been contemplated for forty years. During this time, various pipeline projects have been proposed that consider economics, regulatory requirements, socio-economic and environmental conditions, and engineering and geotechnical issues in the decision-making process (IOL et al. 2004).

The proponents of the proposed MGP include Imperial Oil Resources Ventures Limited Partnership (IOL), ConocoPhillips Canada (North) Limited (ConocoPhillips), ExxonMobil Canada Properties (ExxonMobil), Shell Canada Limited (Shell) and Mackenzie Valley Aboriginal Pipeline Limited (MVAPL) partnership.

The purpose of the proposed project is to develop three onshore natural gas fields (anchor gas fields) in the Mackenzie Delta and to transport natural gas and natural gas liquids (NGLs) by pipeline to southern markets (Figure 8-13).

The MGP received approval from the National Energy Board in December 2010 and the Canadian government in March 201l. At the 2011 Inuvik Petroleum Show, IOL reported that the earliest possible date for a decision to construct was late 2014 (IOL 2011). This would be followed by four winters of construction leading to the earliest possible project start-up in late 2019.


Moon Lake
Lennie Lake
Mahony Lake
Oscar Lake
Kelly Lake
Kelly Lake
SAHTU SETTLEMENT AREA
DÉLINE DISTRICT
Talisman Energy Inc.
1060km
1050km
1040km
1030km
1020km
1010km
1000km
990km
980km
970km
960km
950km
940km
930km
920km
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880km
870km
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850km
840km
830km
820km
810km
800km
Norman Wells
CMV2011-10
Three Day Lake
Mackenzie River
Brackett Lake
Déline
Great Bear Lake
Talisman Energy Inc.
Great Bear River
Talisman Energy Inc.
CMV2011-08
CMV2011-06
Canol Heritage Trail
Tulita
MGM Energy Corp.
MGM Energy Corp.
CMV2011-04
CMV2011-02
CMV2011-03
Tate Lake
CMV2011-01
Stewart Lake
SAHTU SETTLEMENT AREA
TULITA DISTRICT
Keele River
65°30'0"N
65°0'0"N
64°30'0"N

However, there remains considerable uncertainty as to when the MGP may proceed. In particular, as indicated by IOL (2011), an appropriate fiscal framework still needs to be developed with the Canadian government, and negotiations with the Deh Cho on benefits and access agreements need to be completed. In addition, a number of other critical factors, including economic, market and strategic priority considerations, could potentially affect the viability of the MGP.

8.6.2 Great Bear River Bridge

The proposed Great Bear River Bridge Project, when constructed, will be the largest bridge of the Mackenzie Valley Winter Road Bridge Program. The Great Bear River crossing is considered by DOT to be one of the major bottlenecks along the current Mackenzie Valley Winter Road. The residents of Tulita and other users of the winter road have long been concerned about the safety of the current winter road route across the Mackenzie River around the Great Bear River. The construction of the Great Bear River Bridge would address this important issue.

This bridge is proposed to cross the Great Bear River at km 938 of the Mackenzie Valley Winter Road, near the community of Tulita, at 64'54'N Latitude and 125'34'W Longitude (DOT 2006).

The total length of the proposed bridge between the north and south abutments is approximately 460 m (1,500 ft). The three spans over the navigation channel of the Great Bear River are ~100 m (300 ft) and the bridge will have a 15 m (50 ft) clearance above the navigation high water level at elevation 52.5 m (172 ft).

Sahtu Land and Water Board Water License S06L8-001 dated June 16, 2006 was issued for construction of the bridge but the bridge construction program continues to be on hold at this time.

8.6.3 Oil and Gas Exploration

New oil and gas exploration have recently been awarded by AAND indicating that oil and gas exploration will likely extend into the future. The all-weather Highway is expected to encourage exploration of those parcels of land by significantly decreasing logistical costs for seismic and drilling programs in the SSA.

8.7 Natural Resources Harvesting

Diverse assemblages of wildlife and plant species occur along the Highway. Many of these species are harvested for subsistence (mainly for food and clothing) and commercial purposes.

Residents from Norman Wells, and Tulita are the primary users of the area in the vicinity of the Highway in Tulita District (SLUPB 2010).

8.7.1 Wildlife

Traditionally, wildlife has been harvested for subsistence, survival materials and for trade. Tradition based hunting for subsistence and trapping continues today.

The Sahtu Settlement Harvest Study, conducted by the SRRB (SRRB 2005) between 1998 and 2005, summarizes the annual harvest information for animals, fish and birds, by the Sahtu Dene and Metis hunters. This study includes the hunters from the communities of Colville Lake, Fort Good Hope, Normal Wells, and Tulita. This harvest data does not include resident or non-resident harvest in the SSA. Harvest

data is summarized under the specific species or group sections below, and is only included for the communities of Normal Wells and Tulita.

8.7.2 Caribou

Both boreal woodland and barren-ground caribou are harvested by residents of Norman Wells and Tulita. Barren-ground caribou are reported to be the most economically important species (SLUPB 2010). Based on the SRRB harvest data (2005), barren-ground caribou are harvested more frequently than woodland caribou (Table 8-4).

In the draft *SLUP*, the southern Mackenzie River (Deh Cho) Special Management Zone is identified as post rut habitat by the Bluenose East Herd. It also identifies that woodland caribou are present, and are harvest, in this area (SLUPB 2010).

Table 8-4: The Sahtu Settlement Harvest Study – Caribou Harvest Data, 1998-2005*

Species Name	Report Harvests (1998-2005)		
	Norman Wells	Tulita	Total
Barren-Ground	36	8	73
Woodland	8	8	33

*Source: Sahtu Renewable Resource Board (2005); 1 Note that the total count is for all SSA Communities.

McDonald (2010) indicated that boreal woodland caribou are harvested as a subsistence food source throughout the SSA, and used for clothing. This report also noted that community residents do not regularly pursue these animals and most boreal woodland caribou are harvested opportunistically when other species are hunted. Typically only a few caribou from each group are harvested and hunters target bulls more than cows and calves. Areas where woodland caribou are found that are within close proximity to the Highway include Kelly Lake, Lennie Lake and Oscar Lake (McDonald 2010).

8.7.3 Moose

Like caribou, moose are also an important subsistence species. Moose occur in the region year round and are harvested opportunistically most of the year (primarily between August and April). Harvest information summarized below is from the Sahtu Settlement Harvest Study (Table 8-5). Between 1998 and 2005, a total of 509 Moose were reported to have been harvested by the Sahtu Dene and Metis hunters (SRRB 2005). Residents in Tulita harvested approximately half of these animals.

Table 8-5: The Sahtu Settlement Harvest Study - Moose Harvest Data, 1998-2005*

Species Name	Report Harvests (1998-2005)		
	Norman Wells	Tulita	Total
Moose	72	259	509

*Source: Sahtu Renewable Resource Board (2005); 1Note that the total count is for all SSA Communities.

The draft *SLUP* (SLUPB 2010) identifies the following zones, located within close proximity to the Highway, to be important for moose harvesting:

- Mackenzie River (Deh Cho) Special Management Zone;
- Kelly and Lennie Lake Conservation Zone;
- Kelly Lake Protected Area Conservation Zone;
- Bear Rock Conservation Zone; and
- Mio Lake Conservation Zone.

8.7.4 Bears

Both black and grizzly bears occupy the region. Data from the Sahtu Settlement Harvest Study indicated that 19 black bears (on average, less than two black bears per year) and no grizzly bears (Table 8-6) were harvested in the eight years between 1998 and 2005 (SRRB 2005).

Table 8-6: The Sahtu Settlement Harvest Study - Bear Harvest Data, 1998-2005*

Bears	Report Harvests (1998-2005)		
	Norman Wells	Tulita	Total
Grizzly Bear	0	0	0
Black Bear	6	2	27

*Source: Sahtu Renewable Resource Board (2005); 1Note that the total count is for all SSA Communities

The draft *SLUP* identifies Oscar Lake and Kelly Lake Protect Area Conservation Zones as important harvesting areas for bears (SLUPB 2010).

8.7.5 Furbearers

For the purposes of this PDR, the term furbearer applies to small mammal species that have been hunted or trapped for their fur, or are important to the local economy. Furbearers in the vicinity of the Highway include beaver, muskrat, marten, snowshoe hare, red squirrel, red fox, wolf, wolverine, lynx, and porcupine.

Trapping was historically a major economic resource for the people of the Sahtu (SLUPB 2010). Wildlife species were trapped for subsistence (for example, snowshoe hare, beaver and muskrat) and pelts were traded or sold. Trapping continues today. Furbearers are commonly harvested along traplines in the region. Based on the Sahtu Harvest Data, the most commonly harvested species are snowshoe hare, muskrat, marten and beaver. Table 8-7 list the species and number of harvests reported as part of the Sahtu Settlement Harvest Study (SRRB 2005).

Table 8-7: The Sahtu Settlement Harvest Study – Furbearers Harvest Data, 1998-2005*

Species Name	Report Harvests (1998-2005)		
	Norman Wells	Tulita	Total
Beaver	14	136	403
Muskrat	1	76	690
Mink	0	1	2
Marten	61	120	635
Red Squirrel	0	0	4
Squirrel Spp.	2	0	2
Red Fox	6	3	18
Wolf	3	8	18
Wolverine	1	1	13
Lynx	1	0	3
Porcupine	0	6	6
Snowshoe Hare	534	788	4,844
Total	**623**	**1,139**	**6,638**

*Source: Sahtu Renewable Resource Board (2005); 1 Note that the total count is for all SSA Communities.

Important furbearer harvesting areas that are within close proximity to the Highway, as identified in the draft *SLUP* (SLUPB 2010) include:

- Mackenzie River (Deh Cho) Special Management Zone;
- Oscar Lake Conservation Zone;
- Kelly and Lennie Lake Conservation Zone;
- Kelly Lake Protected Area Conservation Zone; and
- Bear Rock Conservation Zone.

8.7.6 Waterfowl and Game Birds

The Sahtu Settlement Harvest Study included three species of grouse, one species of ptarmigan, thirteen species of ducks, four species of geese, two species of swans, Arctic loons and sandhill cranes (SRRC 2005).

Norman Wells residents reported the harvest of 2,427 waterfowl and Tulita residents reported a harvest of 2,682. This is low in comparison with Fort Good Hope, who reported a harvest of 11,052 waterfowl. Table 8-8 shows the harvest distribution among species.

The draft *SLUP* notes that the following management areas that are within close proximity to the Highway are important for migratory bird harvest:

- Mackenzie River (Deh Cho) Special Management Zone; and
- Oscar Lake Conservation Zone.

Table 8-8: The Sahtu Settlement Harvest Study – Small Mammals Harvest Data, 1998-2005*

Species Name	Report Harvests (1998-2005)		
	Norman Wells	Tulita	Total
Ruffed Grouse	2	8	10
Sharp-tailed Grouse	91	31	152
Spruce Grouse	266	251	1694
Grouse Spp	248	250	805
Willow Ptarmigan	19	1	20
Ptarmigan Spp	176	46	278
American Widgeon	25	90	125
Bufflehead	0	16	16
Canvasback	0	50	52
Goldeneye Spp	0	0	1
Ring-necked Duck	0	6	6
Mallard	565	677	1611
Northern Pintail	156	218	459
Northern Shoveler	6	30	36
Oldsquaw	0	0	26
Lesser Scaup	0	10	10
Black Scoter	0	56	66
Surf Scoter	9	116	125
White-winged Scoter	0	2	2
Scotter Spp	131	182	2982
Duck Spp	82	162	2347
Brant Goose	42	24	66
Canada Goose	1065	754	2155
Great White-fronted Goose	4	40	54
Snow Goose	268	76	433
Goose Spp	73	155	5180
Trumpeter Swan	1	11	12
Tundra Swan	0	7	14
Swan Spp	0	0	416
Arctic Loon	0	2	2
Loon Spp	1	0	1
Sandhill Crane	0	4	5

*Source: Sahtu Renewable Resource Board (2005); 1Note that the total count is for all SSA Communities.

8.7.7 Berries

Berry harvesting is an important traditional in this region. Although limited information regarding the traditional or contemporary berry harvesting sites is available, the draft *SLUP* (SLUPB 2010) identifies that the following management zones are important for berry picking:

- Mackenzie River (Deh Cho) Special Management Zone;
- Kelly and Lennie Lake Conservation Zone; and
- Kelly Lake Protected Area Conservation Zone.

Several species of berry-producing plants, such as bearberry, cranberry, blueberry, cloudberry, crowberry, raspberry, and black and red current, are likely an important food for local people and are expected to occur throughout the study area in both upland and lowland habitats.

9.0 COMMUNITY AND REGULATORY CONSULTATION

9.1 Introduction

This section provides information on the community consultations and meetings with regulatory agencies that have taken place to date regarding the Highway. The section includes information on meeting dates, meeting format, the comments and questions received at the meetings, and a summary of the comments and questions that were heard in the communities of Norman Wells and Tulita.

Consultations were conducted at the start of the undertaking to share the process and gather initial information; at the midpoint of the development of the PDR to show progress, confirm some decisions about the alignment and to gather further information; and near the end of the development of the PDR to present the description of the project.

The main purpose of the community meetings was to receive comments, views, and questions that would directly inform and influence the development of the Highway. Topics such as the alignment of the Highway, its effects on the environment, economy and areas of cultural value, and the benefits of the development of the Highway were discussed at the consultations.

9.2 Consultation Plan

The consultation plan to gain input and guidance for the preparation of the preliminary design and the project description included: community meetings; specific and separate consultation meetings with boards, councils and bands; and information meetings/telephone contact with other organizations, regulatory agencies and government departments.

Community meetings were held in both Norman Wells and Tulita in July 2010, March 2011, and October 2011. Specific and separate consultation meetings were held in August 2011 with:

- The Hamlet of Tulita;
- Tulita Dene Band;
- Tulita Renewable Resource Council;
- Tulita Land Corporation;
- Tulita District Land Corporation;
- Fort Norman Metis Land Corporation;
- Town of Norman Walls;
- Norman Wells Land Corporation; and
- Norman Wells Renewable Resources Council.

Information meetings/telephone contact with other organizations, regulatory agencies and government departments throughout the preparation of the PDR included:

- SLWB;
- SLUPB;
- SRRB;
- AANDC;
- DFO;
- ENR;
- ARI;
- MACA;
- Transport Canada;
- PWNHC;
- Sahtu Dene Council;
- Sahtu Secretariat Inc.; and
- Canadian Wildlife Service (CWS).

Questions and comments received at the meetings are included in the appendix. Key information was used in the preparation of the preliminary design and PDR. The input received is summarized in the following sections.

9.3 Community Consultation in Norman Wells and Tulita

9.3.1 Meetings Dates and Format

Initial consultations were held in July 2010 in the communities of Norman Wells and Tulita. The midpoint round of consultations was held for both communities in March 2011, and the third round of consultation in October 2011.

The meetings typically took place in community halls or recreation centers within each of the communities. The dates and general format of each meeting are summarized in Table 9-1. The consultation documents, including background information and notices that were distributed prior to the meetings, attendance sheets, and presentations are included in Appendix C.

Table 9-1: Consultation Summary

Consultation Location	Date	Format and Content of Meeting
Norman Wells	July 28, 2010	Community supper followed by community meeting. Project presentation and discussion around maps showing the preliminary corridor for the Highway.
	March 28, 2011	Community supper followed by community meeting. Project updates presentation and discussion around large maps showing the preliminary alignment for the Highway. The discussion included Traditional Knowledge, environmental and socio-economic issues, among other topics.
	October 4, 2011	Mackenzie Mountain School. Interactive presentation and discussion about future Highway details, benefits, potential impacts and mitigative measures with students of grades 7 through 12.
	October 4, 2011	Community supper followed by community meeting. Project Description presentation and how community's input had been included in different sections of the document. Discussion included bridge details and next steps among other topics.
Tulita	July 29, 2010	Community supper followed by community meeting. Project presentation and discussion around maps showing the preliminary corridor for the Highway.
	March 29, 2011	Community supper followed by community meeting. Project update presentation and discussion around large maps showing the preliminary alignment for the Highway. The discussion included Traditional Knowledge, environmental and socio-economic issues among other topics.
	October 5, 2011	Chief Albert Wright School. Interactive presentation and discussion about future Highway details, benefits, potential impacts and mitigative measures with students of grades 6 through 12.
	October 5, 2011	Community supper followed by community meeting. PDR presentation and how community's input had been included in different sections of the document. Discussion included bridge details and next steps among other topics.

9.3.2 Information Provided At the Community Meetings

At each of the meetings in the communities a presentation was given. A copy of each of the presentations is provided in Appendix C. As a summary, the presentation given at the first round of consultations covered the following topics:

- introductions of the consultation team (EBA);
- the main organizations involved in the project (5658 NWT Ltd.);
- partnership approach to the project;
- project planning and main components of the project;
- making decisions together and timescales for producing the PDR;
- history of the development of the Highway including highlights from the *SDMCLCA*;
- planned community consultations;
- the next steps; and
- possible discussion topics (many topics listed to aid discussion).

The presentation given at the second round of consultations in March (Appendix C) included many of the points covered above, with the addition of how the project had developed since the previous community meeting. Emphasis was placed on having a discussion about the project around maps and marking the community's comments and concerns in them. Copies of the large maps (approximately 1.25 m by 0.75 m) used at the consultations were also left in the communities for reference.

The third round of consultations held in October 2011 included a brief review of the history and background of the highway, a short video showing the Highway alignment and touched on the next steps of the process. Emphasis for the sessions was placed on how the community's comments and input, received in the two previous consultation rounds, were incorporated into the PDR. Copies of the large maps (approximately 1.25 m by 0.75 m) used at the consultations were also left in the communities for reference.

In the initial meetings, the maps provided an overview of the proposed alignment of the Highway from Inuvik to Wrigley and a more detailed view of the preliminary corridor for the Highway within the Tulita District. In the second round, the maps showed the preliminary options of alignment for the Highway, bridge locations, wildlife observations from the field programs and location of potential borrow sources. In addition to the detailed alignment maps, two figures were included which detailed the Tulita District Land Tenure and Management Areas. Materials for the third round of consultations included detailed alignment maps, and two figures, the Tulita District Land Tenure and the Management Areas. In addition, a video rendering of the Highway was featured to show the preferred alignment relevant to existing features such as the winter road and the communities and relevant to the proposed MGP.

Photograph 9-1
Norman Wells Meeting – July 28, 2010

Photograph 9-2
Norman Wells Community Meeting – March 28, 2011

Photograph 9-3
Tulita Community Meeting – March 29, 2011

Photograph 9-4
Mackenzie Mountain School Presentation – October 4, 2011

Photograph 9-5
Norman Wells Community Meeting – October 4, 2011

5658 NWT Ltd.

Photograph 9-6
Norman Wells Community Meeting – October 4, 2011

Photograph 9-7
Chief Albert Wright School Presentation – October 5, 2011

Photograph 9-8
Tulita Community Meeting – October 5, 2011

Photograph 9-9
Tulita Community Meeting – October 5, 2011

9.3.3 Community Consultations – What was Heard

The comments and questions received at the community meetings about the Highway were placed under one of six categories. The categories are:

- Mackenzie Valley Highway (practical considerations);
- Society;
- Economy;
- Environment;
- Consultation; and
- Other.

The comments and questions received were recorded in tables and organized by community to allow the comments and questions to be compared across the communities. The tables are included in Appendix D and include information specific to how the comment or question was addressed in this PDR. This information is shown in the column titled, "Consideration of Comments" in the summary tables.

Below are examples of the comments and questions that were raised more than once, either within one community, or by both communities. The answers for these and other comments have been addressed throughout the PDR, for more detail see Appendix D.

Mackenzie Valley Highway (practical considerations)

- Are gravel sources needed? Have these been identified?
- What will happen to Oscar Bridge?
- Is the PDR a realignment of the winter road?
- How close is Great Bear Bridge to the Town? This is a major concern from the Elders.
- What technical safety issues are promoted in the design stage?
- What are the criteria used to determine the proposed and alternate routes?
- How many bridges will be required, and how will they be constructed?
- When will the construction take place (seasons)?

Society

- Concerned that the Highway will create big change, and not sure if it have positive or negative impacts for the community.
- Is the Project Team considering Land Tenure and Land Rights?
- Make sure Traditional Knowledge process is done properly from the first time.

Economy

- What kinds of jobs will be generated by the Highway (construction and operation)?
- Is the funding for the project available?

Environment

- Concerns regarding increased access to the area for exploration.
- How will monitor camps function to make sure construction is being done properly? Will it be some kind of enforcement to avoid companies' damage to the environment? What will happen when all the work is done?
- Concerns about minimal damage to the environment and the job being done properly.
- Concerned about Highway around Hamlet of Tulita. Collisions, animals, children on highway, pollution, dust.
- What are the plans to mitigate dust?

Consultation

- Keep in mind through the process to consult more with the community when addressing bridge location, especially with Great Bear Bridge.
- Have more information shared/available at schools.
- The definition and the requirements for consultation are identified in the Sahtu Land Agreement.
- "I'm happy to see EBA working with Land Claim groups in Tulita District".

9.4 Specific and Separate Consultation Meetings Held in August 2011

Specific and separate consultation meetings were held in August 2011 with the boards and councils from governments in the Tulita District. Detailed notes relative to the Highway from those meetings are included in Appendix D. A summary of the input from each meeting is as follows.

The Hamlet of Tulita and Tulita Dene Band (August 16, 2011; 11 am)

A short presentation was provided to the Hamlet and Band that covered the progress to date on the preliminary design and the PDR. The alignment options that are considered around the Hamlet of Tulita are outlined in Section 6.0 of this PDR. Attendees indicated an overall support for the Highway and their satisfaction with the consultation process over the course of the project development. During the meeting a concern regarding the alignment along the existing winter road was identified around Bear Rock; special care and consideration was requested by the attendees.

Fort Norman Metis Land Corporation and Tulita Renewable Resource Council (August 16, 2011; 2 pm)

A short presentation was made to the Fort Norman Metis Land Corporation and the Tulita Renewable Resource Council that covered the progress to date on the preliminary design and the PDR. The alignment options that are considered around the Hamlet of Tulita are outlined in Section 6.0 of this PDR. Attendees indicated an overall support for the Highway and indicated the importance of Traditional Knowledge and community consultation and participation for the continuation of the project. Also discussed during the meeting was availability of funding and training opportunities.

Tulita Land Corporation (August 16, 2011; 3 pm)

A short presentation was made to the Tulita Land Corporation that covered the progress to date on the preliminary design and the PDR. The alignment options that are considered around the Hamlet of Tulita are outlined in Section 6.0 of this PDR. Attendees indicated an overall support for the Highway and indicated their preference to deliver the highway as a P3 (public-private partnership) project. During the meeting, the attendees called the attention to the alignment location between the airstrip (south) and lake (north) in the vicinity of Tulita, recommending a detail review during the design stage that considers the ground conditions, and the location to confirm that future expansion of the airstrip and the Highway can be accommodated.

Town of Norman Wells (August 2, 2011; 7 pm)

A short presentation was provided to the Town Council that covered the progress to date on the preliminary design and the PDR. The alignment options that are considered around the Town of Norman Wells are outlined in Section 6.0 of this PDR. The Town Council indicated an overall support for the Highway, a preference for the alignment that is on high ground near the Town's material source, and support for continuing discussions with DOT relative to use of material from the source to support construction. The Town Council also indicated that short duration operational closures for the future Highway will need to be considered as blasting does occur in the material source.

Norman Wells Land Corporation and Norman Wells Renewable Resource Council (August 15, 2011; 6 pm)

A short presentation was provided to the Land Corporation and Renewable Resource Council that covered the progress to date on the preliminary design and the PDR. The alignment options that are considered around the Town of Norman Wells are outlined in Section 6.0 of this PDR. Most of the attendees supported the Highway and related economic and tourism benefits it would bring to the community. The concept of the Transportation Corridor Management group was also put forward. A preference for the alignment near the Town's material source was indicated due to good ground location and future development opportunities.

Sahtu Dene Council

Grand Chief Frank Andrew advised that no separate meeting would be needed with Sahtu Dene Council.

Sahtu Secretariat Inc.

Executive Director Freda Taniton advised no specific consultation would be needed with Sahtu Secretariat. She advised the consultants to continue to work with the District Land Corporations.

9.5 Information Meetings/Telephone Contact with Other Organizations, Regulatory Agencies and Government Departments

Sahtu Land and Water Board (SLWB)

A meeting with the SLWB Executive Director, Mr. Paul Dixon, was scheduled to take place on March 28, 2011; due to road conditions the meeting was canceled. The Community meeting materials were provided to the Board and these were included for discussion during their May board meeting. The SLWB did not have any specific questions or concerns at the time; further communication regarding the highway work and PDR process was agreed upon.

In subsequent phone calls in June and July 2011, Mr. Dixon provided information regarding the application and permitting process for Land Use Permits and Water Licenses for the MVH in the Tulita District. The MVLWB will likely screen, regulate and permit the project due to its trans-boundary nature, while the SLWB will screen regulate and permit all other pre-construction activities. The decision regarding jurisdiction is yet to be made by regulators and will likely be defined at the time of the application.

Sahtu Land Use Planning Board (SLUPB)

A meeting with the SLUPB Plan Development Lead, Ms. Heidi Wiebe, took place on April 12, 2011. EBA made a short presentation of the March 2011 consultation materials and maps with extra focus on:

- explanation of all Highway sections (GSA, K'ahsho Got'ine District, Tulita District, Deh Cho and the separate project Inuvik – Tuktoyaktuk);
- ownership of the project; and
- consultation stages, past and upcoming.

Ms. Wiebe explained the Land Use Plan draft revisions and timelines. The main highway related points raised by Ms. Wiebe are presented below:

- The Land Use Plan considers transportation as a permitted use within its zoning, even within conservation zones.
- Quarrying is not permitted within conservation zones. More detail on conservation zones check Conformity Requirement #1, "Land Use Zoning", subsection 2 of the Land Use Plan.
- A submission to expand the conservation zones around Three Day Lake in order to include parcels 105, 106 and 107 had been presented to the board.

Sahtu Renewable Resources Board (SRRB)

Conversations were held with the SRRB Executive Director at the time, Mr. Chris Hopkins, who also attended the Tulita Community meeting that took place on March 29, 2011. The main concern raised by

the Mr. Hopkins was the impact of an all-weather road to the wildlife population by increasing the access. With this regard the SRRB provided EBA harvesting information to compare against the proposed highway alignment.

Aboriginal Affairs and Northern Development Canada (AANDC)

A meeting with Mr. Steve Deschene, Resource Management Officer of the North Mackenzie District, from AANDC took place on March 29, 2011, in Norman Wells. The main topics at the meeting include:

- the bridge locations and number of crossings;
- the existing borrows sources to be tested and used;
- the permits and licenses that need to be in place and their required timelines;
- the pipeline crossings and their treatment; and
- the highway contracting plans in the time of construction.

At the time of the meeting this information was not yet available, but is now included in this PDR.

In addition, Mr. Conrad Baetz, District Manager, Inuvik provided information regarding access to Crown lands for temporary roads to temporary borrow sources, what a quarry permit allows (access to and use of the borrow source) and the increased effort in permitting that may be required in staging the design and construction of the Highway.

Department of Fisheries and Oceans Canada (DFO)

A telephone conversation with Ms. Corrie Gibson from DFO provided information about Letters of Advice and Authorizations issued by DFO, both dependent on the degree of disturbance to fish habitat and the requirements for each crossing. Ms. Gibson explained that at the time of application, information regarding the design, potential habitat to be disturbed, the footprint, the monitoring and mitigation activities to reduce sediment and other impacts would be used to determine if a Letter of Advice or and Authorization would be issued. She also advised that a Scientific Licence for fish assessments would be required at the detailed investigation stages of the project development.

Department of Environment and Natural Resources (ENR), GNWT

A meeting with Mr. Alasdair Veltch and Mr. Phil Spencer from ENR – Wildlife Management took place on March 29, 2011, in Norman Wells. Conversations were continued afterwards and included Mr. Paul Rivard from ENR – Forest Management. During these communications information regarding Values at Risk and Harvesting areas was discussed. This information was subsequently provided and used in the preliminary design and PDR.

Mr. Tom Lakusta, ENR Forestry Management, Hay River, provided information regarding permits needed for clearing land. Mr. Lakusta advised that sometime in 2012, legislation would be in place requiring an Incidental Use of Forests Licence before any tree cutting could take place. This license application would need to include the following information: area of land to be cleared, quantity of wood to be cut, means in

which wood will be disposed of, wood cutting timelines (i.e., during frozen conditions), equipment to be used.

Ms. Suzanne Carriere, ENR Wildlife representative, provided information regarding the types of permits issued by ENR for investigative activities along the MVH proposed alignment. ENR's Wildlife Research Permit includes: investigations of wildlife habitat, vegetation used for wildlife food sources, and investigations into wetlands used by wildlife. Ms. Carriere also elaborated on the Wildlife Care Committee, the application process and the time and consultation requirements.

Aurora Research Institute (ARI)

Discussions were held with Mr. Jonathan Michel of the ARI regarding the types of activities ARI would issue permits for such as fish and aquatic studies, vegetation and rare plants studies, Traditional Knowledge studies and any interviews with people regarding any of these topics. ARI would issue one research permit, renewable every calendar year for five years, to cover all of the research needed for the environmental assessment of the project, except those activities permitted by other organizations such as PWNHC – archeologist permit, ENR – wildlife habitat and vegetation used for food, CWS – Migratory Birds and Species at Risk.

Department of Municipal and Community Affairs (MACA)

Mr. Dwayne Semple from MACA explained the four types of land ownership within Sahtu community municipal boundaries – Sahtu lands, Commissioner's Lands, Private Lands and Crown Lands. Mr. Semple suggested accessing the "atlas GIS" feature on the MACA website for further information on current land tenure within community municipal boundaries.

Transport Canada

Conversations with Mr. Greg Black from Transport Canada, Navigable Waters Protection, provided information on permits required for bridges and culverts over or under navigable waters and barge landings. Mr. Black explained separate permits are required for each bridge and culvert over navigable waters and barge landing and they take about 3-6 months to process.

Prince of Wales Northern Heritage Centre (PWNHC)

Ms. Shelley Crouch of PWNHC provided information about obtaining Archaeologists Permits, the application process and the time frame needed to obtain one. The application process takes 60 days from the time the application is completed and received by the PWNHC. The PWNHC considers the information contained in a completed application through internal review by the Collections and Conservation staff members. The application is also sent to the aboriginal groups in the area where the research is proposed to take place, in this case, the Tulita District Land Corp. The aboriginal group is given 45 days to respond. If there is no response within that time period, PWNHC deems the lack of response to mean that there is no problem with the research proceeding. The permit is issued for signing and then sent to the Minister for Education, Culture and Employment for approval, after which the signed permit is mailed to the applicant.

Alternatively, the applicant can obtain a letter from the aboriginal organization that specifically supports the archaeological study and not just the larger project it is part of. This letter can be filed with the

application and will shorten the application process. The permit will then be sent to the Minister for signing and then will be mailed to the applicant.

Canadian Wildlife Service (CWS)

Mr. Paul Latour, Habitat Biologist for the CWS explained any pre-construction investigations with respect to Migratory Birds or species at risk in the vicinity of the Highway did not require permits from CWS.

9.6 Examples of How the Input was Used in the Development of the Project

As noted above, the input obtained during the individual and community meetings influenced the location of the Highway, how it will be built, identification of the social and environmental impacts and how these will be minimized or mitigated. Examples are provided in the paragraphs below.

Early input to the development of the Highway alignment from the community of Norman Wells focused on convenient access to the Highway from the Town and potential for future development on both sides of the Highway balanced with safety issues that could result with increased traffic through the community and engineering requirements for design and construction. As discussed in Section 6.0, options for the alignment through the Town of Norman Wells were evaluated based on these needs/concerns and the preferred alignment presented.

The use of Traditional Knowledge to guide the location of the Highway was raised at all meetings. In development of the preliminary design and the PDR, the consultants followed the direction provided by members of the communities and representatives of the relevant organizations on where to find the available information (published sources, specific databases), how to interpret the information relevant to the Highway in the Tulita District and how additional information should be gathered. Traditional Knowledge on harvesting, hunting, locations of cabins and seasonal use areas, location of known or potential heritage resources was provided directly at the meetings through discussions over the alignment sheets and maps and refinement of the alignment to avoid impacting these areas was undertaken at these opportunities. Direction on how to obtain additional and more specific Traditional Knowledge to use in detailed design stages was also provided. Section 6.0 provides a discussion on how Traditional Knowledge was used in the development of the preliminary design, and Section 11.0 provides a discussion on how ongoing collection and use of more specific Traditional Knowledge will be used as a mitigative measure for certain impacts in the detailed design stages of the Highway.

The location of the Great Bear River Bridge was raised as a concern at the meetings in Tulita. In the initial community meeting, participants reflected on and discussed the design and permitting work that was undertaken in 2006. The participants at the meeting varied in their opinions and concerns and directed the consultants to revisit the alternatives presented in 2006. This review and the resulting preferred location for the bridge near the community is presented in Section 6.0 and was presented and discussed and the March and October 2011 meetings in Tulita. At the October 2011 meeting, the location of the bridge near the community remained a concern with some of the participants only in respect to impacts to the community's water source due to raising of silt during construction and the design of the bridge impeding the flow of ice during break up. Mitigative measures for these concerns are discussed in Section 11.0 and will be reconfirmed in the present design of the bridge during the detailed design stages for the Highway.

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10.0 ENVIRONMENTAL OVERVIEW

10.1 Climate

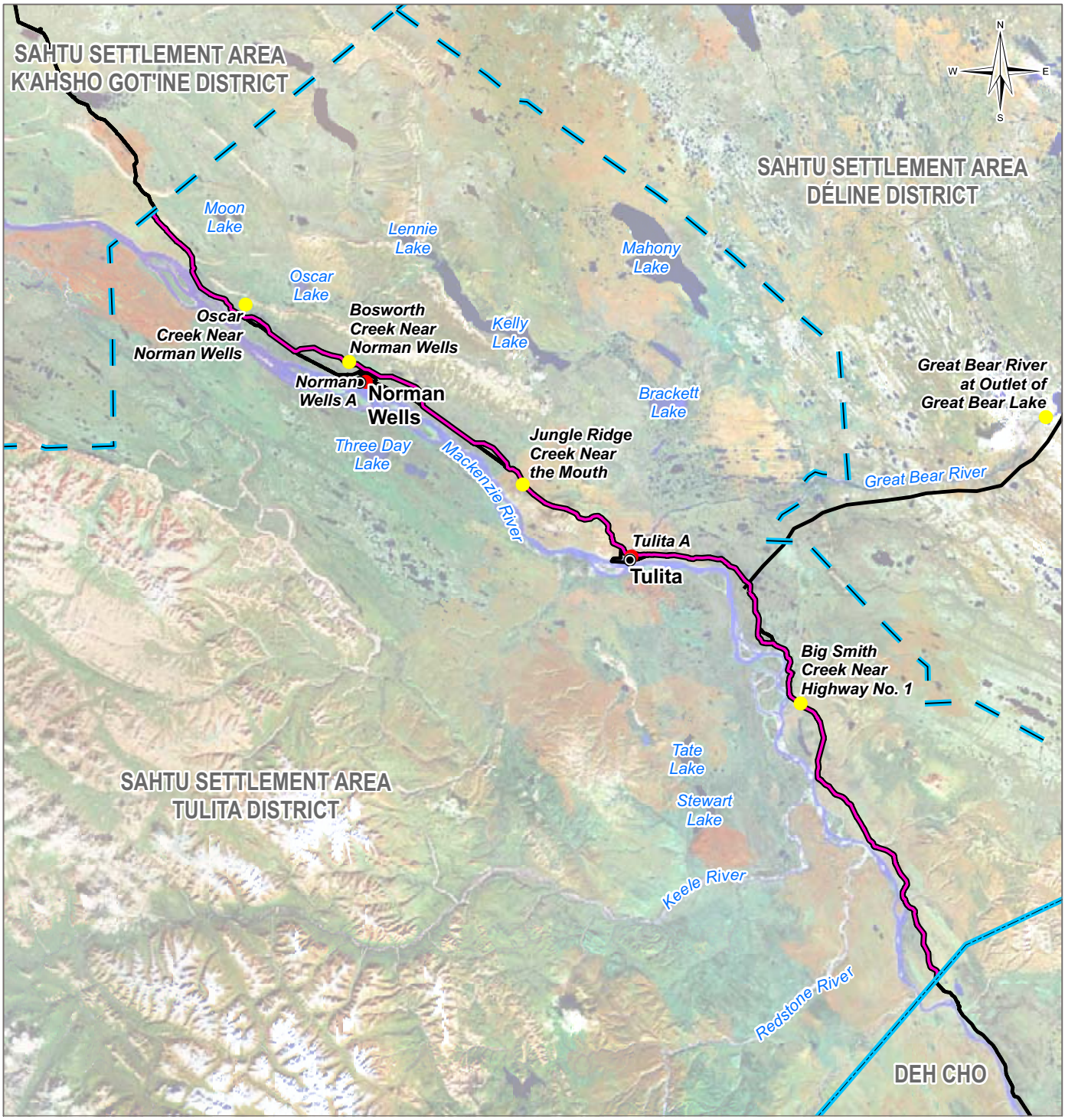
The general climate of the Central Mackenzie Valley is sub-arctic, characterized by long, cold winters, short, mild summers and extreme seasonal temperature variations. The Mackenzie Valley itself has a somewhat milder climate than adjacent areas to the east and west, while cooler temperatures remain longer over the more mountainous areas (Kokelj 2001). The average annual temperature is below zero with a very short frost-free season and insufficient summer warmth to melt prevalent permafrost areas. Snow and ice cover typically persist between October and May. Annual precipitation is typically low, but sufficient for tree growth, and occurs more frequently in the warmer summer months than during the winter. A large portion of the annual precipitation is stored for several months in the form of snow and therefore snowmelt runoff in spring is a dominant feature of regional stream hydrographs.

The climate along the Highway is described with meteorological data recorded by Environment Canada stations at Norman Wells A (65°16'57" N, 126°48.01' W; elevation: 72.5 m; Climate ID: 2202800), Tulita A (64°54'31" N, 125°34.06' W; elevation: 101.2 m; Climate ID: 2201700), Fort Good Hope A (66°14'27" N, 128°39'03" W; elevation: 81.7 m; Climate ID: 2201400), Fort Good Hope CS (66°14'32" N, 128°38"39" W; elevation: 81.7 m; Climate ID: 2201450) and Wrigley A (63°12'34" N, 123°26'12" W; elevation: 149.0 m; Climate ID: 2204000). Fort Good Hope is located 50 km northwest of the Tulita/K'ahsho Got'ine District boundary along the Highway. Wrigley is located 75 km southeast of the SSA/Deh Cho boundary along the Highway (Figure 10-1).

Table 10-1: Climate Normals: Norman Wells, NT (1981–2010)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature:													
Daily Maximum (°C)	-22.3	-19.6	-12.7	0.9	12.1	20.7	22.6	19.0	11.0	-1.7	-15.2	-19.4	-0.4
Daily Average (°C)	**-26.2**	**-24.1**	**-18.6**	**-5.2**	**6.4**	**15.0**	**17.1**	**13.7**	**6.6**	**-4.8**	**-18.8**	**-23.2**	**-5.2**
Daily Minimum (°C)	-30.0	-28.6	-24.4	-11.2	0.6	9.4	11.6	8.4	2.0	-7.8	-22.3	-27.0	-9.9
Extreme Maximum (°C)	12.4	7.9	9.2	20.0	31.3	33.5	35.0	32.4	27.1	21.0	8.4	5.7	35.0
Extreme Minimum (°C)	-48.6	-48.2	-42.8	-33.7	-17.8	-0.1	1.5	-4.5	-15.7	-29.6	-40.6	-44.4	-48.6
Precipitation:													
Mean Total Precipitation (mm)	**15.3**	**14.9**	**10.9**	**11.2**	**18.6**	**43.8**	**42.2**	**42.8**	**32.8**	**27.2**	**18.2**	**18.1**	**296.0**
Mean Snowfall (cm)	20.5	19.9	14.7	12.9	6.7	0.4	0.0	0.7	6.7	27.7	25.5	25.7	161.4
Mean Rainfall (mm)	0.2	0.0	0.1	1.2	12.7	43.5	42.2	42.1	26.5	4.7	0.0	0.2	173.4
Extreme Daily Precipitation (mm)	24.6	20.6	9.6	10.6	19.6	45.1	31.2	37.2	50.8	21.8	10.2	8.8	50.8
Extreme Daily Snowfall (cm)	23.1	27.0	13.0	14.6	19.0	4.6	0.0	7.6	10.1	18.8	16.8	14.8	27.0
Extreme Daily Rainfall (mm)	3.0	0.9	1.8	8.6	19.6	45.1	31.2	37.2	42.8	21.4	0.6	2.0	45.1
Average Snow Depth (cm)	27	30	31	18	1	0	0	0	0	5	14	22	12
Snow Depth at Month End (cm)	28	30	27	5	0	0	0	0	1	10	18	24	-

Source: Environment Canada, 2011 - NORMAN WELLS A Station: 65°16'57" N, 126°48.1' W; Elevation: 72.5 m; Climate Station ID: 2202800. Monthly data meets WMO completeness requirements for describing climate normals with the exception of the period December 1992 - December 1993 which was omitted.



LEGEND

- Communities
- Hydrometric Stations (Operated by Water Survey of Canada)
- Meteorological Stations (Operated by Environment Canada)
- MVH Concept - EBA June 2011 (Preferred Alignment)
- Public Winter Road
- Settlement Area Boundary
- District Boundary

NOTES

Base data source: ESRI
Alignment is considered preliminary and is subject to change

MACKENZIE VALLEY HIGHWAY TULITA DISTRICT

Meteorological Stations

PROJECTION	DATUM
UTM Zone 9	NAD 83

1:1,300,000

0 10 20 40

Kilometres

FILE NO. Y22101155_Figure10-1 Meteorological Stations.mxd

PROJECT NO.	DWN	CKD	APVD	REV
V33101053	TV	MS	RM	0

OFFICE EBA-RIV

DATE October 14, 2011

5658 NWT Ltd.

A TETRA TECH COMPANY

Figure 10-1

M:\TRANSPORTATION\NWT_Mackenzie_Highway\Y22101155_TulitaMaps\Overview\Y22101155_Figure10-1 Meteorological Stations.mxd modified 10/13/2011 by tony.vuong

The data record of daily synoptic observations at Norman Wells meets World Meteorological Organization standards for completeness and describes 30-year regional climate normals for the period 1981 to 2010, summarized in Table 10-1. The records at Fort Good Hope, Tulita and Wrigley have many instances of missing data and do not meet completeness standards to describe climate normals, but are summarized as meteorological observations over the period 1981 to 2010 (or a portion thereof where noted) in Table 10-2 through Table 10-4.

Table 10-2: Meteorological Summary: Fort Good Hope, NT (1981 – 2010)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature:													
Daily Maximum (°C)	-23.9	-20.8	-14.4	-0.5	11.1	20.9	22.3	18.8	10.6	-2.0	-15.8	-20.3	-1.2
Daily Average (°C)	**-28.2**	**-25.4**	**-20.5**	**-7.3**	**5.0**	**14.8**	**16.3**	**12.8**	**5.5**	**-5.8**	**-20.1**	**-24.6**	**-6.5**
Daily Minimum (°C)	-32.1	-29.9	-26.4	-13.9	-1.1	8.7	10.5	6.9	0.6	-9.4	-24.1	-29.0	-11.6
Extreme Maximum (°C)	5.0	5.0	8.5	19.6	30.5	34.6	35.0	32.0	27.5	22.1	9.7	5.9	35.0
Extreme Minimum (°C)	-52.0	-47.5	-48.3	-35.5	-25.0	-3.0	-2.3	-4.0	-17.0	-38.0	-43.7	-48.5	-52.0
***Precipitation:**													
Mean Total Precipitation (mm)	**19.0**	**19.1**	**15.4**	**10.3**	**12.4**	**27.5**	**39.2**	**40.6**	**31.3**	**28.6**	**21.9**	**20.9**	**286.1**
Mean Snowfall (cm)	19.9	20.7	16.9	9.6	5.8	0.0	0.0	0.0	5.8	27.3	23.4	22.6	152.0
Mean Rainfall (mm)	0.0	0.0	0.0	0.2	6.8	26.8	39.0	40.0	26.3	2.6	0.0	0.0	141.7
Extreme Daily Precipitation (mm)	16.0	16.0	15.0	19.0	14.0	25.0	37.0	34.0	45.4	14.6	15.0	14.0	45.4
Extreme Daily Snowfall (cm)	16.0	16.0	15.0	19.0	10.6	1.0	0.0	10.0	17.0	14.0	15.0	14.0	19.0
Extreme Daily Rainfall (mm)	0.0	0.0	0.2	2.6	14.0	25.0	37.0	25.0	45.4	11.2	0.0	0.0	45.4
Average Snow Depth (cm)	47	51	55	49	7	0	0	0	0	7	22	32	23
Snow Depth at Month End (cm)	51	54	57	32	0	0	0	0	0	15	25	41	-

Source:

Environment Canada, 2011. FORT GOOD HOPE A Station: 66°14'27" N, 128°39'03' W; Elevation: 81.7 m; Climate Station ID: 2201400 Daily Data (1981 - 2005).

Environment Canada, 2011. FORT GOOD HOPE CS Station: 66°14'32" N, 128°38'39" W; Elevation: 81.7 m; Climate Station ID: 2201450 Daily Data (2006 - 2010).

Table 10-3: Meteorological Summary: Tulita, NT (1983 – 2008)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature:													
Daily Maximum (°C)	-21.9	-19.4	-12.0	0.4	11.5	21.0	22.4	18.8	10.7	-1.3	-14.5	-18.8	-0.3
Daily Average (°C)	**-25.8**	**-23.8**	**-17.9**	**-5.6**	**5.6**	**15.1**	**16.8**	**13.7**	**6.4**	**-4.2**	**-18.0**	**-22.6**	**-5.0**
Daily Minimum (°C)	-29.5	-28.1	-23.7	-11.5	-0.2	9.1	11.2	8.3	2.1	-7.1	-21.3	-26.2	-9.7
Extreme Maximum (°C)	4.0	5.0	10.0	19.5	28.5	33.5	35.0	32.5	28.5	20.7	4.9	3.0	35.0
Extreme Minimum (°C)	-50.0	-52.5	-50.0	-36.5	-17.6	-2.5	0.0	-5.0	-25.5	-30.0	-49.0	-45.0	-52.5
***Precipitation**													
Mean Total Precipitation (mm)	**14.3**	**11.0**	**8.4**	**10.0**	**12.7**	**36.6**	**43.3**	**46.9**	**38.9**	**31.4**	**21.5**	**14.8**	**289.8**
Mean Snowfall (cm)	14.3	11.0	8.4	9.4	3.3	0.0	0.0	0.0	2.2	28.9	21.9	14.8	114.1
Mean Rainfall (mm)	0.0	0.0	0.0	0.6	9.3	36.6	43.3	46.9	36.5	2.5	0.0	0.0	175.8
Extreme Daily Precipitation (mm)	16.0	11.0	8.2	13.0	14.5	25.0	30.0	39.0	49.0	28.0	17.5	13.2	49.0
Extreme Daily Snowfall (cm)	16.0	11.0	8.2	13.0	11.4	0.8	0.0	0.0	10.0	28.0	17.5	13.2	28.0
Extreme Daily Rainfall (mm)	0.0	0.0	0.0	3.2	13.8	25.0	30.0	39.0	49.0	6.4	0.4	0.0	49.0
Average Snow Depth (cm)	28	33	34	21	1	0	0	0	0	4	17	21	13
Snow Depth at Month End (cm)	31	35	33	9	0	0	0	0	2	8	22	23	-

Source: Environment Canada, 2011. TULITA A Station: 64°54'31" N, 125°34.06' W; Elevation: 101.2 m; Climate Station ID: 2201700. Daily Data (November 1983 – December 2008).

Table 10-4: Meteorological Summary: Wrigley, NT (1981 – 2009)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature:													
Daily Maximum (°C)	-20.9	-17.7	-8.6	4.1	14.5	21.3	23.5	20.2	12.1	0.1	-14.3	-18.7	1.3
Daily Average (°C)	**-25.3**	**-22.8**	**-15.7**	**-3.0**	**7.8**	**14.5**	**16.8**	**13.6**	**6.7**	**-3.7**	**-18.2**	**-23.0**	**-4.4**
Daily Minimum (°C)	-30.4	-28.0	-22.7	-9.7	1.1	7.8	10.2	7.3	1.4	-7.2	-22.0	-27.3	-10.0
Extreme Maximum (°C)	6.5	10.0	12.7	25.0	34.0	37.0	35.5	33.5	27.2	21.5	6.2	3.0	37.0
Extreme Minimum (°C)	-50.0	-50.0	-43.0	-32.6	-20.9	-3.3	-1.0	-6.0	-18.0	-31.5	-48.0	-46.1	-50.0
***Precipitation:**													
Mean Total Precipitation (mm)	**16.7**	**14.9**	**10.0**	**8.6**	**21.0**	**42.5**	**63.2**	**48.1**	**34.0**	**29.4**	**20.4**	**17.4**	**326.0**
Mean Snowfall (cm)	19.1	15.7	10.5	8.5	3.6	0.0	0.0	0.0	2.8	22.3	22.4	18.2	123.0
Mean Rainfall (mm)	0.0	0.0	0.0	0.3	17.5	42.8	63.2	48.1	30.8	6.8	0.0	0.0	209.5
Extreme Daily Precipitation (mm)	23.0	25.0	12.4	24.0	26.0	31.7	48.0	33.3	27.0	29.4	20.0	20.5	48.0
Extreme Daily Snowfall (cm)	23.0	25.0	16.0	24.0	12.5	0.0	0.0	0.0	10.0	29.4	20.0	20.5	29.4
Extreme Daily Rainfall (mm)	0.0	0.0	0.4	1.6	26.0	31.7	48.0	33.3	27.0	16.2	0.2	0.0	48.0
Average Snow Depth (cm)	35	41	43	23	1	0	0	0	0	3	17	25	16
Snow Depth at Month End (cm)	38	47	41	6	0	0	0	0	1	8	22	28	-

Source: Environment Canada, 2011. WRIGLEY A Station : 63°12'34" N, 123°26'12" W; Elevation: 149.0 m ; Climate ID: 2204000. Daily Data (January 1981 – December 2009).

Hourly wind observations from all four locations for the period of 2006 to 2010 have been summarized in Table 10-5. Hourly meteorological observations at Fort Good Hope, Tulita and Wrigley are recorded only during daytime hours and wind summaries are therefore representative of daytime conditions only.

Table 10-5: Summary Of Hourly Wind Observations (Tulita District) (2006 – 2010)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Fort Good Hope (Daytime Observations Only)													
Average Hourly Speed (km/hr)	3.8	4.5	6.6	8.0	9.0	9.9	8.8	8.6	7.8	5.9	5.4	4.3	6.9
Maximum Hourly Average (km/hr)	28	32	30	30	37	41	39	46	48	37	44	33	48
Prevalent Wind Direction (2ND Notable)	W/E	E(w)	W(E)	W/E	E(W-NE)	E(W-NE)	W(E)	W(E)	E(w)	E(w)	E(w)	E(w)	E/W
Source: Environment Canada, 2011. FORT GOOD HOPE A Station : 66°14'27" N, 128°39'03" W; Elevation: 81.7 m; Climate Station ID: 2201400. Hourly Data (January 2006 – August 2008). Environment Canada, 2011. FORT GOOD HOPE CS Station: 66°14'32" N, 128°38'39" W; Elevation: 81.7 m; Climate Station ID: 2201450. Hourly Data (September 2008 – December 2010).													
Norman Wells:													
Average Hourly Speed (km/hr)	6.6	7.3	9.1	10.9	10.3	11.1	9.7	10.1	10.0	8.7	8.0	7.4	9.1
Maximum Hourly Average (km/hr)	52	46	48	50	50	46	48	46	46	56	41	56	56
Prevalent Wind Direction (2ND Notable)	W(SE)	SE/W	W(SE)	SE/W	SE/W	SE/W	W/SE	W/SE	W/SE	W/SE	W/SE	W/SE	W/SE
Source: Environment Canada, 2011. NORMAN WELLS A Station: 65°16'57" N, 126°48.01' W; Elevation: 72.5 m; Climate Station ID: 2202800. Hourly Data (January 2006 – December 2010).													
Tulita: (Daytime Observations Only)													
Average Hourly Speed (km/hr)	9.3	10.4	10.3	12.8	13.0	13.6	11.7	13.1	12.0	10.0	10.5	12.1	11.6
Maximum Hourly Average (km/hr)	28	56	28	37	30	32	46	37	37	37	37	65	65
Prevalent Wind Direction (2ND Notable)	NE	NE	W(NE)	NE(w)	NE(W/E)	E(W/NE)	E(w)	W/E	E(W/NE)	NE(W/E)	NE	NE	NE(W/E)
Source: Environment Canada, 2011. TULITA A Station: 64°54'31" N, 125°34.06' W; Elevation: 101.2 m; Climate Station ID: 2201700. Hourly Data (January 2006 – December 2010).													
Wrigley: (Daytime Observations Only)													
Average Hourly Speed (km/hr)	7.2	8.4	11.3	12.1	10.9	10.4	8.4	9.3	8.3	7.1	6.6	6.9	8.9
Maximum Hourly Average (km/hr)	33	33	28	32	41	37	32	32	33	41	37	28	41
Prevalent Wind Direction (2ND Notable)	NW/SE	NW/SE	NW(SE)	NW/SE	NW/SE	NW/SE	NW/SE	NW/SE	SE(NW)	SE(NW)	SE(NW)	SE(NW)	SE/NW

Source: Environment Canada, 2011. WRIGLEY A Station: 63°12'34" N, 123°26'12" W; Elevation: 149.0 m ; Climate ID: 2204000. Hourly Data (January 2006 – December 2010).

10.1.1 Air Temperature

Mean annual, winter and summer temperatures along the Highway are summarized in Table 10-6.

Table 10-6: Summary of Air Temperatures (1981 – 2010) – Tulita District

	Latitude	Mean Annual Temperature (°C)	Mean Winter (DJF) Temperature (°C)	Mean Summer (JJA) Temperature (°C)
Fort Good Hope	66.24°	-6.5	-26.1	14.6
Norman Wells	65.28°	-5.2	-24.5	15.4
Tulita	64.91°	-5.0	-24.1	15.2
Wrigley	63.21°	-4.4	-23.7	15.0

Source: Environment Canada

As expected, mean annual temperature in the region decreases with increasing latitude. This pattern is also observed in winter months (taken as the average of December, January and February mean air temperatures) but is much less pronounced in summer months. As a result, it would be expected that snow melt in southern portions of the Highway would begin to occur slightly in advance of northern areas.

The annual temperature distribution is typical for mid- to high-latitudes in the northern hemisphere with July as the warmest month and January as the coldest. Temperatures are typically below zero between

October and April. Over the 30-year period, air temperatures extremes are 37°C during the summer (at Wrigley) and -52.5°C during the winter (at Tulita). The historical high and low temperature extremes at Norman Wells are 35°C and -54.4°C respectively (Environment Canada 2011).

10.1.2 Precipitation

Mean annual precipitation over the district is described in Table 10-1 through Table 10-4 as a sum of 30-year monthly averages and summarized for the region in Table 10-7.

Table 10-7: Summary of Annual Precipitation – Tulita District

	Latitude	Total Precipitation (mm)	Rainfall		Snowfall		Average March Snow Depth (cm)
			mm	Pct.	cm	Pct.	
Fort Good Hope	66.24°	286	142	50%	152	50%	31
Norman Wells	65.28°	296	173	58%	161	42%	55
Tulita	64.91°	290	176	61%	114	39%	34
Wrigley	63.21°	326	210	64%	123	36%	43

Source: Environment Canada

Like air temperature, mean annual precipitation and mean annual rainfall shows a general decrease with increasing latitude through the region; however, a strong variability to regional precipitation patterns weakens the trend somewhat. Snowfall as a total percentage of annual precipitation also increases towards the north.

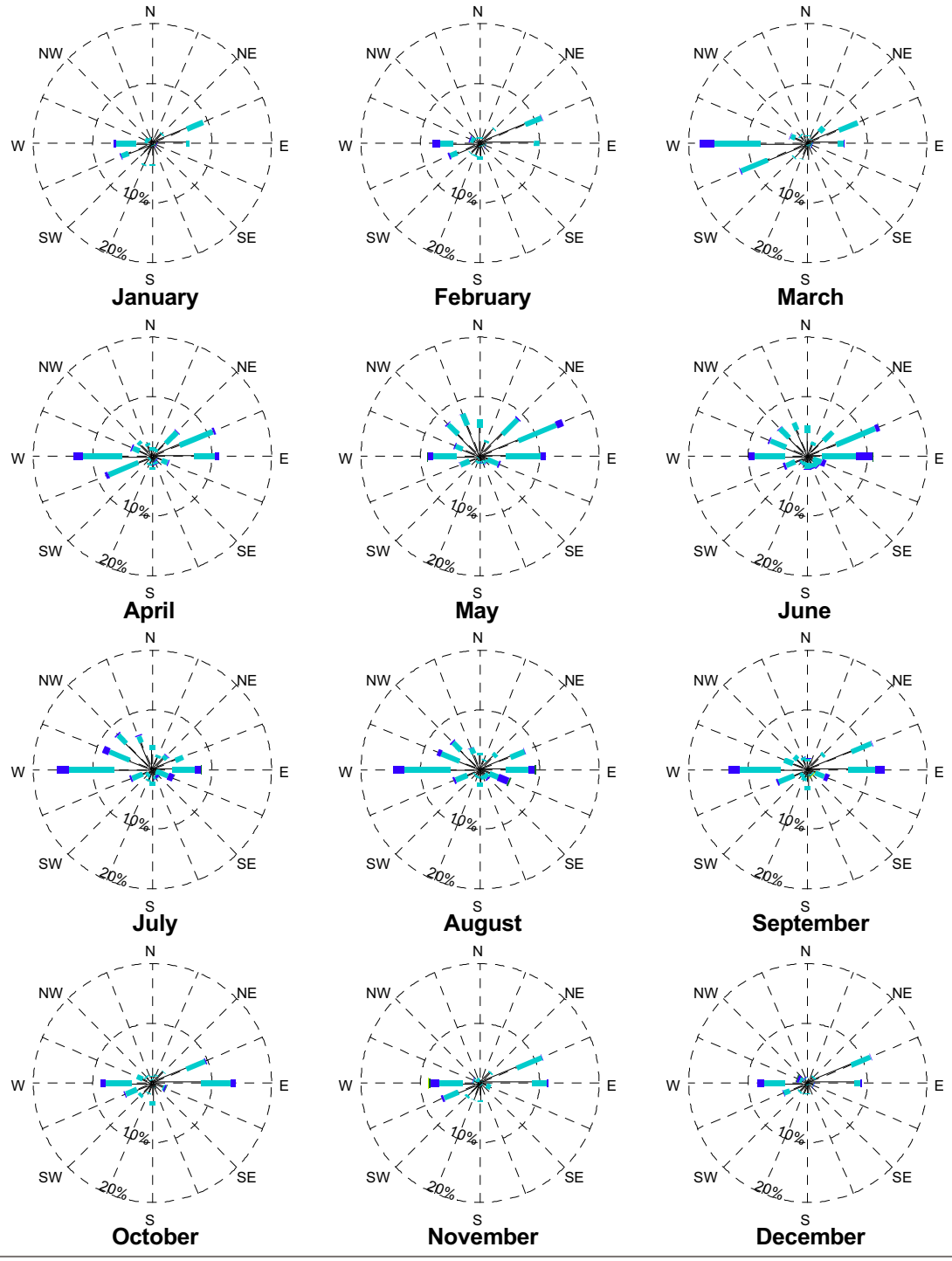
The average maximum snow depth prior to freshet (the peak average monthly snow depth for March) varies through the region from 55 cm at Norman Wells to 31 cm at Fort Good Hope. It should be noted that average monthly snowpack for March at Tulita, located only 75 km south of Norman Wells, is 34 cm, compared to 55 cm at Norman Wells, illustrating the spatial variability in regional snowfall.

The largest one-day precipitation event over the thirty-year period was 50.8 mm in Norman Wells on September 6, 1988 which also represents the historical daily maximum. The largest single-day snowfall between 1981 and 2010 was 29.4 cm in Wrigley on October 4, 1984 which is higher than the historical maximum 24-hour snowfall recorded at Norman Wells.

10.1.3 Wind Speed and Direction

Winds are most intense on average in Tulita (hourly average wind speed 11.6 km/hr) (Table 10-5). Average wind speeds are much lower at Fort Good Hope (6.9 km/hr) than at Norman Wells (9.1 km/hr) or Wrigley (8.9 km/hr). Wind speeds over the entire region are typically higher on average during the summer months, although the highest hourly average wind speeds have been observed in December in Norman Wells (56 km/hr) and Tulita (65 km/hr).

The prevalent wind direction along the Mackenzie River tends to follow the orientation of the valley, with a general NW/SE or W/E component as the river meanders. At Tulita; however, northeasterly winds dominate over Mackenzie Valley flows, particularly during the winter months, due to the convergence with the Great Bear River valley. This convergence is likely responsible for producing higher wind speeds in the area. Wind roses for Fort Good Hope, Norman Wells, Tulita and Wrigley are summarized by month on Figure 10-2 through Figure 10-5.



SPEED (m/s)

1-3 3-6 6-9 9-12 12-15 15-18 18+

NOTES
Source: Environment Canada

MACKENZIE VALLEY HIGHWAY
TULITA DISTRICT

Fort Good Hope Station
Monthly Wind Roses

PROJECTION	DATUM

5658 NWT Ltd.

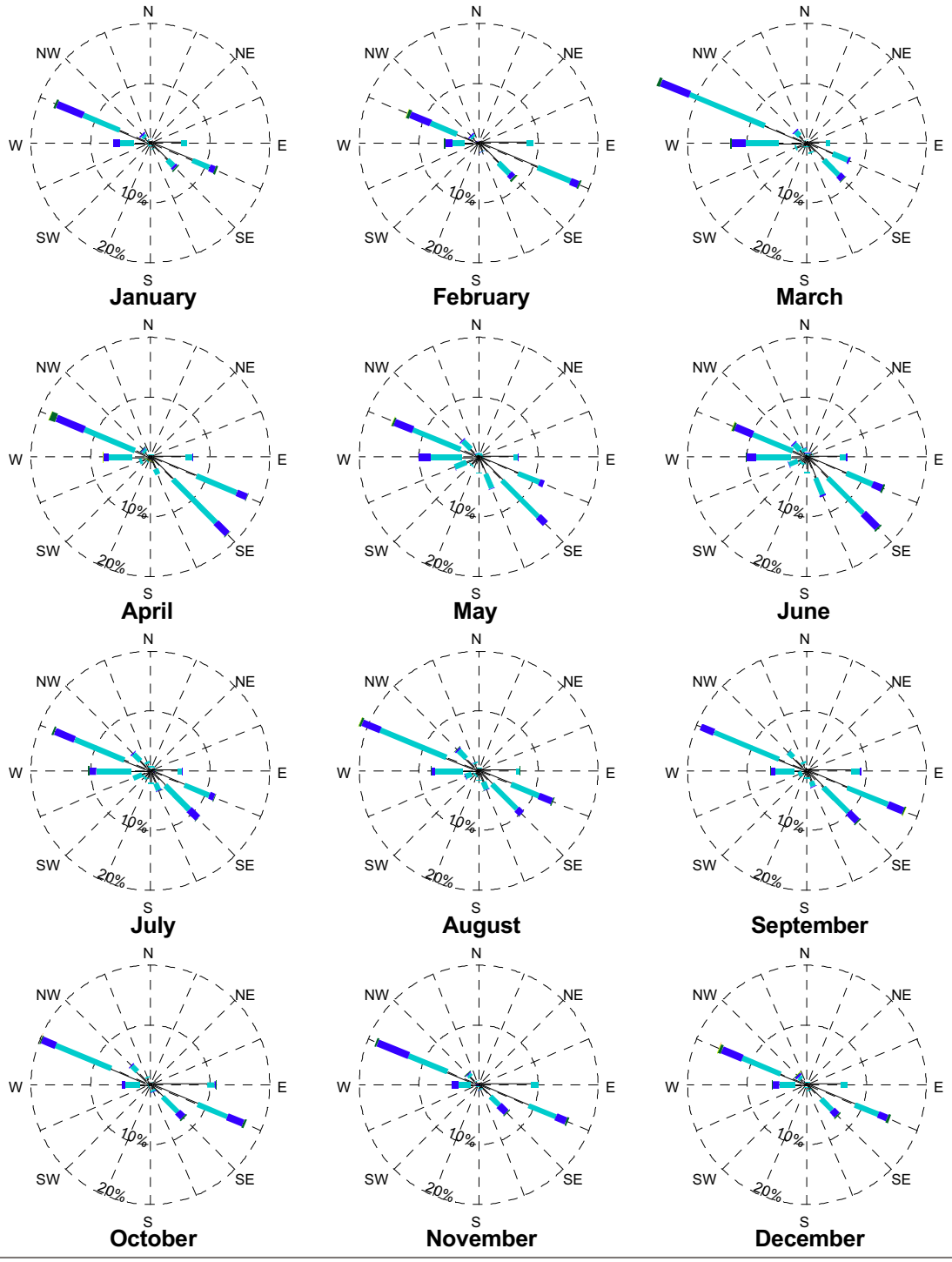
FILE NO.
Y22101155_Figure10-2-MonthlyWindRose.mxd

PROJECT NO.	DWN	CKD	APVD	REV
V33101053	TV	BA	RM	0

OFFICE	DATE
EBA-RIV	October 14, 2011

Figure 10-2

M:\TRANSPORTATION\NWT_Mackenzie_Highway\Y22101155_TulitaMaps\Overview\Y22101155_Figure10-2-MonthlyWindRose.mxd modified 10/11/2011 by tony.vuong



SPEED (m/s)

1-3 3-6 6-9 9-12 12-15 15-18 18+

NOTES
Source: Environment Canada

MACKENZIE VALLEY HIGHWAY
TULITA DISTRICT

Norman Wells Station
Monthly Wind Roses

PROJECTION	DATUM

5658 NWT Ltd.

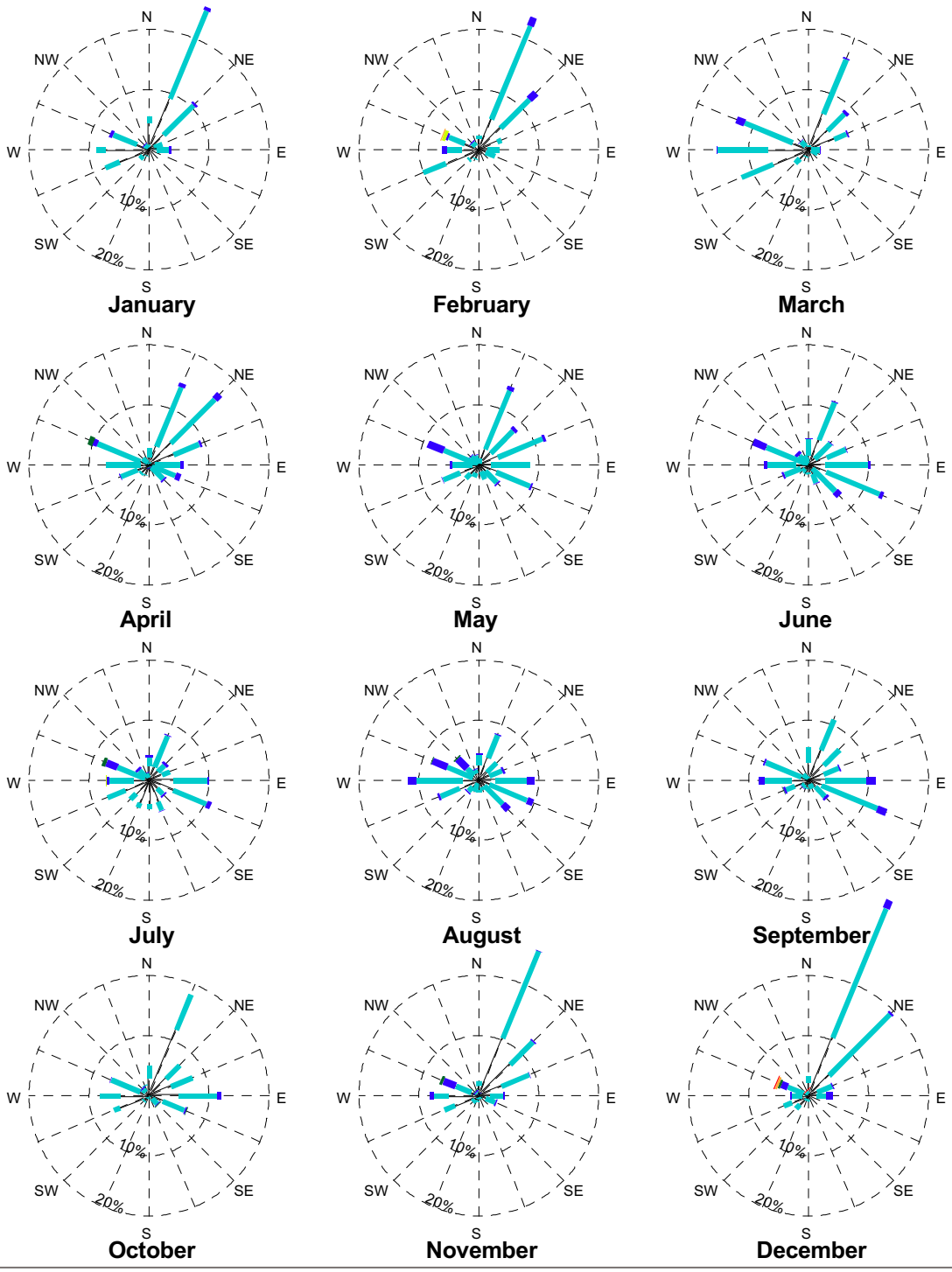
FILE NO.
Y22101155_Figure10-3-NWellWindRose.mxd

PROJECT NO.	DWN	CKD	APVD	REV
V33101053	TV	BA	RM	0

OFFICE	DATE
EBA-RIV	October 14, 2011

Figure 10-3

M:\TRANSPORTATION\NWT_Mackenzie_Highway\Y22101155_TulitaMaps\Overview\Y22101155_Figure10-3-NWellWindRose.mxd modified 10/11/2011 by tony.vuong



SPEED (m/s)

1-3 3-6 6-9 9-12 12-15 15-18 18+

NOTES
Source: Environment Canada

MACKENZIE VALLEY HIGHWAY
TULITA DISTRICT

Tulita A Station
Monthly Wind Roses

PROJECTION	DATUM

5658 NWT Ltd.

Northwest Territories

eba A TETRA TECH COMPANY

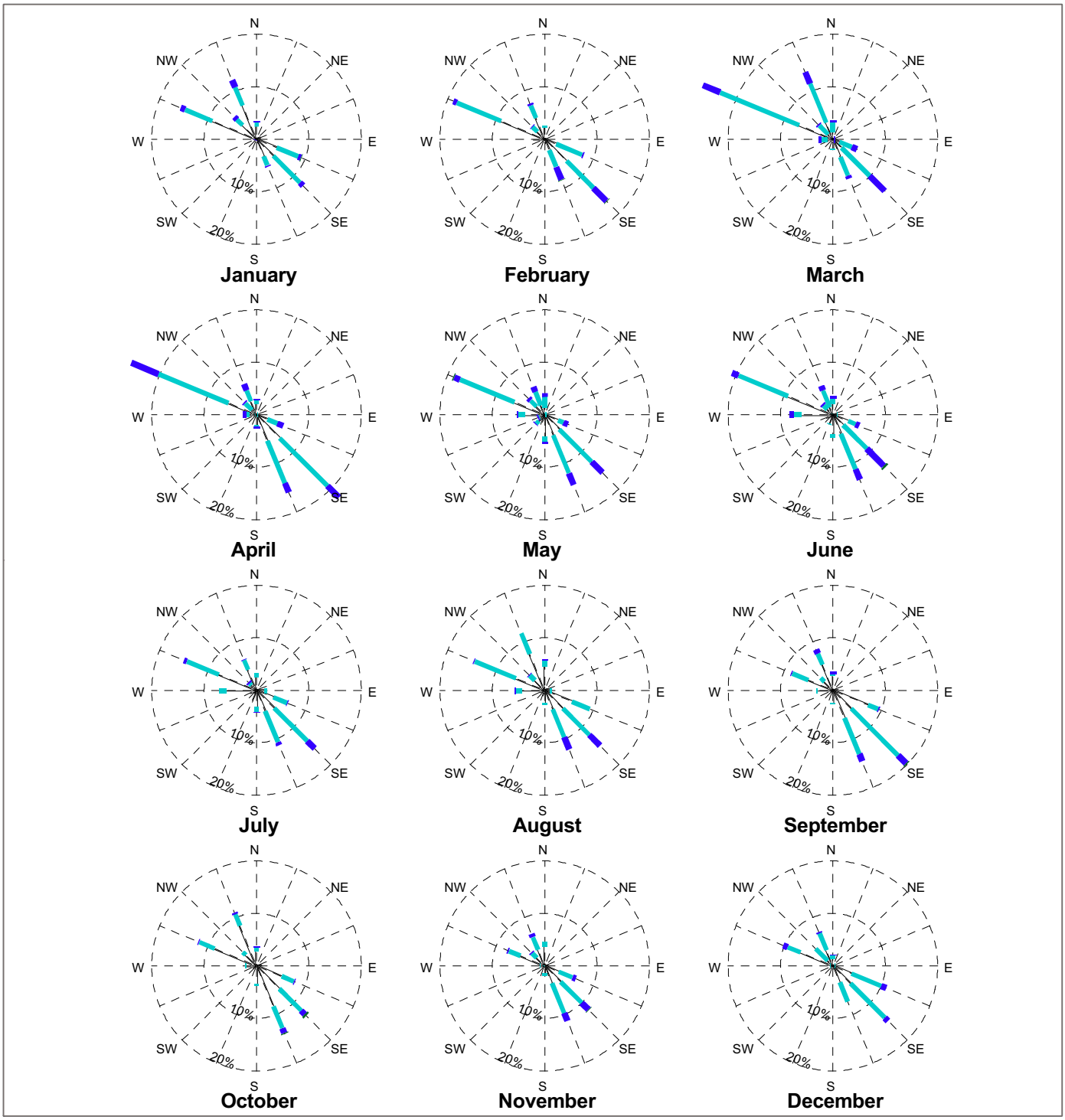
FILE NO.
Y22101155_Figure10-4-TulitaWindRose.mxd

PROJECT NO.	DWN	CKD	APVD	REV
V33101053	TV	MS	RM	0

OFFICE	DATE
EBA-RIV	October 14, 2011

Figure 10-4

M:\TRANSPORTATION\NWT_Mackenzie_Highway\Y22101155_TulitaMaps\Overview\Y22101155_Figure10-4-TulitaWindRose.mxd modified 10/11/2011 by tony.vuong



SPEED (m/s)

1-3 3-6 6-9 9-12 12-15 15-18 18+

NOTES
Source: Environment Canada

MACKENZIE VALLEY HIGHWAY
TULITA DISTRICT

Wrigley A Station
Monthly Wind Roses

PROJECTION	DATUM

5658 NWT Ltd.

FILE NO.
Y22101155_Figure10-5-WrigleyWindRose.mxd

PROJECT NO.	DWN	CKD	APVD	REV
V33101053	TV	MS	RM	0

OFFICE	DATE
EBA-RIV	October 14, 2011

Figure 10-5

M:\TRANSPORTATION\NWT_Mackenzie_Highway\Y22101155_TulitaMaps\Overview\Y22101155_Figure10-5-WrigleyWindRose.mxd modified 10/11/2011 by tony.vuong

10.1.4 Air Quality

Ambient air quality is monitored in the Sahtu Settlement Area at the Northwest Territories ENR station at Norman Wells. Results from the 2008 and 2009 Northwest Territories Air Quality Report are presented in Table 10-8 along with current Northwest Territories air quality standards.

Table 10-8: Norman Wells Ambient Air Quality (2008 & 2009)

Species	NWT Standard (*NAQQO , **BC or Alberta		2008 Maximum	2008 Exceedances	2009 Maximum	2009 Exceedances
	Maximum	Averaging Period				
SO_2	450 µg/m^3	1 hr	5 µg/m^3	0	8 µg/m^3	0
	150 µg/m^3	24-hrs	n/a	n/a	5 µg/m3	0
	30 µg/m^3	Annual	<2 µg/m^3	0	<3 µg/m^3	0
NO_2	*400 µg/m^3	1-hr	29 µg/m^3	0	73 µg/m^3	0
	*200 µg/m^3	24-hrs	n/a	n/a	10 µg/m^3	0
	*60 µg/m^3	Annual	2 µg/m^3	0	2 µg/m^3	0
CO	*15 mg/ m^3	1-hr	n/a	n/a	n/a	n/a
	*6 mg/ m^3	8-hr	n/a	n/a	n/a	n/a
$PM_{2.5}$	30 µg/m^3	24-hr	23 µg/m^3	0	32 µg/m^3	1
PM_{10}	**50 µg/m^3	24-hr	n/a		n/a	
ground level O_3	*160 µg/m^3	1-hr	105 µg/m^3	0	108 µg/m^3	0
	127 µg/m^3	8-hr	n/a	n/a	100 µg/m^3	0
H_2S	**14 µg/m^3	1-hr	3 µg/m^3	0	5 µg/m^3	0
	**4 µg/m^3	24-hr	n/a	n/a	2 µg/m^3	0

*Northwest Territories Air Quality Report, Northwest Territories Environment and Natural Resources, 2008 & 2009

SO_2 concentrations are consistently very low at Norman Wells. Since industrial processes are a major contributor to SO_2, baseline levels throughout the Tulita District would be highest near Norman Wells, near negligible at smaller communities like Tulita, and negligible in pristine areas.

Ambient concentrations of NO_2 are well below air quality objectives. NO_2 concentrations are much higher in the winter months as winter inversions, characterized by very low wind speeds and a stable atmosphere, are very common in the region resulting in a diminished ability for dispersion of pollutants (ENR 2009). Baseline NO_2 would likely be lower in more remote areas due to less sources of combustion (automobiles, butane stoves/heaters, industry).

Fine particulate matter ($PM_{2.5}$) is typically higher on average during winter months due to the presence of inversions; however, short-period peaks which exceed air quality standards can occur during summer months due to forest fire smoke. Throughout the region, $PM_{2.5}$ would be variable during the summer as a result of prevalence and proximity of forest fires and the migration of smoke from other regions such as Yukon or Alaska.

Ground level ozone (O_3) exhibits a springtime maximum, typical for remote locations in the Northern Hemisphere. Monthly average levels typically exceed 50 µg/m^3 in April and May compared to the annual

average of 44 µg/m³. Similar levels would be expected throughout the district. Spikes in ground level O_3 in the region would be nearly entirely related to natural mechanisms.

H_2S emissions are due to oil and gas development in the region. Hourly concentrations at Norman Wells indicate essentially non-detectable levels (less than 1 µg/m³). H_2S concentrations would likely be zero in more pristine areas.

The monitoring station at Norman Wells does not monitor carbon monoxide (CO); however, 2009 data recorded at Yellowknife shows a peak 1-hour maximum concentration of 2.2 mg/m³, well below air quality standards (ENR 2010). In small northern communities, the major contributor to CO production is individual-dwelling wood burning, so peak values would tend to occur during the winter months and be worsened by inversion; however, are not expected to pose a concern to air quality with sparse pockets of small populations.

10.1.5 Climate Change

The Highway is more sensitive to changes in temperature than in precipitation. Changes in mean annual temperature would most certainly affect the distribution of permafrost and thermokarst processes in the region (Lawford 1989). A general warming and a snow cover of shorter duration would disrupt the thermal stability of the permafrost which is sensitive to minor changes in heat transfer at the ground surface, initiating thaw and decreasing the overall stability of the ground (EBA 2010). Stability of the permafrost depends on maintaining ground temperatures to minimize the thickness of the active layer and to impede thaw (EBA 2010).

Climate trends with respect to air temperature and precipitation were determined for Fort Good Hope, Norman Wells and Wrigley for the period 1945 – 2010 based on Environment Canada data. The trends are summarized in Table 10-9.

Table 10-9: 1945 - 2010 Climate Change Trends – Tulita District

	Mean Annual Temperature Change	Mean Winter (DJF) Temperature Change	Mean Summer (JJA) Temperature Change	Annual Precipitation Change
	°C/year			mm/year
Fort Good Hope	+0.04	+0.08	+0.02	-0.06
Norman Wells	+0.03	+0.07	+0.02	-0.7
Wrigley	+0.02	+0.06	+0.01	+0.4

Historical data shows a warming trend throughout the district. Warming has been occurring at a faster rate, on average, during the winter than in the summer. Trends in annual precipitation are more variable.

Due to the uncertainty of climate change, it is no longer an accepted procedure to adopt historic trends as design parameters in regions of permafrost (EBA 2010). General circulation models (GCM) in combination with various population and economic growth scenarios provide simulations of future climate change.

Burn (2003) summarized 29 simulation results from Intergovernmental Panel on Planetary Change (IPCC)-approved GCMs for the Mackenzie Valley over the period 2010 to 2039, referenced to 1961-1990 climate

normals. Upper and lower estimates (selected as the 86th percentiles of the distribution) and the median projection scenarios are summarized in Table 10-10 for mean annual temperature, mean winter temperature and annual precipitation for the Southern Mackenzie Valley (predictions for the central and southern valley are similar). The 65-year historic trends at Norman Wells are also provided as a comparison.

Table 10-10: Climate Change Scenarios for Southern Mackenzie Valley

	[1]1961-1990 Climate Normals (Baseline)	1981 – 2010 Climate Normals (Norman Wells)	1945 – 2010 Trend (Norman Wells)	2010-2039 Climate Change Projections		
				[2]Low	Med	[2]High
Mean Annual Temperature (ºC)	-6.0 ºC	-5.2 ºC	+0.03 ºC/yr	+1.0	+1.3	+2.1
[3]Mean Winter Temperature (ºC)	-26.1 ºC	-20.4 ºC	+0.07 ºC/yr	+0.6	+1.6	+2.5
Annual Precipitation (mm)	317 mm	296 mm	-0.7 mm/yr	+0.9%	+6.2%	+9.6%

Source: Burn (2003)

1 Source: Environment Canada: Norman Wells 1961-1990 Climate Normals.

2 Low and high represents the 12th and 86th percentile of 29 climate change projections.

3 Mean winter temperature defined in climate scenarios as DJF and as the mean of December, January and February monthly means in climate normal.

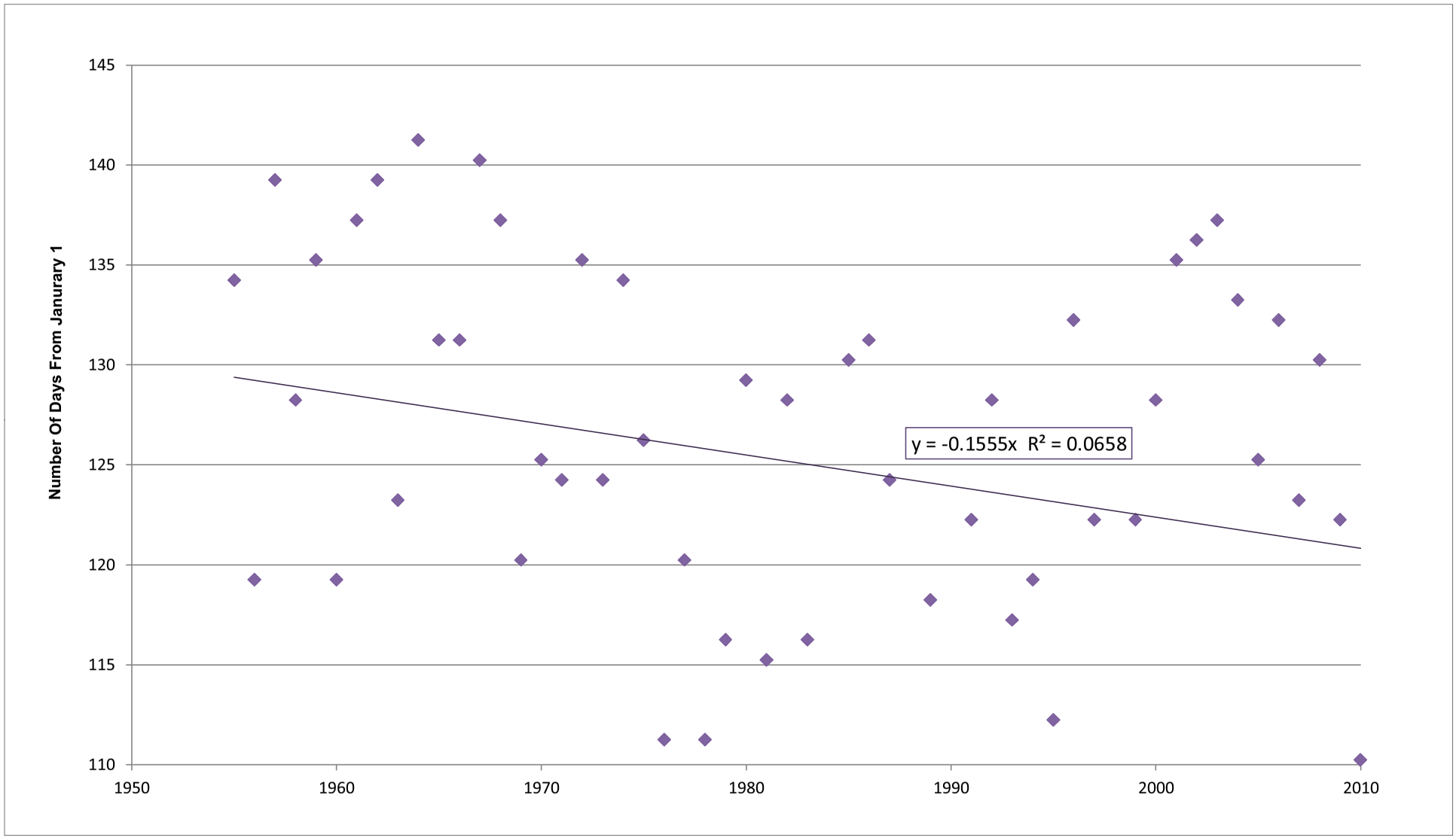
Global climate models (Table 10-10) predict a general warming trend for the region, with mean annual temperatures potentially increasing to -4°C from the 1961-1990 normals of -6°C over the next 30 years. The predicted increase is similar in magnitude to the observed warming trend at Norman Wells over the past 65 years. Simulation results are slightly more variable with respect to winter temperatures, although a warming rate similar to the historical is also expected.

Warmer winters would lead to a shortened snow season. The historical (1955-2010) regional trend is illustrated on Figure 10-6 as a plot of the final day of snow on ground at Norman Wells. The plot shows a trend towards an earlier melt and more snow-free days which would continue at the expected rate of winter warming.

Although the warming trends are evident, the magnitude of natural year-to-year variations in annual temperature is 2 to 3 times the projected temperature increase. Over the next 30 years, annual air temperatures will be increasing on average in the region, decreasing the duration of continuous snow cover and sub-zero temperatures for the region of permafrost; however, natural climate variability will be more noticeable than the climate change trend.

Although climate models tend to predict that an increase in precipitation at high latitudes is very likely, the effects of climate change on regional precipitation patterns are uncertain as they will be significantly influenced by changes in global circulation patterns (Hengeveld 1997). For the Middle and Upper Mackenzie Valley, the GCM projected increase in precipitation over the next 30 years is between 0.9% and 9.6% over the 1961-1990 baseline (317 mm for Norman Wells). The 65-year trend of annual precipitation at Norman Wells; however, is towards decreasing precipitation at an average rate of 0.7 mm per year. Climate models have tended to produce mixed results in terms of precipitation projections and have often over-predicted (Burn 2003).

M:\TRANSPORTATION\NWT_Mackenzie_Highway\Y22101155_Tulita\Maps\Overview\Y22101155_Figure10-6-NWellFinalDayOfSnow.mxd modified 10/11/2011 by tony.vuong



NOTES
Source: Environment Canada

FILE NO.
Y22101155_Figure10-6-NWellFinalDayOfSnow.mxd

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Northwest Territories

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MACKENZIE VALLEY HIGHWAY TULITA DISTRICT

Last Day of Snow on Ground Norman Wells (1955 - 2010)

PROJECT NO.	DWN	CKD	APVD	REV
Y22101155	TV	MS	RM	0

OFFICE: EBA-RIV

DATE: October 14, 2011

Figure 10-6

10.2 Terrain and Topography

10.2.1 Terrain Conditions Along the Preferred Alignment

Table 10-11 below, provides a summary of terrain conditions along the Highway. This summary incorporates observations made during the 2010 field program and information readily available in published documents.

Table 10-11: Terrain Conditions along the Highway

Kilometre (km)		General Description of Route and Terrain Conditions
From	To	
796.3	800.0	The Highway enters the Tulita District of the SSA at approximately km 796.3 and traverses a glaciolacustrine plain that gently slopes to the west towards a low-lying area with thermokarst ponds underlain by organic deposits 2 m to 3 m thick. Elevation (topographic relief) along this section of the Highway changes from approximately 148 m a.s.l. (in the low-lying areas) to 161 m a.s.l. (at km 796.3). The plain, which slopes gently (less than 5% grade) to the west, is composed predominantly of glaciolacustrine silt and clay with minor sand. It is commonly overlain by a discontinuous veneer of organic deposits and locally overlain by outwash sand. The Highway crosses a few well-defined drainage channels requiring culverts, but drainage conditions are generally poor. Permafrost is extensive discontinuous (50% to 90% of land area underlain by permafrost) along the Highway and is characterized by predominantly medium (10% to 25%) ground ice content in the upper 10 m to 20 m of the ground (% by volume of visible ice). Ground ice is commonly represented by segregated ice that occurs as thin (1 mm to 20 mm-thick) lenses in the upper 1 m to 3 m, as reticulate cryostructures (to 50% by volume), or larger discrete tabular bodies of nearly pure massive ice at greater depth. The terrain is highly susceptible to gullying and the development of active layer detachment slides followed by retrogressive thaw flow slides even on gentle slopes, following fire or other disturbance or removal of vegetation. Thermokarst depressions and thaw ponds are developed locally near the Highway. At km 797, the Highway passes relatively near material source 9.037PA that would need to be accessed via a winter road. The Highway follows the winter road alignment along this section.
800.0	811.0	The Highway ascends northward onto an elongated north-south oriented glaciofluvial terrace travelling along the terrace in a northerly direction. The Highway generally follows the winter road alignment with a minor realignment onto more favorable terrain from about km 803.0 to km 805.0. Elevation (topographic relief) along this section of the Highway changes from approximately 139.8 m a.s.l. to 150 m a.s.l. Drainage is mainly subsurface, locally with seepage along channels; the area is well-drained except for the channels. At km 805.3, the route crosses a short, wet section that bisects the terrace and then continues along the terrace with wet areas and water on either side. The flat to gently sloping terrace is composed of gravel and sand, locally with a veneer of aeolian silt or sand. Material source 9.034PA was identified at the south end of the terrace and material source 9.034PB was identified along the Highway near km 804.

Table 10-11: Terrain Conditions along the Highway (continued)

Kilometre (km)		General Description of Route and Terrain Conditions
From	To	
811.0	815.2	At about km 811.0, the Highway returns to the flat to gently sloping glaciolacustrine plain and follows it from this location to approximately Steep Creek valley. Elevation (topographic relief) along this section of the Highway changes from approximately 143 m a.s.l. (along most of the section) to 130 m a.s.l. (km 815.2). The plain is poorly drained. The plain is composed predominantly of silt and clay with minor sand. It is commonly overlain by a discontinuous veneer of organic deposits and locally overlain by outwash sand. The nature of the materials and the generally flat relief give rise to ponding of surface water. Additional culverts should be included in the design of this section. Permafrost conditions are characterized by the occurrence of 1 mm to 20 mm thick discontinuous lenses of segregated ice (10% to 25% by volume) in the upper 1 m to 3 m. Thicker continuous ice lenses, which form reticulate cryostructures or larger discrete tabular bodies of massive ground ice may occur at greater depth. Permafrost features include thermokarst depressions, thaw ponds and peat plateaus in poorly drained areas, and thermal erosion features in areas of better drainage. The Highway crosses a few thermal erosion features with drainage channels requiring culverts and travels around a large thermal erosion gully at km 813.
815.2	816.5	At km 815.2, the Highway begins to descend moderately steep grades following the winter road alignment, with minor realignments on the approaches to Steep Creek. Elevation (topographic relief) along this section of the Highway changes from approximately 85.0 m a.s.l. (at the toe of the slope) to 130.0 m a.s.l. (km 815.2). The slope gradient is approximately 15%. This section appears to be moderately well drained. The surficial material is predominantly a complex of colluvium deposits – sand, silt and clay of various proportions, with coarser particles accumulating at the toe of the slope.
816.5	817.0	Steep Creek (DOT km 815.8)
817.0	820.4	After crossing Steep Creek, the Highway ascends onto a glaciofluvial terrace and travels in a northwesterly to northeasterly direction across the terrace crossing a number of incised channels that will need to be crossed with culverts to accommodate cross drainage. The terrace is flat to gently sloping to the west towards the Mackenzie River. Elevation (topographic relief) along this section of the Highway changes from approximately 90.0 m a.s.l. (at the toe of the slope) to 165.0 m a.s.l. (on the terrace surface). Drainage is mainly subsurface, locally with seepage along channels; well-drained except for the channels. The terrace is composed predominantly of gravel and sand, locally with a veneer of aeolian silt or sand. Permafrost conditions are characterized by low ice content.
820.4	828.4	In this area, the Highway crosses a till plain and travels in a northwesterly direction toward Devil's Canyon crossing following the winter road alignment. The plain is flat to gently sloping to the west towards the Mackenzie River. Elevation (topographic relief) along this section of the Highway changes from approximately 140.0 m a.s.l. (in the southeast) to 190.0 m a.s.l. (near the Devil's Canyon crossing, km 828.4). Drainage conditions are generally poorly to moderately well drained. The plain is composed of till with a silty clay matrix containing minor sand, with cobbles and boulders disseminated throughout. Permafrost conditions are characterized by the occurrence of 1 mm to 20 mm-thick discontinuous lenses of segregated ice (10% to 25% by volume) in the upper 2 m to 3 m. Larger discrete bodies of ground ice, including buried ice, may occur at greater depth.
828.4	828.6	Devil's Canyon (DOT km 828.4)

Table 10-11: Terrain Conditions along the Highway (continued)

Kilometre (km)		General Description of Route and Terrain Conditions
From	To	
828.6	831.8	From the Devil's Canyon crossing, the Highway continues along a direct, descending route to the Saline River valley across a flat to gently sloping glaciofluvial terrace. The approach to the Saline River bridge location is relatively steep and the egress is also steep. Elevation (topographic relief) along this section of the Highway changes from approximately 180.0 m a.s.l. (on the northwest side of Devil's Canyon) to 130.0 m a.s.l. (on the southeast bank of Saline River valley). Drainage is mainly subsurface, locally with seepage along channels; well-drained except for the channels. The terrace is composed predominantly of gravel and sand, with a local veneer of aeolian silt or sand. Permafrost conditions are characterized by low ice content.
831.8	832.8	Saline River (DOT km 832.4)
832.8	844.4	After crossing the Saline River, the Highway ascends a slope and crosses a till plain, travelling in a northwesterly direction toward the Seagrams Creek Bridge, following the winter road alignment with only minor geometric adjustments north of the Saline River and at the approaches to Seagrams Creek. The plain is gently sloping to the west towards the Mackenzie River. Elevation (topographic relief) along this section of the Highway changes from approximately 120.0 m a.s.l. (on the southwest bank of Saline River) to 236 m a.s.l. (km 840.0). The plain is generally poorly- to moderately well-drained. There are several well-defined local drainage courses, which handle much of the overland flow in this area. The plain is composed of till with a silty clay matrix containing minor sand, with cobbles and boulders disseminated throughout. Permafrost conditions are characterized by the occurrence of 1 mm to 20 mm-thick discontinuous lenses of segregated ice (10% to 25% by volume) in the upper 2 m to 3 m. Larger bodies of ground ice, including buried ice, may occur at greater depth.
844.4	844.7	Seagrams Creek (DOT km 844.9)
844.7	850.4	The Highway continues along a gently sloping till plain, travelling in a northwesterly direction and following the existing winter road alignment from Seagrams Creek. The plain slopes gently to the west towards the Mackenzie River. Elevation (topographic relief) along this section of the Highway changes from approximately 170.0 m a.s.l. (on the northwest bank of Seagrams Creek) to approximately 132 m a.s.l. (near km 850.4). The plain is generally poorly- to moderately well-drained. There are several well-defined local drainage courses, which handle much of the overland flow in this area. The plain is composed of till with a silty clay matrix containing minor sand, with cobbles and boulders disseminated throughout. Permafrost conditions are characterized by the occurrence of 1 mm to 20 mm-thick discontinuous lenses of segregated ice (10% to 25% by volume) in the upper 2 m to 3 m. Larger discrete bodies of ground ice, including buried ice, may occur at greater depth.

Table 10-11: Terrain Conditions along the Highway (continued)

Kilometre (km)		General Description of Route and Terrain Conditions
From	To	
850.4	852.3	The Highway crosses complex terrain, i.e. a transitional type between glaciofluvial and glaciolacustrine plains with characteristic thermokarst features, and travels in a northwesterly direction towards the Little Smith Creek (km 852.3), following the existing winter road alignment to the Little Smith Creek. The terrain is characterized by gently irregular topography that is flat to gently sloping. Elevation (topographic relief) along this section of the Highway changes from approximately 132 m a.s.l. (km 850.4) to 120.0 m a.s.l. (on the south bank of Little Smith Creek). The surface is drained by channels connecting thaw ponds. The underlying deposits consist of glaciofluvial sand and silt underlain by glaciolacustrine silt and clay. Permafrost conditions are characterized by the ubiquitous process of thermokarst, which is well-defined in the present-day topography as numerous shallow thermokarst lakes and other irregularities of the surface morphology. Ice content varies from high in perennially frozen glaciolacustrine silts and clays to low and medium in glaciofluvial sands and gravels. Active layer detachment slides ("skin-flows") followed by development of retrogressive thaw flow slides are common on slopes in this terrain type. The area is highly susceptible to gullying, even on gentle slopes, following removal of vegetation.
852.3	853.6	Little Smith Creek (DOT km 853.8)
		The approaches to Little Smith Creek (km 852.7) crossing are relatively steep. Fluvial terraces, potential sources of good quality granular material, are developed along the north and south sides of the Little Smith Creek valley. The existing borrow source 9.002PB, located on the south side of Little Smith Creek, was the source used to construct the bridge crossing embankments.
853.6	861.6	North of Little Smith Creek, from about km 853.6 to km 861.6, the Highway continues in a northerly direction across a glaciofluvial and glaciolacustrine complex terrain similar to that described above (km 850.4 to km 852.3). Elevation (topographic relief) along this section of the Highway changes from approximately 120 m a.s.l. (on the north bank of Little Smith Creek) to 180.0 m a.s.l. (km 861.6).
861.6	872.0	At approximately km 861.6, the Highway enters a till plain, travelling in a northerly-northwesterly direction towards Big Smith Creek (km 872.0). The terrain along this section of the Highway is characterized by hummocky, ridged and hilly glacial topography with patches of gravel, colluvium and exposed bedrock in the south; whereas, in the north, the topography is mostly flat to gently sloping. Elevation (topographic relief) along this section of the Highway changes from approximately 180 m a.s.l. (km 861.6) to 240 m a.s.l. (km 864.6) to 110 m a.s.l. (on the south bank of the Big Smith Creek). The plain is generally poorly- to moderately well-drained. There are several well-defined local drainage courses, which handle much of the overland flow in this area. The plain is composed of till with a silty clay matrix containing minor sand, with cobbles and boulders disseminated throughout. Permafrost conditions are characterized by the occurrence of 1 mm to 20 mm-thick discontinuous lenses of segregated ice (10% to 25% by volume) in the upper 2 m to 3 m. Larger bodies of ground ice, including buried ice, may occur at greater depth. The Highway is located to the east of Mio Lake to avoid the lacustrine soils that surround the lake. The Highway climbs onto a gently to moderately sloping till plain routing along alluvial, colluvial and sheet wash deposits and away from the ice rich fine grained lacustrine deposits alongside Mio Lake. The Highway extends west along the northeast side of Mio Lake and connects to the bridge across Big Smith Creek at km 872.2.
872.0	872.1	Big Smith Creek (DOT km 871.1)

Table 10-11: Terrain Conditions along the Highway (continued)

Kilometre (km)		General Description of Route and Terrain Conditions
From	To	
872.1	936.8	From Big Smith Creek to Great Bear River (at about km 936.8), the Highway crosses an extensive flat to gently sloping glaciolacustrine plain dotted with numerous lakes and local parabolic dunes composed of aeolian sand. Elevation (topographic relief) along this section of the Highway changes from approximately 120 m a.s.l. (north bank of Big Smith Creek) to 140 m a.s.l. (local highs along the route) to 90.0 m a.s.l. (east bank of the Great Bear River). The topography varies from flat to gently undulating with the only major breaks in the surface being Gotcha Creek, Twelve Mile Creek and Four Mile Creek. The plain is poorly drained. The plain is composed predominantly of silt and clay, with minor sand. It is commonly overlain by a discontinuous veneer of organic deposits. Locally, the plain is overlain by a blanket (3 m to 5 m thick) to a veneer (less than 3 m thick) of aeolian deposits consisting of fine- to medium-grained sand and minor silt. Permafrost conditions are characterized by the occurrence of 1 mm to 20 mm-thick lenses of segregated ice (10% to 25% by volume) in the upper 1 m to 3 m. Thicker ice lenses, which form reticulate cryostructures, or larger discrete tabular bodies of massive ground ice, may occur at greater depth. The terrain is highly susceptible to gullying, as well as the development of active layer detachment slides ("skin flows") followed by retrogressive thaw flow slides. The latter form even on gentle slopes, following fire or other disturbance or removal of vegetation. Thermokarst depressions, lakes and thaw ponds are ubiquitous. The Highway is routed between and around the lakes and depressions along the most favorable ground in the area. In the September 2010 field program, two alignment options were identified within this section, specifically between Big Smith Creek and km 882.6. Option A follows the existing winter road and Option B follows drier terrain to the east. Along Option A, a wet section was identified between km 875.1 to km 876.1, and for Option B a bridge structure would be required along the alignment at about km 875.6B. The terrain continues to be wet along Option A between km 877.1 to km 880.1, whereas Option B is drier from km 877.1B to km 880.1B. The Highway follows some aeolian sand dunes through this section. Cut and fill may be required on the top of sand ridges and dune formations. Permafrost generally has lower moisture contents (10% to 15%, non-visible and no excess). However, the fine grained soils that comprise the sand dunes are susceptible to erosion. The two alignment options converge and are located around the head of an unnamed gulley at km 879. One alignment continues along the glaciolacustrine plain to km 890.1 where two options are again presented. Option A follows the PWC 1974 alignment along a glaciofluvial ridge, while Option B routes along the existing winter road. At about km 897.1, the two options converge and a single alignment continues along the glaciofluvial ridge and sand dunes along the winter road right of way and then meanders its way around an extensive series of thermokarst lakes following the existing winter road. The Highway continues north along relatively level terrain with the only steep gradients located at the bridge crossings. The soils are lacustrine, comprising interbedded clay, silt and sand. Moisture/ice contents are extremely variable. Given the variability of ice content, the construction should be fill only.
912.7	913.0	Gotcha Creek (DOT km 913.7)
913.0		Between Gotcha Creek and Twelve Mile Creek, the quality of local drainage deteriorates and is generally poor with numerous small thermokarst ponds present. The frozen, fine-grained nature of the soil precludes subsurface drainage and the relatively flat nature of the terrain may lead to some drainage problems.
922.0		Twelve Mile Creek
		The Highway crosses a relatively flat glaciolacustrine plain interspersed with concentrations of thermokarst. Numerous small thermokarst lakes and ponds present a threat of potential ponding of overland flow along the east side of the Highway. The general drainage direction is towards the Mackenzie River. The terrain is poorly drained.

Table 10-11: Terrain Conditions along the Highway (continued)

Kilometre (km)		General Description of Route and Terrain Conditions
From	To	
931.5		Four Mile Creek (DOT km 932.2)
		The Highway crosses Four Mile Creek and continues to cross poor terrain with poor drainage and numerous thermokarst features. The ground is level with general drainage toward the Mackenzie River. The Highway parallels the airstrip at Tulita and then crosses the Great Bear River.
936.8	937.1	The Highway crosses a flat to gently sloping fluvial terrace of the Great Bear River. The terrace is elevated approximately 10 m above the river channel. Elevation (topographic relief) along this section of the Highway is approximately 60 m a.s.l. The terrace is moderately well drained. The terrace is composed of fluvial deposits: mainly sand and silt, in places these are underlain by gravel. Patches of permafrost with low to moderate ground ice content may occur within the terrace.
937.1	937.6	Great Bear River
		The Highway from Tulita/Bear Rock massif to Norman Wells (km 1015) traverses the base of the Norman Range and crosses numerous drainage channels coming out of the mountains. The drainage is dominated by a series of 8 major (named) crossings which flow from the adjacent Norman Range. The Highway crosses these creeks at a perpendicular angle and bridge structures exist at these creeks. The topography along the Highway is generally level. Steep gradients are only encountered at river and creek crossings and where the Highway passes through the pass northeast of Bear Rock. Surficial soils consist mainly of till, and organic cover is typically 0.3 m to 1.2 m thick. The till generally has high densities and lower ice contents and generally would be good embankment material. Placing this material in the summer would not pose any difficulties except for exclusion of high ice content material. Winter placement is more difficult, as it would entail building the embankment to a considerable height above design to allow for subsidence during subsequent summers. Bedrock consisting primarily of shale, sandstone and limestone has been previously identified by others at shallow depths in a few of locations. Generally, the areas between the creeks along the existing winter road and the Highway are well drained and the creeks have braided channels containing boulder and gravel beds.
937.6	938.1	The Highway crosses a flat to gently sloping fluvial terrace of the Great Bear River. The terrace is elevated approximately 10 m above the river channel. Elevation (topographic relief) along this section of the Highway is approximately 60 m a.s.l. The terrace is moderately well drained. The terrace is composed of fluvial sand and silt, which is locally underlain by gravel. Patches of permafrost with low to moderate ground ice content may be encountered within the terrace.
938.1	939.1	The route crosses a flat to gently sloping glaciofluvial terrace. Elevation (topographic relief) along this section of the Highway changes from approximately 70.0 m a.s.l. (at the toe of the slope, km 938.1) to 100.0 m a.s.l. (at the terrace break) to approximately 118.0 m a.s.l. (near km 939.1). Drainage is mainly subsurface, locally with seepage along channels; it is well-drained except for the channels. The terrace is composed predominantly of gravel and sand, with local veneers of aeolian silt or sand. Permafrost conditions are characterized by low ice content.

Table 10-11: Terrain Conditions along the Highway (continued)

Kilometre (km)		General Description of Route and Terrain Conditions
From	To	
939.1	952.6	From km 939.1, the Highway trends north and west around the east side of the Bear Rock massif, travelling along a hummocky, irregular bedrock-controlled plain composed of till veneers less than 2 m thick (from km 939.1 to approximately km 947.1), till blankets 3 to 20 m thick (from km 947.1 to km 949.1) and till blankets less than 3 m thick (from km 949.1 to km 952.6). The till veneer slopes conform to the underlying bedrock topography around the Bear Rock massif. The route follows the existing winter road around the massif for the most part and then travels through a pass to the east. North of the massif, the Highway continues along the till plain, which gently slopes toward the Mackenzie River in this location. Elevation (topographic relief) along this section of the Highway changes from approximately 120 m a.s.l. (near km 939.4) to 260 m a.s.l. (km 949.3) to 150 m a.s.l. (km 952.6). The plain is poorly to moderately well drained with downslope seepage in sub-parallel runnels. Locally, where subjacent bedrock is limestone or sandstone, the surface is well-drained. The till consists of unsorted clay, silt, sand and gravel with dispersed clasts (cobbles and sometimes boulders). Permafrost conditions are characterized by the occurrence of 1 mm to 20 mm-thick, irregular discontinuous lenses of segregated ice (10% to 25% by volume). Fractures and joints in the subjacent bedrock are not typically infilled with ice. Patches of the exposed bedrock are unfrozen.
952.6	954.1	The Highway crosses a complex terrain that consists of slope deposits (colluvium and sheetwash deposits). Elevation (topographic relief) along this section of the Highway changes from 150 m a.s.l. (km 952.6) to 170 m a.s.l. (km 954.1). The terrain is poorly to moderately well drained. The slope complex consists of a veneer (less than 2 m thick) to blanket (more than 2 m thick) of diamicton and rubble derived from bedrock and surficial material accumulated through a variety of slope processes. Permafrost conditions are likely characterized by highly variable ice content depending on texture and thickness of the material that forms the terrain unit.
954.1	1011.6	From approximately km 954.1, the Highway travels along a bedrock-controlled plain that is covered by till veneer (less than 2 m thick) to till blanket (3 to 6 m thick). Elevation (topographic relief) along this section of the Highway changes from 170 m a.s.l. (km 954.1) to approximately 110 m a.s.l.(Jungle Ridge Creek crossing (km 967.7) to 100 m a.s.l. (Vermillion Creek North crossing, km 973.5) to 135 m a.s.l. (km 978.1) to 90 m a.s.l. (Prohibition Creek crossing, km 984.7) to 80 m a.s.l. (Christina Creek crossing, km 990.8 and Francis Creek crossing, km 984.0) to approximately 100 m a.s.l. near Canyon Creek crossing (km 998.0). From the Canyon Creek crossing (km 998.0), the Highway ascends a moderately steep slope to an elevation of 200 m (km 1003.1), following 200 m to 210 m elevation contour lines to approximately km 1009.1, and, then descending a moderately steep slope to an elevation of 130.0 m a.s.l. at approximately km 1011.6 at an average grade of 10%. The terrain along this section of the Highway is generally poorly to moderately well-drained. The soils in this section are glacially deposited tills consisting of a silty clay matrix and minor sand and gravel with cobbles and boulders disseminated throughout. Moisture contents in this material type are variable, ranging from 10% to 40%. Permafrost conditions are characterized by the occurrence of 1 mm to 20 mm-thick irregular discontinuous lenses of segregated ice (10% to 25% by volume) in the upper 2 m to 3 m of the till blanket. Thicker ice lenses or discrete tabular bodies of massive ground ice may occur at greater depth. Ice contents are higher in low-lying areas and generally decrease as higher elevations are reached. Borrow material in low-lying areas is poor but improves as higher ground is reached.
967.7		Jungle Ridge Creek (DOT km 978.5)
		From km 964.0 to km 981.0 the local drainage characteristics are dominated by Jungle Ridge and Jungle Ridge Creek. The relief afforded by the ridge line and the presence of the creek suggest that few drainage problems would be encountered in this section. This section is level but relatively well drained with most of the drainage being into Jungle Ridge Creek. Soils are mainly composed of till.

Table 10-11: Terrain Conditions along the Highway (continued)

Kilometre (km)		General Description of Route and Terrain Conditions
From	To	
971.4		Notta Creek (DOT km 982.3)
		This section of the Highway is generally perpendicular to the drainage. The topography is gently undulating with the only sharp breaks being the banks of creeks. Drainage is generally good and the creeks have permanent bridge structures along the existing winter road. The soils consist of a layer of till overlying clay shale. Well drained soils suggest that ice contents are generally low, in the range of 10% to 20%.
973.4		Vermillion Creek (DOT km 984.4)
		At Vermillion Creek, two options are proposed. Option A follows along the existing winter road, while Option B follows higher ground to the east, paralleling the winter road about 2 km to the east between Vermillion Creek and Prohibition Creek at DOT km 996.3. Option B also has the option of continuing along the higher ground with a new crossing of Prohibition Creek and reconnecting with the winter road at Christina Creek.
984.3		Prohibition Creek (DOT km 995.3)
		Two options are presented between Prohibition Creek and Christina Creek. Option A follows along the existing winter road and Option B continues as previously discussed with a new crossing of Prohibition Creek and reconnects with the winter road at Christina Creek. Both options traverse good ground conditions.
990.3		Christina Creek (DOT km 1001.7)
		From Christina Creek to Canyon creek, crossing the bridges at Hellava Creek and Francis Creek, the Highway follows the winter road.
991.3		Hellava Creek (DOT km 1002.7)
		This section covers the area north of Hellava creek to the north side of Canyon creek. Drainage is good and is perpendicular to the Highway, except in the last kilometre where drainage is parallel to the Highway.
993.5		Francis Creek (DOT km 1005.0)
		Drainage is good and is perpendicular to the Highway, except in the last kilometre where drainage is parallel to the Highway.
997.5		Canyon Creek (DOT km 1009.3)
		North of Canyon Creek there are two options again. Option A takes the higher ground following the 1974 PWC alignment, which intersects the base of the rock quarry near Norman Wells. Option B follows the existing winter road and passes closer to the Town of Norman Wells. These options were considered in the preliminary design; however, the 1974 PWC alignment would require a significant bridge structure over the gorge to the northeast of Norman Wells, and the existing winter road alignment is subject to natural ground that has lesser stability due to moisture and thawing of permafrost. The Highway passes through the rock quarry which avoids the unstable ground along the existing winter road and the need for the bridge structure to the northeast of Norman Wells.
1011.6	1032.1	From approximately km 1011.6 (3.0 km northeast of the Norman Wells Airport), the Highway crosses a till plain that is flat to gently sloping to the southwest towards the Mackenzie River. Elevation (topographic relief) along this section of the Highway changes from approximately 130.0 m a.s.l. (km 1011.6) to approximately 100.0 m a.s.l. (Bosworth Creek crossing, KM 1020.2) to 60 m (an unnamed stream crossing between two lakes at km 1032.1). The plain is generally poorly- to moderately well-drained with downslope seepage in shallow sub-parallel runnels. The plain is composed of till with a silty clay matrix containing minor sand, with cobbles and boulders disseminated throughout. Permafrost conditions are characterized by the occurrence of 1 to 20 mm-thick discontinuous lenses of segregated ice (10% to 25% by volume) in the upper 2 m to 3 m. Larger discrete bodies of ground ice, including buried ice, may occur at greater depth. Permafrost features include thermokarst lakes and depressions indicative of the ice-rich condition of the underlying till.

Table 10-11: Terrain Conditions along the Highway (continued)

Kilometre (km)		General Description of Route and Terrain Conditions
From	To	
1019.8		Bosworth Creek
		North of Norman Wells, after crossing Bosworth Creek, the Highway continues along the till plain that is slopes gently toward the Mackenzie River. The terrain gradually rises toward the Norman range to the west, with locally well-defined drainage running to the Mackenzie River. The ground is organic covered and relatively wet in areas indicating that the underlying till is ice-rich and would be sensitive to thermal disturbance. The plain is dotted with thermokarst lakes and depressions indicative of poor drainage and ice-rich conditions. The two Options presented entering Norman Wells from the south continue past Norman Wells to the north. Option A stays on the higher ground to the east, whereas Option B is located closer to town and crosses Bosworth Creek along the existing bridge crossing.
1031.8		Billy Creek (DOT km 1033.4)
		Two options are proposed for accessing the area north of Billy Creek. Option A stays on higher terrain to the east and connects to the winter road at about km 1043.8. Option B uses the existing bridge structure along the winter road. The Highway will follow the winter road and use the existing bridge structure at this location. North of Billy Creek to the north extent of the Tulita District, two additional named creeks are crossed: Oscar Creek and Elliot Creek. North of Billy Creek, the Highway follows the existing winter road, with a deviation at km 1051.3 to target more favorable terrain, and two Options are presented at km 1055.8. Option A follows the existing winter road and Option B follows more favorable terrain along the 1970s PWC alignment. The two Options converge on the north side of Oscar Creek. Option A uses the existing bridge structure at Oscar Creek, while Option B would require a new bridge up-gradient/upslope of the existing bridge. The Highway follows Option A at this location.
1032.1	1071.1	The Highway crosses a complex glaciolacustrine-glaciofluvial terrain, i.e. a transitional type between glaciolacustrine and glaciofluvial plains dotted with numerous thermokarst lakes. The terrain is characterized by gently irregular topography that is flat to gently sloping to the southwest towards the Mackenzie River. Elevation (topographic relief) along this section of the Highway changes from approximately 60 m (an unnamed stream crossing between two lakes at km 1032.1) and approximately 45.0 m a.s.l. (Oscar Creek crossing, km 1050.8) to approximately 80.0 m a.s.l. (along most of the section) to 100.0 m a.s.l. (km 1071.1). The surface is generally poorly drained, but is locally moderately well-drained by channels connecting thaw ponds. The underlying deposits consist of glaciofluvial sand and silt underlain by glaciolacustrine silt and clay. Permafrost conditions are characterized by the ubiquitous process of thermokarst, well-defined in the present-day topography as numerous shallow thermokarst lakes and other irregularities of the surface morphology. Ice content varies from high in perennially frozen glaciolacustrine silts and clays to low and medium in glaciofluvial sands and gravels. Active layer detachment slides ("skin-flows") followed by development of retrogressive thaw flow slides are common on slopes in this terrain type. The area is highly susceptible to gullying, even on gentle slopes, following removal of vegetation.
1050.8		Oscar Creek (DOT km 1054.4)
		There is an opportunity for the two options to reconnect at about km 1059.6, or for Option B to follow the PWC 1974 alignment and for Option A to continue along the winter road. Option A could use the existing bridge at Oscar Creek, while a new bridge would be required to cross Oscar creek further upslope for Option B. The Highway follows Option A at this location. After crossing Oscar Creek, the Highway continues along the existing winter road with minor modifications to improve geometric alignment to km 1088.6, where two options again exist for crossing the irregular terrain.
1064.4		Elliot Creek (DOT km 1072.4)

Table 10-11: Terrain Conditions along the Highway (continued)

Kilometre (km)		General Description of Route and Terrain Conditions
From	To	
1071.1	1081.0	The Highway crosses a till plain, which is flat to gently sloping to the southwest toward the Mackenzie River. Elevation (topographic relief) along this section of the Highway changes from approximately 100.0 m a.s.l. (km 1071.1) to approximately 170.0 m a.s.l. (km 1079.1) to 110.0 m (km 1081.0). The plain is generally poorly- to moderately well-drained, with downslope seepage in shallow sub-parallel runnels. The plain is composed of till with a silty clay matrix containing minor sand, which has cobbles and boulders disseminated throughout. Permafrost conditions are characterized by the occurrence of 1 mm to 20 mm-thick discontinuous lenses of segregated ice (10% to 25% by volume) in the upper 2 m to 3 m. Larger discrete bodies of ground ice, including buried ice, may occur at greater depth.

10.2.2 General Topography and Geology

The Highway crosses two distinct physiographic regions in the Tulita District, but predominantly lies within the Mackenzie Plain physiographic region and crosses the Franklin Mountains physiographic region.

Physiographic divisions are areas of similar geomorphic and geologic features. The terrain, types of granular deposits and bedrock borrow sources within each physiographic region are related to the physiographic region and surficial and bedrock geology of the area. Each physiographic region exhibits, in very general terms, similar basic geomorphologic characteristics.

10.2.2.1 Mackenzie Plain Physiographic Region

The Mackenzie Plain encompasses both sides of the Mackenzie River. The Plain on the east side of the river is narrow relative to its counterpart west of the river. The eastern margin of the Plain is intersected by the Bear Rock massif northwest of Tulita on the north side of the Great Bear River.

The prevailing cover of the Mackenzie Plain consists of glaciolacustrine deposits and till. In general, segments covered with glaciolacustrine deposits are deficient in granular materials, while other segments (notably glaciofluvial and alluvial deposits) present some prospects for construction materials. Glaciofluvial outwash plains and terraces usually contain irregularly alternating sand and gravel strata with variable silt content. Large bodies of outwash are located on the east side of the Mackenzie River south of Saline River and south of Little Smith Creek. Glaciofluvial deltas are found in the gaps in the Norman range north of Norman Wells.

The bedrock in the area generally consists of weakly cemented sandstone, incompetent siltstone and shale, which are for the most part not suitable for manufactured construction aggregate (surfacing gravel), but could suffice for embankment material. Competent Devonian Limestone outcrops only at a few locations along scattered ridges southeast of Norman Wells, as well as in the Franklin Mountains physiographic region.

10.2.2.2 Franklin Mountains Physiographic Region

The Franklin Mountains parallel the east side of the Mackenzie Plain. The Norman range represents the Franklin Mountains unit in the northern sector of the area. It begins west of Tulita with the prominent Bear

Rock massif and continues in a northwesterly direction. The Franklin Mountains are composed of Middle Devonian unnamed and undivided carbonate strata with minor shale and anhydrite inclusions, as well as Ordovician and Silurian dolomite, anhydrite and shale. In general, the Franklin Mountains consist of rocks which are competent and represent a good source of construction materials. The Franklin Mountains contain unconsolidated granular deposits in the form of talus and alluvial deposits.

A thin veneer of till and/or colluvial material typically covers the bedrock in the Franklin Mountains. Alluvial fans and coarse-and fine-grained material occur where streams flow out of the bedrock-controlled gorges/valleys. Talus slopes often occur at the base of cliffs. In some cases where ice contents are high, rock glaciers have formed. Surface drainage in the Franklin Mountains is variable. In rugged and ridged areas, drainage is good and streams and rivers flow toward the Mackenzie River. Some poorly drained areas have formed in lower lying areas between ridges and recent lacustrine soils. Thick organic deposits are common where poorly drained fine-grained glaciolacustrine and/or till materials are present.

10.2.3 Surficial Geology

The surficial deposits along the Highway are glacial and post-glacial in age. Surficial geology mapping for the Tulita District prepared by the Geological Survey of Canada (Duk-Rodkin 2002; Duk-Rodkin and Couch 2004), provides an overview of the terrain conditions along the Highway.

Terrain types common along the Highway vary from relatively dry glacial till to wet, ice-rich glaciolacustrine and thick organic deposits. Recent alluvial deposits line the stream/river channels that cross through the area and wind deposited aeolian dunes are found along some sections of the Highway. The unfavorable thick organic and ice-rich terrain was avoided where possible. Selection of the route for the Highway focused on traversing the most favorable terrain in the vicinity of the existing winter road, the MGP and the PWC 1974 alignment, with attention paid to overall length.

Various types of surficial materials occur along the Highway. The surficial geology along the Highway has been divided into four generalized terrain types; (1) till, (2) glaciolacustrine, (3) glaciofluvial outwash and ice-contact deposits, and (4) alluvial/aeolian/colluvial deposits. Alluvial, aeolian and colluvial deposits have been grouped into one terrain type since collectively they comprise a small portion of the Highway.

The Highway crosses many seasonal watercourses, wet lowlands, peatlands and thermokarst lakes, which are remnants of glacial outwash channels. Organic deposits can overlie any of the generalized terrain types, but as a general rule are thin over relatively dry till deposits and thick over wet glaciolacustrine deposits. Fluvial deposits are found along watercourses, and pond (lacustrine) deposits have accumulated in shallow depressions. Wind-blown fine silty sand deposits are found south of Tulita, gravity induced colluvial deposits exist along slopes, and thicker organic deposits have formed on poorly drained floodplains and low-lying flat areas.

Periglacial processes through the Holocene Period have resulted in the mechanical breakdown of materials and contributed to wind and gravity transport of both glacial soils and products of periglacial grinding.

The following provides a summary of each terrain type and is based on mapping by Duk-Rodkin (2002) and Duk-Rodkin and Couch (2004). The generalized terrain types are presented in Table 10-12. This classification is based on observations from the field investigation, a review of orthophotographs, LIDAR topographic survey data along the Highway, and the above mentioned surficial geology mapping of the

area. The majority of the route traverses Terrain Type 1 and Type 2, with Terrain Type 3 and Type 4 comprising the remainder of the Highway.

Table 10-12: Terrain Types Along the Highway

Terrain Type	Terrain Description	Approximate Percent Distribution Along the Highway
1	Glacial Till Deposits – deposited directly, or with minor reworking by glacier ice. (relatively stable, tills overlain by a thin organic cover)	49
2	Glaciolacustrine Deposits – deposited in proglacial or glacially dammed environments, and recent lacustrine deposits. (Generally wet, silt and clay, fine sand and organic sediments, moderate organic cover.)	40
3	Glaciofluvial Outwash and Ice-Contact Deposits – deposited at ice front or at ice margin, or within/under glacier ice. (Kame and kettle complexes and thermokarst modified plains, dry to wet, overlain by a thin to moderate organic cover.)	7
4	Alluvial/Aeolian/Colluvial Deposits – channel, floodplain and deltaic units found along present-day streams, debris flow deposits found along steep slopes, colluvial sheetwash and downslope gravity-induced deposits, and elongated dune deposits formed by post-glacial wind–blown sand.	4

10.2.3.1 Terrain Unit 1

Glacial Till deposits consist of well-compacted material that is non-stratified and contains a heterogeneous and variable mixture of particle sizes set in a matrix of clay, silt and sand. It is deposited directly by and underneath a glacier, by glacial action. Glacial till covers about 49% of the route. These deposits are generally moderately-well-drained and form smooth to rolling topography having little surface expression of ice-rich permafrost conditions. However, till deposits can also be wet with ice-rich permafrost features indicative of more thermally sensitive terrain.

Till units generally provide suitable foundation conditions for road construction. They present few limitations to construction except in areas with steep slopes or where drainage is poor and conditions are ice-rich. Ice contents in till typically decrease with depth.

10.2.3.2 Terrain Unit 2

Glaciolacustrine deposits include wet silt, clay and fine sand. They formed in pond/lake bottom settings due to settling of fine particles from suspension, and occasionally by underwater gravity flows in bodies of standing fresh water and glacial lakes. These units are found in low-lying, wet lowland terrain and old lakebed locations. Glaciolacustrine deposits are found along about 40% of the route. In general, this terrain is poorly drained and often contains standing water. It is commonly overlain by moderate to thick organic over. Permafrost is present under this terrain unit, except for locations adjacent to large water bodies. Because of the fine textured nature of these sediments, and the imperfectly to poorly drained conditions, these sediments are ice-rich and highly susceptible to compaction and rutting. High ice contents are common in glaciolacustrine deposits, especially if they are insulated by an organic cover and are poorly drained.

Glaciolacustrine sediments present limitations for road construction and maintenance due to their fine-grained nature. Their limitations are due to their wetness (relatively high ground ice content), high settlement potential and erodibility. Glaciolacustrine deposits are highly susceptible to gullying even on gentle slopes, following removal of vegetation. Deposit thicknesses are typically greatest in areas of lacustrine sediments and thick organic terrain.

Retrogressive thaw flow often develop in this unit following active layer detachment and rotational failures. Retrogressive flow slides are also common on slopes within this unit following disturbance of vegetation.

10.2.3.3 Terrain Unit 3

Glaciofluvial Outwash and Ice-Contact deposits dominate about 7% of the Highway. These materials are usually interbedded mixtures of sand and gravel with some silt. They have been transported away from their glacier source by streams or rivers of glacial meltwater and deposited as a floodplain along a pre-existing valley bottom or over a pre-existing plain. Alternately, they may have been deposited as ridges, terraces and hummocky terrain along glacial ice contact zones. The ground ice contents of these deposits vary greatly and are usually dependent on topographic location. Crests of prominent ridges and hummocks are typically well-drained and ice free to depths of 2 m to 5 m. Typically the high crests and hummocks yield useful material.

Ice-contact deposits are often hummocky and irregular, comprising irregularly stratified sand and gravel, and forming kames, kame fields, kame terraces, eskers and esker-kame complexes. These deposits are moderately well to well drained in most instances; however, imperfectly to poorly drained outwash materials are found where groundwater seepage is pronounced. Textures are quite variable and range from silt to subrounded gravels. There is generally low ice content in the near surface (active layer), but ice content increases with depth and massive ice may be encountered. These deposits generally represent sources of useful borrow material.

Most glacial outwash materials provide a suitable foundation for roads as drainage is generally good. In addition, some outwash deposits provide good construction material sources. Ice-contact deposits also provide suitable foundation conditions for roads, but the irregular and hummocky terrain can be a challenge and may require cut and fill construction or higher fill volumes to construct a highway.

10.2.3.4 Terrain Unit 4

Post-glacial Fluvial, Colluvial and Aeolian deposits are materials transported and deposited by streams, gravity and wind during the recent Holocene Period. Fluvial, colluvial and aeolian deposits in total comprise a small percentage of the materials encountered along the route, about 4%.

Fluvial deposits are found along many of the watercourses, colluvial materials are indicative of instability on steeper slopes as noted along channels where sediments have slumped into the valley, and aeolian sediments were deposited by early Holocene winds. Fluvial sediments are commonly moderately to well sorted and display stratification. Colluvial materials are unsorted deposits derived from gravity-induced downslope movement of surficial materials. Aeolian deposits consist of fine- to medium-grained silty sand deposited according to prevailing post-glacial wind directions.

From an engineering perspective, many fluvial deposits represent potential material sources; however, these materials are often located in sensitive areas near water bodies, are variable and typically of small volume, and are poorly mapped, so they should not be relied upon as significant material sources. Colluvial materials are heterogeneous mixtures that may contain organic inclusions; they are not well suited as construction materials. Aeolian deposits are highly erodible, and are better suited to construction of embankments on top of the deposits, rather than using the material found in the deposits as fill material.

10.2.4 Permafrost

Permafrost is present in the fine-grained, high moisture content materials along the Highway and occurs at variable depths within the coarser granular deposits. The thickness of the active layer can be greater than 2.5 m on elevated, ice-poor, organic-free slopes.

Melting of permafrost can result in substantial thaw settlement, the loss of the soil's structural integrity, and can thus ultimately adversely affect the stability of the Highway. Minimizing disturbance to permafrost and avoiding ice-rich sensitive terrain are important and key routing considerations.

Frozen ground can contain excess ice, where the amount of water contained in the soil matrix in a frozen state is higher than would be retained in the soil in an unfrozen state. The excess ice can be found mixed (disseminated, non-visible) within the soil matrix, or can be in the form of pure ice, ice lenses or ice wedges. These ice-rich soils are sensitive to thermal disturbance and can result in significant thaw settlement and instability if disturbed. The importance of these ice inclusions is the susceptibility of these materials to melt, the resultant ground disturbance, and the suitability for use as construction material (NRCAN 2007).

10.2.5 Geohazards

Geohazards are natural, existing or potential, geomorphic and geologic processes and formations that could lead to damage to engineering structures. Geohazards identified along the Highway during the 2010 field program are all classified as permafrost-related because they occur in a permafrost-dominated terrain. These permafrost-related geohazards include the near-surface occurrence of ice-rich ground or massive ground ice bodies, as indicated by thermokarst and thermal erosion features, retrogressive thaw flow landslides, and ice-rich, thaw-sensitive peatland terrain.

10.2.5.1 Massive Ground Ice

Features indicating massive ground ice deposits are readily identifiable on aerial photographs and from the air, for example ice wedges, which were interpreted by the presence of a prominent polygonal pattern on the ground surface. Other types of massive ground ice, such as massive ice beds, are not directly revealed by the present-day surface features. Their occurrence is suggested by indirect geomorphic indicators developed where massive ice has been disturbed naturally, such as thaw flow landslides, oval-shaped depressions and thermokarst lakes. Some observations of prominent polygonal patterned ground were made in the 2010 field program.

10.2.5.2 Retrogressive Thaw Flows

According to Aylsworth et al. (2000), landslides in permafrost terrain are characterized by two distinct classes (flows and slides) based on mechanism of failure and morphology. Several different types of landslides make up each of these two major classes. Flows can be further subdivided into shallow active layer detachments (or skin flows), deeper retrogressive thaw flows, and rapid debris flows. Slides are subdivided into rotational slides and translational slides.

Along the Highway, the most common type of landslide is the "retrogressive thaw flow". Thaw flows are indicative of ice-rich permafrost terrain and are often associated with thawing of massive ground ice bodies. They have a characteristic bowl shape and a bimodal profile with a steep headwall and a low-angle tongue. The headwall gradually erodes upslope as massive ground ice or icy sediment thaws in the scarp, and the resulting water-saturated sediment flows downslope away from the scarp (Aylsworth et al. 2000).

10.2.5.3 Peatland Terrain

A peatland is any wetland terrain with a surficial layer of peat that is greater than 0.4 m in thickness (Mollard and Janes 1984). Along the Highway, organic deposits that comprise peatlands are commonly found in the low-lying areas within undulating glaciolacustrine or till plains, and as a cover over recent alluvial deposits on the floor of drainage paths and river valleys.

Although there are many classes of peatland, bog and fen are the two main classes that are found along the Highway. Each of these peatland types has distinctive vegetation assemblages (bogs consist of *Sphagnum* and dwarf shrubs with a few stunted trees, whereas fens are dominated by grassy species, shrubs and scattered trees), morphologies, water regimes, and thermal conditions. Soils and organic deposits underlying the bog area are typically frozen (and ice-rich), while soils underlying fen deposits are typically unfrozen.

10.2.5.4 Thermokarst

The melting of discrete bodies of massive ground ice and the thawing of ice-rich perennially frozen fine-grained soils produce a conspicuous irregular surface relief comprising isolated depressions and mounds known as thermokarst terrain. The presence of thermokarst indicates subsurface conditions that require additional design and construction care or terrain that is best avoided altogether. Areas of thermokarst terrain were observed in the 2010 field program in the vicinity of the Highway.

10.2.5.5 Thermal Erosion

Thermal erosion is a dynamic process involving the wearing away of frozen ground by thermal means (the melting of ground ice), often augmented by mechanical means (hydraulic transport).

10.3 Vegetation

This section describes the vegetation communities and habitats that are present along the Highway.

10.3.1 General

An ecozone represents a large generalized unit at the top of the ecological hierarchy as defined by the Canada Committee on Ecological Land Classification, and is characterized by distinctive regional ecological factors, including climate, physiography, vegetation, soils, water, fauna and land use (Ecosystem Classification Group 2007).

The Highway is located within the Taiga Plains and Taiga Cordillera Ecozones. North of Tulita, the Highway is within the Taiga Plains Ecozone. South the Tulita, the Highway lies within the Taiga Cordillera Ecozone. Both Ecozones are dominated by Canada's largest river, the Mackenzie, and its tributaries.

The boundary between the Taiga Plains Ecozone and the Taiga Cordillera Ecozone is defined by the eastern extent of mountain ranges. From north to south, the foothills of the British-Richardson Mountains, the Franklin Mountains, and the Nahanni Range mark the eastern edge of the Taiga Cordillera. In the extreme southwest, the Kotanalee Range and the Hyland Highlands define the limits of the Taiga Cordillera Ecozone. The transition from Taiga Plains to Taiga Cordillera is clearly marked by an abrupt change from the forested Mackenzie Delta to treeless foothills west of Aklavik, nearly at sea level. Elsewhere, the 400 m contour line arbitrarily defines the boundary between the Taiga Plains and the Taiga Cordilleran ecozones, reflecting the generally more pronounced topography and greater occurrence of thin soils and exposed bedrock above this elevation (Ecosystem Classification Group 2007).

10.3.1.1 Taiga Plains Ecozone

The Taiga Plains Ecozone occurs mainly within the Northwest Territories and northern Alberta, with small extensions southward into British Columbia and westward into the Yukon. It is characterized by subdued relief with a few significant hill systems; within the Northwest Territories, it covers 480,753 km^2. Much of the Taiga Plains drains to the Arctic Ocean via the Mackenzie River, and its main tributaries, the Liard, Root, Peel, Keele, Carcajou, Mountain, Great Bear, and Arctic Red Rivers. Two of Canada's largest freshwater bodies, Great Slave Lake and Great Bear Lake, occur within the Taiga Plains, along with more than a hundred thousand smaller lakes and ponds averaging less than 10 ha in size. The total area covered by water is over 88,000 km^2, or about 18% of the Taiga Plains within the Northwest Territories. The Mackenzie River Delta occurs mainly within the Taiga Plains, and is the largest delta in Canada (Ecosystem Classification Group 2007).

Peatlands in the Taiga Plains Ecozone are extensive; the Mackenzie Valley is one of the major peatland areas of Canada (Robinson 2002). Tarnocai et al. (2005) indicate that over 218,000 km^2 of peatlands occur across the Taiga Plains, nearly half the total area. Upland areas are predominantly level to undulating variable-textured and often bouldery till plains derived from the last major glaciation. Glacial Lake McConnell, an enormous post-glacial lake, once covered all of the lowlands from the Northwest Territories-Alberta border north to Great Bear Lake; extensive lacustrine deposits, wave-cut bedrock escarpments and beach ridges (wave-washed, typically coarse-textured linear features) well above the current shorelines of Great Slave Lake and Great Bear Lake attest to its former volume (Ecosystem Classification Group 2007).

The Taiga Plains is characterized by long, cold winters and short cool summers that limit tree and plant growth, and contribute to large areas of permafrost. Climate is highly variable throughout the Taiga Plains and the Taiga Plains is divided into four main climatic-physiographic divisions (Level III ecoregions) which

are defined by vegetation and permafrost. The Highway lies within the Central Great Bear Plains Low Subarctic (LS) Ecoregion (Level III) which occupies the middle third of the Taiga Plains. Closed- to open canopied slow-growing coniferous forests with comparatively low species diversity and black spruce (*Picea mariana*) dominated wetlands are the main community types, and jack pine (*Pinus banksiana*) and trembling aspen (*Populus tremuloides*) are uncommon except on well-drained southerly slopes (Ecosystem Classification Group 2007).

Within the Taiga Plains Ecozone, Central Great Bear Plaines Ecoregion (Level III), the Highway lies within two Level IV ecoregions: North Mackenzie Plain Low Subarctic and Normal Range Low Subarctic Ecoregion. These Level IV ecoregions are described in further detail below.

North Mackenzie Plain Low Subarctic Ecoregion

The Highway is located within the North Mackenzie Plain Low Subarctic Ecoregion (Level IV) found within the larger Central Great Bear Plains Low Subarctic Ecoregion (Level III). This ecoregion is characterized as a transitional area between the Level II Taiga Plains and Taiga Cordillera Ecoregions. Major watercourses in this Ecoregion are the Mackenzie, Great Bear, Carcajou, Mountain and Hare Indian Rivers (Ecosystem Classification Group 2007).

Recent fires in this area have had a major influence on the vegetation. Most of the till uplands have been burned and large areas are covered by dwarf birch (*Betula nana*), green alder (*Alnus viridis*) and Alaska paper birch (*Betula neoalaskana*), or regenerating mixed black and white spruce (*Picea glauca*) forests. Regenerating white and black spruce-Alaska paper birch–dwarf birch communities are dominant throughout this Ecoregion with Alaska paper birch being the most common deciduous species. Closed to open mixed spruce-shrub-moss-lichen stands are common in unburned areas. The northern limits of trembling aspen and mixed aspen-white spruce forests and jack pine forests are located at the Tulita gap. Peat plateaus are also scattered throughout the Ecoregion; however, they are found mainly in the north (Ecosystem Classification Group 2007).

Three main landform types exist in this Ecoregion. Fluvial or glacio-fluvial terraces parallel the Mackenzie River and its tributaries, medium to course textured lacustrine plains occupy narrow discontinuous bands along the river and undulating to hummocky till veneers lie in higher terrain. Bedrock is also exposed in some areas (Ecosystem Classification Group 2007).

Norman Range Low Subarctic Ecoregion

The Norman Range Low Subarctic Ecoregion (Level IV) found within the larger Central Great Bear Plains Low Subarctic Ecoregion (Level III) is located near Norman Wells, NT. The Norman Range Low Subarctic Ecoregion is also a transitional area between the Level II Taiga Plains and Taiga Cordillera Ecoregions. It is characterized by well separated ridges, rather than continuous mountain ranges and high elevation terrain. The outer boundaries of this Ecoregion consist of narrow rocky ridges with exposed rock and treeless alpine tundra. The interior is a rolling and ridged plateau that has been eroded and incised from glacial meltwaters (Ecosystem Classification Group 2007).

Vegetation and permafrost patterns indicate apparent west to east climatic variations. Mixed-wood forests including trembling aspen, Alaska paper birch, mixed white and black spruce-shrub white spruce forests

are common. Mixed black and white spruce stands with shrub, moss and lichen understories occur throughout the Ecoregion, but tend to be taller and denser to the west. In recent years, extensive areas have been burned by forest fires, with the most recent fire occurring in 2005 in the northern interior. The fires have resulted in regenerating forest stands, including Alaska paper birch, black and white spruce, and dwarf birch communities. Jack pine stands occur only near the southern limits of the Ecoregion. In the east, runnel patterns and peat plateaus are common, with some localized areas in the west. The dominant vegetation of the fens and marshes are sedge and shrub communities. Tundra vegetation occurs on ridgetops in areas above 500m above sea level (ASL) (Ecosystem Classification Group 2007).

The main ridges of this Ecoregion consist of dolomites and limestone from the Cambrian-Devonian age. The dominant landform are till veneers and blankets over bedrock and rolling to hummocky fine to medium textured tills, with fine to course-textured lacustrine and galcio-fluvial deposits common in the north. Talus slopes exist below the steep ridges and organic deposits occur on valley bottoms and as veneers on slopes (Ecosystem Classification Group 2007).

10.3.1.2 Taiga Cordillera Ecozone

The Cordillera is a complex landscape of rugged peaks and ridges, rolling hills, eroded plateaus and deep valleys. The Cordillera covers 164,351 km^2, which is about 14% of the Northwest Territories land base. The Cordillera is separated in to three different ecosystems, including the Tundra Cordillera, Taiga Cordillera and the Boreal Cordillera Ecozones. The Highway is located within the Taiga Cordillera Ecozone. Approximately half of the Taiga Cordillera lies within the Northwest Territories, half within the Yukon and a minor extension into Alaska. About 61% of the total Cordillera lies within the Northwest Territories, covering a total of 99,505 km^2. A high subarctic climate dominates the northern third of the Taiga Cordillera Ecozone as indicated by continuous permafrost and sparsely treed stunted spruce woodlands and the remaining two thirds to the south is influenced by a milder Low Subarctic climate, resulting in discontinuous permafrost and denser woodlands than in the north. The Taiga Cordillera is also characterized by the presence of boreal tree species. To the east of the Cordillera lies the Taiga Plains Ecozone (Ecosystem Classification Group 2010).

The Cordillera includes both fast-flowing and slow meandering braided rivers and streams in the south and west. Glaciers and icefields are present. Glacial deposits are widely distributed and occur mainly on the floors and lower slopes of valleys and lakes. Wetlands are common only on the floodplains and lower slopes of large rivers and on a few broad plateaus. The Cordillera is typically low-relief with slow-flowing meandering rivers, contains thousands of lakes and ponds, deep layers of glacial till, ancient lakebed materials and glacial stream deposits over bedrock, and huge wetland expanses with thick organic blankets overlying wet mineral soil (Ecosystem Classification Group 2010).

Mountain landscapes in the Cordillera are highly variable because of historic and ongoing mountain building, erosion, and glaciation processes. Bedrock in the Cordillera consists of sedimentary, metamorphic or igneous rock forms. Limestones, dolomites, sandstones, quartzites, siltstones, shales, and slates sometimes occur within layers of the bedrock. The southern portion of the Cordillera has been affected by at least five Continental and Cordilleran glaciations over the past two million years (Duk-Rodkin et al. 2004), but there are parts of the Cordillera in the far north that have not been glaciated for approximately three million years. Geologic variations within the Cordillera along with climate change

from west to east and south to north interact to produce regionally distinctive vegetation patterns. Vegetation patterns reflect latitudinal and elevational changes, and are strongly affected by landform characteristics. In the far northwest corner adjacent to the Mackenzie Delta, alpine and arctic tundra communities prevail even at low elevations and conifers grow only in sheltered areas on well-drained river terraces and lower slopes. In the north part of the main massif, tree line is generally below 1,000 m ASL and stunted conifers grow in open woodlands intermixed with sedge, shrub and lichen tundra (Ecosystem Classification Group 2010).

Tree species typical of the Cordillera include trembling aspen, jack pine, lodgepole pine (*Pinus contorta*) and alpine fir (*Abies lasiocarpa*). Subalpine plants that flourish in Alaska, British Columbia and Alberta under the influence of mild, moist Cordilleran climates occur in the Northwest Territories in the southwestern part of the main massif and along with lush forest, shrub and wetland communities in the valley bottoms. The high mountain ranges in the western parts of the Cordillera remove much of the Pacific moisture and create a rain shadow effect to the east (Ecosystem Classification Group 2010).

Soil development in the Cordillera is mainly restricted to lower valley slopes and valley bottoms. Soil development on exposed bedrock or bouldery colluvial slopes is restricted to small pockets of fine-textured materials between boulders or in crevices (Ecosystem Classification Group 2010).

The Highway lies within one Level IV Ecoregion: The Central Mackenzie Plain Low Subarctic Boreal Ecoregion, as described below.

Central Mackenzie Plain Low Subarctic Boreal Ecoregion

The southern portion of the Highway is located within the Central Mackenzie Plain Low Subarctic Boreal Ecoregion (Level IV) found within the larger Taiga Cordillera Low Subarctic Ecoregion (Level III), south of Tulita, NT. The Mackenzie River is the largest watercourse in the Central Mackenzie Plain Low Subarctic Ecoregion. Wetlands account for 10% to 20% of the entire Ecoregion, comprised mostly of peatlands south of the Keele River and east of the Mackenzie River. Overall, this Ecoregion is comprised of highly diverse vegetation types and landform features (Ecosystem Classification Group 2010).

The Central Mackenzie Plain Low Subarctic Ecoregion is characterized by shales and sandstone that are occasionally exposed in valleys and hillsides. Fine textured lacustrine and till deposits parallel the Mackenzie River, with extensive alluvial and glacio-fluvial deposits within the Keele River floodplain. The remaining portion of the Ecoregion is comprised of undulating and eroded till plains. Continental till deposits are common on slopes and in areas with higher terrain. Continuous permafrost with earth hummocks occur on both lacustrine and till deposits. Peat plateaus with large thermokarst lakes and organic deposits overlying lacustrine and till plains are often observed (Ecosystem Classification Group 2010).

Large fires over the past two decades have influenced the vegetation types found in this ecoregion. Most of the ecoregion has been burned recently, resulting in regeneration of shrubby and deciduous species. The dominant vegetation type in areas characterized by level to gently rolling, unburned lacustrine and till deposits, are black spruce-shrub-moss forests. Spruce-paper birch (Betula papyifera) forests are commonly seen growing on alluvial terraces and in areas that are moist, such as along streams channels.

Peat plateaus are common on lacustrine and till plains and jack pine and aspen occur in the southern portions of the Ecoregion on well-drained soils (Ecosystem Classification Group 2010).

10.3.2 Vegetation Communities

An aerial reconnaissance assessment of the Highway, and alternate routes, was completed between September 6 and September 10, 2010. In general, the area is dominated by level, or rolling, topography characterized by open black spruce and shrub meadows and upland open black spruce, mixed, upland tall, and regenerating forests. Small lakes are common along the Highway. Rocky outcrops occurred at the northern end of the Highway and near Bear Rock, approximately 5 km north of Tulita.

During the September 2010 field program, seven broad vegetation communities were identified along the Highway:

- open black spruce;
- riparian shrub;
- upland mixed forest;
- upland tall spruce;
- regenerating forest;
- graminoid fen; and
- emergent.

These broad vegetation communities are expected to encompass the community types described by the MGP Environmental Impact Statement. Many of the vegetation communities within the North Mackenzie Plain Low Subarctic, Norman Range Low Subarctic and Central Mackenzie Plain Low Subarctic Boreal Ecoregions were described in the MGP using satellite imagery and detailed ground surveys (Imperial Oil 2004).

What follows is a description of each of the eight broad vegetation communities observed along the Highway during the September 2010 field program.

10.3.2.1 Open Black Spruce

Open black spruce communities occur along the Highway. The canopy cover, dominated by black spruce and some tamarack (*Larix laricina*), ranges from approximately 5% to 20%. Understory vegetation includes black spruce, Labrador tea (*Ledum groenlandicum*), willow (*Salix spp.*), dwarf birch, bog bilberry (*Vaccinium uliginosum*), and variable cover of mosses and lichens. The ground cover is dominated either by lichen and/or moss. This broad community type may be similar to the Black Spruce/Ground Birch, Black Spruce-Tamarack, Upland Black Spruce/Lichen, and Black Spruce-Labrador Tea/Mountain Cranberry (*Vaccinium vitis-idaea*) communities described within the MGP Environmental Impact Statement (Imperial Oil 2004).

10.3.2.2 Riparian Shrub

Most of the small drainage channels throughout the length of the Highway include a riparian shrub community along the water's edge (Photograph 10-1). These small drainage channels commonly have low to negligible valleys, but include a shrub dominated community of varying widths. These riparian shrub communities are dominated by willow, scrub birch, alder (*Alnus species*), and sedges (*Carex species*). The Riparian Shrub broad vegetation community type is expected to encompass the Riparian Willow community described in the MGP Environmental Impact Statement.

Photograph 10-1
Riparian shrub often is associated with streams along the Highway.

10.3.2.3 Upland Mixed Forest

A forest mixed with white and black spruce and Alaska Birch occur on middle slopes to crest positions, including some potential granular source sites. This community includes an open canopy of spruce and birch trees. The understory is dominated by Alaska Birch, willow, alder, and Labrador tea, moss, and lichens in the understory. This Upland Mixed Forest broad community type is expected to encompass the Upland Alaska Birch-Spruce and Upland White Spruce-Alaska Birch communities described in the MGP Environmental Impact Statement.

Photograph 10-2
This Upland Mixed Forest community type.

10.3.2.4 Upland Tall Spruce

Tall stands of white and black spruce communities occur on upper slopes and crests of isolated moraine deposits. Some Alaska Birch occurs in this community. Willow, alder, shrubby cinquefoil (*Dasiphora fruticosa*) are present in the understory, as well as a minor component of lichen, moss, and grass. The Upland Tall Spruce broad community type is expected to encompass the White Spruce-Black Spruce/Shrubby Cinquefoil community described in the MGP Environmental Impact Statement.

Photograph 10-3
Upland Tall Spruce communities occur as isolated pockets on moraine deposits. The Upland Spruce can be seen on the right side of this photograph.

10.3.2.5 Regenerating Forests

Forest fires, approximately six to 30 years earlier, have affected large portions of the area in the vicinity of the Highway, particularly near the Hamlet of Tulita to the southern boundary of the Tulita District. Deciduous trees (paper birch species) and shrubs (willow and alder), white and black spruce, fireweed (*Chamerion angustifolium*), and grass are regenerating these areas. Small isolated patches of un-burnt upland mixed, tall spruce forests, and lowland riparian shrub communities remain.

Photograph 10-4
Large sections the area have been affected by forest fires.

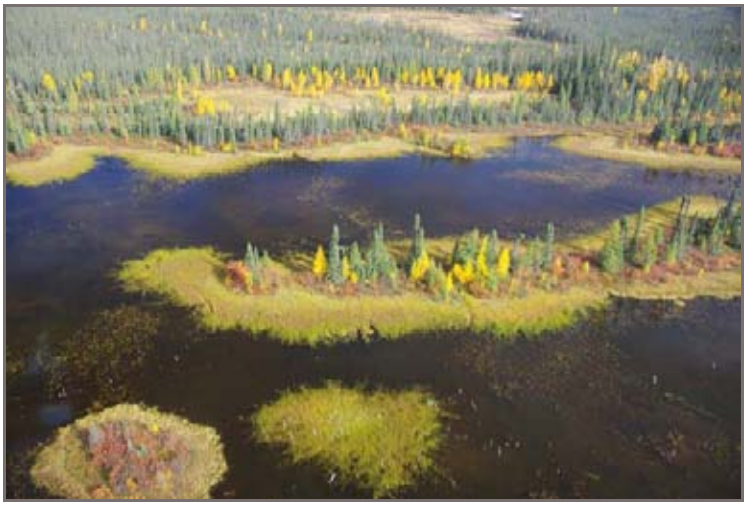
10.3.2.6 Graminoid Fen

Graminoid Fens are frequently associated open in the northern (north of Norman Wells) and southern portions (south of Tulita) of the Highway. This community type is found on depressional or level topography and is dominated by sedges. A minor component of shrubs including dwarf birch, willow, and sweet gale (*Myrica gale*) may be present. This Graminoid Fen broad community type is expected to encompass or be analogous to the Graminoid Wetland community described in the MGP Environmental Impact Statement.

Photograph 10-5
As seen here, Graminoid Fens are also associated with Palsa Bog communities.

10.3.2.7 Emergent

Emergent vegetation communities exist along shallow shorelines of lakes and ponds along the Highway. Emergent vegetation, dominated by sedges, forms a continuous to discontinuous cover of vegetation along lake margins. The Emergent broad community type is expected to encompass or be analogous to the Water Emergent community mapped, but not described in the MGP Environmental Impact Statement.



Photograph 10-6
Emergent vegetation communities are present along shallow lake margins.

10.3.3 Rare Plants

Rare plant surveys were conducted as part of the work completed for the MGP. During these surveys, 19 rare plants species were documented; 2 species in the North Taiga Plains Ecological Zone and 17 in the South Taiga Plains Ecological Zone (Imperial Oil 2004). The following information is summarized from the Imperial Oil 2004 report.

In the North Taiga Plains Ecological Zone, the following rare plants were found:

- prairie gentian (*Gentiana affinis*) was documented in common juniper/common bearberry vegetation community type; and
- moor rush (*Juncus stygius*) was found to be associated with the bog rosemary/cotton-grass-peat moss vegetation community type.

In the South Taiga Plains Ecological Zone, the following rare species were found:

- prairie gentian was observed in the riparian willow vegetation type and riparian willow-red-osier dogwood (*Cornus sericea*) vegetation type;
- leafy pondweed (*Potamogeton foliosus*) was observed in the riparian willow vegetation type;
- indian hemp (*Apocynum cannabinum*) was documented in the riparian willow-red-osier dogwood vegetation type;
- fragrant goldenrod (*Solidago spp.*) was documented in the riparian willow-red-osier dogwood vegetation type;
- poverty oat grass (*Santhonia spicata*) was documented in the riparian willow-red-osier dogwood vegetation type;
- alkali cord grass (S*spartina gracilis*) was documented in the riparian willow-red-osier dogwood vegetation type;
- canada wild rye (*Elymus Canadensis*) was documented in the riparian willow-red-osier dogwood vegetation type;
- mudwort (*Atremisia vulgaris*) was observed in black spruce/cloudberry-lichen bog vegetation type;
- pitcher-plant (*Sarracenia purpurea*) was observed in black spruce/cloudberry-lichen bog vegetation type.

Thirteen rare plant species were found in either graminoid or patterned fens. Dwarf clubrush (*Scirpus rollandii*) was the only species found that is considered nationally rare. The rare species observed are:

- dwarf clubrush;
- indian hemp;
- fragrant goldenrod;
- prairie gentian;
- tuberous water-horehound (*Cicuta maculata*);
- slender naiad (*Najas flexilis*);
- white water lily (*Nymphaea odorata*);
- leafy pondweed;

- floating-leaf pondweed (*Potamogeton* natans);
- moor rush;
- swamp lousewort (*Pedicularis spp.*);
- white beakrush (*Rhynchospora alba*); and
- pitcher-plant.

10.4 Wildlife

10.4.1 General

The distribution and abundance of wildlife species in the vicinity of the Highway will vary with season, life history stage, habitat availability, and hunting and trapping pressures. This section summarizes known and expected wildlife use in the vicinity of the Highway based on available literature and fieldwork conducted in September 2010.

This section has been divided into mammals, birds and amphibians to address the large and diverse group of species along the Highway.

A total of 31 species of mammals, 118 species birds and 2 species of amphibians occur, or have the potential to occur, along the Highway (Cornell 2010; COSEWIC 2010; ENR 2010a; Government of Canada 2010; Banfield 1977; ENR 2005; National Geographic 2006; Wilson and Ruff 1999). These species are listed in Appendix E. Eight species are designated as having special conservation status. For the purposes of this PDR, special conservation status includes those species listed under the *Species at Risk Act* (*SARA*), and/or assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) to be endangered, threatened, or special concern, and/or ranked by the GNWT.

Table 10-13: Wildlife Species of Special Conservation Status

Common Name	Scientific Name	Conservation Status		
		NWT	SARA	COSEWIC
Horned Grebe	*Podiceps auritus*	Secure	No Status	Special Concern
Peregrine Falcon	*Falco peregrinus anatum/tundrius*	Sensitive	No Status	Special Concern
Short-eared Owl	*Asio flammeus*	Sensitive	Special Concern (Schedule 3)	Special Concern
Gray-headed Chickadee	*Poecile cincta*	May Be At Risk	No Status	Not Assessed
Rusty Blackbird	*Euphagus carolinus*	May Be At Risk	Special Concern (Schedule 1)	Special Concern
Grizzly Bear	*Ursus arctos*	Sensitive	Not Assessed	Special Concern
Wolverine	*Gulo gulo*	Sensitive	No Status	Special Concern
Woodland Caribou (Boreal)	*Rangifer tarandus caribou*	Sensitive	Threatened (Schedule 1)	Threatened

[1] Species ranked as Sensitive in the Northwest Territories are not listed (refer to Appendix E).

10.4.2 Mammals

Species that are considered to be important to area residents, have special conservation status, or commonly use habitats in the vicinity of the Highway are described in further detail below. The extensive and detailed wildlife data collected for the MGP is the most current, publicly available information that is specific to the area along the Highway and is referenced in this PDR in multiple sections.

10.4.2.1 Caribou

Two subspecies of caribou occur within the vicinity of the Highway. Woodland caribou (*Rangifer tarandus caribou*) remain in the region throughout the year, whereas barren ground caribou (*Rangifer tarandus groenlandicus*) are known to periodically use the area in the winter (Nagy et al 2005).

Woodland Caribou, Boreal Population

Woodland caribou, boreal population (herein referred to as boreal caribou) are listed by *SARA* as Threatened. By definition, this species will likely become endangered if limiting factors are not reversed. In the Northwest Territories, boreal caribou are ranked by ENR as Sensitive under the general status program. In the Northwest Territories, the boreal caribou population is estimated to be between 6,000 to 7,000 animals (ENR 2010a). The population size specifically within the Sahtu local population/analysis unit, which includes the area within the vicinity of the Highway, is estimated at 2,000 animals. The population is reported to be self-sustaining (Environment Canada 2008). The current range conditions are described as sufficient to support a self-sustaining population given the existing disturbance level (largely fire influenced disturbances) (Environment Canada 2008).

Although boreal caribou may occur year round in the vicinity of the Highway, they were not observed during the 2010 field program, which was conducted in early September.

Boreal caribou may occur in all forested habitats in the vicinity of the Highway; however, they prefer mature or old growth coniferous forests (greater than 100 years old) associated with peatland complexes, lakes, and ponds that have abundant ground and tree lichens and few predators (ENR 2010b; Environment Canada 2008).

Cows widely disperse during the calving season (late May to mid June) and are typically found in groups of one to two animals (Nagy et al. 2003; Environment Canada 2008). During calving season, cows favour treed islands surrounded by open water in peatlands, lakes, and ponds to minimize predation risks, even if these islands provide sub-optimal forage resources (Environment Canada 2008). High fidelity to these calving sites has been reported (Environment Canada 2008). Nagy et al. (2003) reported two collared cows calved in open black spruce and black spruce-paper birch dominated habitat types that consist of 20% to 30% crown closure, 10% to 15% shrub cover (dominated by willows and scrub birch), and moss and lichen groundcover.

In the summer, caribou feed on fresh green growth of flowering plants, sedges, grasses, lichens, and horsetail found in open coniferous forests, low shrub, riparian, sparsely vegetated, and recently burned habitats (Nagy et al. 2003; Nagy et al. 2006). Their winter diet consists of up to 80% ground and tree lichens; however, the remaining diet is supplemented by evergreen shrubs, grasses, sedges, and other vascular plants (ENR 2010b). In winter, boreal caribou tend to favour open coniferous forests with an

abundance of lichen, with only a minor selection of open mixed forests and riparian areas (Nagy et al. 2006).

Boreal caribou can be expected to use all available habitat types found along the Highway at some time during the year. Traditional knowledge indicates boreal caribou use the Mackenzie River (Deh Cho) Special Management Zone (SLUPB 2010).

Barren ground caribou (Bluenose West and Bluenose East herds)

Barren ground caribou (*Rangifer tarandus groenlandicus*) are ranked by ENR as Sensitive under the general status program, but are not listed under *SARA*.

The Highway lies within the range of two barren-ground caribou herds: Bluenose West and Bluenose East Herds. The 2009 population estimate for the Bluenose West herds was 17,897 animals and is considered to be stable (CARMA 2011). The Bluenose East herd was estimated to be 98,600 animals in 2010 and is considered to be increasing (CARMA 2011).

Both herds may occupy areas along the Highway during winter months (November to May). Based on satellite collared caribou data, the northern portion of the Highway is infrequently used by the Bluenose-West herd in the winter and the southern portion is used by the Bluenose East herd (Nagy et al. 2005). Nagy et al. (2005) reported low to moderate frequency of fall/post rut and winter use for both herds.

Both herds are known to calve and spend the summer and fall along the coast on tundra habitats outside the SSA. However, by November, the herds begin migrating south to their winter ranges within the Gwich'in and Sahtu Settlement Areas, and may remain there until spring migration (November to May). Occupied winter ranges are known to vary annually in response to food availability, snow depth, and predator abundance.

Winter is a critical period for caribou populations. Caribou dig craters in the snow and graze on the exposed vegetation, principally ground lichens. Habitats that provide winter foraging habitat include open, mature, spruce forests with an abundance of lichen, and areas with low snow depths. Lichens are an important food for caribou all year, but especially during the winter. Sedges and evergreen leaves are also eaten during the winter (ENR 2010b). During times with low snowfall, caribou will also feed in richer valleys and low lying lakeshores and wetlands. Carruthers et al. (1986) reported over-wintering Bluenose caribou use open coniferous habitats in proportion to the habitat available in the landscape; whereas, all other habitat types, particularly fire regenerating habitats are used less.

Caribou seek security from predators and travel in open habitats such as frozen lakes where wind action has hardened the snow and predators are easily visible (Carruthers et al. 1986). Carruthers et al. (1986) reported Bluenose caribou use lakes and open wetlands four times more often than their availability on the landscape. Cow caribou reportedly favour landscapes with a high density of smaller lakes (Carruthers et al. 1986). Both of these habitat types are abundant along sections of the Highway.

During the September 2010 field program, no caribou or caribou sign (i.e., antler sheds) were observed.

10.4.2.2 Moose

Moose (*Alces alces*) do not have any special conservation status but are considered to be a very important resource in many Northwest Territories Communities. In the Northwest Territories, moose are widely distributed south of the treeline (ENR 2011).

Moose are generally non-migratory and may occupy all habitats within the vicinity of the Highway throughout the year. Moose prefer semi-open early successional habitats with an abundance of browse (e.g., willow and alder) found on floodplains, riparian areas, lakeshores, regenerating burns (approximately 15-30 years following the fire), and disturbance areas. Preferred habitats, particularly during the fall and winter are those dominated by shrubs and deciduous trees; most conifer dominated habitats provide sub-optimal moose feeding habitat. During the spring and summer when forbs, grasses, and aquatic plants are available the use of browse material declines. The use of wet and aquatic habitats for food commonly occur during all non-winter months, but tend to peak during late June to early August when plant nutrition and digestibility and insect harassment are highest (Peek 1998).

Moose also seek forests or tall shrub stands to reduce detection from bears and wolves, their primary predators. Shorelines and islands are also used to reduce predator encounters, particularly during calving (late May to early June) (Van Ballenberghe 1987; ENR 2010b).

MGP habitat suitability modeling results indicated that 71% of the North Taiga Plains Ecological Zone (which includes the upper half of the MGP) and 52% of the South Taiga Plains Ecological Zone (which includes the lower half of the MGP) provides effective moose habitat (Imperial Oil 2004).

Winter moose surveys conducted in the Sahtu have identified high moose densities within the riparian areas along the Mackenzie River and its tributaries. This area is located within Mackenzie River (Deh Cho) Special Management Zone (SLUPB 2010). Winter track surveys conducted by Imperial Oil (2004) noted high moose use in recent burn areas in the Northern Taiga Ecological Zone and in mixed woodland and black spruce- tamarack and shrub habitats in the South Taiga Ecological Zone.

Early winter moose surveys conducted by McLean (1994) in the Kelly Lake area (to the east of the Highway) and the Keele and Redstone River area reported that moose densities in the area ranged from 0.06 moose/km^2 to 0.19 moose/km^2, with an average of 0.08 moose/km^2.

A total of 37 moose were observed along the Highway during the September 2010 field program. These observations are summarized in Table 10-14 and shown on Figure 10-7. In addition to these moose observations, multiple wildlife trails were documented during the field program. The recent burn areas and riparian areas located along the Highway provide very high quality, year round moose habitat.

Table 10-14: Moose Observations, September 5-10, 2010

Total	Bulls	Cow	Cow with One Calf	Cow with Two Calves	Unknown
37	10	4	2	4	7

Photograph 10-7
Bull Moose bedded down in a mixed-spruce forest.

10.4.2.3 Grizzly Bears

Grizzly bears (*Ursus arctos*) (including barren ground and northern interior populations) occur in all habitat types within the vicinity of the Highway. Grizzly Bears are assessed by COSEWIC as Special Concern (as of May 2002), but have no status under *SARA*. In the Northwest Territories, grizzly bears are ranked by ENR as Sensitive under the general status program.

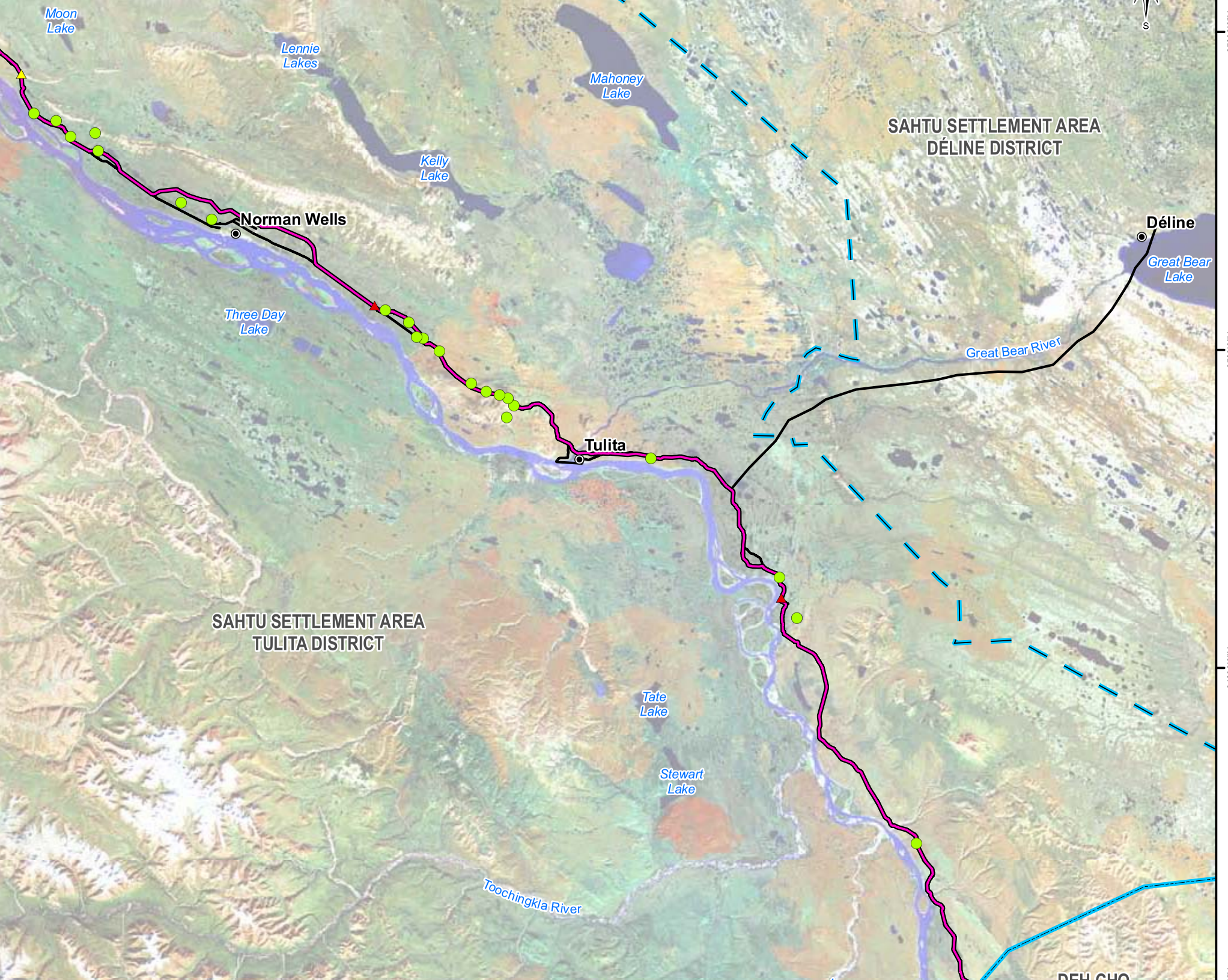
In the Northwest Territories, the estimated grizzly bear population is approximately 5,100 (Gua and Veitch 1999, as cited in Ross 2002). During the review of existing information for this PDR, no information was available indicating that grizzly bear population estimates have been completed in the vicinity of the Highway.

Both grizzly and black bears use similar habitat types and their distributions may overlap. Bears require extensive home ranges with a variety of landforms and plant types to adequately provide food and cover.

Bears are omnivores and feed on a variety of plant material, small and large mammals, birds, fish, and insects. In the spring, bears gravitate towards areas with early-emerging vegetation such as roadsides and wetlands, as well as areas with winter-killed wildlife. Moose and caribou calves are also preyed upon opportunistically during this time. In summer, insect activity peaks and bears feed heavily on colonies of ants, bees, and wasps. By fall time, their diet shifts as berries become ripe and available. Forests regenerating from fires (at least 20 years prior) commonly provide summer and fall feeding habitat for bears as berry producing plants regenerate and ants invade downed and burned trees (Laviviere 2001; Snyder 1991).

Grizzly bears typically begin denning in September with the first frosts and emerge from their dens in April (ENR 2010b). Bears typically dig dens in till material available on mountain slopes, eskers, drumlins, stream banks, or in natural cavities. Appropriate denning habitat occurs in patches along the Highway.

During the September 2010 field program, no grizzly bears were observed along the Highway. Three dens were observed but it is not known if the dens were used by grizzly or black bears. Descriptions are provided below in the black bear section.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10.4.2.4 American Black Bear

Like grizzly bears, american black bears (*Ursus americanus*) are likely to occur in all habitat types along the Highway.

Black bear densities at their northern limits are estimated at 10 bears/100 km^2 (ENR 2010a). The black bear population for the Northwest Territories is estimated to be approximately 10,000 but this is said to be a very conservative estimate (ENR 2010a). There have been no formal attempts to estimate black bear densities in the area.

Both bear species use similar habitat types and their distributions may overlap; however, black bear abundance is expected to diminish with an increase in grizzly bear presence and a decrease in forest cover. Bears require extensive home ranges with a variety of landforms and plant types to adequately provide food and cover.

Black bear diets are similar to grizzly bears. They too are omnivores and feed on a variety of plant material, small and large mammals and birds, fish, and insects (Laviviere 2001; Snyder 1991).

Black bears begin to den in early October and emerge from their dens in April (ENR 2010b, Popko, pers. comm). Bears typically dig dens in till material available on eskers, drumlins, stream banks, or in natural cavities. Appropriate denning habitat for both species occurs in patches along the Highway.

During the September 2010 field program, ten black bears were observed in the vicinity of the Highway (Figure 10-8). In addition, three bear dens were documented during the field program (Figure 10-8). Two dens were located on eskers near km 874 and km 1,021 and the other potential den was located in a cave in a rocky outcrop near km 962. The Highway has been located to avoid these bear dens.

Photograph 10-8
Potential Bear Den Located Near km 1,021.

Photograph 10-9
American Black Bear observed near Bear Rock (km 874).

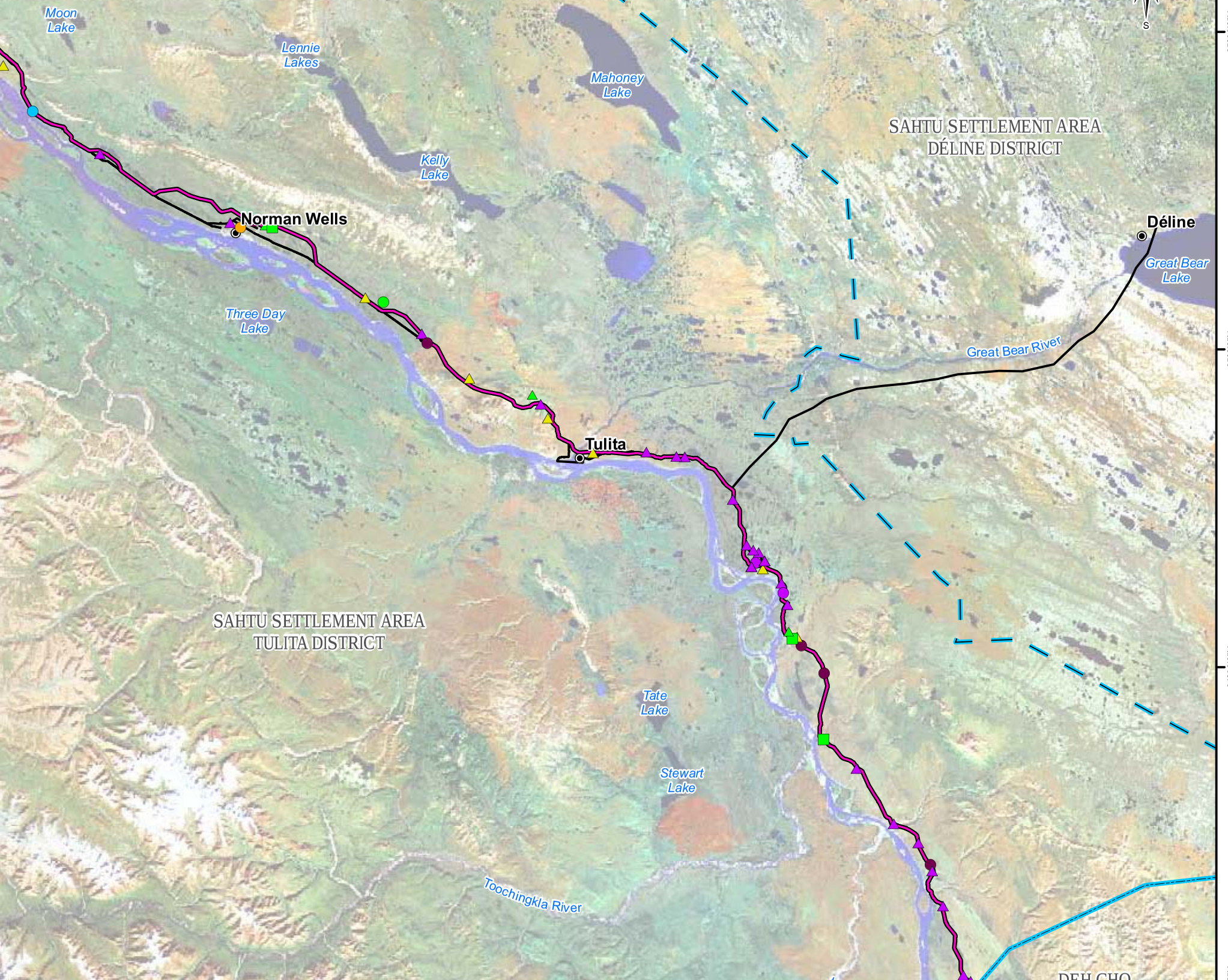
10.4.2.5 Grey Wolf

The grey wolf (*Canis lupus*) is assessed by COSEWIC as "Not at Risk" (April 1999), and is ranked by ENR as "Secure" under the general status program. The density of wolves in the northern Northwest Territories is estimated at 1 wolf/944 km^2 (ENR 2010a). Wolf densities specific to the area in the vicinity of the Highway are unknown; however, they have been shown to be dependent on prey densities. Wolves are expected to occupy all habitat types available in the vicinity of the Highway.

Two different groups of grey wolves can be expected to occur in the vicinity of the Highway: migratory and resident. Migratory wolves (also known as tundra wolves) follow the barren ground caribou herds and would occupy the area in the winter if barren ground caribou are present. Resident wolves, also known as timber or boreal wolves, remain below the tree line year-round and depend on non-migratory prey such as moose and boreal caribou. Timber wolves maintain regular territories, which vary in size depending on prey densities. Tundra wolves do not maintain regular territories and travel extensively following the barren ground caribou herds. Besides moose and caribou, wolf diets also include snowshoe hares, small rodents, beaver, muskrat, birds, fish, eggs, and even small quantities of grass and other vegetable matter (ENR 2010b).

Wolf dens are traditional and may be used for many years; however, some wolves may have several dens in the territory (ENR 2010b). Wolf dens are constructed in esker material, within a rock crevice, or along creeks or riverbanks. Dens are commonly constructed near water or heights of land. The denning period typically begins in early May, and litters are born inside the den in late May or early June (ENR 2010b).

No wolves were observed in the vicinity of the Highway during the September 2010 field program.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10.4.2.6 Red Fox and Arctic Fox

The red fox (*Vulpes vulpes*) and the arctic fox (*Vulpes lagopus*) are not assessed by COSEWIC, but are ranked by ENR as "Secure" under the general status program. Population estimates for both fox species in the Northwest Territories are unknown, but both populations are considered secure (ENR 2010a).

Both fox species occur in the vicinity of the Highway; however, Arctic fox abundance is anticipated to diminish with an increase in red fox densities and an increase in forest cover. Red Foxes, which are larger, may displace Arctic foxes by usurping their dens and other limiting habitat resources (Bailey 1992; ENR 2010b). Both species' numbers fluctuate in response to their food abundance (ENR 2010b). Fox diets include a variety of small mammals and birds including mice, voles, lemmings, muskrats, squirrels, snowshoe hares, grouse/ptarmigan, and waterfowl, eggs, carrion, and plant materials.

Foxes require suitable substrate to establish their dens, and commonly reuse den sites in consecutive years. Fox dens are commonly found on eskers, riverbanks, and other areas with glacio-fluvial materials. Arctic fox pups are born in the den between mid May and mid June; whereas, red fox pups are born between March and May (ENR 2010b). Family groups focus much of their activity around dens until midsummer, and juvenile foxes disperse in the fall or winter.

One red fox was observed along the Highway during the September 2010 field program (Figure 10-8).

10.4.2.7 Wolverine

Wolverines (*Gulo gulo*) are assessed by COSEWIC as "Special Concern" and by ENR as "Sensitive" under the general status program; however, they have not been listed by *SARA*. Population numbers for the Northwest Territories are unknown; however, estimates suggest the population is stable (ENR 2010a). The Sahtu Harvest Study (1999–2001) reported annual harvest rates between five and 12 wolverine per year (Bayha, pers. comm. as cited in COSEWIC 2003).

Wolverines live at low densities even under optimal conditions (Banci 1994). They are opportunistic hunters and travel extensively in search of food. Their diet includes carrion, moose and caribou, small mammals, birds, fish, beaver, berries (Banci 1994; ENR 2010b; Pasitschniak-Arts and Lariviere 1995). Wolverines occupy multiple habitat types provided sufficient food resources are present.

Although active year round, wolverines will construct snow dens to escape predators, cache food, and raise their young. Kits (young) are born in February or March in a shallow pit dug in the ground within a constructed snow den (Banci 1994). In addition, natal dens have been documented in abandoned beaver lodges and bear dens, in upturned roots and fallen logs, or rocks crevices (Banci 1994).

No wolverines were documented during the September 2010 field program.

10.4.2.8 Marten

The American marten (*Martes americana*) is not assessed by COSEWIC, but is ranked by ENR as "Secure" under the general status program. Although population densities are unknown across the Northwest Territories, martens occur at 0.5 animals/km^2 in the southern Northwest Territories with smaller densities further north (ENR 2010a).

The Highway is located at the northernmost limit of the marten's known range (ENR 2010b). Marten prefer mature spruce forests, particularly those with a complex understory structure and 30% to 50% crown closure (Clark et al. 1987), but will also use other forest types including sparse open forests, riparian areas, and forest edges if sufficient prey and cover exist (Clark et al. 1987; ENR 2010b). Large burned areas typically provide little habitat for martens for approximately 15 years, unless a complex of unburned patches and significant deadfall remain as cover (Clark et al. 1987; Winbourne 2004; ENR 2010b).

They are opportunistic foragers, and will feed on voles, mice, snowshoe hare, squirrels, birds, eggs, insects, berries, and carrion (ENR 2010b; Buskirk and Ruggiero 1994).

In March or April, litters are born in dens located in rock piles, tree roots, deadfall, peat banks, usually in mature forests (ENR 2010b). These dens, as well as red squirrel middens may also be used in the winter during inclement weather (Clark et al. 1987).

No martens were documented during the September 2010 field program.

Habitat suitability modeling results within a 40 km buffer along the MGP indicates there is 74% effective marten habitat in the North Taiga Plains ecological zones (Imperial Oil 2004). Winter track surveys conducted in 2002 and 2003 for the MGP indicated marten were common throughout the area, particularly in the black spruce-tamarack/shrub, medium shrub, treed bog, sedge-peat moss, and burn habitat types (Imperial Oil 2004). Densities within these habitat types range from 2.33 marten/km/day to 17.33 marten/km/day (Imperial Oil 2004).

10.4.2.9 Beaver and Muskrat

Beaver (*Ondatra zibethicus*) and muskrat (*Castor canadensis*) are ranked by ENR as Secure, and are not assessed by COSEWIC.

Beavers and muskrats are common throughout the SSA wherever appropriate aquatic habitat is found, such as lakes, ponds, wetlands, and slow-moving watercourses. Beaver and muskrat densities are highly variable and are dependent on habitat quality.

Both Beavers and muskrats cache food under the water for winter use. Beaver's main diet includes twigs, leaves and buds, and soft inner back of willow, alder, and dwarf birch, as well as roots and stems of various aquatic plants (Environment Yukon 2010; Jenkins and Busher 1979). Muskrat diets include roots, stems, and leaves of aquatic plants including pondweeds, water milfoils, and burreed, and horsetails along the shoreline (Environment Yukon 2010).

Aerial surveys for beaver lodges were conducted in 2001 in three areas within the SSA (Popko et al. 2002). Although these survey blocks were not located along the Highway, they are located within close proximity and likely give a good estimate for the area. During the survey, 130 active lodges and 82 inactive lodges were observed. The average density was 48 active lodges per 100 km^2. For comparison, surveys conducted in these same blocks in 1989 and 1997 averaged 58 active lodges per 100 km^2 and 43 active lodges per 100 km^2, respectively.

Incidental beaver sign was recorded in medium shrub, treed bog, water, mixed wood forest, riparian shrub, black spruce-tamarack/shrub, sedge-peat moss, and burn habitat types along the MGP (Imperial Oil 2004).

During the September 2010 field program, 2 beavers, 15 beaver lodges and 21 beaver dams were observed and documented (Figure 10-8). No muskrats or their sign were documented during the field program.

10.4.3 Birds

The Mackenzie River acts as a major flyway for Arctic breeding birds during spring and fall migrations (USGS 2010). Numerous bird species, including waterfowl and waterbirds, raptors, and other upland birds use the Mackenzie River during migrations and disband along the route to appropriate breeding habitat. As with breeding territories, the migration routes between wintering and breeding grounds are traditional and are used each year. Migration is influenced and governed by weather (Terres 1982). Birds advance northward as the weather warms and return south when the weather cools. The speed of migration varies among species and is influenced by the annual prevailing weather patterns.

10.4.3.1 Waterfowl (Swans, Geese, Loons and Ducks)

The term waterfowl is typically used in the context of swans, geese and ducks; however, for this PDR it also includes loons and grebes. Furthermore, the term waterbird includes cranes, shorebirds, gulls, and terns.

A total of 46 species of waterfowl and waterbirds occur or have the potential to occur along the Highway (Appendix E). Many of these species migrate to the area for breeding and summer feeding, and some use the area for staging before continuing on with migration. Within the vicinity of the Highway, waterfowl and waterbirds breed in varying densities, and can be expected to breed wherever their habitat requirements are met. Many species show fidelity to nesting territories.

The diets of waterfowl consist primarily of aquatic vegetation; however, aquatic invertebrates and small fish are also eaten. In general, the majority of waterfowl exploit food resources found in the shallow waters of lakes, ponds, marshes, sedge meadows, and bogs. Shallow bays containing emergent and submerged vegetation are also important feeding areas and provide appropriate cover for their young.

Waterbirds, as a group, use a variety of habitats for nesting and feeding, including shorelines of wetlands, ponds, and lakes, dry uplands, sandy ridges, and disturbed areas, depending upon the species. Their diet ranges widely and may include aquatic and terrestrial invertebrates, seeds, berries, small fish, and frogs. Gulls and Jaegers are opportunistic feeders and will also feed on carrion, small mammals, and eggs.

Photograph 10-10
South of Tulita, this shallow lake provides high quality habitat for waterfowl.

Although no formal waterfowl/waterbird surveys were conducted during the September 2010 field program, waterfowl and waterbird species were observed using more than 22 lakes and wetlands (Table 10-15) (Figure 10-9).

Table 10-15: Summary of Waterfowl and Waterbird Observations, September 6 - 10, 2010

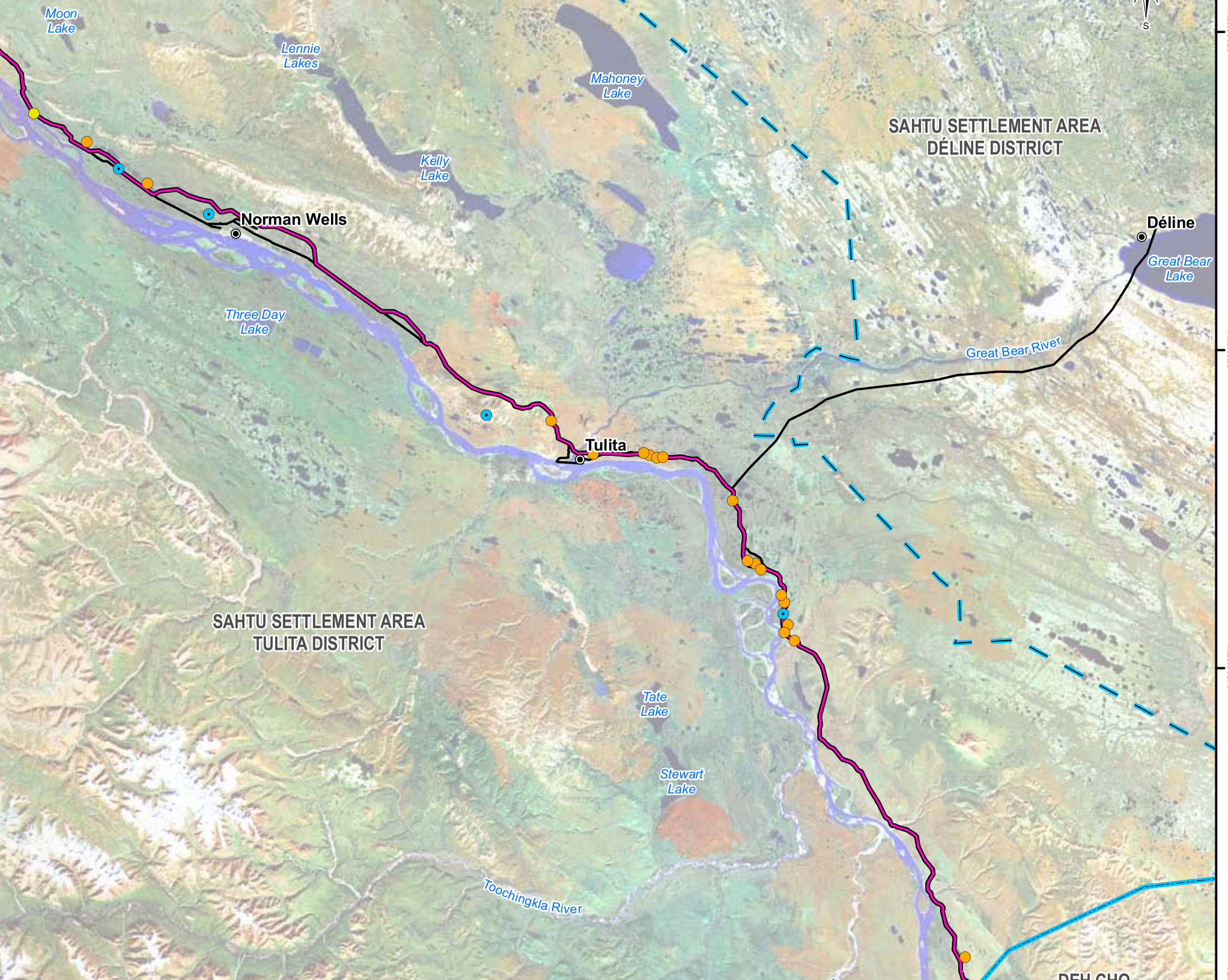
Species	Number Observed	Number of Groups
Ducks	> 258	17
Loons	2	1
Swans	10	4

Horned Grebe

The horned grebe has been assessed by COSEWIC as "Special Concern" (as of April 2009). This conservation status is imparted upon species whose inherent characteristics (e.g., low reproductive rates) make them sensitive to human activities or natural events. To date, the horned grebe is ranked by ENR as "Secure" and is not listed by *SARA*. Population estimates for horned grebes in the Northwest Territories are unknown.

Horned grebes occupy small ponds, wetlands, shallow lakeshores and protected bays, and other natural or man-made permanent or semi-permanent waterbodies (ENR 2010c; Government of Canada 2010). Their diet consists of aquatic insects, fish, frogs, and crustaceans. In the Yellowknife area, horned grebes were found to prefer lakes less than 1 hectare (ha) in size, although breeding also occurred on larger lakes as well (Fournier and Hines 1999). Favourable breeding ponds include areas of open water and emergent vegetation.

Horned grebes are expected to arrive in the area in May and depart by September (ENR 2010c). Adults are known to leave the young well before they've fledged (Fournier and Hines 1999). These adults may remain at larger water bodies immediately prior to fall migration (Fournier and Hines 1999). Although the Highway is located within the range of the horned grebe, none were observed during the September 2010 field program.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10.4.3.2 Raptors

Raptors make up a small but important group of birds frequenting the area in the vicinity of the Highway. Although this group covers a small number of species, it is diverse and includes hawks, eagles and osprey, falcons, and owls.

Sixteen raptor species have the potential to occur in the vicinity of the Highway. The majority of these species are summer residents; however, five species (northern goshawk, gyrfalcon, northern hawk owl, great horned owl, and great grey owl) may over-winter, particularly years when prey densities are high. Little is known about the local population abundance of individual species. However, appropriate nest sites and food are the main resources that naturally limit breeding populations of peregrine falcon (Bromley 1992) and other raptors (Blood and Anweiler 1994).

Raptors breed the area along the Highway where their habitat requirements are met. Some species nest in trees, while others nest on cliffs and on the ground. Raptors exhibit nest site fidelity, returning to the same nest site each year. Summer residents may appear within the area as early as mid-April and depart in October, while others overwinter. Other raptors are spring and/or fall migrants and may pass through en route to and from their breeding ranges on the tundra.

A total of eighteen observations of raptors, representing six different species, were documented during the September 2010 field program (Figure 10-10). The species observed were osprey, northern harrier, sharp-shined hawk, rough-legged hawk, peregrine falcon, and great gray owl. Raptor observations are summarized in Table 10-16 and locations are shown on Figure 10-10.

Table 10-16: Summary of Raptor Observations, September 6 - 10, 2010

Species	Number Observed	Additional Comments
Osprey	2	1 nest
Northern Harrier	3	
Sharp-shinned Hawk	1	
Rough-legged Hawk	2	
Golden Eagle	0	2 nest observed on rock cliffs
Peregrine Falcon	5	7 nests observed on rock cliffs
Great Gray Owl	5	

In additional to the observation of individual raptors, ten raptor nests were observed during the September 2010 field program. The surveys were conducted outside of the breeding season. However, based on the size and location of the nest, and observation of raptors near the nest site, one nest is likely used by an osprey, two are likely used by golden eagle and seven of the nests are likely to belong to peregrine falcon.

Photograph 10-11
Peregrine Falcon Nest located near Bear Mountain

Short-eared Owl

The short-eared owl is listed by *SARA* as "Special Concern" (Schedule 3), and is ranked by ENR as "Sensitive". Under *SARA* Schedule 3, the short-eared owl requires assessment or re-assessment by COSEWIC and is not yet protected under *SARA*.

The short-eared owl arrives in the Northwest Territories to breed by late April or May and depart by late October (ENR 2010c). Short-eared owls occur wherever an abundance of small mammals are present, particularly in bogs, marshes, and other non-forested areas (ENR 2010c). Nests are normally located in dry open sites with enough vegetation to conceal an incubating female.

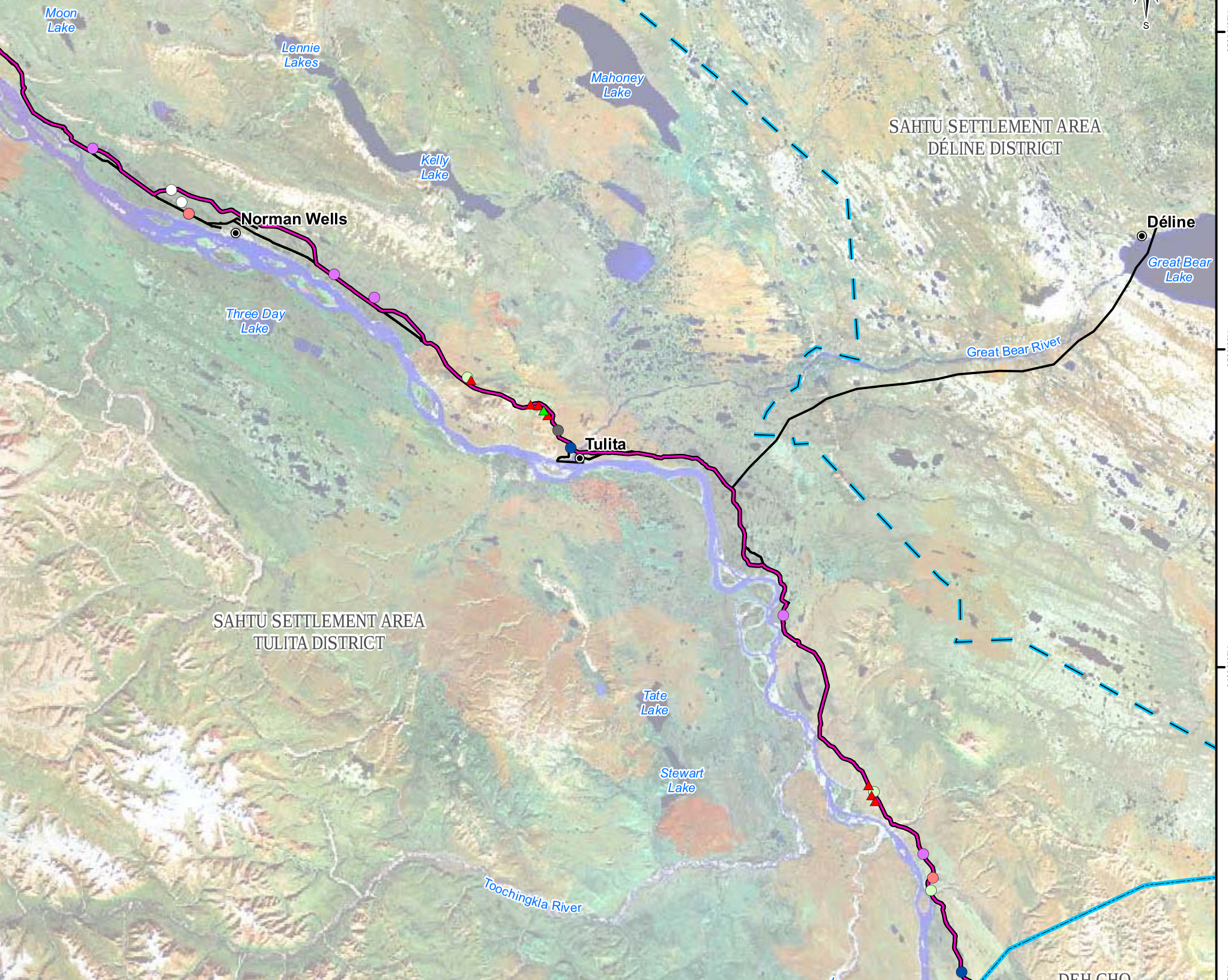
The Northwest Territories population status of these owls is difficult to assess because individuals are nomadic and prone to annual fluctuations in numbers. The Northwest Territories short-eared owl population is unknown, but estimated to be between 1,000 and 10,000 individuals (ENR 2010a).

No Short-eared owls were observed during the September 2010 field program.

Peregrine Falcon

The peregrine falcon (*anatum/tundrius*) has been assessed by COSEWIC as "Special Concern" (April 2007), but has not been listed by *SARA*. Peregrine falcons are ranked by ENR as "Sensitive" under the Northwest Territories general status program.

Peregrines have three main habitat requirements. They need appropriate cliff nesting sites, a nesting range (actively guarded range approximately 1 km from nest), and a home range that can extend up to 27 km from the nest for hunting (not defended) (ENR 2010b). Between May and early June two to four eggs are laid in a scrap usually on cliff ledges near water. Peregrines mainly hunt other birds in the air; so open habitats and waterways are important.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During the September 2010 field program, five peregrine falcons were observed. All of these observations were located within close proximity to cliff nesting habitat. Seven stick nests were also observed and are likely to be used by peregrine falcons for breeding.

10.4.3.3 Upland Birds

For the purposes of this PDR, the term "upland bird" refers to a group of birds that nest in upland habitats and includes perching birds, woodpeckers, kingfishers, and grouse/ptarmigan. Densities of upland birds within the SSA are unknown.

Upland birds occupy all terrestrial habitat types in the vicinity of the Highway. A total of 52 upland bird species occur, or have the potential to occur, in the area as summer or year-round residents (Appendix E). Twelve upland bird species regularly over-winter within the vicinity of the Highway, including: sharp-tailed grouse, spruce grouse, willow and rock ptarmigan, american three-toed woodpecker, gray jay, common raven, boreal and gray-headed chickadee, hoary and common redpoll, and white-winged crossbill (Sibley 2003).

During the September 2010 field program, grouse were repeatedly observed on a daily basis. Although not all grouse observations were documented, more than 60 grouse (not identified to species) observations were recorded. Other upland birds are typically too small and/or concealed to document from the helicopter used in the field program.

Gray-headed Chickadee

In the Northwest Territories, the gray-headed chickadee's (*Poecile cincta*) range is limited to the northwest Mackenzie District. The Highway is located to the south of their range but this species may occasionally use this area. This species is ranked by ENR as "May Be at Risk" as a result of its limited distribution; however, it has not been assessed by COSEWIC. Little is known about gray-headed chickadee ecology and density in the Northwest Territories, but ENR estimates the population is less than 100,000 (ENR 2010b).

The gray-headed chickadee is a year round resident of open canopied coniferous, deciduous, and mixed forests that have an abundance of tall shrubs (Hailman and Haftorn 1995). Typical canopy closures at occupied habitats are less than 20% (Hailman and Haftorn 1995). Appropriate habitat occurs within the vicinity of the Highway, especially at its northernmost portion.

Gray-headed chickadees are obligate cavity nesters, and depend on existing natural and woodpecker cavities for nesting (Hailman and Haftorn 1995). Their preferred diet includes insects and larvae, spiders, and seeds (e.g., spruce, tamarack, birch, alder, and juniper) (Sibley 2003; Hailman and Haftorn 1995).

No gray-headed chickadees were observed during the September 2010 field program. However, this species is likely too small and/or concealed to be observed or documented from the helicopter used in the field program.

Rusty Blackbird

Rusty blackbirds (*Euphagus carolinus)* are listed by *SARA* as "Special Concer" (Schedule 1) and ranked by ENR as "May Be at Risk". By definition this species possesses inherent characteristics (e.g., specific habitat requirements) that make them sensitive to human activities or natural events. Population densities within the Northwest Territories are unknown (ENR 2010b).

Rusty blackbirds occur along the Highway where suitable habitat exists. Rusty blackbirds forage primarily on the ground along the edges of ponds, wetlands, and streams for aquatic and terrestrial insects and plant materials (e.g., seeds and fruits) (Avery 1995). Typical feeding habitat consists of wet coniferous and mixed forests, such as fens, bogs, muskegs, beaver ponds, and swampy shores along lakes and streams (Avery 1995; ENR 2010c). Nest sites are commonly in dense areas of vegetation, close to the water in either dead or alive trees or shrubs (Avery 1995).

Near Yellowknife, rusty blackbirds have been recorded arriving as early as April or May and departing by mid-October (Bird Studies Canada et al. 2010; Bromley and Trauger ND). Arrival and departure dates within the area are unknown.

No rusty blackbirds were observed during the September 2010 field program. This species is likely too small and/or concealed to be observed or documented from the helicopter used in the field program. (Figure 10-11).

10.4.4 Amphibians and Reptiles

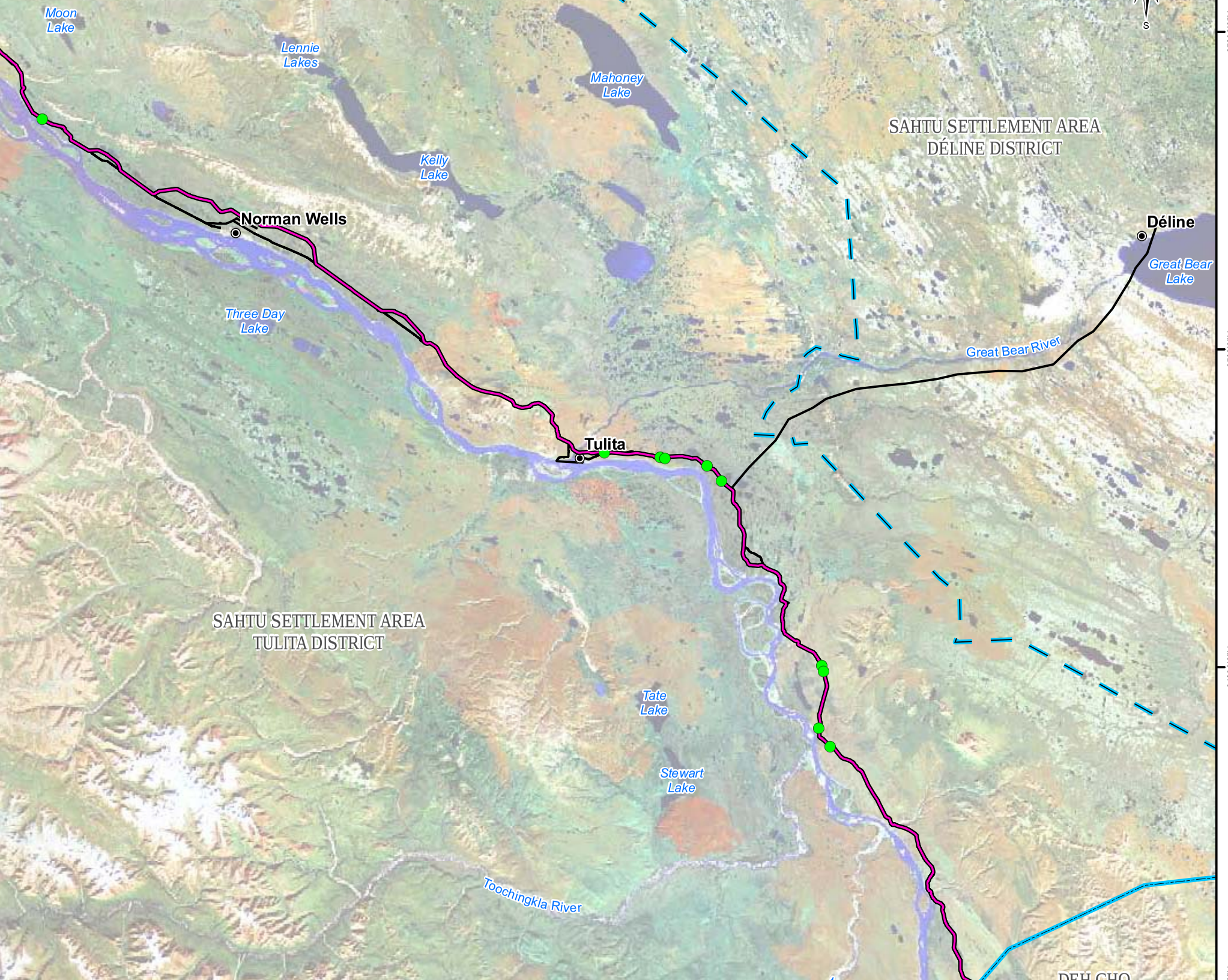
Two amphibians occur in the vicinity of the Highway: the wood frog (*Rana sylvatica*) and the boreal chorus frog (*Pseudacris maculate*). No reptiles occur in the area (Fournier 1997).

10.4.4.1 Boreal Chorus Frog

The boreal chorus frog occurs across most of North America reaching its northern limit to the southwest of Great Bear Lake, NT (Hammerson 2008). The boreal chorus frog has been observed as far north as the mouth of the South Nahanni River (Fournier 1997). According to the International Union for Conservation of Nature (IUCN), boreal chorus frog populations are considered stable. The boreal chorus frog uses wetlands, ponds, marshes and upland areas such as meadows, which are within close proximity to stagnant waterbodies (Hammerson 2008). Overwintering and hibernation occurs in upland areas under logs and leaf litter. Boreal chorus frogs can tolerate a minor amount of freezing during hibernation for survival throughout the winter (Fournier 1997).

Breeding occurs as soon as the snow melts in the spring (Government of Alberta 2010), typically in areas such as marshes, pools, bog ponds, and marshy edges of lakes (Hammerson 2008). Eggs are laid in shallow ponds and marshes, attached to aquatic vegetation. After breeding season, boreal chorus frogs will move to damp grassy and wooded areas (Fournier 1997). When active, boreal chorus frogs feed primarily on invertebrates such as snails and insects (Government of Alberta 2010).

No observations of the boreal chorus frog were made during the September 2010 field program as this species is too small and conspicuous to observe from the air.


Moon Lake
Lennie Lakes
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SAHTU SETTLEMENT AREA
DÉLINE DISTRICT
Kelly Lake
Norman Wells
Déline
Great Bear Lake
Three Day Lake
Great Bear River
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10.4.4.2 Wood Frog

The geographic range of the wood frog extends across most of Canada, including a large portion of the Northwest Territories. The northern limit of the wood frog's range extends in to areas north and northwest of Great Bear Lake, encompassing the area along the Highway. According to the IUCN, wood frog populations are considered stable. Habitat includes a mix of forest types such as woodlands, grass-willow-aspen communities, ponds, streams and marshy areas. Wood frogs are often found hidden under logs, rocks or among other leaf littered areas (Hammerson 2004).

Breeding occurs in the early spring after the snow has melted (Government of Alberta 2009). Females lay their eggs in clumps attached to aquatic vegetation in ponds absent of fish (Hammerson 2004). After breeding, adult wood frogs move into damp woodland areas, staying in close proximity to pond edges throughout the summer months. In the fall, they hibernate under forest floor debris such as leaves and logs where they will spend the winter. Wood frogs are considered cold tolerant amphibians and can withstand temperatures to as low as -6°C (Fournier 1997). During the summer, wood frogs sustain themselves on a diet of worms and insects (Government of Alberta 2009).

Like many other species, this species is too small and conspicuous to be observed from the air.

10.5 Fish and Fish Habitat

10.5.1 General

The Highway will cross numerous ephemeral and permanent streams, and pass near many lakes along its route within the Tulita District. It is therefore important to identify the fish and fish habitat resources that these waterbodies sustain to develop suitable avoidance and mitigation strategies designed to protect fish populations that are ecologically important, and socially and economically valuable to northern residents. This section of the PDR identifies the species that may be encountered or affected by highway construction and operation, and is based on previous studies, as well as preliminary reconnaissance observations of existing habitat characteristics.

Previous fish and fish habitat surveys have been conducted in streams along the Highway, which closely follows the route proposed for the MGP. Results of these surveys were summarized in the Environmental Impact Statement for the MGP (IOL et al. 2004). The MGP is proposed to cross a total of 204 watercourses within the SSA, varying from seasonal ephemeral drainages to large rivers, including the Great Bear River (IOL et al. 2004). In addition, four lakes occur along the MGP. These surveys identified the fish species shown in Table 10-17 as having the potential to use habitats in streams along the MGP within the Tulita District. However, actual species presence is dependent on several habitat and watershed characteristics, often including the availability and accessibility of upstream lakes that provide feeding, rearing, and/or overwintering habitats. There are a number of streams within the Tulita District that could support overwintering habitat due to the presence of year-round flow beneath ice.

Table 10-17: Fish Species with Potential to Exist along the Highway

Sportfish			Baitfish		
Arctic cisco (*Coregonus autumnalis)*	Arctic grayling (*Thymallus arcticus*)	Arctic lamprey (*Lampetra arcticus*)	emerald shiner (*Notropis artherinoides*)	flathead chub (*Platygobio gracilis*)	lake chub (*Cousesius plumbeus*)
broad whitefish (*Coregonus nasus*)	bull trout (*Salvelinus confluentus)*	Burbot or loche (*Lota lota*)	longnose dace (*Rhinichthys cataractae*)	longnose sucker (*Catostomus catostomus*)	nine-spine stickleback (*Pungitius pungitius*)
Goldeye (*Hiodon alosoides*)	inconnu (*Stenodus leucichthys*)	lake trout (*Salvelinus namaycush*)	slimy sculpin (*Cottus cognatus*)	spoonhead sculpin (*Cottus* ricei)	spottail shiner (*Notropis hudsonius*)
least cisco (*Coregonus sardinella*)	longnose sucker (*Catastomus catastomus*)	mountain whitefish (*Prosopium williamsoni*)	trout perch (*Perscopsis omiscomaycus*)		
northern pike (*Esox lucius*)	round whitefish (*Prosopium cylindraceum*)	walleye (*Stizostedion vitreum*)			
white sucker (*Coregonus commersoni*)					

[1]Source: Imperial Oil Limited et al. 2004b.

Table 10-18 provides a generalized summary of habitat preferences and life cycle information for each of the major fish species likely using stream habitats in the vicinity of the Highway. Arctic grayling is the valued species most likely to be affected by Highway construction activities and stream crossing structures. This is because grayling utilize and are dependent upon stream habitats for spawning, juvenile rearing, and adult life stages, and require clean, well oxygenated gravel-cobble substrates to complete their life cycle. As such, their productivity within a system is highly sensitive to perturbations that degrade or alter migration access or habitat quality. The following sections provide brief life history and habitat preference information for each of the valued fish species that will possibly be encountered along the Highway.

10.5.2 Lake Whitefish

Lake whitefish (*Coregonus clupeaformis*; "Humpback"; "Crooked Backs") are primarily a freshwater fish, inhabiting lakes and larger rivers. However, they will enter brackish water (Scott and Crossman 1973). Lake whitefish feed on aquatic insects, molluscs, amphipods and a variety of small fish and fish eggs. They are an important commercial and domestic fish in the north.

Lake whitefish are primarily a lake dwelling fish generally restricted to cool well-oxygenated regions of lakes, usually near the bottom (Nelson and Paetz 1992). They generally move from shallow to deep water during the summer months, and then back into shallow water as the temperature cools. Spawning occurs in early fall, normally in shallow areas of lakes where the substrate is composed of cobble and gravel, and less frequently, sand. Whitefish may on occasion move into tributary streams to spawn. Eggs are broadcast over the substrate and hatch during the following spring. Larval fish tend to stay near steep shorelines, but as juveniles, move into deeper waters during summer.

10.5.3 Cisco

Least cisco (*Coregonus sardinella*; "Big-Eye Herring") inhabit the fresh and brackish waters of the Mackenzie Delta and also occur as inland, landlocked populations (Rescan 1999). They are less migratory than the Arctic cisco and tend to be associated with the plume of their home river. In freshwater, spawning

migrations take place in the fall (late September-early October). Clear streams or lake shores with sand or gravel bottoms are their preferred spawning habitats. They are eaten by lake trout, inconnu, northern pike, and burbot (Scott and Crossman 1973). This species predominantly prefers lake habitats and it would be uncommon in the small streams that comprise most of the watercourses along the Highway.

10.5.4 Round Whitefish

Round whitefish (*Prosopium cylindraceum*) is primarily a freshwater species, although it is known to inhabit brackish estuarial waters, such as in the mouth of the Mackenzie River (Scott and Crossman 1973). Spawning normally occurs during October in northern latitudes, over the gravelly shallows of lakes or river mouths. Eggs hatch in spring. Round whitefish are predominantly found in moderate to deep lakes where they feed on benthic invertebrates. Given their habitat preferences, it is unlikely that these fish will be encountered in the small, shallow streams that make up most of the watercourses crossed by the Highway.

10.5.5 Inconnu

Inconnu (*Stenodus leucichthys*; "Coney") are the largest and fastest growing member of the whitefish family. They are primarily anadromous (fish are that migrate from the sea to spawn in fresh water), migrating long distances up the Mackenzie River and its major tributaries to spawn just prior to freeze up in October. After spawning, inconnu move back downstream to the lower reaches of the Mackenzie River, Tuktoyaktuk Harbour and west along the Beaufort Sea coast to feed and overwinter (DFO 1998). At maturity, these fish are greater than a half-metre in length (Scott and Crossman 1973). Their size and preference for large tributaries for spawning suggests that they are unlikely to spawn in the small streams that predominate along the Highway.

Table 10-18: Life History Information for Common Fish Species in Streams along the Highway

Fish Species	Migratory Behaviour	Spawning Period	Spawning Habitat	Hatching Period	Juvenile Freshwater Habitat Preferences	Adult Freshwater Habitat Preferences	Risk of Potential Effects from Road Construction
lake whitefish *Coregonus clupeaformis*	Resident or anadromous	Late September-early October	▪Lakes and large rivers ▪Hard or stony substrate ▪Water <7.5m	Late spring	▪Larvae along steep shorelines ▪Juveniles move to deep water in summer	Deep water in lakes and large rivers.	Low
least cisco *Coregonus sardinella*	Migrate upstream to spawning grounds in fall	Early October	▪Clear streams ▪Gravel substrates		Lakes, rivers, lowest reaches of tributary streams	▪Lakes and streams ▪estuaries, plume of home river	Moderate
round whitefish *Prosopium cylindraceum*	Limited migrations to lake shallows or upstream to rivers	Late September-October	Gravelly shallows of lakes or river mouths	Spring	Near or beneath rocks	Moderate to deep lakes	Low
inconnu (Coney) *Stenodus leucichthys*	▪Anadromous or lake dwelling. ▪Begin upstream migrations at spring break-up. ▪Return to coastal areas or lakes after spawning.	Late September to early October	▪1-3 m depth ▪Fast current ▪Gravel substrate	6 mos. after spawning	Fry washed downstream to coastal areas or lakes	Coastal areas or lakes	Low
lake trout *Salvelinus namaycush*	▪Limited migrations, usually within resident lake or large, deep river ▪Migrate to nearshore areas for spawning ▪Move into surface waters in winter ▪Move into deeper waters in summer	Early September	▪Littoral areas of lakes ▪Cobble boulder substrates ▪5-40 m water depth	May-June, depending on water temperature	Shallow, inshore waters	▪Large deep lakes (common) ▪Large rivers (less common) ▪Little movement in summer	Low

Table 10-18: Life History Information for Common Fish Species in Streams along the Highway

Fish Species	Migratory Behaviour	Spawning Period	Spawning Habitat	Hatching Period	Juvenile Freshwater Habitat Preferences	Adult Freshwater Habitat Preferences	Risk of Potential Effects from Road Construction
Arctic grayling *Thymallus arcticus*	▪Can be highly migratory at all life stages or non-migratory ▪Usually migrate to winter habitat in early fall	Spring, just as ice breaks up	▪Gravel substrate ▪<20-30% fines ▪Good flow (25-60 cm/s)	Hatch 3 weeks after spawning	Fry: quiet waters near site of hatching	▪Clear small, shallow streams or medium rivers ▪groundwater fed springs ▪overwinter in lakes or lower reaches of rivers ▪segregate in streams by age	High
northern pike *Esox lucius*	▪Limited range ▪Move from deep water winter habitat to spawning habitat in spring	Early spring, occasionally before ice melt	▪Grassy margins of lake shores ▪slow moving streams or sloughs	Spring, ~30 days after spawning	▪Stream or lake margins ▪Slow flowing waters	▪Lakes ▪Main river channels ▪Slack water areas in rivers	Moderate
burbot *Lota lota*	▪ Migrate to lake spawning areas in winter ▪ Migrate to tributaries in late winter/early spring ▪ Migrate to deep water in summer	▪January-March ▪Water temp. 0-4° C	▪Under ice in Lakes or river ▪Sand/gravel substrate ▪shallow (<3 m bays or on gravel shoals	At ice-out	▪Shallow waters ▪Debris cover ▪Rocky riffles ▪Pools or deeper water in lakes	▪Mouths of creeks in fall ▪May be found during winter/spring in coastal embayments (brackish or freshwater ▪Deep water in summer	Moderate
slimy sculpin *Cottus cognatus*	▪ Sedentary benthic species showing limited movement ▪ Migrate to inshore areas for spawning	▪Spring after ice-breakup (May/June) ▪Water temp. 4.5 - 10° C	▪Nests built under rock ledge or submerged tree root ▪cobbles, gravel substrate (<1.5 m)	Four weeks following spawning period	▪Cold, clear lakes, rivers and streams ▪cobble, gravel and rubble substrates ▪Rock cover	▪Cold, clear lakes, rivers and streams ▪gravel and rock substrate ▪boulders and rock cover	Moderate

10.5.6 Lake Trout

Lake trout (*Salvelinus namaycush*) are representatives of the char family that typically live in deep, cold lakes although at northern latitudes will inhabit shallow lakes and rivers throughout their life cycle (Scott and Crossman 1973). They spawn during early fall over clean cobble substrates in water that is generally less than 16 m deep (Marsden and Chotkowski 2001). Due to the preference of this species for lake habitats during all life stages, it is unlikely that spawning or rearing would take place in the relatively shallow streams that would be crossed by the Highway.

10.5.7 Arctic Grayling

Arctic grayling (*Thymallus arcticus*), a cousin of the trout, are game fish of clear, cold streams known for their beautiful colours and flowing, sail-like dorsal fins. They can be highly migratory, or spend much of their lives within a fairly short distance of their preferred section of stream or lake. Generally, grayling spawn in clean, cool streams in spring at about the time of ice break-up, over silt free gravel substrates. They do not create nests (redds), which leaves the eggs vulnerable to high water velocities and streambed disturbances (Beauchamp 1990). During the fall, grayling will migrate to overwintering habitats in lakes or deep sections of slow flowing rivers. Due to their choice of stream habitats for spawning and rearing in summer, the Highway will inevitably cross streams that support these fish.

10.5.8 Northern Pike

Northern pike (*Esox lucius*) are highly carnivorous fish that prefer slow, meandering vegetated rivers or lakes. Spawning takes place in shallow, heavily vegetated areas (Scott and Crossman 1973) soon after ice-out. The eggs adhere to grass, rocks, or other debris. Incubation generally takes about 30 days in the north. Pike fry start life feeding on small crustaceans and insects, but begin eating smaller fish by the time they are only about 5 cm in length. As adults, these voracious feeders principally feed on fish but will also take shore birds, small ducks, muskrats, mice, shrews, and insects. In winter, pike will migrate to large rivers or lakes; smaller lakes are avoided due to the potential for oxygen depletion. Generally, pike migrations between summer and winter habitats are short. In summer, their movements from feeding habitat areas are minimal. Due to the habitats selected by pike, it is expected that the Highway will cross streams used by pike for spawning, rearing, and feeding.

10.5.9 Burbot

Burbot (*Lota lota*) are unique in that they spawn in rivers and lakes under ice during the winter. Spawners tend to select shallow waters over gravel substrates. Eggs filter down into interstitial spaces where they develop for 4-5 weeks. The newly hatched larvae are only about 3 mm to 3.5 mm and are transported downstream into quiet waters where they feed. In streams, young burbot seek out shallow waters that have vegetation and debris. As they grow they move to rocky riffles and then on to pools or beneath undercut banks. Adult burbot prey on smaller fish. The selection of stream habitats by some burbot for both spawning and rearing suggests that they may be encountered in streams crossed by the Highway.

10.5.10 Slimy Sculpin

Slimy sculpin (*Cottus cognatus*) occurs throughout the Northwest Territories in rivers, streams and lakes, but is absent from the mainstem of the Mackenzie River (Birtwell et al. 2005). They inhabit cold, well oxygenated waters of lakes and rivers and exhibit both lacustrine and riverine life history types (Birtwell et al. 2005). Adult habitat consists of clear, cold streams with gravel which is used for nest building and spawning, but otherwise will inhabit deeper water. Following spring ice breakup slimy sculpin will spawn in waters between 4.5°C and 10°C. Fry will remain within the nest for 3 to 4 days following hatching (Birtwell et al. 2005). Slimy sculpin feed predominantly on stream benthos, particularly aquatic insect larvae; however, the species predated depends on availability and habitat (Birtwell et al. 2005 and Scott and Crossman 1973). Because of the widespread distribution and the selection of habitats by slimy sculpin, it is expected that the Highway will cross streams used by slimy sculpin for spawning, rearing and feeding.

10.5.11 Stream Crossing Site Investigations

10.5.11.1 Scope and Methods

The September 2010 field program consisted of an aerial reconnaissance along the Highway and adjacent alternative alignments. The Highway is located within the North and South Taiga Plains Ecological Zones (Imperial Oil Limited et al. 2004b). The route was observed from helicopter specifically to gather morphological information on potential identified watercourse crossings as well as identify additional watercourse crossings.

This purpose of the 2010 field program was to:

- provide input as to the location of the Highway from a fisheries habitat perspective;
- assist with identifying preliminary engineering constraints with respect to road construction through potential fish habitat; and
- characterize and prioritize watercourse crossings for a future field sampling program of fish and fish habitat.

Preliminary investigation of potential aquatic resources was conducted prior to the September 2010 field program and through detailed examination of 1:20,000 scale topographic maps. Lakes, rivers, creeks and their reaches were identified in the vicinity of the Highway as potential sources of fish habitat. Common sportfish and forage fish (baitfish) species present in the area are summarized above in Table 10-17 (Imperial Oil Limited et al. 2004a).

The September 2010 field program was carried out via helicopter at an average speed of 30 km/hr to 60 km/hr and 15 m to 25 m above ground. Potential waterbody crossings were surveyed (visually) from the air. Elements of the British Columbia Fisheries Information Services Branch, Resources Inventory Committee (RISC 2001) standards for detailed fish habitat assessment that could be readily observed from the air were used to document habitat characteristics. In addition, standard habitat assessment procedures (Johnston and Slaney 1996) were applied to the extent possible using only aerial reconnaissance. Documentation of characteristic watercourse attributes included a continuous channel bed, signs of bed scouring from water, and/or possible deposition of minerals (RISC 2001). Presumptions of non-fish bearing status were based on assessment of waterbodies which did not meet the criteria of potential fish habitat (e.g., excessive gradient, insufficient water; obstructions; lack of suitable spawning/rearing/overwintering habitats) while implementing the above mentioned procedures. Substrate composition and morphological characteristics of these waterbodies were quantified to determine differences amongst the sites. The September 2010 field program included assessment of the following habitat variables: approximate channel width, stream discharge stage, approximate crown closure, riparian vegetation type, bed substrate composition, channel morphology (i.e., pattern, islands present, confinement etc.), presence of obstructions or barriers to fish movement, habitat type (i.e., riffle, run, pool, rapid) and spatial location (i.e., proximity to lakes and larger rivers or creeks).

10.5.11.2 Results

Of the water crossings observed along the Highway, 46 were identified to be potential fish habitats (Table 10-19), 247 were determined to be topographic low lying areas with no potential as fish habitat, and 18 currently have existing winter road bridges (Appendix F). All crossing types and locations are identified in the attached map book (Appendix A). In addition, field observation data of each of the stream crossings identified as being potential fish habitat are included in Appendix G.

The 46 potential fish habitat (PFH) water crossings are detailed and summarized in Table 10-19. Preliminary examination of the PFH watercourses determined that seven water crossings were located in primary channels, 17 in secondary channels, and 22 in tertiary channels (defined below). These results may be used in the selection of future baseline sampling locations, based on reconnaissance level characterization of fish habitats at water crossings along the Highway.

km Post	Survey (dd/mm/yyyy)	UTM (NAD83)	Crossing Structure[2]	Comments (observations at time of survey)
1019.8	8/9/2010	9 W 598244 7245877	B	Bosworth Creek Option B: Anecdotal reports of grayling in the creek and lake trout at the confluence with the Mackenzie bridge over Bosworth, beside the refinery. Option A requires a new bridge at km 1019.5 DOT
1031.5	8/9/2010	9 W 587530 7248934	B	Drainage between two lakes, probable migration habitat.
1050.8	8/9/2010	9 W 572193 7258537	B	Unfinished Oscar Creek Bridge. Probable migration, rearing and spawning habitats present. It is possible to use the cur 'river training' would be required. If moved, it could be either at the Option B location, several km upstream, or possibly
1063.3	8/9/2010	9 W 563986 7267203	B	Outflow of large lake into creek; wetted width >10 m.
983	8/9/2010	9 W 626464 7228215	B	Prohibition Creek new crossing option A; Good habitat conditions at proposed crossing site. Option A and Option B bo
891.7	10/9/2010	10 W 406854 7178332	B	Creek drains series of small lakes; beaver dam and debris obstructions downstream may affect fish passage.
937	10/9/2010	10 W 377412 7201254	B	Great Bear River. Width approximately 400-500 m; very good habitat for sportfish and baitfish. Crossing to be built, elimir access.
922	10/9/2010	10 W 392020 7198797	B	Locally named Twelve Mile Creek. Upstream lakes suitable for pike and whitefish. Width variable 1-3 m; some woody del bridge, 20m east of existing winter road, possible oversize culvert
880.6	10/9/2010	10 W 411798 7171042	B	Large drainage channel from lake. Prelim design reroute of road to avoid windy curved winter road alignment. Requires fu design stage.
1023	8/9/2010	9 W 595048 7247716	C	Small undisturbed creek —1 m wide; migration, spawning, and rearing potential if flow is sufficient.
1026.3	8/9/2010	9 W 592072 7248904	C	Small undisturbed creek —1 m wide; migration, spawning, and rearing potential if flow is sufficient.
1027.8	8/9/2010	9 W 590700 7249449	C	Small undisturbed creek —1-2 m wide; migration, spawning, and rearing potential if flow is sufficient.
1029.5	8/9/2010	9 W 589085 7249107	C	Small undisturbed creek —1-2 m wide; migration, spawning, and rearing potential if flow is sufficient.
1030.4	8/9/2010	9 W 588162 7249047	C	Small undisturbed creek — 1 m wide; migration, spawning, and rearing potential if flow is sufficient.
796.4	9/9/2010	10 W 437813 7101870	C	Pool in area of the proposed crossing; baitfish rearing and migration habitat; sportfish migration habitat.
803.4	9/9/2010	10 W 435639 7108217	C	Wide flooded area through disturbed winter road crossing; beaver activity upstream near lake outflow; fish migration are
811.1	9/9/2010	10 W 434299 7115389	C	Creek widens into pool at winter road crossing; banks affected by winter road route; flooded trees present; baitfish rearing migration habitat.
876.6	9/9/2010	10 W 410947 7168766	C	Small, partially confined creek at existing disturbed winter road crossing; wetted width 0.5 m; seasonal fish migration ha
874.5	9/9/2010	10 W 412162 7167518	B or C	Creek is a channel between lakes; channel and riparian vegetation affected by winter road route; wide unconfined wette
884.3	10/9/2010	10 W 411435 7174830	C	Creek drainage from series of lakes; beaver pond formed north of proposed crossing at winter road crossing location-pote during low water; channel and riparian area affected by winter road. Realignment avoids ponded area.
889	10/9/2010	10 W 408491 7178378	B or C	Crossing is at creek near lake outflow; riparian area disturbed by existing winter road; creek narrows at existing crossing
891.2	10/9/2010	10 W 407681 7179921	C	Creek drainage between lakes; crossing at narrow section (1-2 m wide); habitat for sport and bait fish. Riparian area dis
892	10/9/2010	10 W 407102 7180445	C	Creek drainage between lakes; riparian area disturbed by existing winter road; crossing area partly obstructed; width 0.5 fish.
918	10/9/2010	10 W 394969 7198798	B or C	Creek is dispersed at existing disturbed winter road location; migration possible; channel connects lakes.
931	10/9/2010	10 W 382776 7200651	B	Four Mile Creek; new bridge proposed just south of existing bridge; existing bridge crossing riparian area disturbed by v
1034.5	8/9/2010	9 W 584611 7250128	C	Dispersed creek flow in unconfined channel (wetland area); riparian area disturbed by existing winter road; drains small
1035.5	8/9/2010	9 W 583812 7250539	C	Unconfined channel (wetland) through disturbed winter road area; poor habitat.
1036.8	8/9/2010	9 W 582790 7251290	C	Unconfined channel draining small lake; flows through disturbed winter road; poor habitat.
1041.2	8/9/2010	9 W 579722 7254467	C	Unconfined channel flowing from lake; poor habitat; little flow at time of survey.
1041.9	8/9/2010	9 W 579335 7254832	C	Unconfined channel through vegetation; poor habitat; little flow at time of survey; flows from lake 600 m to North
1042.7	8/9/2010	9 W 578715 7255332	C	Unconfined channel through grass vegetation; poor habitat; little flow at time of survey; flows from lake 600 m to North
987.2	8/9/2010	9 W 623577 7230276	C	Proposed crossing at area disturbed by existing winter road crossing; —2-3 m wide; option A (south of crossing at #187 (

km Post	Survey (dd/mm/yyyy)	UTM (NAD83)	Crossing Structure[2]	Comments (observations at time of survey)
980.3	8/9/2010	9 W 629551 7227955	C	Very small, undisturbed shallow creek flows from small lake.
819.2	9/9/2010	10 W 432940 7121733	C	Crossing site is disturbed due to existing winter road; creek is partly confined at crossing area due to bank damage from
821.9	9/9/2010	10 W 431935 7123962	C	Confined channel with good substrate habitat but shallow flow and cobble step pools; channel 2 m wide.
824.5	9/9/2010	10 W 431072 7126467	C	Outflow creek from small lake; dispersed flow through wetland area and through disturbed existing winter road route; ba
836.2	9/9/2010	10 W 424671 7135082	C	Creek dry at time of survey; riparian area disturbed by existing winter road; channel <2 m wide.
855.9	9/9/2010	10 W 415870 7151094	C	Crossing is in an unconfined wetland area with dispersed flow; multiple culverts may be necessary; existing winter road in this area.
871.6	9/9/2010	10 W 412724 7164552	C	Crossing is at unconfined channel (wetland area); winter road crosses at this location causing disturbance of vegetation
874	9/9/2010	10 W 410998 7166150	C	Dispersed creek flow in unconfined channel (~11 m wide); upstream lakes with possible pike habitat.
875.5	9/9/2010	10 W 410938 7167644	C	Dispersed creek flow in unconfined channel (~5 m wide); upstream lake with possible pike habitat.
877.8	9/9/2010	10 W 411245 7169818	C	Unconfined channel through seasonal drainage area affected by existing winter road. Poor habitat conditions.
878.8	9/9/2010	10 W 411627 7170638	C	Confined dry channel at time of survey; approximately 2 m wide; stream drains small lakes; poor habitat conditions.
879.2	9/9/2010	10 W 411952 7170879	C	Confined dry channel at time of survey; approximately 3 m wide; stream drains small lakes and wetlands; poor habitat c
880	9/9/2010	10 W 411981 7171329	C	Confined, very small, nearly dry channel at time of survey; ~20 cm wetted width, 2 m channel width; drains small lakes.
915.6	10/9/2010	10 W 397368 7198303	C	Unconfined channel at crossing due to flow through winter road ruts; wetted area at crossing ~ 3-8 m wide; drains small

t importance, bridge required; 2=secondary fish habitat importance, bridge or culvert requirement based on site specific conditions; 3=Tertiary fish habitat importance (Imperial Oil Limited et al. 2004)

ons based solely on aerial fish/fish habitat observations and are subject to further investigation.

10.5.11.3 Discussion

As noted in the previous section, the following stream assessments are based upon available background information and the September 2010 field program. From the perspective of identifying engineering constraints for highway construction waterways presumed to be potential sources of fish habitat were classified as having primary, secondary or tertiary importance (Imperial Oil Limited et al. 2004a). Examples of these levels of classification are found in Photo 10-12, Photo 10-13, and Photo 10-14.

Photo 10-12
Bosworth Creek along road alignment option B, site 088, rated primary importance to potential fish habitat.

Photo 10-13
Unnamed crossing site 148, was rated secondary importance as potential fish habitat.

Photo 10-14
Unnamed crossing site 129, was rated tertiary importance as potential fish habitat.

Primary channels are permanent waterways with the potential to provide fish habitat all year round. Secondary channels have irregular water flow, may be used in migration and/or provide spawning habitat during the spring, and may either dry or freeze to the bottom during winter. Both primary and secondary channels have discernable bed and banks. Tertiary channels do not have discernable bed and banks due to ingrown vegetation and infrequent water flow. This potential habitat may be used by baitfish during spring migration, while use by sportfish species is unlikely.

The crossing structures suggested are based on importance as PFH and other channel characteristics (i.e., water flow, channel width, topography). The culvert and bridge crossings identified have been used in the preliminary design of the Highway.

The primary PFH waterbodies likely require bridge installations, some of the secondary channels may require small bridges, and appropriately sized culverts will probably be sufficient for the remaining secondary and tertiary crossings.

The waterbodies identified as having no potential fish habitat do not provide suitable fish habitat and will likely require appropriately sized culverts to convey melt water. These watercourses typically consisted of a drainage area without a defined channel, varied in size from l m to greater than 30 m, with dense grasses, willows and other vegetation throughout the drainage. These streams were small, ephemeral drainages that generally convey seasonal flow from terrestrial upland areas or small, shallow lakes or ponds, most of which do not provide suitable fish habitat features. In many cases flow was not observed or water existed intermittently through dense in-stream vegetation. In addition, typical watercourse characteristics favourable for fish habitat were not apparent from the aerial reconnaissance. In addition, these drainages were typically obscured by dense riparian overgrowth.

Results of previous stream surveys along the Highway were summarized in the MGP Environmental Impact Statement (IOL et al. 2004). Sampled fish included Arctic grayling, slimy sculpin, northern pike, longnose

sucker, round whitefish, emerald shiner, white sucker, flathead chub and lake chub. According to IOL et al. (2004) the predominant fish habitats observed within the streams assessed along the Highway would provide spawning and incubating, rearing, and adult feeding and holding habitat for these species.

Actual species presence would be dependent on several habitat and watershed characteristics. With exception of the watercourses determined as having primary fish habitat importance, it is unlikely that many would provide overwintering habitat due to complete freezing. Similarly, many of the small, shallow headwater lakes within the watersheds crossed by the Highway would freeze either to the bottom or to a sufficient depth to preclude the possibility of overwintering, partly due to a diminishment of oxygen to lethal levels (Cott et al. 2008b).

Further site investigations will be required to provide a more complete inventory of habitat conditions, as well as fish presence and relative abundance in streams that will be crossed along the Highway.

10.6 Hydrology

The hydrology in the vicinity of the Highway is defined by climatic factors (long cold winters, short mild summers and low precipitation with between 40% and 45% falling as snow (Section 10.1.2), and the properties of the underlying permafrost. Surface runoff patterns are defined by the annual freeze-thaw cycle, in which only four months of the year have a mean temperature above zero (May to September). Freshet is the dominant flow event, which typically begins in May and is relatively brief. Peak water levels in creeks often develop because of high flows and to backwatering effects from ice jams in the Mackenzie River (IOL et. al. 2004). During the summer, intense precipitation events can also produce floods, particularly in smaller creeks (IOL et. al. 2004). Freeze up typically begins to occur in late September or October with a noticeable drop in discharge as water is stored as ice (IOL et. al. 2004).

10.6.1 Watersheds

The east side of the Mackenzie Valley in the Tulita District is characterized by gently sloping plains of low relief which originate in northern sections from the low peaks of the Franklin Mountains and in southern sections from the Taiga Plains. Numerous small shallow lakes cover the terrain. Runoff drains into the Mackenzie River through permanent and ephemeral channels with small drainage basins. Continuous, extensive discontinuous and intermediate discontinuous permafrost underlies the majority of the area, above which is an active layer that varies in depth (Kiggiak-EBA 2010). Permafrost can act as a barrier to water infiltration, leaving more water available on the surface for evaporation, plant uptake or surface runoff to streams (Kokelj 2001). This can result in extensive slope runoff and rapid rises in stream water levels during rainfall events.

Ice decay in lakes begins once snow is melted from the ground surface. Increases in lake water storage lag behind snowmelt due to meltwater retention within the snow cover and in small depressions characterizing the land surface (Kiggiak-EBA 2010). During the melt, snow dams generally cause water levels in lakes to rise above outlet elevations. Breaching of these dams causes rapid increases in downstream discharge. The freshet recharges tundra ponds, creating surface flow connections which typically persist for a period of two weeks (Kiggiak-EBA 2010).

The spring freshet results in a sudden peak in the hydrograph. The shallow active layer is not able to retain much water, causing the water table to rise rapidly, delivering runoff to the lower slopes and stream channels. Over the spring and summer, the active layer increases in depth due to heating from the surface, causing the water table to drop and resulting in a decline in surface flows. Summer rainfall causes short-period rises in water levels above base flows, the magnitude of which is a function of the ability of the ground to receive and attenuate flow.

10.6.2 Streams and Rivers

The Highway has several watercourse crossings, many of which are defined as ephemeral. The ephemeral streams are characterized as drainages without a defined channel, varying in widths between 1 m and 30 m with water existing intermittently through dense in-stream vegetation. Various crossings have been identified as requiring construction of a bridge or utilizing existing winter road crossing infrastructure. Descriptions of these rivers and streams are limited to historical discharge data recorded at relevant WSC stations, field observations and descriptions of the topography from orthophotos and topographic maps.

The existing and new bridge crossings are described in order from the northwest and are referenced with the approximate kilometre marking and appropriate page in the Map Book in Appendix A.

Elliot Creek at km 1064.4 is a meandering creek which drains a portion of the terrain to the east of the Mackenzie River, south of Moon Lake. The creek runs 6 km along the base of a ridge and would likely be highly responsive to rainfall events. The bridge crossing located approximately 2.5 km upstream from the confluence with the Mackenzie River in a section with very low slope (approximately 1:250). Water levels would likely be influenced by ice jams or high water levels in the Mackenzie River and would result in backwatering. Quantitative discharge data is not available for Elliot Creek.

Oscar Creek at km 1050.8 - is a meandering creek which originates 30 km upstream as the outlet from local lake (el. 202 m). The bridge crossing is located approximately 1 km from the confluence with the Mackenzie River. Water levels at the crossing would likely be influenced the Mackenzie River, particularly during spring break-up, as a result of ice jams and high freshet flows.

Discharge and water levels on Oscar Creek are currently monitored by WSC station Oscar Creek Near Norman Wells (Station ID 10KA008) located approximately 8 km upstream of the crossing at 65°26'44" N, 127°22'7" W (Figure 10-12). The total drainage area upstream of the hydrometric station is 638 km^2. Data are available for the period May 15, 2009 to December 31, 2010.

The 2009 and 2010 hydrographs for Oscar Creek are shown on Figure 10-12. Peak freshet discharge occurred prior to the start of the data record in 2009 and therefore was not recorded. Peak discharge recorded during the 2010 freshet was 18.5 m^3/s, although water levels were affected by backwatering and discharges calculated as a function of water level are to be used with discretion. Oscar Creek exhibits a strong response to summer rainfall events. A series of late-June and early-July 2009 rainfall events raised creek discharge from 4 m^3/s following the freshet to 21 m^3/s. A short-period increase of 8 m^3/s (over a baseline flow of 2 m^3/s) was recorded in late July 2010 as a result of 45 mm of rainfall recorded over three days at Norman Wells. Thirty-two mm of rainfall over a 24-hour period in late June 2009 produced a rise in discharge of nearly 5 m^3/s.

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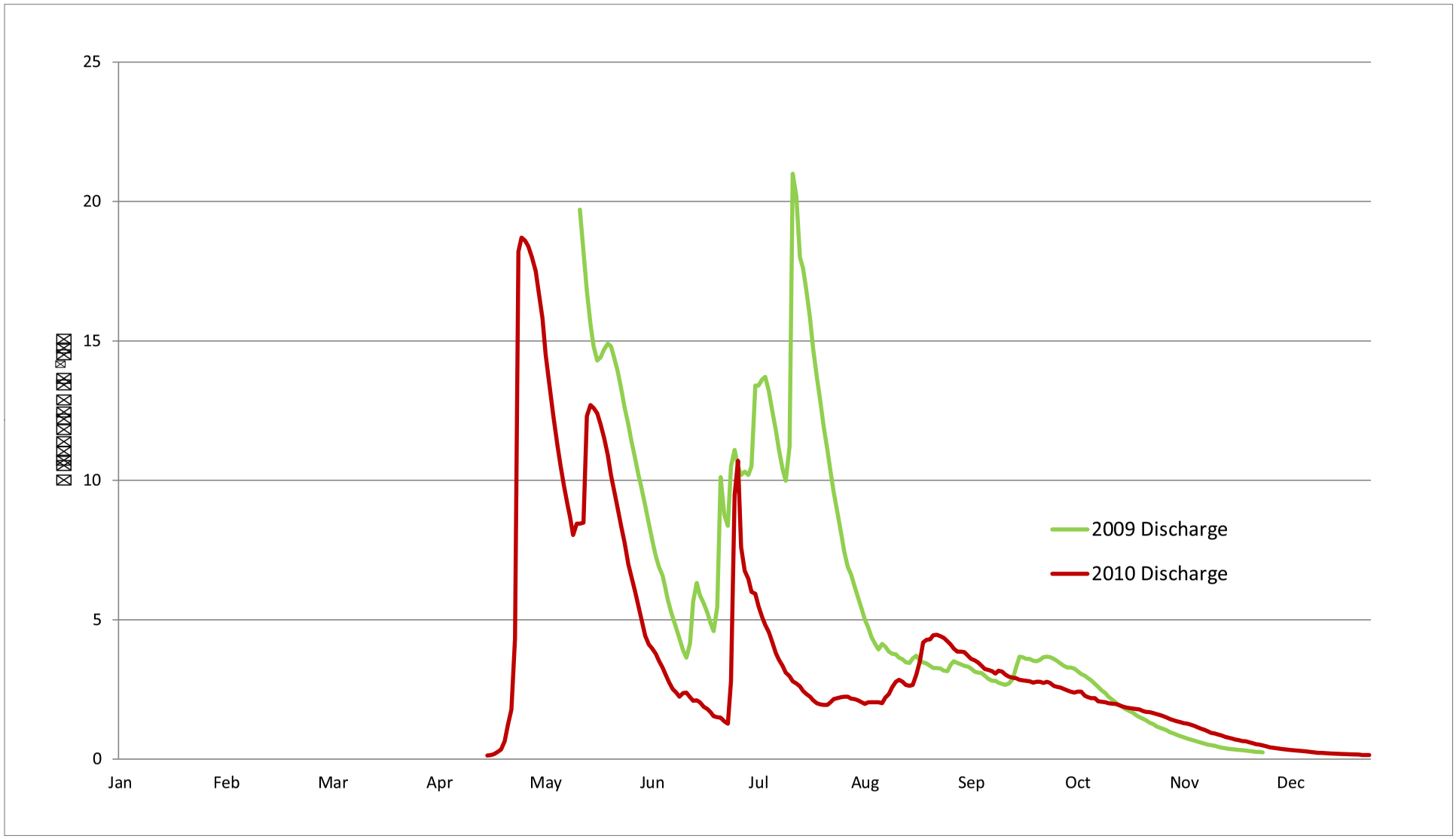

NOTES
Source : Water Survey of Canada - Oscar Creek Near Norman Wells (10KA008)
Drainage Area: 638 km2
** 2009 OPEN WATER RECORD CONSIDERED GOOD. BACKWATER RECORD VERY POOR DUE TO FLOODING.
** 2010 OPEN WATER RECORD CONSIDERED GOOD. FLOW UNDER BACKWATER SHOULD BE USED WITH DISCRETION.
Ice conditions observed during 2010 freshet

MACKENZIE VALLEY HIGHWAY
TULITA DISTRICT

Location Discharge Hydrograph Oscar Creek (2009 and 2010)

FILE NO.
Y22101155_Figure10-12-OscarCreekHydrograph.mxd

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Figure 10-12

Flow conditions at the upstream WSC station are likely indicative of conditions further downstream at the crossing, however backwatering effects would be more pronounced due to its closer proximity to the Mackenzie River.

Billy Creek at km 1031.8 is a 250 m long connection between two lakes (el. 58, 57 m) which are at the lowest elevation in a chain of lakes lying within a pocket of low terrain running parallel (NW-SE) to the Mackenzie River. The creek is approximately 20 m wide and has little relief on either bank. Outlet flows from the lake system are contained in a meandering creek which runs 4 km to the Mackenzie River. Billy Creek is not gauged and no quantitative flow data is available; however, the storage capacity of the lakes would likely have a strong control over the flow regime.

Bosworth Creek at km 1019.8 at the crossing has a vegetated floodplain approximately 80 m to 100 m wide with an active channel width of approximately 10 m to 20 m. Bosworth Creek originates in the Franklin Mountains to the northeast and flows 5 km downstream from the crossing, through the town of Norman Wells before discharging into the Mackenzie River.

Bosworth Creek is gauged less than 1 km upstream of the crossing at WSC station Bosworth Creek Near Norman Wells (Station ID 10KA007) located at 65°19'25" N, 126°52'38" W (Figure 10-13). The station has recorded flows from a drainage area of 125 km^2 over an 18-year period of record (1980 – 1996 & 2005 – 2010). The hydrograph showing mean (red), maximum (green) and minimum (blue) discharge is shown on Figure 10-13. Freshet typically begins in mid-April, reaching its peak at the beginning of May and subsiding by the beginning of June. Mean freshet discharge is in the range of 3 m^3/s to 3.5 m^3/s. Short-period spikes during freshet may be indicative of backwatering due to ice jamming rather than flow volume, although backwatering at the crossing would likely be less frequent than that experienced closer to the confluence with the Mackenzie River. Late-summer baseline flows are typically less than 1 m^3/s.

Canyon Creek at km 997.5 is a meandering stream which originates 7 km to the east in the Franklin Mountains and contains inputs from Bandy Lake. Upstream of the crossing, the creek is much wider, deeply incised and runs straighter due to the stronger slope gradient. There is a confluence with a significant tributary just upstream of the crossing. Canyon Creek is not gauged and no quantitative flow data is available; however, it is likely that freshet flows are significant and run longer due to snow melt from the higher elevations to the east.

Francis Creek at Km 993.5 is similar in morphology to Canyon Creek. Francis Creek is not gauged and no quantitative data is available. The flow regime would likely be similar to that observed at Canyon Creek; however, discharges would likely be of slightly lower magnitude as it drains a smaller area.

Hellava Creek at km 991.3 similar to conditions described for Francis Creek.

Christina Creek at km 990.3 similar to conditions described for Francis Creek.

Prohibition Creek at km 984.3 is an incised meandering creek which carries runoff from the Franklin Mountains. The creek is not gauged and no quantitative flow data is available; however, the creek has a similar drainage area as Canyon Creek and would likely show similar flow characteristics.

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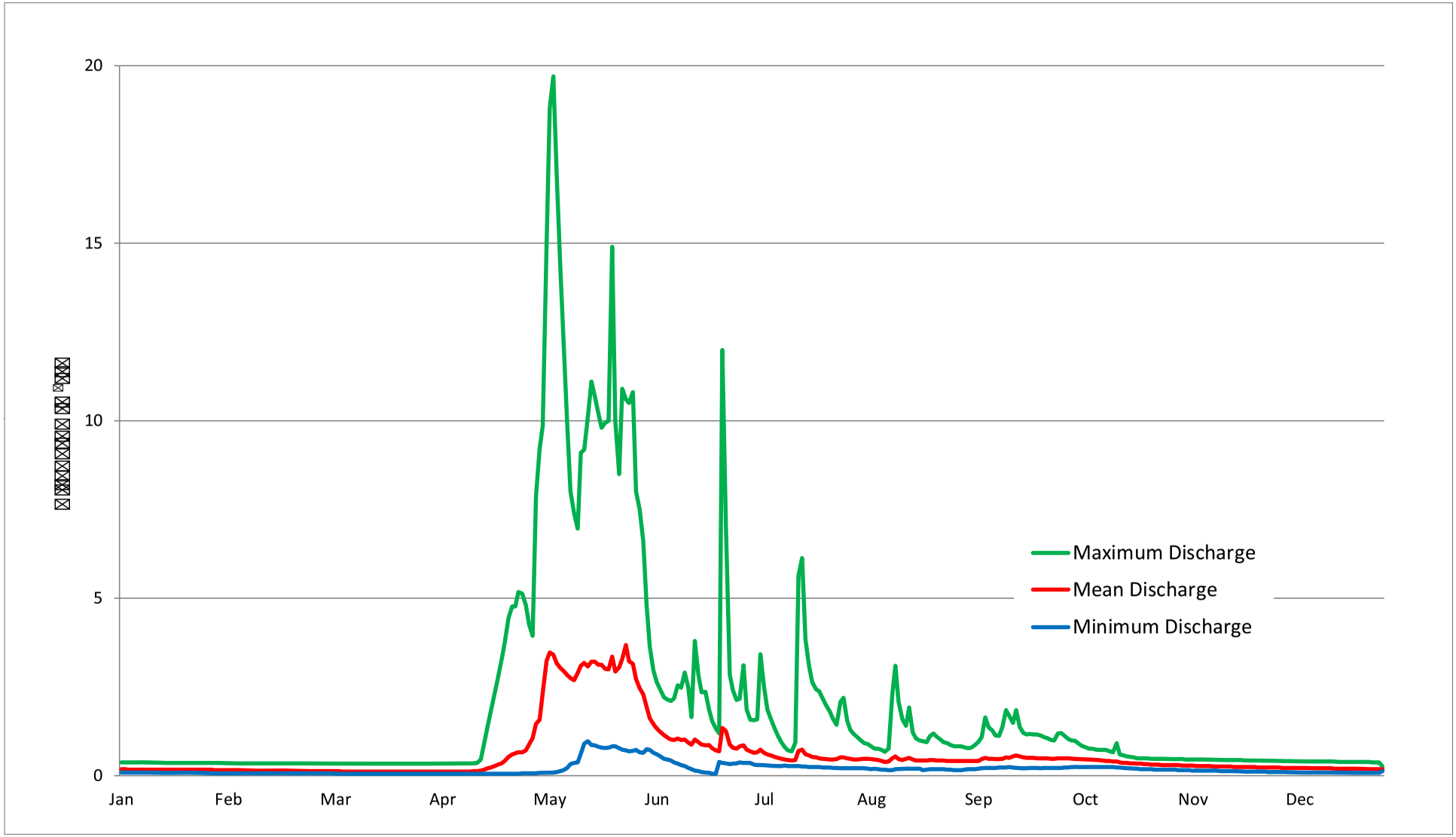

NOTES
Source : Water Survey of Canada - Bosworth Creek Near Norman Wells (10KA007)
Gross Drainage Area: 125 km2
STAGE-DISCHARGE RELATIONSHIP IS NOT WELL-DEFINED AND DATA SHOULD BE USED WITH DISCRETION.
Ice conditions typically observed during freshet

MACKENZIE VALLEY HIGHWAY
TULITA DISTRICT

Annual Hydrograph
Bosworth Creek
(1980 - 2010)

FILE NO.
Y22101155_Figure10-13-BosworthCreekHydrograph.mxd

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Figure 10-13

Vermillion Creek at km 973.4 at the crossing is a braided stream channel with approximately 15 m of relief on either bank, approximately 5 km upstream from its confluence with the Mackenzie River. Vermillion Creek originates 15 km upstream in the higher terrain to the northeast and captures runoff from the southern slopes of the Franklin Mountains. Vermillion Creek is not gauged and no quantitative flow data is available. Vermillion Creek likely has a strong freshet and would be responsive to precipitation events due to a large drainage area in higher terrain to the east.

Notta Creek at km 971.4 is a small meandering creek which originates as an outlet of a small lake in a depression of higher terrain to the east which captures a portion of the runoff. Notta Creek discharges into Vermillion Creek south of the bridge crossing. No quantitative flow data is available; however, discharge would likely be significantly smaller (likely 20% based on aerial observation) than that observed in Vermillion Creek.

Jungle Ridge Creek at km 967.7 is a small incised creek which originates near Jungle Ridge, 12 km to the east, and discharges into the Mackenzie River approximately 5 km downstream from the crossing. Jungle Ridge Creek is gauged at WSC station Jungle Ridge Creek Near The Mouth (Station ID 10KA006) located near the crossing at 65°3'51" N, 126°4'4" W. The station has a continuous record of 10 years (1992 – 1996 and 2006 – 2010) with seasonal observations between 1980 and 1991. The drainage area upstream of the station is 60 km^2.

The mean hydrograph for Jungle Ridge Creek is shown on Figure 10-14. Average peak freshet discharge is 4 m^3/s, typically peaking in mid-May. The maximum freshet discharge recorded was 12.3 m^3/s, but may be overestimated due to backwatering from partial ice conditions. Late summer baseline flows are typically in the range of 0.2 to 0.5 m^3/s. The response to rainfall is significant. 52 mm of rainfall (recorded at Norman Wells) over 72 hours in mid-June 1989 resulted in a rise from baseline flows (0.5 m^3/s) to 11 m^3/s over the same period.

Great Bear River at km 937.1 at the bridge crossing is approximately 400 m wide. Great Bear River originates at Great Bear Lake, 100 km to the east. Great Bear River is gauged at WSC station Great Bear River At Outlet Of Great Bear Lake (Station ID 10JC003) located at 65°7'42" N, 123°33'3" W. The station captures flow from a drainage area of 146,400 km^2. Although the crossing is located 100 km downstream of the lake outlet, it is reasonable to use the data to describe conditions near the crossing considering runoff inputs over the 100 km will consist of a small percentage of the total input from Great Bear Lake.

The mean annual hydrograph for Great Bear River is shown on Figure 10-15. The river does not have a freshet regime as the substantial storage capacity of Great Bear Lake controls the regime where a steady supply of water is supplied year-round and there is little year-to year variation to the pattern. Peak flow occurs in mid-August and is typically 600 m^3/s. Winter and spring discharge is typically 500 m^3/s.

Four Mile Creek at km 931.5 is a small creek, which originates as an outlet from a pocket of small unnamed lakes (el. 152 m), approximately 3 km upstream from the crossing. The drainage basin is relatively small, flat and pocked with many small lakes which would control runoff into the creek. The creek at the crossing is 1 km upstream of the confluence with the Mackenzie River and would likely experience some backwatering due to ice jams or high flows. The creek is not gauged and no quantitative flow data is available.

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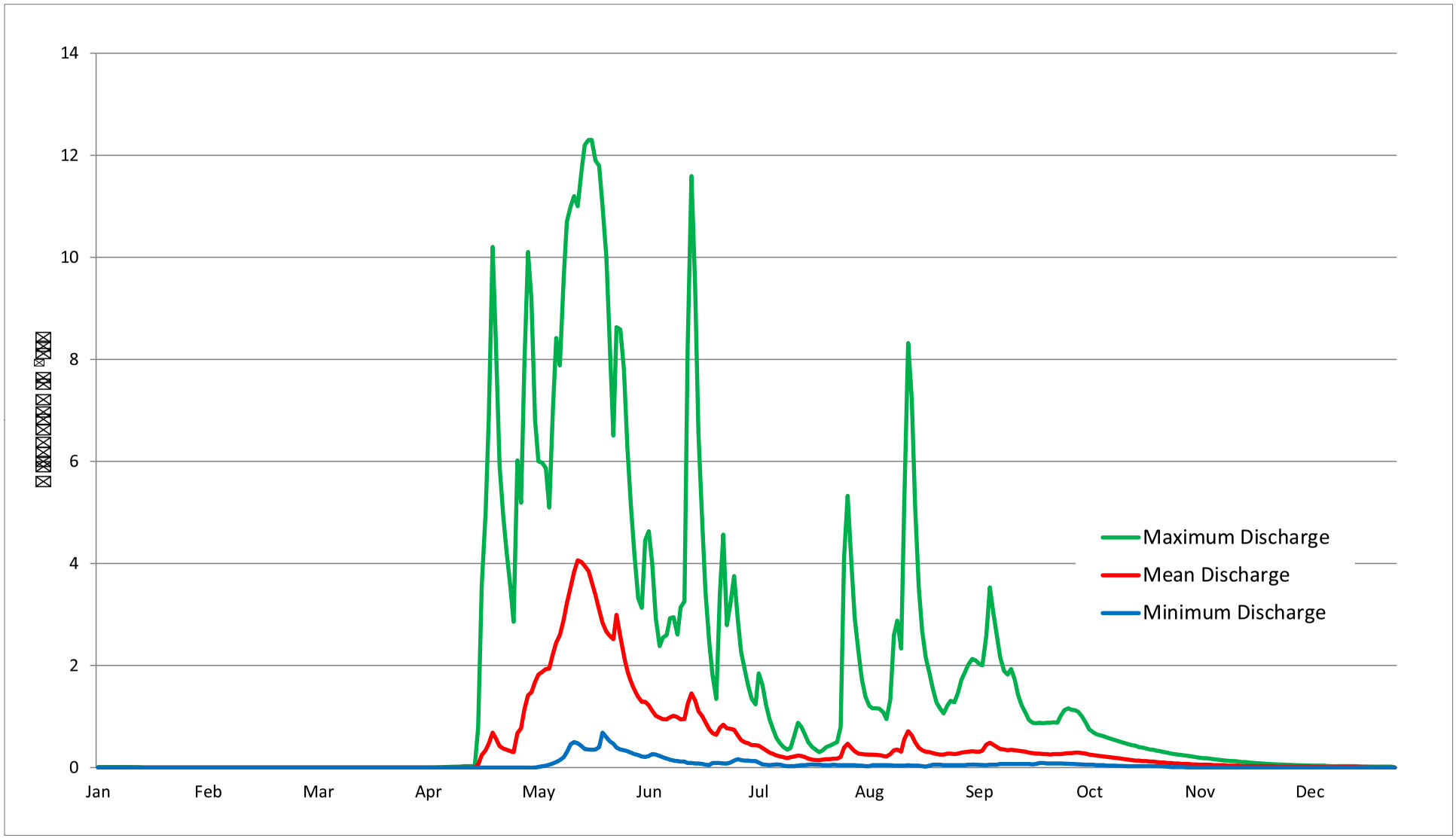

NOTES
Source : Water Survey of Canada - Jungle Ridge Creek Near The Mouth (10KA006)
Gross Drainage Area: 60 km2
Ice conditions typically observed during freshet

MACKENZIE VALLEY HIGHWAY
TULITA DISTRICT

Annual Hydrograph
Jungle Ridge Creek
(1980-2010)

FILE NO.
Y22101155_Figure10-14-JungleCreekHydrograph.mxd

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Figure 10-14

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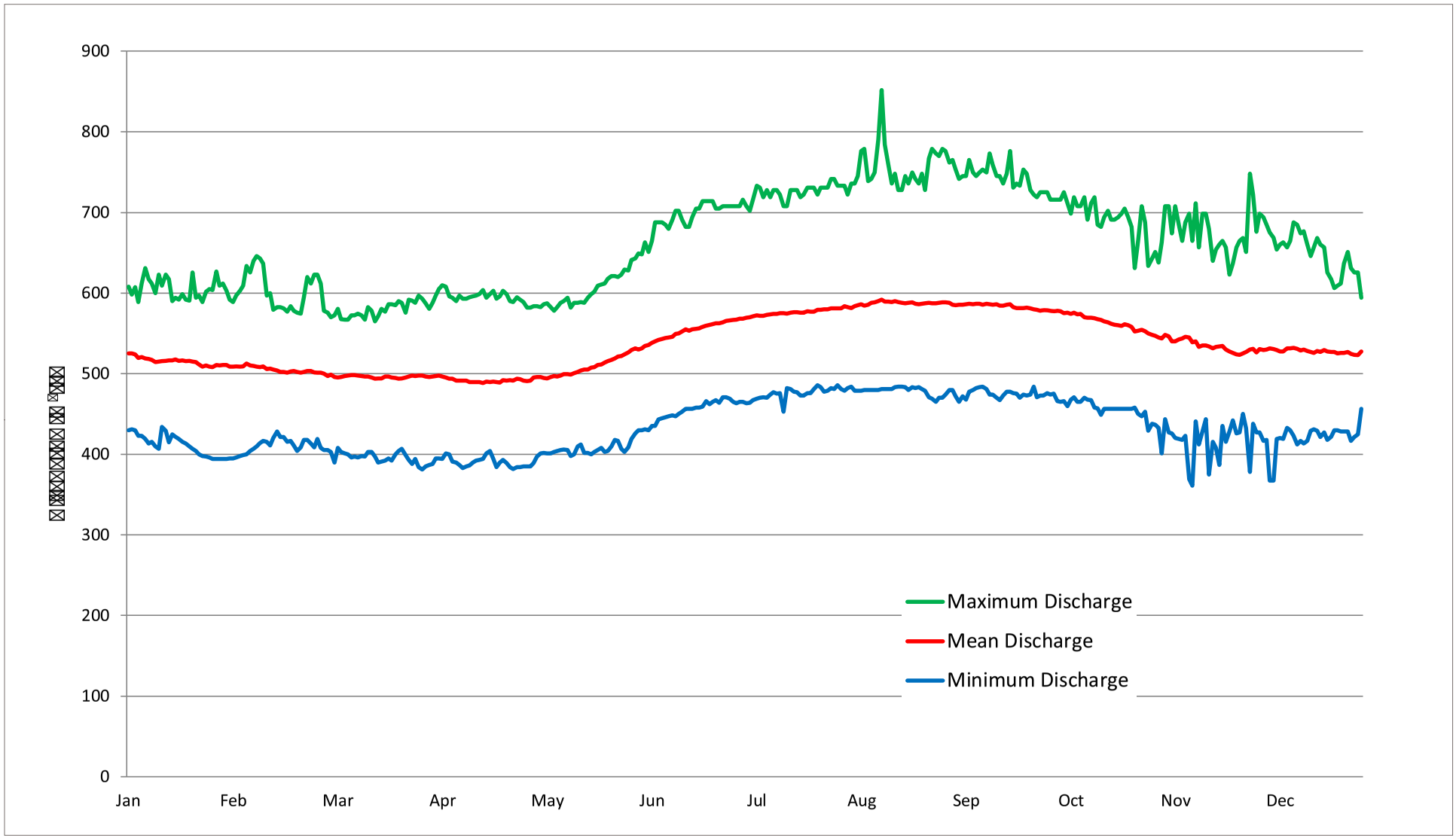

NOTES
Source : Water Survey of Canada - Great Bear River At Outlet Of Great Bear Lake (10JC003)
Gross Drainage Area: 146400 km2
** THE OVERALL RECORD IS CONSIDERED FAIR.

MACKENZIE VALLEY HIGHWAY
TULITA DISTRICT

Annual Hydrograph Great Bear River (1961 - 2010)

FILE NO.	PROJECT NO.	DWN	CKD	APVD	REV
Y22101155_Figure10-15-GreatBearHydrograph.mxd	Y22101155	TV	MS	RM	0
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Figure 10-15

Big Smith Creek at km 872.0 has a meandering and well defined morphology, originating 40 km to the east in the Taiga Plains. The river is approximately 30 m wide at the bridge crossing, 8.5 km upstream from the confluence with the Mackenzie River.

Big Smith Creek was monitored over a twenty year period (1973 to 1994) at WSC Station Big Smith Creek Near Highway No. 1 (Station ID 10HC003) located at 64°35'33" N, 124°48'46" W, near the crossing with a total basin area of 980 km^2. The mean annual hydrograph for Big Smith Creek is shown on Figure 10-16. The plot indicates a mean freshet peak of 40 m^3/s which typically occurs in mid- to late-May. Peak freshet discharges have exceeded 100 m^3/s, although much of the high flows have occurred under partial ice conditions which may overpredict discharge due to backwatering.

Snow melt is the primary source of water to the creek; however, there is a significant response to rain events in late summer/early fall.

Little Smith Creek at km 852.3 has a similar morphology as Big Smith Creek, originating 40 km to the northeast in the Taiga Plains. Flows have not been monitored on Little Smith Creek; however, since the drainage basin is similar to Big Smith Creek, discharge would likely be of similar magnitude and exhibit a similar flow regime.

Seagrams Creek at km 844.4 is in an incised gully which carries runoff from the gently sloping plain to the east and southeast. Flow data has not been collected on Seagrams Creek.

Saline River at km 831.8 contains runoff from the plain west of Mt. Clark. The Saline River forms one channel with wide gently sloping banks approximately 5 km upstream from the confluence with the Mackenzie River. Upstream of the confluence, the Saline River tributaries form deep canyons. Flow data has not been collected on the Saline River; however, due to the terrain characteristics of the drainage basin, the river likely shows quick response to summer rain events. At the crossing, backwatering may be experienced during the spring due its proximity to the Mackenzie River.

Steep Creek at km 816.5 is similar from aerial observations to Saline River in that it starts as several deeply incised tributaries which form a single meandering channel which forms sand bars as the terrain flattens nears the Mackenzie River. Flow data has not been collected on Steep Creek.

10.7 Communities and Demographics

The socio-economic area for the Highway consists of those communities that are more likely to experience effects due to their relatively close proximity to the Highway within the Tulita District, as well as their possible contributions to the Highway workforce. These communities are Tulita and Norman Wells. . The communities' geographic locations in relation to the Highway are shown on Figure 10-17.

Community profile information was obtained from several primary and secondary resources such as the GNWT Bureau of Statistics, Legislative Assembly of Northwest Territories, and available information from the Town, Hamlet, and Chartered Communities. The statistical data used to prepare the figures and tables in this section are included in Appendix H.

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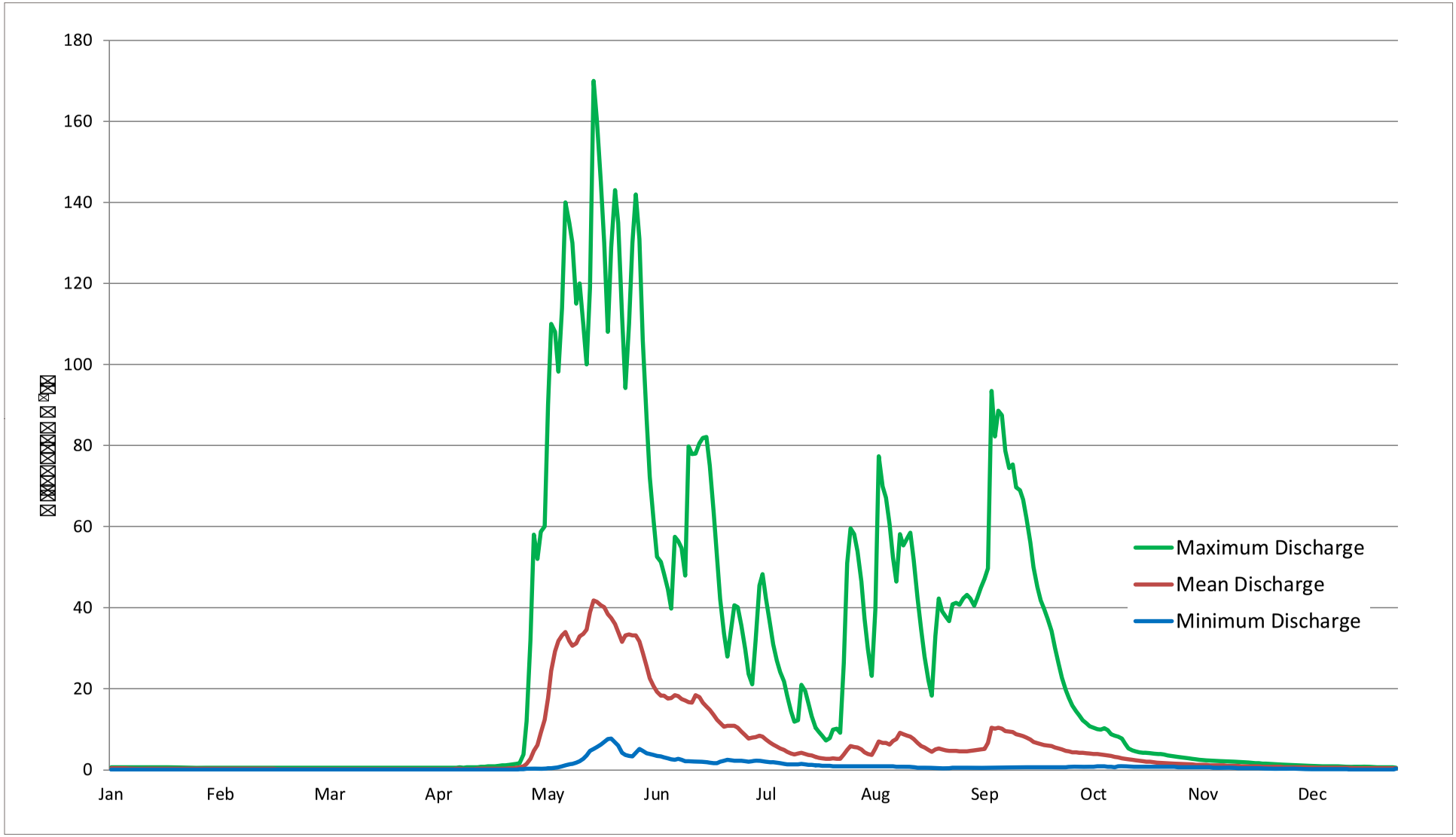

NOTES
Source : Water Survey of Canada - Big Smith Creek Near Highway No. 1 (10HC003)
Gross Drainage Area: 980 km2
Ice conditions typically observed during freshet

MACKENZIE VALLEY HIGHWAY
TULITA DISTRICT

Annual Hydrograph
Big Smith Creek
(1973 - 1994)

FILE NO.
Y22101155_Figure10-16-BigSmithHydrograph.mxd

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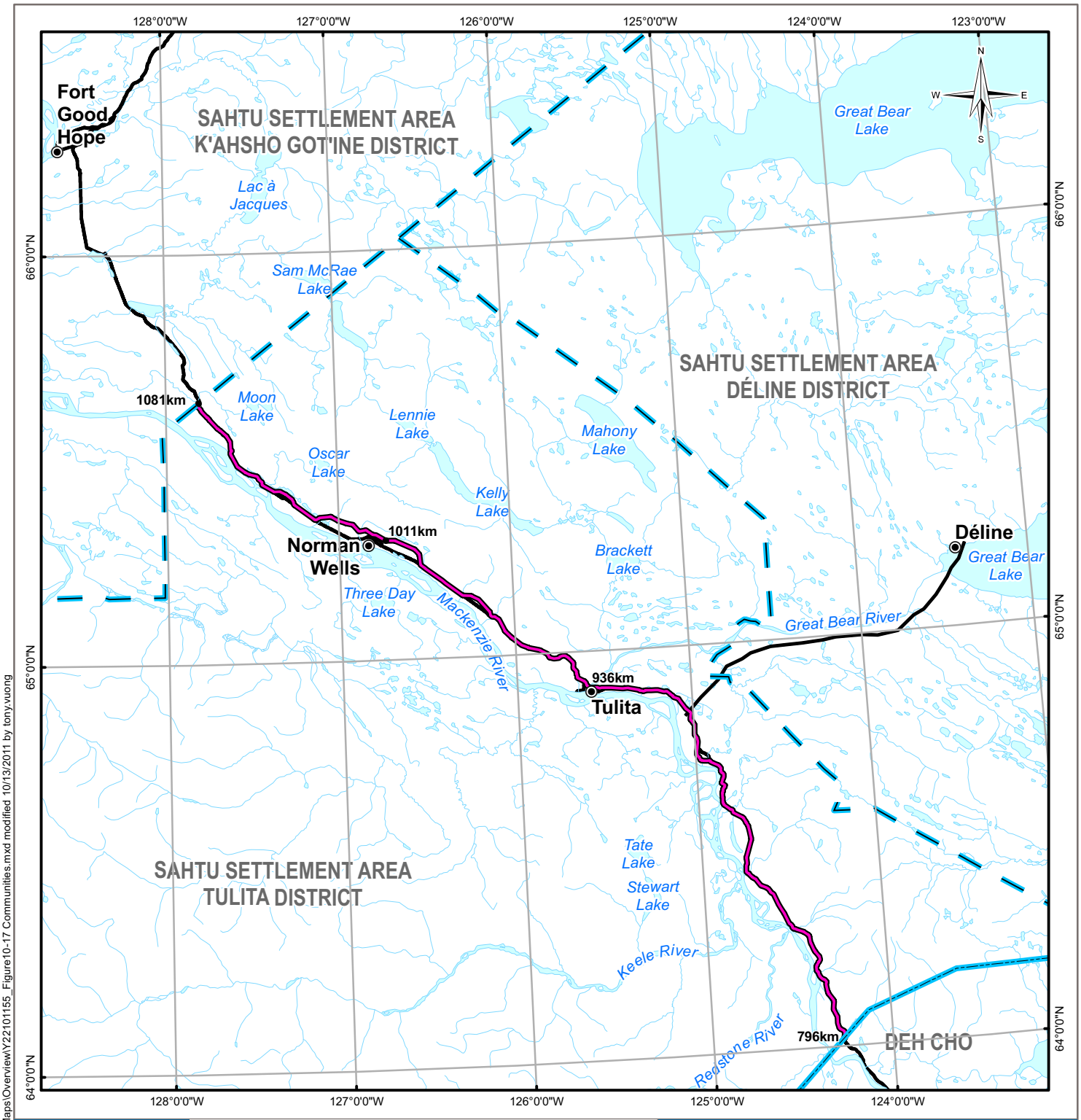
Figure 10-16



LEGEND

- Communities
- MVH Concept - EBA June 2011 (Preferred Alignment)
- KM Marker
- Public Winter Road
- Settlement Area Boundary
- District Boundary
- River
- Waterbody

NOTES

Base data source: NTS 1:250,000
Alignment is considered preliminary and is subject to change

MACKENZIE VALLEY HIGHWAY TULITA DISTRICT

Communities in the Vicinity of the Proposed Highway

PROJECTION UTM Zone 9			**DATUM** NAD 83	
1:1,500,000 0 10 20 40 Kilometres				
FILE NO. Y22101155_Figure10-17 Communities.mxd				
PROJECT NO. V33101053	**DWN** TV	**CKD** MS	**APVD** RM	**REV** 0
OFFICE EBA-RIV	**DATE** October 14, 2011			

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Figure 10-17

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10.7.1 Norman Wells Community Profile

10.7.1.1 Background

The Town of Norman Wells is located on the north bank of the Mackenzie River, approximately 684 km northwest of Yellowknife and 80 km northwest of Tulita (Figure 10-17). It is accessible by air from Inuvik and Yellowknife year round. A winter road links the community with Tulita and Wrigley. Bulk supplies and food are barged to the community during the summer months (Legislative Assembly of the Northwest Territories ND(a)).

Norman Wells, traditionally called "Legohli" (means "where there is oil), was the first community in the Northwest Territories to be established entirely as a result of non-renewable resource development. Oil seepages were reported by early explorers, including Alexander Mackenzie. In 1911, J.K. Cornwall of the Northern Trading Company investigated the oil seepages. Three leases were staked in 1914 and the Northwest Company, a subsidiary of Imperial Oil Ltd., acquired the claims in 1918 and the discovery well was drilled in 1919.

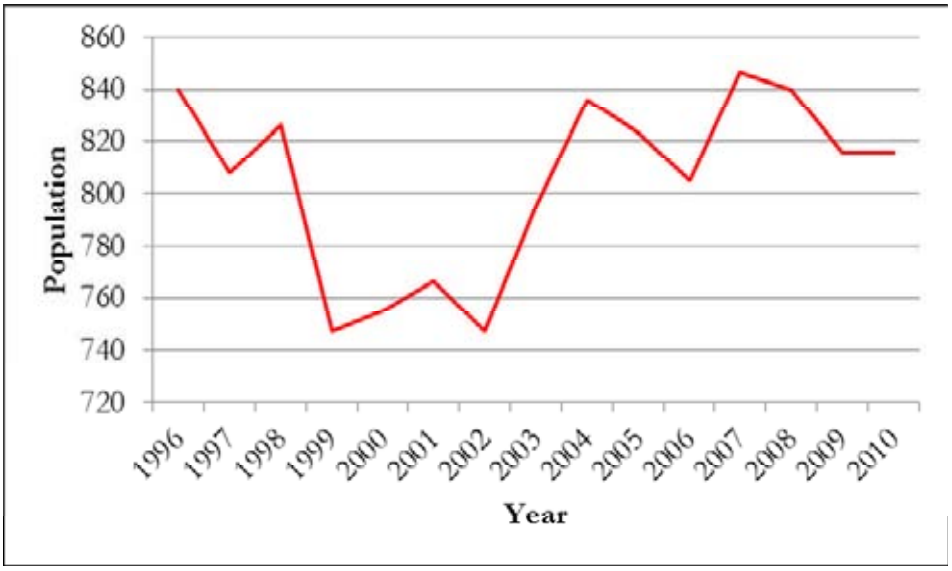
A small refinery capable of producing gasoline and diesel fuel was built in the 1920s, but a local market for the fuel was unavailable until 1933, during the development of the Port Radium mine. Industrial demand in Yellowknife prompted Imperial Oil to construct a new refinery capable of producing a wider range of petroleum products in 1939.

During the last two years of World War II, the United States government constructed the CANOL Pipeline from Norman Wells to Whitehorse due to security concerns with its supply routes to Alaska. Imperial Oil was then contracted to expand the Norman Wells oilfield from 4 to 64 producing wells. By the time the development was complete in 1944, the need for the Norman Wells fuel had passed as the Japanese threat to Alaska had been countered and alternative sources of petroleum products could be delivered more economically. The CANOL Pipeline was sold and dismantled in 1947; the road paralleling the dismantled pipeline is still used as a hiking trail and is called the Canol Heritage Trail. The completion of an oil pipeline from Norman Wells to Zama City, Alberta in the mid-1980s has resulted in increased activity in the non-renewable resource sector. This pipeline is operated by Enbridge.

Norman Wells remains the hub of transportation for the SSA and supplies fuel throughout the north. The community has a well-developed service industry and continues to rely on oil drilling and exploration for its economy (Town of Norman Wells 2010(a); Legislative Assembly of the Northwest Territories ND(a); Outcrop Ltd. 1990).

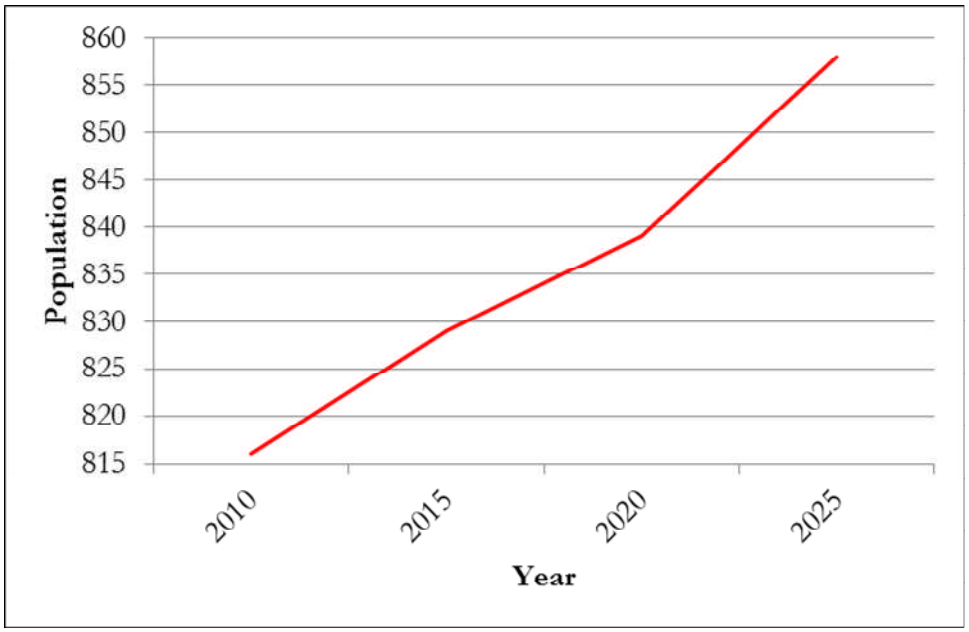
10.7.1.2 Population

The historic and projected population estimates for Norman Wells are provided on Figure 10-18 and Figure 18-19, respectively. Norman Wells' population has decreased from 840 to 816 between 1996 and 2010, indicating an average annual growth rate of -0.2 since 1996 (GNWT Bureau of Statistics 2011). Between 1998 and 2002, the population decreased suddenly to a low of 747 residents, then increased to previous population levels by 2004. Despite the recent decline in population, the population is projected to increase to 829 by 2015 and to 858 by 2025. Approximately 38.6% of Norman Wells' population is Aboriginal as shown in Table 10-20 (GNWT Bureau of Statistics 2011).



Source: GNWT Bureau of Statistics (2011)

Figure 10-18
Norman Wells Historical Population, 1996 - 2010.



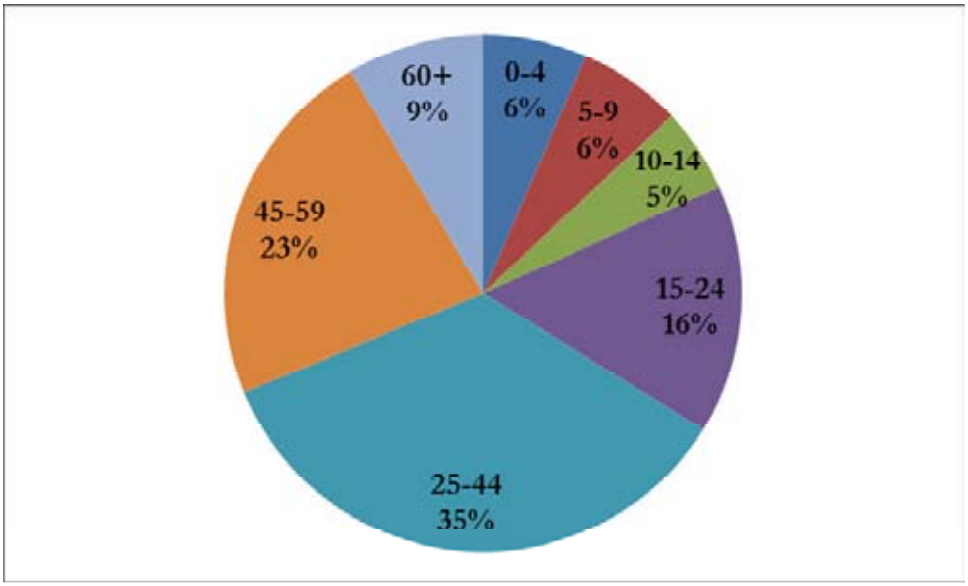
Source: GNWT Bureau of Statistics (2011)

Figure 10-19
Norman Wells Projected Population, 2010 - 2025.

From 1998 to 2007, there were between 7 and 17 births each year, with an average of 12.7 births per year over the ten year period. The number of teen births (births to women aged 19 years or less) ranged between 0 and 2 from 1998 to 2007, with an average of 0.8 teen births per year. The annual death rates

have fluctuated between 0 and 4 deaths reported per year between 1997 and 2007 (GNWT Bureau of Statistics 2011).

The population by age, gender, and ethnicity are presented on Figure 10-20 and Table 10-20, respectively. The population in Norman Wells is relatively young, with 68% of the population aged 44 or younger. There are a greater number of males than females in the community (GNWT Bureau of Statistics 2011).



Source: GNWT Bureau of Statistics (2011)

Figure 10-20
Norman Wells Population by Age Group, 2010.

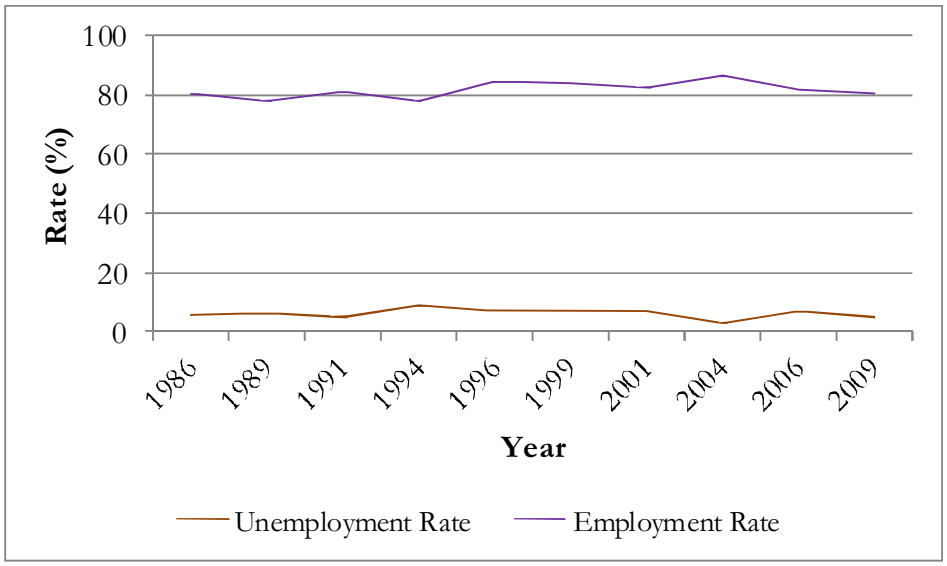
Table 10-20: Norman Wells Population by Gender and Ethnicity, 2010

Gender and Ethnicity	Population	Percent
Male	425	52.1%
Female	391	47.9%
Aboriginal	315	38.6%
Non-Aboriginal	501	61.4%

Source: GNWT Bureau of Statistics (2011)

10.7.1.3 Employment

Community employment data for Norman Wells are provided on Figure 10-21. In 2009, 649 residents were aged 15 years and older. Employment data indicates that 521 residents were employed, 29 residents were unemployed, and 99 residents were not in the labour force. Of the 550 Norman Wells residents in the labour force, this translates into a participation rate (the percentage of persons 15 years of age and over who are in the labour force) of 84.7% and an unemployment rate of 5.3%. Since 1986, the general trend for Norman Wells indicates a relatively consistent, yet increasing, trend in unemployment and employment rates over time (GNWT Bureau of Statistics 2011).

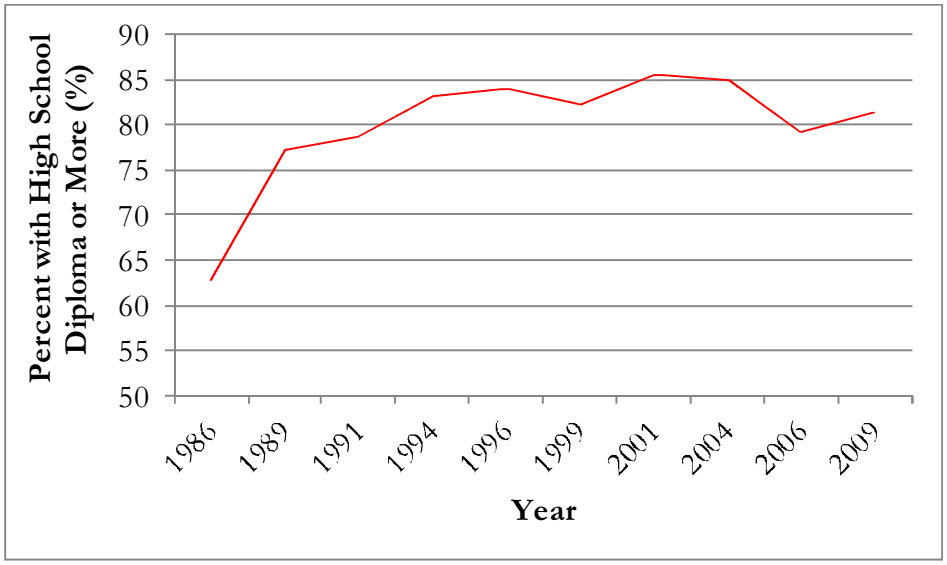


Source: GNWT Bureau of Statistics (2011)

Figure 10-21
Norman Wells Employment and Unemployment Rates, 1986 - 2009.

10.7.1.4 Education

The percent of residents achieving a high school diploma has increased overall since 1986 (Figure 10-22). The percentage of people achieving a high school diploma was 62.8% in 1986; this increased to 85.6% in 2001 and has since declined to 81.5% in 2009. The employment rate for those with a high school diploma or higher qualification was 89.2% in 2009, whereas the employment rate for those with less than a high school diploma was 39.5% (GNWT Bureau of Statistics 2011).



Source: GNWT Bureau of Statistics (2011)

Figure 10-22
Norman Wells Educational Levels, 1986 - 2009.

10.7.1.5 Business Services

The Town of Norman Wells is a commercial and service hub in the SSA with more than twenty types of services offered by local businesses. The economy in Norman Wells is based primarily on oil and gas drilling and exploration. The service industry in the Town is well-developed and provides supplies for both residents and visitors to the community (Legislative Assembly of the Northwest Territories ND(a)) and employment to the local and regional population. The local District Chamber of Commerce informs the region's business members about issues that could affect their businesses (Norman Wells Chamber of Commerce 2009). The types of business services offered and list of businesses in Norman Wells are shown in Table 10-21 and Table 10-22, respectively.

Table 10-21: Businesses Services in Norman Wells, NT

▪ Accommodation	▪ Medical services
▪ Automotive	▪ Musical instruction
▪ Bank	▪ Office rentals
▪ Bookkeeping and accounting	▪ Office supplies and stationary
▪ Childcare	▪ Oilfield services
▪ Construction	▪ Outfitting
▪ Consulting services	▪ Property management
▪ Dental services	▪ Real estate
▪ Electrical	▪ Restaurant and catering
▪ Electrical utility	▪ Retail
▪ Gasoline and diesel sales	▪ Salon
▪ Guiding	▪ Telecommunications
▪ Logistics	▪ Transportation
▪ Maintenance and janitorial	▪ Warehousing

Source: Town of Norman Wells (2010(b))

Table 10-22: Businesses in Norman Wells, NT

▪ AECOM Canada Ltd.	▪ Norman Wells Liquor Agency Ltd.
▪ Akita / Sahtu Drilling	▪ Norman Wells Logistics
▪ Arctic Flight Training Ltd	▪ Norman Wells Transportation Ltd.
▪ Arctic Winds Environmental Services	▪ North Ventures Ltd.
▪ ATCO Midstream Ltd.	▪ Northern Cartrols Ltd.
▪ Aurora College, Community Learning Centre	▪ Northern Industrial Sales Ltd.
▪ Aurora Technologies	▪ Northern Store
▪ Bailes Family Sales and Service	▪ Northwest Territories Power Corporation
▪ Bear Rock Welding	▪ North-Wright Airways Ltd.
▪ Brava Bookworks	▪ Northern Transportation Company Ltd.
▪ Bushmasters Catering Co.	▪ Northridge Contracting Ltd.
▪ Busy Bee Cleaning Services II	▪ Nahanni Air Services Ltd
▪ Call-Yer Repairs and Stuff	▪ Norman Wells Claimant Corporation Ltd.
▪ Canadian Helicopters Ltd.	▪ Norman Wells Early Childhood Society
▪ Canadian Imperial Bank of Commerce	▪ Northern Transportation Company Limited
▪ Canadian North Airlines	▪ Northridge Contracting Ltd.

Table 10-22: Businesses in Norman Wells, NT

- Canadian North Inc.
- Canoe North Adventures Ltd.
- Cathy's Kitchen
- Commercial Office Space Rental
- Copper Barging Service Ltd.
- Creations Gift Shop
- De She Ne Enterprises
- DJ Enterprises
- Dowell Schlumberger Canada Ltd.
- Economy Janitorial and Camp Services
- Elliot Creek Investments Ltd.
- Enbridge Pipelines (NW) Inc.
- Ernie MacDonald Land Corporation
- Exlogs Sahtu Ltd.
- Explosives Ltd.
- First Air
- Flint Energy Services
- Geokinetics Exploration Inc.
- Global Technical Systems Ltd.
- Green Enterprises Northwest Territories
- Green Fortress
- Hamlyn's Carpentry
- Harold's Construction
- Heritage Hotel (Whiponic Northern Cartrols Inc.)
- Hodgson's Contracting (2005) Inc.
- Imperial Oil Resources (NWT) Ltd.
- Island Valley Oil Ltd (Esso)
- J & P Lennie Services Inc. (2001)
- Jacobs Field Services Ltd. (Triton Projects Ltd.)
- Jued Enterprises
- Kesajo Construction
- Lennie Custodian
- Lone Loon Fine Woodworking
- Lonkar Services Ltd.
- Lorraine Tremblay CGA and Associates
- Mackenzie Gas Project (Imperial Oil Resources)
- Mackenzie Mountain Outfitters
- Mackenzie River Outdoor Adventures Inc.
- Mackenzie Valley Hotel
- Mackenzie Valley Logistics Inc.
- Margaret McDonald Holdings
- McCoy Enterprises Ltd.
- Northwest Territories Power Corporation
- Northwestel Inc.
- Norwel Developments Ltd.
- Penaster Transportation Ltd.
- Perm N' Frost
- Pete Rose's Welding
- Petra's Cleaning Services
- Premium Services
- Priority North (5719 NWT Inc.)
- Produce North
- Pure Note Piano Tuning & Repair
- Pyramid Corporation
- Rampart Rentals
- Rapid Travel
- Rayuka Developments Ltd.
- Red Dog Mtn. Contracting Ltd.
- Redstone Resource Development (Elliot Creek Investments Ltd.)
- Reg's Water Service Ltd.
- Ridgeline Consulting
- Riverview Property Maintenance
- Riverview Stationery & Supplies
- Royal Canadian Legion
- S.R.P. North Ventures Ltd.
- S.R.P. Petroleum (A division of S.R.P. North Ventures Ltd.)
- Sahtu Building Supplies
- Sahtu Bushman
- Sahtu Computer Services
- Sahtu Contractors Ltd.
- Sahtu Dental Clinic
- Sahtu Helicopters
- Sahtu Oil Incorporated
- Sakuskensis Enterprises
- Sam's Care
- Scott's Taxi
- Shehtah Nabors L.P.
- Superior Propane
- Sure Shot Oilfield Services
- Taiga Services
- Tamarack Enterprises
- The Professionals Ltd.
- Time's Three

Table 10-22: Businesses in Norman Wells, NT

▪ Mid-Arctic Transportation Co. Ltd. (MATCO)	▪ Tool-Box Construction
▪ Mop's Services Ltd.	▪ Town Square Hair
▪ Mountain River Outdoor Adventures	▪ Trav-cor Holdings Inc.
▪ Mountain River Outfitters	▪ Trumpeter Camp Co. Partnership
▪ Mountain View Enterprises	▪ Tulita District Consulting Services
▪ Mr. Joe's	▪ Velocity Express Canada Ltd.
▪ Normal Wells Janitorial Services	▪ Whiponic Northern Cartrols Inc.
▪ Norman Wells Claimant Corporation Ltd.	▪ Whiponic Wellputer Ltd.
▪ Norman Wells Early Childhood Society	▪ Wolverine Custom Framing Studio
▪ Norman Wells Historical Society (1977)	▪ X-Treme Mechanical Services
▪ Norman Wells Land Corporation	▪ Yamourni Inn Ltd.

Source: NWT Business Directory (2006); Town of Norman Wells (2010(b))

10.7.2 Tulita Community Profile

10.7.2.1 Background

The Hamlet of Tulita is located on the northern bank of the Mackenzie River, at its junction with the east bank of the Great Bear River (Figure 10-17). Tulita is accessible year round by air from Norman Wells and bulk supplies and food are barged to the community during the summer months. The winter road connects Tulita with Norman Wells and Wrigley during the winter months (Legislative Assembly of the Northwest Territories ND(b)).

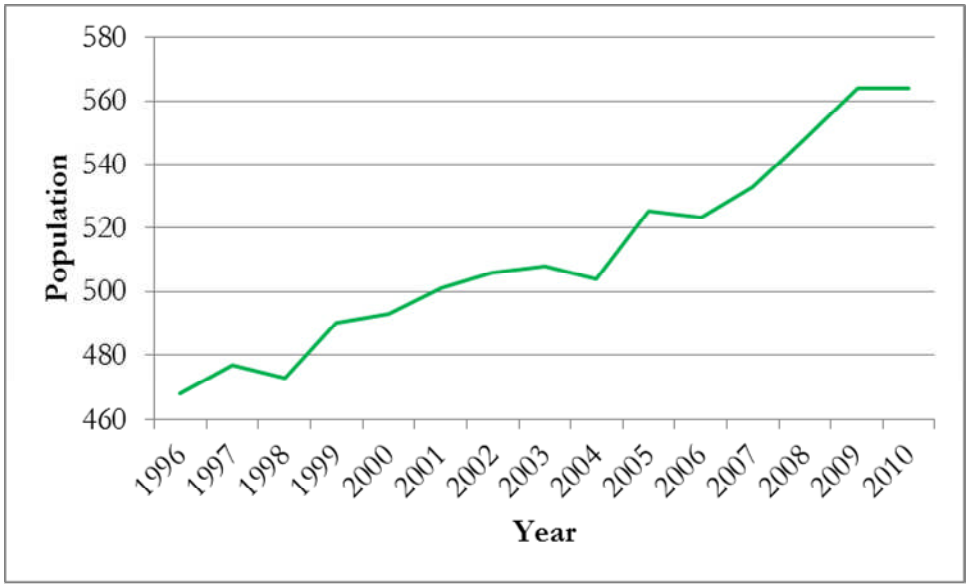
The confluence of the Great Bear River with the Mackenzie River was of seasonal importance to the Slavey Dene. Tulita, which means "where the waters meet", was formerly known as Fort Norman.

The Northwest Company was active in the area in the 1700s and a post was founded at Fort Norman in 1810. The post was relocated by the Hudson's Bay Company several times, but was moved to its first and most northerly site again in 1872. The strategic location at the junction of the two rivers made it a transportation centre from the time of Franklin's explorations in the Great Bear region through to the pitchblende discoveries of the 1920s.

The economy is based on hunting, fishing, trapping, oil exploration, tourism, and the sale of local arts and crafts (Legislative Assembly of the Northwest Territories ND(b); Outcrop Ltd. 1990).

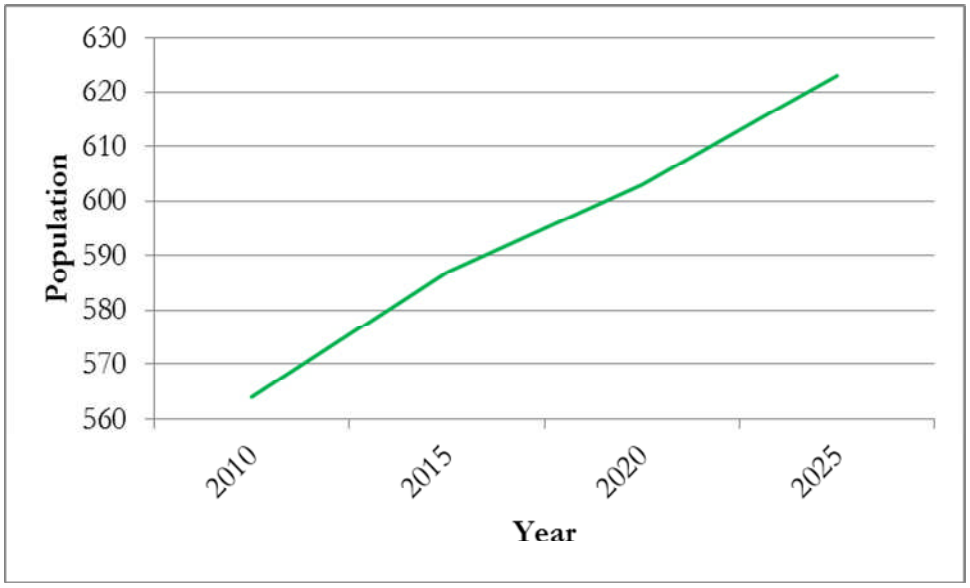
10.7.2.2 Population

The historic and projected population estimates for Tulita are provided on Figure 10-23 and Figure 10-24, respectively. Tulita's population has increased from 468 to 564 between 1996 and 2010, indicating an average annual growth rate of 1.3 since 1996. The population is projected to increase to 623 by 2025. Approximately 89.9% of Tulita's population is Aboriginal as shown in Table 10-23 (GNWT Bureau of Statistics 2011).



Source: GNWT Bureau of Statistics (2011)

Figure 10-23
Tulita Historical Population, 1996 - 2010.

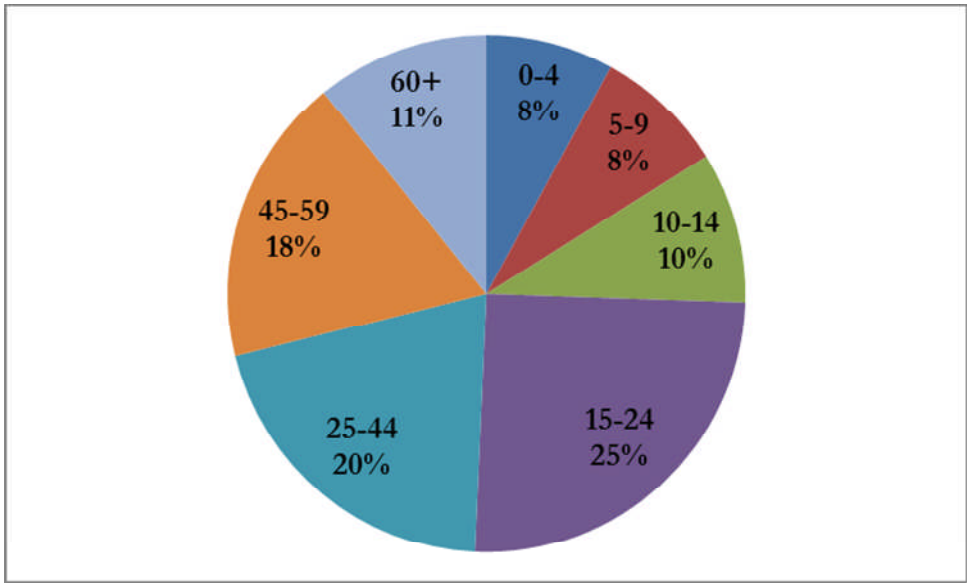


Source: GNWT Bureau of Statistics (2011)

Figure 10-24
Tulita Projected Population, 2010 - 2025.

From 1998 to 2007, there were between 2 and 13 births each year, with an average of 7.5 births per year over the ten year period. The number of teen births (births to women aged 19 years or less) ranged from 0 to 4 between 1998 and 2007, with an average of 1.3 teen births per year. The annual death rates have fluctuated between 0 and 5 deaths reported per year between 1997 and 2007 (GNWT Bureau of Statistics 2011).

The population by age, gender, and ethnicity are presented on Figure 10-25 and Table 10-23, respectively. The population in Tulita is relatively young, with 71% of the population aged 44 or younger. There are a greater number of males than females in the community (GNWT Bureau of Statistics 2011).



Source: GNWT Bureau of Statistics (2011)

Figure 10-25
Tulita Population by Age Group, 2010.

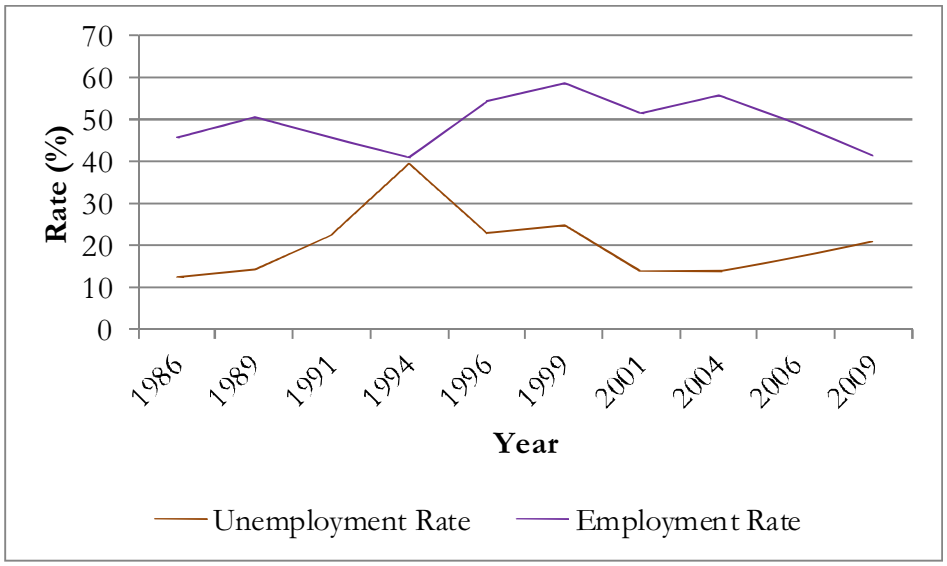
Table 10-23: Tulita Population by Gender and Ethnicity, 2010

Gender and Ethnicity	Population	Percent
Male	285	50.5%
Female	279	49.5%
Aboriginal	507	89.9%
Non-Aboriginal	57	10.1%

Source: GNWT Bureau of Statistics (2011)

10.7.2.3 Employment

Community employment data for Tulita are provided on Figure 10-26. In 2009, 410 residents were aged 15 years and older. Employment data indicates that 171 residents were employed, 46 residents were unemployed, and 193 residents were not in the labour force. Of the 217 Tulita residents in the labour force, this translates into a participation rate (the percentage of persons 15 years of age and over who are in the labour force) of 52.9% and an unemployment rate of 21.2%. Since 1986, the general trend for Tulita indicates a slight increase in employment over time, with periods of fluctuation. The unemployment rate has also fluctuated, reaching a high of 39.8% in 1994, and has increased since 1986 (GNWT Bureau of Statistics 2011).

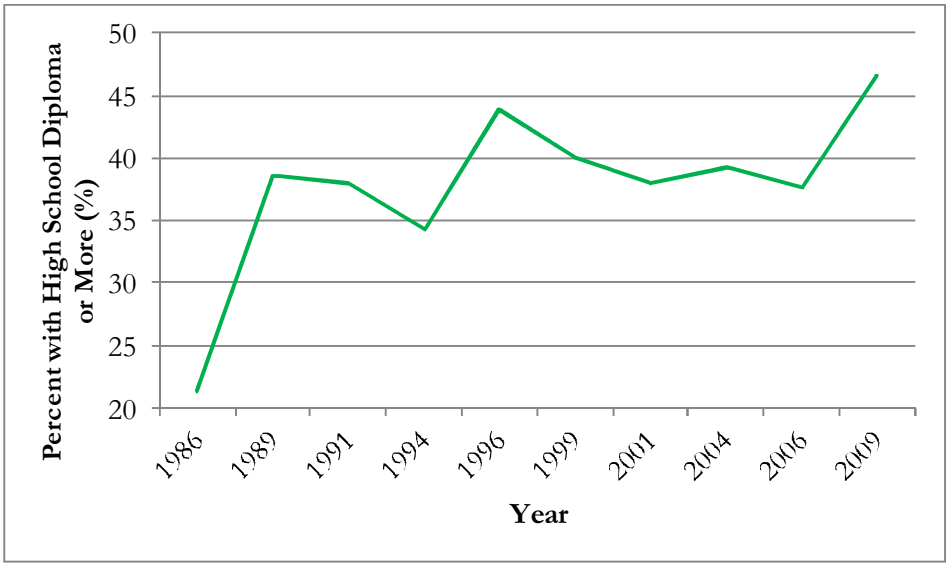


Source: GNWT Bureau of Statistics (2011)

Figure 10-26
Tulita Employment and Unemployment Rates, 1986 - 2009.

10.7.2.4 Education

The percent of residents achieving a high school diploma has increased since 1986 (Figure 10-27). In 1986, 21.3% of the Tulita population had completed high school. This reached 43.9% in 1996 and then declined to 37.7% by 2006. In 2009, a high of 46.6% was obtained. The employment rate for those with a high school diploma or higher qualification was 57.6% in 2009, whereas the employment rate for those with less than a high school diploma was 26.6% (GNWT Bureau of Statistics 2011).



Source: GNWT Bureau of Statistics (2011)

Figure 10-27
Tulita Educational Levels, 1986 - 2010.

10.7.2.5 Business Services

The local economy in Tulita is primarily based on hunting, fishing, and trapping. Oil exploration, tourism, arts and crafts are also features of the economy (Legislative Assembly of the Northwest Territories ND(b)). The types of services and list of businesses in Tulita are shown in Table 10-24 and Table 10-25, respectively.

Table 10-24 Business Services found in Tulita, NT

▪ Accommodation	▪ Guiding and hunting
▪ Catering	▪ Lease and rental services
▪ Construction	▪ Retail
▪ Food sales	▪ Transportation

Source: Spectacular NWT (ND); Tulita Land Corporation (2002); NWT Business Directory (2006)

Table 10-25 Businesses that are located and/ or operate in Tulita, NT

▪ Bear River Enterprises	▪ North-Wright Airways
▪ Bushmaster Catering	▪ Red Dog Mountain Contracting
▪ Community Economic Development	▪ Sahtu Renewable Resources
▪ Fort Norman Band Council	▪ Tulita Developments
▪ Fort Norman Metis Land/Financial Corporation	▪ Tulita Land Corporation
▪ M and L Food Services	▪ Tulita Water Services Ltd.
▪ Mackay Range Contracting Ltd.	▪ Two Rivers Hotel
▪ Northern Store	▪ Ursus Aviation

Source: Spectacular NWT (ND); Tulita Land Corporation (2002); NWT Business Directory (2006)

11.0 POTENTIAL ENVIRONMENTAL AND SOCIAL EFFECTS AND MITIGATION

The Valued Components (VCs) presented in this PDR draw from the extensive cumulative effects assessment completed for the MGP (IOL et al. 2004), from the scoping studies completed for DOT in 1999, and from the comments and information received from residents in Norman Wells and Tulita during community consultations.

The VCs that have been identified for the Highway include:

- climate (including impacts from air quality, noise and climate change);
- terrain and topography (including permafrost and geohazards);
- vegetation (including rare plants);
- wildlife;
- fish and fish habitat;
- hydrology;
- communities and cultural resources;
- traditional and other land uses (including heritage resources);
- safety; and
- the economy.

The overview information relative to the Highway for each of the VCs is presented in the previous sections of this PDR.

The following section reviews the proposed activities for Highway construction, assesses the potential environmental effects and impacts, and describes mitigation measures. It includes discussion of all of the above VCs with the exception of the economy. The economic impact of the Mackenzie Valley Highway is discussed in Section 12 and the cumulative effect of the Highway combined with other projects is discussed in Section 13.

This PDR focuses on the construction of the Highway; however, some a brief discussion of selected activities for operation, maintenance and preservation of the Highway is presented to address questions that were raised in the consultations.

11.1 Approach to Environmental Management

The Proponent is committed to constructing the Highway, material sources, and associated winter access roads in an environmentally responsible manner, based on a comprehensive environmental management framework as described in this section.

The regulatory and other management instruments (Section 4.0) that define the environmental terms and conditions for the Highway include:

- Land and Water Board preliminary screening decision, including recommended terms and conditions;
- Land Use Permit terms and conditions;
- Quarry Permit terms and conditions;
- Water Licence terms and conditions;
- Navigable Waters Protection Act Approval terms and conditions;
- Conformance with DFO Operational Statements, Letters of Advice and potential Fisheries Authorization(s);
- supporting research permits;
- explosives permits; and
- directions from Sahtu organizations.

Key environmental management components of the Highway include avoidance and/or protection of:

- sensitive terrain and habitats;
- species of concern;
- identified heritage and traditional values; and
- archaeological sites.

To ensure that environmental management is present, the Proponent will hire experienced and qualified construction contractors. Contractors will be required to develop and implement management plans such as:

- contractor HSE manuals including general spill contingency and emergency response plans (an example of a fuel spill contingency plan is included in Appendix I);
- contractor work procedures documents;
- site-specific health and safety plans;
- site-specific spill contingency plans; and
- any training related to the above to ensure that all environmental management plans are implemented effectively.

The Proponent is committed to monitoring activities and enforcing contractor compliance in the delivery of activities within the prescribed management plans.

11.2 Effects on Climate (Air Quality, Noise and Climate Change)

11.2.1 Air Quality

Dust and air emissions associated with Highway construction and material sources development are expected to have localized and temporary effects on air quality in the vicinity of the Highway when appropriate mitigations such as blast mats are used.

Dust particles of various sizes will be generated by handling of embankment and granular materials in material sources and along the Highway during construction. Dust is also generated by vehicles travelling along the Highway during construction and after the Highway is in operation. Dust control products such as calcium and magnesium chloride that are traditionally used in spot applications each year as part of highway maintenance, can coat granular dust particles and the chemical can become airborne with the dust particle as the dust control application nears the end of its serviceable life (a few months without re-watering). 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.

The application of water from nearby, suitable lakes, as per the GNWT Guideline for Dust Suppression (GNWT 1998), 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 as determined by the Land and Water Board, which could also determine which lakes could be used for extraction. Additionally, DFO water withdrawal criteria will also apply.

Once the Highway is in operation, dust control applications with products other than water will be undertaken in selected areas, such as curves and approaches to waterbodies. Products other than calcium and magnesium chloride have been discussed in Section 6.0.

Emissions from diesel engine combustion exhaust during construction and operation will be generated and will negatively impact air quality in the local area around where the equipment is operating at the particular time. To minimize emissions from construction and maintenance equipment, contractors will be required to keep equipment well maintained and in good operating conditions, and to minimize unnecessary idling even during winter months. Power sources and heated maintenance facilities will be included at construction and maintenance camps to minimize the need to keep a vehicle or equipment running during cold weather.

11.2.2 Noise

Most of the noise during the construction phase will be associated with equipment operation and, if required, blasting activities to break up the frozen granular or embankment in a material site. Increases in noise level and unfamiliar noise will disturb wildlife.

Trucks will typically be dump trucks or other haul trucks, operating at slow speeds. Noise levels associated with such trucks are typically within 78 dBA to 82 dBA at 15 m from the truck. This noise level is low and the impact will be to the local area within which the specific activity is taking place.

Although there are no local noise regulations that directly apply to construction, the contractors will be directed to apply reasonable mitigation to reduce possible effects associated with construction noise. These will include adequate maintenance of their construction equipment, including mufflers.

Blasting activities require special care in planning and execution. The use of explosives will be timed to avoid periods when sensitive wildlife species are in the area. Locations will be chosen to avoid potential harm to fish species in local waterbodies. Prudent design, best management practices, and mitigation can be combined to minimize sound levels generated by blasting during the construction phase.

Activities in material sources, including blasting will be intermittent and temporary in nature. Most of the noise will be associated with earth-moving equipment operation during periods of aggregate borrow activity. Best management practices and mitigation measures will be applied to reduce the effect of noise.

Examples of prudent design and management practices include:

- limitation of construction activity during sensitive time periods to minimize effects on wildlife;
- effective logistics planning such as the use of vans or extended cab pick-up trucks to transport workers, thereby minimizing vehicle movements; and
- regular maintenance of equipment and provision of appropriate mufflers for all internal combustion engines.

11.2.3 Climate Change

Climate change effects are already observable in some regions. As previously discussed in Section 10.0, projections show that increases in ground and air temperatures due to climate change is expected to be most significant in Canada's northern territories.

The Highway will not have an impact on climate change. Instead, the effects of climate change (i.e., warming temperatures, greater precipitation, extreme and unpredictable weather events) could have an impact on the stability of the Highway from operation, maintenance, and preservation aspects, potentially resulting in negative impacts to the surrounding environment.

The stability of permafrost and the stability of infrastructure built on it depend on maintaining ground temperatures to minimize the thickness of the active layer, and to impede thaw. The Highway is located within the permafrost region and stability of the highway structure will be dependent on maintaining the perennially frozen ground.

The frozen ground has variable proportions of ground ice. When thaw occurs, the excess water is expelled and consolidation produces substantial settlements. The thermal stability of the frozen ground is sensitive to minor changes in heat transfer at the ground surface. These minor changes in heat transfer alter the surface heat balance, initiating thaw and increased active layer thickness. Such heat transfer and potential settlement due to thaw is possible in permafrost regions even without climate warming. Subtle increases in temperature and extreme weather events that result in extreme precipitation and rapid snow melt can contribute to the thaw and accelerate it.

A risk-based approach for incorporating climate change into highway infrastructure design on permafrost is now the recommended practice. The challenge for design and construction over thaw-sensitive

permafrost terrain is to assess the capital cost of Highway construction and the long-term maintenance implications. The design parameters and construction techniques take into account consideration of these risks and provide mitigative approaches in the Highway design. The two most significant elements of the design are the use of non-woven geotextile between the existing ground and the embankment, and maintaining minimum height, based on terrain type, to mitigate heat gain that can result in thawing of the permafrost. As indicated in Section 6.4.2, nearly 93% of the Highway will be built on embankment, using these two techniques.

The remaining 7% will probably require excavation. The following principles are followed in the design and construction of the excavated sections:

- where the materials in question are stable during and after thaw, the excavation is designed to be carried out using conventional sloping techniques; and
- in areas of unstable soils where vertical cuts are undesirable for reasons such as quality of vegetative cover, then back slopes are designed with the slopes and ditch bottoms being blanketed for the purpose of insulation and or containment as well as protection against erosion.

In the design, the depth to which excavation and backfill takes place at any particular location is determined on the basis of the anticipated effect of the insulating effort was well as the ice content and soil characteristics within the depth of thermal degradation that could be expected. Preliminary estimates of such have been made in the design. When the geotechnical investigation at later stages in the project development is used to confirm the subsurface characteristics along the Highway, depth of fill, and excavation and backfill will be refined in the detailed design.

As with roadway cuts, ditching in permafrost will be avoided whenever possible. In the preliminary design this is accomplished by increasing the number of cross drainage culverts to eliminate or minimize the ponding or flow of surface runoff water along the toe of the embankment. In some sections along the Highway, ditching in the permafrost is unavoidable. To eliminate undesirable ponding or to improve dispersal of drainage flows, the following principles have been followed in the preliminary design:

- Due to the general susceptibility of permafrost materials to erosion when thawed or thawing, the gradient of any necessary ditches is kept as flat as possible.
- Where a gradient is unavoidably steeper than that considered stable for the material in question, or where there is the likelihood of uncontrolled thermal erosion, estimates have been included for the ditch to be lined with granular or other suitable erosion resistant material.

Another risk factor that is related to climate uncertainty is precipitation, including rain and snow. Building conservatism into a design to account for climatic warming is more complex than simply projecting air temperature trends into the future. The greatest risk is often associated with extreme events that are now being observed in the northern Canada. Unprecedented warm winters are often followed by rapid and early thaw. High snow cover years are resulting in extreme snow drifting that blankets the downwind sideslopes, insulating the surface and raising the ground temperature under the fringes of the embankment. Standing water against the sideslopes retards winter freezeback of the active layer and can accelerate thaw below the sideslopes.

Key mitigative measures, in addition to those noted above, incorporated into the design parameters to manage uncertainty related to future climate trends and extremes in the permafrost region that this Highway will be constructed in, include:

- thick embankments that insulate and stabilize the active layer and the use of non-woven geotextiles for reinforcement;
- where available, use of porous embankment materials, such as coarser gravels, to reduce the risk of ponding along the toe of the embankment;
- where such material is not available, the use of culverts to balance surface flow has been included; and
- adoption of construction methods that eliminate cuts and minimize disturbance of the natural vegetation before fill is placed.

Of greater importance are the activities undertaken after the Highway is in operation. Given the uncertainty of the events associated with climate change, greater vigilance and effort on the part of maintenance operators will be required including:

- greater effort for spring culvert clearing and fall protection of culverts and drainage structures,
- more frequent inspections, and monitoring, of the performance of the infrastructure; and
- sufficient additional resources for maintenance and rehabilitation in the face of potential permafrost degradation.

11.3 Effects on Terrain and Topography

11.3.1 Permafrost

Permafrost with little or no ice generally does not cause engineering problems; whereas, ice-rich permafrost can cause serious problems if allowed to thaw. As noted above, an increase of average temperatures due to climate change can result in the thawing of permafrost, which could have an impact on the Highway. Alternatively, construction and maintenance activities for the Highway and the physical presence of the road embankment can cause ground disturbance and/or a change in the ground/air temperature balance, the effect of which is an increase in active layer thickness and permafrost thaw. Thawing of permafrost results in instability of the terrain, which has the impact of erosion, loss of habitat, and structural failure on the Highway that presents safety concerns. Thawing of permafrost also results in ponding of surface water and other drainage issues that have similar impacts as those noted above.

The Highway will be constructed using end dumping methods to initially lay down the embankment material and then top it with finer surfacing material. The embankment will be constructed in the winter months to minimize ground disturbance that could cause permafrost degradation. Key design and construction activities to mitigate permafrost thaw are listed above in the discussion on climate change.

11.3.1.1 Sensitive Terrain

Activities that will affect the terrain during Highway construction include removal of overburden at material sources, excavation of highway construction material from sources, Highway construction, and re-contouring of construction sites and associated facilities.

Construction activities in sensitive terrain in the winter months generally minimize ground disturbances that could lead to permafrost degradation. The Highway will be constructed with sufficient cross drainage to prevent and minimize potential water ponding. Ponding conditions could lead to permafrost thaw which could cause ground disturbance, changes to existing drainage conditions and slope instability.

Activities that will affect the terrain during Highway construction include the removal of organic overburden at material sources, the excavation of highway construction material from the material sources, the construction of the Highway, and the re-contouring of construction sites and associated facilities.

Material sources will be located as close to the Highway as possible to minimize haul distances. The material sources will be operated and reclaimed in a manner consistent with Land Use Permit requirements and existing environmental standards and guidelines. To further minimize potential impacts on terrain and associated vegetation, temporary winter access roads, constructed of snow and ice over the frozen ground, will be employed for access to the material sources.

Site-specific reclamation plans will be prepared and approved prior to the commencement of operations at each material source. Material sources will be permanently reclaimed when use of that source is complete in accordance the applicable reclamation plan. Progressive reclamation will occur to ensure that only areas with active borrowing will be disturbed. Mined out areas will be re-contoured and re-vegetated, if possible to mimic the surrounding terrain upon completion of borrowing activities.

The potential effects of activities on terrain can be related to surface disturbance during construction that can cause damage to soils and permafrost, and that may cause erosion and alteration of landforms. Mitigation strategies to reduce effects on soils and landforms include:

- reducing surface disturbance;
- controlling potential erosion;
- stabilizing slopes, if required; and
- revegetation, if possible.

To minimize impacts on the existing terrain along the Highway and the Highway footprint, the temporary construction camps, and the material sources will be minimized to the extent possible. With the application of the proposed mitigation measures, the effects of Highway construction and associated borrow activities on the terrain along the Highway are generally expected to be limited to the physical footprint and are considered to be minor in the context of the overall project area.

The following sections describe the features identified as being sensitive to construction activities and disturbance.

11.3.1.2 Massive Ground Ice

Massive ground ice deposits are a potential threat to the road and related infrastructure in several ways. On flat ground, thawing of massive ice bodies triggered by surface disturbance commonly leads to the development of thermokarst and extensive subsidence of the ground. On slopes, thawing of massive ice bodies can eventually lead to slope failures in the form of retrogressive thaw flow landslides.

The mitigative measure is to avoid these areas.

11.3.1.3 Thick Organics (Peatland)

These deposits generally occur as bog, fen or peat-fen complexes, usually as cover over the underlying mineral soil and typically on low-lying, flat terrain. Peatlands are wetlands with massive deposits of peat that are typically greater than 0.5 m thick and may be several metres thick. There are many classes of Peatland, but most in the Mackenzie Valley are bogs and fens. Bogs are a form of peatland, having a water table at or near the surface, where the waters are virtually unaffected by nutrient rich groundwater from the surrounding terrain. Most bogs are affected by permafrost and take the form of peat plateaus, polygonal peat plateaus and palsas (Tarnocai et al. 2003). Fens, on the other hand, support nutrient-rich waters that originate from the surrounding mineral soil. The mitigative measure used in the preliminary design is to identify thick organic terrain during the September 2010 field program from orthophotographs and from previously published investigations and to avoid these areas.

11.3.1.4 Thermokarst

Thermokarst refers to surface subsidence and expression resulting from the melting of ice-rich permafrost, particularly of massive ice blocks/lenses. Thermokarst is a slow natural process that can be aggravated and accelerated by disturbance. As ground ice thaws, the resultant water cannot drain away and contributes to further degradation of the permafrost. The result is the creation of numerous small ponds and lakes, expressed as kettle lake topography along the Highway, especially in the glaciolacustrine/ lacustrine terrain. Old thermokarst lake beds are found where fine-grained clay, silt, peat, and local sand deposited in low, flat areas previously occupied by lakes or ponds has become exposed. These lake beds often support an organic cover and tend to be very wet. Ice content is generally high in these fine-grained organic materials and they often exhibit thermokarst subsidence and erosion. Again, the mitigative measure used in the preliminary design is to identify areas of existing and potential thermokarst during the September 2010 field program from orthophotographs and from previously published investigations and to avoid these areas.

11.3.1.5 Retrogressive Thaw Flow Slides

Retrogressive thaw flow slides are unique landslides that only occur in permafrost regions. Retrogressive thaw flows develop in ice-rich, fine-grained sediments and result from the thawing and subsequent flow of water-saturated ground. These failures can occur on very gentle slopes and many of these features exist along river banks and lakes in the vicinity of the Highway. These landslides are typically relatively small, but over time can retreat (retrogress) some distance back from the headscarp. These slides would have a significant impact on the Highway if one were to occur after construction. The likelihood of a retrogressive thaw slide impacting the Highway has been reduced by routing it away from existing slides and steeper slopes likely to be susceptible to this type of movement.

Other types of slope instabilities in surficial sediments present in the Highway vicinity are include rotational slides and active layer detachment slides as described by Geological Survey of Canada (2004). These areas have been avoided in the preliminary design.

11.3.1.6 Thermal Erosion

This potential permafrost-related geohazard develops locally, and all areas identified have been avoided in the preliminary design.

11.4 Effects on Vegetation

11.4.1 Footprint

The average width of the Highway footprint will be 18 m to 21 m (and up to 80 m wide in localized areas, depending on the surface finish width) including the embankment. Considering the full 285 km length of the Highway, the total Highway footprint would directly impact approximately 600 ha of terrain and associated vegetation.

11.4.2 Construction

The Highway will be constructed by excavation and end-dumping of aggregate material. Highway construction, including associated material sources, involves clearing vegetation, and grading and altering landscapes. In addition, Highway operation activities include road maintenance and vehicle traffic. These activities have the potential to directly and indirectly impact vegetation.

The Highway may directly and indirectly result in the loss and alteration of plants and plant communities along the Highway and associated material sources. Rare plants and uncommon and sensitive vegetation communities (e.g., peat bogs) have the potential to be impacted by the Highway construction and associated activities. As indicated in the EIS for the MGP, the specialized plant communities that occur on granular sources may be lost because these areas support specific plant species on a sand and gravel substrate – the same material that will be preferentially selected for use in Highway construction (Imperial Oil 2004).

In addition to the direct effects from the proposed construction, several indirect effects may also occur, including the introduction of non-native or invasive plant species, alteration of the hydrological conditions (either ponding of water or reducing water flow), and increased erosion or slumping, thereby changing plant communities. Pomeroy (1985) indicates water ponding from road construction of may lead to the degradation of the underlying permafrost and eventual changes in hydrologic conditions and thus the vegetation community.

11.4.3 Highway Use

Vehicle traffic and road maintenance activities (including snow removal, grading, and possibly, use of dust suppressants) will continue through the life of the Highway. These activities have the potential to directly or indirectly alter vegetation cover and plant assemblages, plant phenology, fire frequencies, and additional vegetation loss.

The amount of dust produced along the Highway will increase during operation. Dust loading is expected to be localized and seasonal. Dust along the Highway can lead to early snow melt, which in turn leads to early green up. In addition, dust loading may lower vegetation cover and change plant assemblages. Dust suppressants (including chloride based) may also negatively affect vegetation health (Goodrich et al. 2008). Even though the Highway is anticipated to have low traffic volumes, dust generation at key locations (curves, bridge approaches, etc.) will be addressed during Highway operation. Dust suppressants other than calcium and magnesium chloride are being investigated for use on the Highway.

Snow removal and grading will be necessary during winter operations. Snow build-up in the ditches has the potential to affect the vegetation communities due to delayed melting in the spring.

In addition, the Highway may increase access to off-road areas which could result in additional vegetation loss or plant damage, and an increased risk of forest fires.

11.4.4 Mitigation Measures

The following measures will be employed to mitigate impacts to terrain and topography:

- minimize the project footprint wherever possible to reduce impacts to native plant communities;
- complete a survey for rare plants along the Highway to cover any areas that were not covered in the rare plant surveys completed for the MGP. Avoidance of any new locations for rare plants will be considered in the detailed design stage;
- install appropriately sized drainage culverts to maintain existing flow conditions;
- monitor and maintain drainage culverts to ensure culverts are in proper working order to avoid ponding;
- employ geotextile as an underlay, where needed, and use sufficient fill depths over the road bed to protect the permafrost;
- minimize the extent and use of material sources as much as possible. Implement progressive reclamation of material sources including re-contouring and re-vegetating in accordance with the appropriate guidelines;
- restrict construction traffic to the planned footprint;
- clean equipment thoroughly prior to use on site to avoid the transfer of non-native or invasive plant species; and
- monitor and manage weed species using an appropriate means of weed control during operation.

11.5 Effects on Wildlife

All habitats adjacent to the Highway support wildlife, including species with special conservation status. The effects of roads on wildlife and wildlife populations are well known; however, negative effects typically increase with road widths, speed limits, and traffic volumes. The Highway is expected to have very low traffic volumes (i.e., less than 50 vehicles per day).

11.5.1 Potential Effects on Wildlife and Wildlife Habitat

Potential direct and indirect effects on wildlife from the construction and operation of the Highway include:

- habitat loss and/or alteration;
- reduction in habitat connectivity;
- habitat fragmentation;
- increased human disturbance;
- increased hunting pressure, including in areas previously not open to hunting; and
- wildlife mortality.

Effects may occur at both the individual and population levels (Jalkotzy et al. 1997). Individual species, particularly grizzly bear, wolverine, and boreal caribou are more sensitive to human disturbances and may avoid the Highway as a result of repeated disturbances (Jalkotzy et al. 1997). However, Jalkotzy et al. (1997) indicated that avoidance behavior, in areas without hunting, is either nonexistent or very short term. Animals can become habituated to the Highway and the low levels of traffic that are estimated. Yost and Wright (2001) report that caribou show an uneasiness to traffic in Denali National Park, Alaska, but no pattern of traffic or road avoidance was detected. Similarly, the distribution of grizzly bears in the park did not indicate road avoidance (Yost and Wright 2001).

To avoid and mitigate these potential effects, various strategies in the form of best management practices are proposed. Proposed monitoring and mitigation plans are provided in the sections below that will help to avoid or minimize adverse effects on wildlife.

11.5.1.1 Habitat Loss or Alteration

Habitats in the vicinity of roads are effectively lost to many species (Jalkotzy et al. 1997). Species with large home ranges and or those that move large distances, such as Grizzly Bear or Caribou, are more vulnerable to habitat loss than species with smaller area needs (Clevenger and Huijser 2009). In addition, populations of species that occur in low densities (including those designated with special conservation status) may be especially vulnerable to further human disturbances and habitat loss (Clevenger and Huijser 2009).

The construction of the Highway will open habitat patches, such as stands of previously undisturbed forest, an impact that can be minimized given that much of the Highway will be along the existing winter road. This will alter the habitat for the local plant and animal species by introducing “habitat edges”, which differ from a patch of inner contiguous habitat with respect to light regime, moisture levels, microclimatic conditions, available shelter and security. New habitat edges may benefit edge-dwelling species and habitat generalists, but can be expected to negatively affect interior forest species whose tolerance for environmental change is limited. Habitat specialists are typically more sensitive to disturbances.

11.5.1.2 Habitat Connectivity and Fragmentation

The Highway may create a barrier to small forest mammal and amphibian movements (Foresman 2004). Because these animals are often prey for larger carnivores and raptors, they are vulnerable crossing areas without protective cover. These species are more likely to be preyed upon crossing the Highway, and may

avoid crossing altogether. Thus, the Highway may negatively affect small forest mammal and amphibian dispersal, resulting in fragmentation of the populations.

Increased noise and edge effects may make adjacent habitats less favourable for many species. Some species may avoid the Highway or change their pattern of use (Jalkotzy et al. 1997; Clevenger and Huijser 2009). Animals that avoid or hesitate to cross roads or those that are disturbed by a vehicle expend greater energy. This expenditure of energy may be considerable in the winter if snow depths are high or the surrounding landscape provides little security cover and animals must travel further for security cover.

Jalkotzy et al. (1997) reported that roads with little traffic are frequently used by a number of wildlife species (including wolves, grizzly and black bear, caribou) as travel routes. Grizzly Bears are also known to cross highways with low traffic volumes (Gibeau and Herrero 1998). However, in northeastern Alberta, roads were considered semi-permeable barriers to Boreal Caribou movements (Dyer 1999). Clevenger and Huijser (2009) indicated low traffic volumes (less than 2,500 annual average daily traffic volumes) had little effect on the number of animals attempting to cross the road.

The existing winter road is currently used by trucks, snow mobiles and all-terrain vehicles (ATV). If the Highway is constructed, off-road traffic may increase as access will be more easily available. Increased off-road traffic has the potential to adversely affect wildlife distributions. For example, woodland caribou have been documented to abandon areas frequented by snowmobiles (Dyer 1999).

11.5.1.3 Wildlife Mortality

Potential direct and indirect wildlife mortality may occur as a result of the Highway. Direct effects include wildlife-vehicle collisions. Indirect effects include increased predation, hunting, trapping, and problem wildlife as a result of the Highway.

Wildlife–Vehicle collisions with wildlife may result in direct wildlife mortality. Amphibians, birds, and small mammals are the species groups most often injured or killed by traffic collisions (Foresman 2004). However, vehicle collisions with large mammals are also a human safety and property hazard, and as a result are the most commonly reported wildlife encounter along highways. Clevenger and Huijser (2009) indicated at low traffic volumes (less than 2,500 annual average daily traffic volumes) traffic related mortality is generally low. The traffic volume estimated for the Highway is less than 50 vehicles per day.

Certain species, such as herbivores (i.e., boreal caribou and moose) and bears may be attracted to the road ditches in search of food, especially in the spring when plant emergence may be earlier than in the forest (Gibeau and Herrero 1998; Dyer 1999). Carnivores (including raptors) may be attracted to the Highway to prey on these foraging animals or carrion (Jalkotzy et al. 1997). Wildlife mortality, for all species in the vicinity of the Highway, may occur as a result of vehicle collisions.

The primary source of indirect mortality is related to human access (Jalkotzy et al. 1997). As access becomes easier, furbearer trapping, hunting, and poaching is likely to increase in areas that were not easily accessible prior to Highway construction. An increase in trapping, hunting, and poaching along the Highway may lead to over-harvesting of populations if not properly managed. Wildlife, such as bears, wolverines, and foxes may become attracted to the harvester's gut piles, food wastes, and wildlife killed by vehicles which may result in more human encounters with wildlife and more problem wildlife.

11.5.1.4 Carnivore Dens

Den site fidelity is common in carnivores such as grizzly and black bears, wolves, and foxes. Like most carnivores, wolves can be sensitive to disturbance, especially during their denning period (Chapman 1977). Nevertheless, wolves' high productivity and dispersal capabilities have shown resiliency to sustained levels of moderate human disturbance (Weaver et al. 1996). Similarly, fox populations may also tolerate moderate levels of human disturbance. Human disturbance to suitable denning areas may limited in the Highway vicinity as a large portion of the area does not provide suitable denning habitat.

The Highway and material sources will selectively remove habitats appropriate for denning. This selective removal of denning habitat will affect carnivores in the local area. Bear dens were identified during the September 2010 field program, and in the preliminary design, the Highway has been moved to avoid these dens.

11.5.2 Mitigation Measures

The draft SLUP acknowledges the development of the Highway (SLUPB 2010). In the preliminary design, the Highway was located to utilize much of the existing winter road and to be in a common transportation corridor with the MGP. Since the effect of the Highway can be reduced by avoiding areas more sensitive to disturbance, the following additional siting strategies were also considered in the preliminary design (Table 11-1).

Table 11-1: Strategies to Avoid Potentially Sensitive Areas During Preliminary Design

Species or Species Group	Sensitive Area	Mitigation Employed in the Preliminary Design or to be Employed in the Detailed Design and Construction
Caribou	Suitable feeding habitat with an abundance of ground lichens exists intermittently in the vicinity of the Highway. In addition, barren-ground caribou security habitat in the form of frozen lakes is common.	Remain as far as possible from lakes to minimize disturbance to animals and reduce hunter visibility from the Highway.
Moose	Appropriate moose habitat exists along the Highway, particularly along lake shorelines, along the willow riparian zones at the culvert crossings, and in areas with relatively recent forest fires.	Remain as far as possible from lake shorelines and minimize the number of riparian crossings.
Carnivore	Bears, wolves, and foxes are expected to occur in all habitat types; however, possible denning habitats are considered most sensitive to disturbance. Bears, wolves, and foxes can be expected to den in all areas suitable for construction materials.	All disturbances to the material sources will be minimized. The SLUP recommends a horizontal setback of 800 m from bear, wolverine and wolf dens (SLUPB 2010).
Beaver	Signs of beaver were observed in the vicinity of the Highway.	Avoid altering the natural drainage conditions (water quality and quantity).
Waterfowl	All open water habitats, including large and small wetlands and lakes are suitable habitat for multiple waterfowl species.	Remain as far back from lakes and wetlands as possible. The SLUP recommends a setback distance of a minimum of 250 m from waterfowl nesting and staging areas (SLUPB 2010).

Table 11-1: Strategies to Avoid Potentially Sensitive Areas During Preliminary Design (Continued)

Species or Species Group	Sensitive Area	Mitigation Employed in the Preliminary Design or to be Employed in the Detailed Design and Construction
Raptor	Tree and ground nesting raptors are expected to occupy all habitat types in the vicinity of the Highway. Cliff nesting habitat exists in specific locations in the vicinity of the Highway and provides nesting habitat for cliff nesting raptors such as Peregrine Falcons and Golden Eagles.	The Highway should avoid all known nests by a conservative buffer of 1,000 m. The SLUP recommends a horizontal setback of 1,000 m from raptor nests during the breeding season (March 1 to August 1) and 500 m for the remainder of the year (SLUPB 2010).
Upland Bird	Multiple upland bird species occur in vicinity of the Highway during the summer months. Rusty Blackbirds (species listed by SARA as Special Concern) are likely to occupy lake shores in the vicinity of the Highway.	Remain as far from lakes and wetlands as possible to minimize impacts to Rusty Blackbirds and other species.
General Wildlife	Wildlife are expected to occupy the area along the Highway year round.	Minimize the disturbance footprint as much as possible. Utilize much of the existing winter road alignment.

Since all habitat types in the vicinity of the Highway support wildlife species and the Highway cannot avoid all areas, mitigation and best management practices are recommended to minimize potential adverse effects (Table 11-2).

Table 11-2: Mitigation and Best Management Practices during Construction and Operation

Species or Species Group	Rationale	Mitigation and Best Management Strategies
Barren-ground Caribou	Most sensitive time is winter (November to May). Sensitive to human disturbance and over- harvesting year round. Along the Dempster Highway, local residents have raised concerns regarding the practice of shooting the lead animals as they approach and cross the Highway. This is thought to cause the herd to change its migration and even abandon its winter range.	Avoid clearing and construction when caribou are present (November to May), if possible. If clearing and construction during caribou over-wintering period is unavoidable, a wildlife monitor will be present to monitor the location of over-wintering caribou. Cease clearing and construction activities if caribou are in the local vicinity. Endorse a hunting best practices education program: respect a one week voluntary hunting closure along the Highway (including 8 km on either side) to permit lead animals to pass (similar to the Dempster Highway volunteer program). See general mitigation below.
Boreal Caribou	Boreal Caribou are sensitive to disturbance year round, especially during winter and calving periods (November to July). Sensitive to human disturbance and over-harvesting year round. Listed by SARA as Threatened.	Cease clearing and construction activities if caribou are in the local vicinity. Avoid open, mature spruce habitats (near peatland complexes, lakes, and ponds) that have abundant ground and tree lichens, as much as possible. See general mitigation below. See mitigation specific to species at risk (Table 11-3 below).

Table 11-2: Mitigation and Best Management Practices during Construction and Operation (Continued)

Species or Species Group	Rationale	Mitigation and Best Management Strategies
Moose	Sensitive time is year round, especially winter (November to May).	Minimize disturbance to riparian shrub communities. See general mitigation below.
Furbearers, including bears and wolves	Sensitive time is year round, especially in the winter.	Conduct an active den survey in the fall prior to disturbing these areas to locate active den sites. Cease clearing and construction activities during carnivore denning season (September to May) within 1 km of all known den sites.
Waterfowl	Sensitive time is spring, summer, and fall.	As indicated in the SLUP, avoid all waterfowl nesting and staging areas by a minimum of 250 m (SLUPB 2010).
Raptors	The most sensitive time is nesting and fledging season (March 1 to August 1), but year round for some resident species. Raptors and their nests are protected under the applicable regulations.	Avoid clearing and construction during raptor nesting and fledging season (March to August) in all habitat types (this timing restriction includes early nesters such as owls and later nesters such as hawks). As indicated in the SLUP, avoid raptor nesting sites by 1,000 m, and not cause adverse negative effects on nesting raptors from March 1 to the August 1. Aircraft remain at an altitude of 650 m (minimum) when flying over areas likely to support nesting raptors (SLUPB 2010). See general mitigation below.
Upland Birds	The most sensitive time is spring, summer, and fall. The majority of upland birds and their active nests in the vicinity of the Highway are protected by the federal Migratory Birds Convention Act.	Avoid clearing and construction during nesting and fledging season (May to August) in all habitat types. See general mitigation below.

Table 11-2: Mitigation and Best Management Practices during Construction and Operation (Continued)

Species or Species Group	Rationale	Mitigation and Best Management Strategies
General Wildlife	Suited for all wildlife species Volunteer based Hunting Best Practices outlined along the Dempster Highway (Yukon Environment 2006; Porcupine Caribou Harvest Management Plan) may also be appropriate for the Highway.	Minimize the project footprint, and re-contour and re-vegetate cleared areas with native vegetation mixes as soon as possible. Maintain waste management along the Highway and around construction and maintenance camps; Endorse a hunting best practices education program: retain a 500 m no-shooting zone along the Highway. Endorse a hunting best practices education program: off road vehicle use is prohibited year round, except for snowmobiles once the ground is completely frozen and covered by snow (includes 8 km on either side of the Highway). Endorse a hunting best practices education program: hunter education program to encourage hunters to track wounded animals, report harvests, identify bulls from cows, and improve marksmanship and use of appropriately sized rifles. Maintain existing drainage patterns by using appropriate sized drainage culverts. Construct all culvert openings flush with the surrounding terrain to allow small mammal and amphibian access. Minimize the line-of-sight from the Highway up converging cutlines, pipelines, and trails by re-planting native cover species. Deter off-road use of converging cutlines and trails by re-planting native cover species. Employ Sahtu based policies and solutions for access off of the Highway.

11.5.3 Mitigation Measures for Species at Risk

A total of eight species with special conservation status exist or potentially exist in the vicinity of the Highway. Of these eight species, boreal caribou have the highest level of conservation status and are listed by SARA as Threatened. Mitigation specific to species with special conservation status are provided in Table 11-3.

Table 11-3: Summary of Effects and Mitigation Specific to Species At Risk

Species	Potential Adverse Effects	Proposed Mitigation	Proposed Monitoring	Existing Species Recovery, Action, or Management
Horned Grebe (assessed by COSEWIC as Special Concern) Sensitive period is spring, summer, and fall.	Habitat loss or alteration, particularly from changes in water quality and quantity. Disturbance during nesting and fledging.	Avoid in-stream work during nesting, incubating, and rearing (May to August). Maintain natural drainage patterns (including quantity and quality). Maintain at least 250 m distance between lakes and construction operations. Adhere to construction restriction window near nesting habitat from May to August.	If in-stream work occurs from May to August, monitor water quality and quantity to ensure that changes, if any, are at acceptable levels. Cease in-stream work if water quality and quantity changes are unacceptable.	No plans currently exist.
Species	Potential Adverse Effects	Proposed Mitigation	Proposed Monitoring	Existing Species Recovery, Action, or Management Plans
Peregrine Falcon (assessed by COSEWIC as Special Concern) Sensitive period is spring, summer, and fall.	Disturbance during nesting and fledging. Habitat loss or alteration.	No clearing or construction operations within 1 km of known nesting locations (Two sites near Bear Rock) from March 1 to August.	No monitoring proposed as ENR periodically surveys these known sites under the Peregrine Falcon Recovery Plan.	Peregrine Falcon Recovery Plan
Short-eared Owl (assessed by COSEWIC as Special Concern) Sensitive period is spring, summer, and fall.	Habitat loss or alteration. Disturbance during nesting and fledging from construction and operation noise. Direct (vehicle-wildlife collision) mortality.	Minimize project footprint in shrub meadows and open black spruce habitats. Avoid clearing and construction during nesting and fledging season (May to August). Encourage participation in vehicle-wildlife collision reporting.	No monitoring proposed.	No plans currently exist.

Table 11-3: Summary of Effects and Mitigation Specific to Species At Risk (Continued)

Species	Potential Adverse Effects	Proposed Mitigation	Proposed Monitoring	Existing Species Recovery, Action, or Management Plans
Gray-headed Chickadee (ranked by ENR as May Be At Risk) Sensitive period is spring, summer, and fall.	Habitat loss or alteration. Disturbance during nesting and fledging from construction and operation noise.	Minimize project footprint in open canopied forests with an abundance of tall shrubs. Avoid clearing and construction during nesting and fledging season (May to August).	No monitoring proposed.	No plans currently exist.
Rusty Blackbird (listed by SARA as Special Concern) Sensitive period is spring, summer, and fall.	Habitat loss or alteration. Disturbance during nesting and fledging from construction and operation noise.	Maintain at least 250 m distance between lakes and construction operations. Avoid clearing and construction during nesting and fledging season (May to August).	No monitoring proposed.	No plans currently exist.
Grizzly Bear (assessed by COSEWIC as Special Concern) Sensitive period is year round, especially during denning (September to May).	Habitat loss or alteration. Habitat fragmentation Direct (vehicle-wildlife collision) and indirect (increased hunting, poaching, problem wildlife kills) mortality.	Encourage user participation in vehicle- wildlife collision reporting. Encourage user participation in the Sahtu Harvest Study. Cease clearing and construction activities during carnivore denning season (September to May) within 1 km of all known den sites. Maintain waste management along the Highway and around construction and maintenance camps. Endorse a hunting best practices education program: retain a 500 m no-shooting zone along the Highway. Endorse a hunting best practices education program: off road vehicle use is prohibited year round, except for snowmobiles once the ground is completely frozen and covered by snow (includes 8 km on either side of the Highway).	Conduct an active den survey in the fall prior to disturbing these areas to locate active den sites. Monitor known active dens during clearing and construction activities, and report any disturbance to denning bears. Cease clearing and construction if disturbance to denning bears. Continual dialogue and support to the Sahtu Renewable Resources Board to manage grizzly bears and their habitat along the Highway.	

Table 11-3: Summary of Effects and Mitigation Specific to Species At Risk (Continued)

Species	Potential Adverse Effects	Proposed Mitigation	Proposed Monitoring	Existing Species Recovery, Action, or Management Plans
Wolverine (assessed by COSEWIC as Special Concern) Sensitive period is year round.	Habitat loss or alteration. Habitat fragmentation Direct (vehicle-wildlife collision) and indirect (increased hunting, poaching, problem wildlife kills) mortality.	Encourage participation in vehicle-wildlife collision reporting. Encourage user participation in the Sahtu Harvest Study. Maintain a horizontal setback of 800 m from all known Wolverine dens. Maintain waste management along the Highway and around construction and maintenance camps. Endorse a hunting best practices education program: retain a 500 m no-shooting zone along the Highway. Endorse a hunting best practices education program: off road vehicle use is prohibited year round, except for snowmobiles once the ground is completely frozen and covered by snow (includes 8 km on either side of the Highway).	No monitoring proposed.	No plans currently exist.
Woodland Caribou (Boreal) (listed by SARA as Threatened) Sensitive period is year round.	Habitat loss or alteration (including increased risk of fire frequency). Habitat fragmentation. Direct (vehicle-wildlife collision) and indirect (increased hunting) mortality.	Encourage participation in vehicle-wildlife collision reporting. Encourage user participation in the Sahtu Harvest Study. Cease clearing and construction activities if caribou are in the local vicinity. Endorse a hunting best practices education program: retain a 500 m no- shooting zone along the Highway. Endorse a hunting best practices education program: off road vehicle use is prohibited year round, except for snowmobiles once the ground is completely frozen and covered by snow (includes 8 km on either side of the Highway). Endorse a hunting best practices education program: hunter education program to encourage hunters to track wounded animals, report harvests, identify bulls from cows, and improve marksmanship and use of appropriately sized rifles.	If clearing and construction during caribou over-wintering period is unavoidable, a wildlife monitor will be present to monitor the location of caribou. Cease clearing and construction activities if caribou are in the local area. Continual dialogue and support to the Sahtu Renewable Resources Board to manage boreal caribou and their habitat along the Highway.	Action Plan for Boreal Woodland Caribou Conservation in the NWT 2010-1015 (ENR 2010d). Federal draft national Recovery Strategy currently in development.

11.6 Effects on Fish, Fish Habitat, and Hydrology

11.6.1 Potential Effects on Fish and Fish Habitat

The assessment of the potential effects of road construction on aquatic resources, including fish and fish habitat, and the development and implementation of effective avoidance or mitigation measures, are major components of the environmental assessment of the Highway. Effects and mitigation are dependent on the characteristics of water bodies and the aquatic life they support. From the perspective of fish and fish habitat protection and management, three categories of streams are recognized along the Highway:

- non-fish bearing: streams that are not utilized by fish for any part of their life cycles;
- migratory channels: ephemeral and perennial (except in winter) streams that are utilized by fish only for migration during open water periods or that contribute to downstream habitat quality; and
- spawning/rearing/feeding streams: ephemeral and perennial streams that are utilized by one or more life cycle stages of fish during open water periods, in addition to migration.

Table 11-4 identifies the principal fish habitat issues which must be considered as part of the regulatory approval process. It recognized that damage to pristine fish habitats in the north is occurring and that activities and developments should be carried out in recognition of the sensitivity and value of these areas (Birtwell et al. 2005). As such, experienced habitat biologists, in consultation with road construction engineers, will develop specific avoidance or mitigative measures designed to achieve no net loss (NNL) of productive capacity of fish habitat. These will be guided by best management practices, such as the DFO Land Development Guidelines for the Protection of Aquatic Habitat (DFO 1993), and appropriate construction timing windows (DFO 2010a), which identify work time periods most suitable for work in or adjacent to watercourses.

Table 11-4: Potential Effects and Generalized Mitigation of Construction and Operation Activities of the Proposed Highway on Fish and Fish Habitat

Activity	Potential Effect	Avoidance or Mitigation
Bridge Construction	Direct loss of riparian habitat due to abutment construction.	Minimize riparian disturbance.
	Direct loss of instream habitat due to piles/piers.	Construct clear span bridges. Minimize instream work. Implement erosion and sediment control measures.
	Flow changes due to stream constriction.	Abutments to be placed at a sufficient distance from active stream channel.
Culvert Installation	Direct loss of habitat.	Avoid critical habitats. Select appropriate culvert design based on habitat characteristics.
	Migration barrier.	Employ best management practices for culvert design, sizing, and installation. Annual monitoring to detect culvert subsidence or lifting.
	Sediment release during construction.	Employ sediment and erosion control measures.
	Changes in stream flow patterns.	Appropriate sizing of culverts based on hydrological assessments.

Table 11-4: Potential Effects and Generalized Mitigation of Construction and Operation Activities of the Proposed Highway on Fish and Fish Habitat (Continued)

Activity	Potential Effect	Avoidance or Mitigation
Use of Heavy Equipment	Soil erosion and sedimentation.	Employ erosion and sediment control measures.
	Fuel, lubricant spills.	Regular maintenance of equipment away from water bodies. On-site spill containment equipment and staff training.
Highway Design	Direct loss of habitat	Avoid critical habitats Design appropriate crossing structures based on site conditions.
	Erosion and sedimentation.	Maintain sufficient distance from waterbodies, if possible. Install sediment control in ditches and cross drainage channels.
Quarry Development	Erosion and sedimentation.	Maintain sufficient distance of undisturbed land between quarry and any waterbody. Apply erosion and sediment control measures and best management practices.
Water Extraction	Oxygen level depression. Exposure of eggs and larvae. Reduction of available habitat for spring spawners.	Follow DFO Protocol for Winter Water Withdrawal.
Public Access	Increased exploitation due to improved access to remote fishing areas.	Public education.

11.6.2 Stream Crossings

Stream category will be a factor in determining, at a minimum, the type of structure at each stream crossing location that would avoid or minimize the HADD of fish habitat, as prohibited by Section 35. (1) of the Fisheries Act. Table 11-5 provides general guidance in this regard, although site specific conditions may dictate alternative measures:

Table 11-5: Generalized Stream Crossing Structure and Mitigation Recommendations, by Stream Category

Stream Category	Stream Crossing Guide
Non-fish Bearing	Culvert. Apply sediment and erosion control best management practices during construction.
Migratory Channels	Culvert. Sizing and placement of culvert is critical to avoid excessive velocities. Culvert should be set into the substrate to prevent erosion at downstream invert. Where possible, culvert should be installed in areas having a hard (gravel/cobble) bottom. Where culvert twinning is required, only one culvert should be set to permit fish passage at low flows. Apply sediment and erosion control best management practices during construction. Follow the DFO Operational Statement for Temporary Stream Crossings (DFO 2010b) where these are necessary. Follow DFO Land Development Guidelines for the Protection of Aquatic Habitat.
Spawning/Rearing/ Feeding Streams	Clear span bridge. Follow DFO Operational Statement for Clear Span Bridges (DFO 2010c). Apply sediment and erosion control best management practices during construction.

Table 10-19 in the previous section, provides preliminary recommendations for the type of stream crossing structures recommended at each crossing along the Highway. This information has been used in the preliminary design. These recommendations have been based solely on fish and fish habitat considerations, and the generalized guidance for stream crossing design identified in Table 11-5 above. As indicated in Table 10-19, there are a number of crossing locations requiring further field investigation to remove uncertainty regarding the quality of available fish habitat and the type of structure that should be constructed. Ground surveys will provide information on fish and habitat presence or potential, and hence, the appropriate construction and environmental management measures that should be adopted at each site. The locations where clear span bridges are recommended due to known fish presence and/or habitat quality are identified on Figure 6-4.

The findings of the September 2010 field program indicate that the majority of channels crossed by the Highway are small, ephemeral streams that generally drain terrestrial upland areas or small, shallow lakes or ponds, most of which do not provide suitable fish habitat features. However, these streams may provide food and nutrients to downstream fish bearing waters and as such, stream crossings at these sites as well should be carried out to avoid deterioration of water quality. As such, appropriately sized culverts (800 mm to 900 mm diameter) installed at these locations will require the implementation of appropriate erosion and sediment control measures to protect downstream habitats, but would not directly impact fish or fish habitat.

11.6.3 Sediment Control

By their nature, road construction activities have the potential to cause erosion and the consequent sedimentation of receiving streams and lakes. Sediment released to streams and lakes, both in suspended and settled forms, presents a serious risk to fish and fish habitat. The effects of sediment on fish and their habitat includes, but is not limited to: degradation of potential spawning areas; smothering of eggs and the benthic invertebrate food supply; reduction in feeding efficiency; avoidance of potentially suitable habitats; and, abrasion of fish tissues (Lloyd et al. 1987; Birtwell 1999). For example, Arctic grayling have been found to be displaced downstream of their preferred habitats at suspended sediment levels greater than 100 mg/L (McLeay et al. 1987); Scannell (1988) determined that only 10% of Arctic grayling food supply would be available at suspended sediment concentrations of about 63 mg/L; and, Birtwell (1999) reports dramatic decreases in salmonid egg survival with increasing levels of fine sediments in the gravel.

Sediment releases from highway construction and material source development originate from exposure of soils during site preparation and grubbing, the erosion of particulates that make up the highway surface and slopes, and the erosion of soils in unstable ditches, which is then carried in runoff. In recognition of the potential adverse effects of sediment, an environmental management plan (EMP) will be prepared prior to construction and approved by regulators, to provide specific and detailed guidance to avoid sediment releases to the aquatic environment. The EMP will refer to appropriate erosion and sediment control guidelines, best management practices, and measures outlined in the DFO Land Development Guidelines for the Protection of Aquatic Habitat (DFO 1993).

Some of the important measures to be followed include:

- limiting the use of construction equipment to the immediate footprint of the highway or material source;
- minimizing vegetation removal and conducting progressive reclamation at the material sources;
- keeping ice bridge and ice road surfaces free from soils and fine gravel that may be tracked out of the material source by vehicles;
- avoiding the use of heavy equipment in streams or on stream banks and the adherence to the DFO Operations Statement for Temporary Stream Crossings, where these are deemed necessary;
- installation of silt fencing and/or check dams, and cross drainage culverts as necessary to minimize siltation in runoff near water bodies; and
- appropriate sizing and installation of culverts to avoid backwatering and washouts.

11.6.4 Water Extraction

Considerable amounts of water will be required for Highway construction. Water for these purposes is proposed to be extracted from lakes in the vicinity of the Highway and material sources. Since construction will take place in winter, water will necessarily be pumped from water beneath ice cover.

The extraction of water from ice covered lakes can potentially contribute to lethal and sub-lethal effects on fish due to depression of dissolved oxygen concentrations, exposure or freezing of littoral spawning beds due to falling water levels, and loss of important habitats for spring spawning fish (e.g., northern pike) if water levels do not sufficiently rebound to flood critical spawning habitats (Cott et al. 2008a; Cott et al. 2008b). As a result, DFO, in conjunction with other regulators and industry, has developed the Protocol for Winter Water Withdrawal in the Northwest Territories (DFO 2005), for projects where a water withdrawal of greater than 100 m^3 is required from any individual water body that has the potential to provide fish habitat.

Based on recent research in Northwest Territories lakes, this protocol sets limits to water withdrawal as a percentage of available water volume under ice, with consideration given to latitude and maximum lake water depth (Cott et al. 2008b). Those water withdrawal thresholds for the area:

- 0% for lakes with less than 1.5 m of free water below the maximum ice thickness (i.e., 2 m);
- 10% of available under ice water volume for lakes with a minimum depth of ≥ 3.5 m; and
- 100% if the maximum depth of the water body is less than the predicted maximum ice thickness (implying no available overwintering fish habitat, but in reality, there would be no water available to withdraw, either.).

In addition, the protocol directs that water be withdrawn from areas of a lake that are greater than 2 m below the ice surface to avoid removing the more highly oxygenated water that tends to collect at the water-ice interface. Water intake screening with mesh of 2.5 mm should be used to avoid entrainment of fish (DFO 1995).

To conform to the thresholds set out in the DFO Protocol, it may be necessary to carry out bathymetric surveys on some of the lakes proposed for water extraction. Minimum requirements for the collection and submission of bathymetric survey information are provided in the Protocol, and are further detailed in Cott et al. (2005).

Compliance monitoring during construction is normally required to ensure that prescribed mitigation measures and best management practices are implemented, and to detect and correct unanticipated problems. Monitoring of the construction will be carried out by trained environmental and wildlife monitors. During construction, wildlife and environmental monitors will be onsite at all times during any time that construction activities are being undertaken. Additionally, contractors will be required to ensure that employees are trained in spill response techniques, working near water safety procedures and wildlife and environmental awareness and safety procedures.

The implementation of site specific monitoring lends itself well to the principle and practice of adaptive management. An objective of the construction of the Highway is to avoid or minimize adverse effects on the environment through investigation of existing natural resource characteristics, designing and employing environmentally compatible construction methods, and modifying procedures based on previously identified contingency measures if monitoring identifies potential or ongoing adverse environmental interactions. This is a systematic, rigorous approach for deliberately learning from management actions with the intent of improving management policy or practice.

11.7 Effects on Communities and Cultural Resources

The Highway has the potential to have both positive and negative effects on the communities within the Tulita District. The main positive effects of the Highway on the communities of Tulita and Norman Wells are discussed in Section 12.0. Any human activity or development has the potential to generate negative effects and mitigation measures can be planned and implemented ahead of time to minimize detrimental effects. Likewise, some of the benefits associated with the Highway can be enhanced with similar foresight and planning. A summary of the positive effects and the potential negative effects are presented in Table 11-6 along with enhancement and mitigation measures.

The Highway has the potential to affect areas of cultural importance directly through highway construction activities and indirectly through providing increased access to the land. As described in Section 8.0, there are some recorded heritage resources in the vicinity of the Highway. Some sites linked to traditional knowledge and culturally important sites that are not necessarily known heritage resource sites are also within the vicinity of the Highway. The potential effects of the Highway on these areas are summarized in Table 11-6.

Table 11-6: Potential Effects of the Highway on Communities and Cultural Resources

Main Area of Potential Effects	Potential Effects	Enhancement or Mitigation Measures
Tulita District Communities	Reduced cost of living.	Reduce costs and shorten driving times to resupply communities from Yellowknife and Edmonton. Increase reliability of supply and general availability of consumable goods.
	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.
	Direct employment opportunities during construction and operation of the Highway.	Implement and support relevant training for employment at the appropriate time. Increase opportunities that emerge with the opening of the Highway – tourism, mining, oil and gas exploration, and development.
	Easier access to better health care, recreation and education facilities.	Shorter travel distances by road to major centres. Creates opportunity to enhance tele-health and distance education options via the future fibre optic cable.
	Increase in community, family, cultural, and sporting interactions.	
	An increase in waged income during highway construction and operation may lead to an increase in drug and alcohol abuse.	Strictly enforce a no alcohol and drugs policy at construction and maintenance camps.
		Explore wage payment options that reduce immediately available 'cash in the hand'
	Public health and safety: Increased traffic during the construction and operation of the Highway.	Preparation of a traffic management plan.
	Potential for accidents and spills.	Ensure that trained response team is available to deal with accidents and spills. As a side benefit, this creates a new employment opportunity.
	An increase in opportunities for education and training.	Implement and support relevant training for employment at the appropriate time. Increase opportunities that emerge with the opening of the Highway – tourism, mining, oil and gas exploration, and development.

Table 11-6: Potential Effects of the Highway on Communities and Cultural Resources (continued)

Main Area of Potential Effects	Potential Effects	Enhancement or Mitigation Measures
Heritage Sites	Potential disturbance of heritage resources, e.g., archaeological remains.	Avoid known locations of heritage resources and archaeological remains in the detailed design and constructions stages of the Highway development.
		Temporary site protection.
		In the event that avoidance of a site is not feasible, detailed mapping, recording and excavation of a sufficient number of units to ensure a representative sample of the site contents is collected should be obtained. This ensures that knowledge of that site is available for future generations.
	Increase access to known sites once the Highway is in operation.	To ensure that travellers along the Highway are aware of restrictions and requirements for accessing adjacent lands, non-typical information signs that identify land ownership, the necessity to gain permission to access, and contact information will be included in the typical highway signing.
Traditional knowledge sites and traditional activities.	Potential direct disturbance of culturally important sites, other than heritage resource sites, e.g., sources of food and shelter, places associated with legends.	Avoid small sites through minor realignments or footprint adjustments.
	Potential indirect effect: Easier access to the land may cause detrimental effects, e.g., misuse of a sacred site, over harvesting of traditionally important animals and plants. Easier access to the land may also be seen as a positive effect of the Highway as it may allow more people to pursue traditional activities and connect with the land.	Monitor and control access to lands adjacent to the Highway. Potential tourism opportunities.
		Public awareness initiatives that raise the profile of the cultural value of the land.

11.8 Effects on Safety

Safety is directly impacted by collisions or malfunctions which can be associated with any human activities, including those associated with the short-term construction periods projected for the Highway.

Environmental consequences of potential accidents or malfunctions associated with the Highway and associated aggregate borrow and construction camp activities would be primarily limited to those related to:

- vehicle collisions; and
- fuel storage, transportation and handling system failures.

To minimize risks of collisions or malfunctions occurring and to minimize possible risks to the environment from such potential collisions or malfunctions, a number of preventative and mitigation measures will be employed. The overriding preventative and mitigation measures to be employed include the following:

- implementation of best management and industry practices as appropriate to prevent or minimize the occurrence of collisions or malfunctions;
- ensuring that all contractors onsite have industry-compliant and satisfactory HSE policies, programs, and manuals and that they are successfully implemented throughout the project;
- compliance with Land Use Permit and Quarry Permit requirements and conditions issued for the construction project;
- conformance with existing applicable GNWT and Workers Compensation Board standards;
- fuel and other hydrocarbons will be stored in accordance to storage tank regulations under the Canadian Environmental Protection Act and the Canadian Council of Ministers of the Environment's (CCME's) Environmental Code of Practice for storage of these products (CCME 2003);
- any uncontrolled discharge will be immediately managed to stop discharge and begin the mitigation process. Spills will be reported to the 24-hour Spill Report Line (867.920.8130) according to current guidelines;
- spill containment and cleanup activities will be implemented in accordance with the site-specific spill contingency plans that will be developed by the prime construction contractors selected for the construction of the Highway (e.g., Appendix I); and
- safety measures to prevent vehicle accidents on the Highway have been and will continue to be incorporated into the design. Measures to avoid or minimize accidents, particularly those which may occur at or near a watercourse crossing, will include posted speed limits, adequate signage alerting drivers to Highway curves, and upcoming bridges. Bridge design will incorporate guardrails to prevent a vehicle from going off the highway and into a watercourse in the event of an accident.

The key strategy will be to prevent collisions from occurring through education and enforcement. With the application and implementation of the preventative and mitigation measures as outlined, no significant fuel, chemical, or other product spills are expected to occur. More specific discussions on mitigative measures are as follows.

11.8.1 Fuel Storage

The estimated volume of fuel to be stored at each construction camp facility is 100,000 L (two 50,000 L storage tanks).

Fuel needed for the aggregate borrow and highway construction activities will be stored in double-walled fuel storage units. All fuel will be stored in accordance with CCME (2003). All fuel will be stored at least 100 m from waterbodies unless expressly authorized by Land Use Permit or authorized by the inspector in writing. An example fuel spill contingency plan is provided in Appendix I. Tanks would need to be registered with Environment Canada.

11.8.2 Refuelling Operations

All fuel truck and equipment re-fuelling will be done at least 100 m from the ordinary high water mark of any adjacent waterbodies. An example fuel spill contingency plan is provide in Appendix I.

11.8.3 Waste Management

11.8.3.1 General Waste Management Planning

Contractors for the Highway will have waste management planning in place that will ensure wastes are handled, stored, transported, and disposed of in a manner that will prevent the unauthorized discharge of contaminants, mitigate impacts to air, land, water, and minimize risks of animal attraction, while maintaining the health and safety of personnel and wildlife. The proponent will develop or require the contractor to develop a Waste Management Plan for all wastes associated with construction activities. The Waste Management Plan will apply the generation, treatment, transferring, receiving, and disposal of waste materials for the Highway. The Waste Management Plan will:

- identify waste sources and related types, including but not limited to liquid, solid, non-hazardous, hazardous and approximate quantities;
- describe all on-site or remote treatment and disposal methods;
- describe all waste streams to be transported off site and final disposal locations;
- describe the related waste segregation strategies for the identified waste sources and types to accommodate their respective storage, treatment, transport, and disposal; and
- describe food and food contaminated waste management methods to mitigate animal attraction from source to transport, treatment, or disposal.

11.8.3.2 Waste Handling and Separation, Storage, and Processing at Source

The wastes will be segregated and stored separately as described in the tables below. Effective separation of different types of wastes at the source will enable proper handling from waste creation through treatment and/or disposal.

11.8.3.3 Food and Food-Contaminated Waste and Animal Attraction

Timely and responsible segregation, storage, and disposal of food and food-contaminated waste, is of critical importance to minimize risks associated with wildlife attraction. To minimize risks of animal attraction to camps and other related activities while maintaining health and safety of personnel, wildlife, and the environment, all food and food contaminated waste will be stored separate to all other wastes, and in airtight sealed container(s), and enclosed in a bear proof container while in bulk storage prior to final transport, treatment, or disposal.

11.8.3.4 General Camp Waste and Sewage

The main wastes produced during the construction of the Highway are those resulting from camps, which is comprised of waste typical and similar to that of municipal solid waste (MSW) streams, as described in

Table 11-7. This MSW will be generated from temporary construction camps used to house construction crews for the duration of the project, as described above.

Table 11-7: Classification of Camp Waste

Type of Waste	Description
Recyclable Material	Paper, glass, bottles, cans, metals, certain plastics.
Food Contaminated	Biodegradable waste, food and kitchen waste, animal and vegetable wastes: typical of restaurants, hotels, markets, etc.
Composite	Waste clothing, non-recyclable plastics, etc.
Human Waste	Sewage related, blackwater.
Greywater	Kitchen and washing related liquid waste.

11.8.3.5 Industrial Waste

Industrial waste, will encompass all other wastes not defined as camp sourced MSW described above.

Table 11-8: Classification of Industrial Waste

Type of Waste	Description
Recyclable/reusable Construction and Demolition	Building materials, etc.
Non-recyclable Construction and Demolition	Inert material, such as soil and granular material.
Hazardous Materials	Contaminated soil/snow/water. Waste fuel. Used oil. Other crankcase fluids. Solvents. Glycol. Batteries. Tank, drum, and container rinsings. Empty drums.

11.8.3.6 Hazardous Waste

Hazardous waste will be generated during the construction of the Highway. Part of this management includes compliance with ENR's requirements to track the movement of hazardous waste from registered generators, carriers, to receivers according to the Guideline for the General Management of Hazardous Waste in the NWT.

DOT is currently a registered generator of hazardous waste and is directly responsible for the hazardous waste generated from their operations. DOT is responsible for the hazardous waste generated from private contractors on the Highway. Hazardous waste must be disposed of at an approved facility, and it is not appropriate to dispose hazardous waste in Northwest Territories community solid waste facilities.

To mitigate potential adverse environmental effects associated with improper hazardous waste disposal and to further demonstrate that proper hazardous waste management planning is in place, a Hazardous Waste Management Plan (HWMP) will be developed. The HWMP will encompass all pre-construction and construction phases of the Highway and will apply to receiving, transferring, and transporting hazardous waste for activities on land, water, and air. The HWMP will include, but will not be limited to:

- identify hazardous waste sources, types, and approximate quantities to be produced (including liquid, solid, dangerous goods and non-dangerous goods);
- description of waste segregation methods;
- description of all on-site treatment and disposal methods; and
- description of all hazardous wastes that will be transported to approved receiving facilities.

12.0 POTENTIAL SOCIO-ECONOMIC IMPACTS OF THE MACKENZIE VALLEY HIGHWAY

This section contains information about the expected economic impacts of Mackenzie Valley Highway construction and long-term operations. The highway strategy developed in 1999 for DOT (Nicholls 1999) had included a study of the socio-economic impacts of the entire Mackenzie Valley Highway extension from Wrigley to Inuvik, but not specifically for each area. It is anticipated that the SSA, which presently is not served by an all-weather highway, will see a positive economic impact as a result of the Highway's construction and long-term operations and maintenance.

Recent studies, including the 2009 report entitled "Mackenzie Valley All-Weather Road Economic Analysis" prepared jointly by Terra-Firma Consultants and Pacific Analytics Inc. for DOT (DOT 2009), and "Mackenzie Valley All-Weather Road Opportunity Assessment, October 2007", prepared by Meyers Norris Penny LLP (MNP 2007) for the Mackenzie Aboriginal Corporation, update the economic impact analyses done in 1999. The highlights of the two studies, which have quantified the economic impacts, are presented below, followed by a discussion of other general benefits of the Highway. These studies estimate the impacts for overall Mackenzie Valley Highway from Wrigley to Tuktoyaktuk, and not for the component parts in each area. The terms "the Highway" and the "Mackenzie Valley all-weather road" are used interchangeably in the studies.

12.1 Regional Economic Impacts

The "Mackenzie Valley All-Weather Road Economic Analysis" (DOT 2009) is a comprehensive study that quantified the various economic impacts of the Highway, which are summarized below. This study found the Highway would have the following four economic effects:

- personal and business income from construction and long-term maintenance activities;
- reduction in the cost of living for all communities and related increase in standard of living through greater disposable income along the route;
- increase in tourism activity and related business development opportunities; and
- impact on the proposed MGP construction and subsequent exploration activities.

Certain economic impacts are directly related to the dollars invested, and the study used the following cost estimates for calculating the economic impacts:

- Construction costs estimated at $1.67 billion for the entire Highway, which includes $1.3 billion for road building, $223 million for bridge construction, $178 million for engineering and $13 million a year for maintenance costs.
- Benefits – direct and indirect – to the Northwest Territories as a whole include $956 million increase in GDP, the creation of 7,718 person-years of employment, and a $78 million increase in revenue for the GNWT.

12.1.1 Economic Impacts from Construction and Maintenance

One of the economic impacts from the construction and maintenance of the Highway is short-term and long-term employment, estimated in the 2009 study as follows:

- 7,785 one-time jobs in the Northwest Territories and 6,297 one-time jobs in the rest of Canada during the period of construction;
- $200 million in earnings from activities for the GNWT and $70 million for the governments in the rest of Canada; and
- 128 permanent jobs in the Northwest Territories for ongoing highway maintenance and another 33 in the rest of Canada (DOT 2009).

The 2009 study reports that once built, the annual budget for Highway maintenance is estimated by DOT to be $13 million a year, which will result in an additional $10 million increase in gross domestic product (GDP) and an increase in GNWT revenues of $0.8 million. These economic benefits will continue throughout the life of the Highway, while the economic benefits from construction will be short-lived through the few years of construction.

The Highway will have positive spin-off benefits for other sectors of the Northwest Territories economy, estimated annually at $5.5 million in GDP, 41 permanent jobs, and an increase in government revenues by $1.1 million, of which $0.6 million would accrue to the GNWT. The rest of Canada will experience an increase of $0.8 million in GDP, 11 more permanent jobs, and $88,000 in additional government revenues.

The GNWT spends $1.3 million annually on winter road construction and operation from Wrigley to Fort Good Hope. This amount includes direct, indirect, and induced contributions to the Northwest Territories GDP and the GDP in the rest of Canada, permanent employment in both the Mackenzie Valley and the rest of Canada, and federal and territorial government revenues.

These annual benefits will be lost because the winter road will no longer be needed, but the anticipated annual economic benefits associated with Highway operation will be much greater, more than replacing this loss. Additionally, not building the winter road frees $1.3 million annually that can be used by the GNWT elsewhere.

All of the estimates above as reported in the 2009 study, are for the overall Mackenzie Valley Highway from Wrigley to Inuvik, and a proportion of these benefits can be expected for the SSA.

12.1.2 Reduction in Cost of Living

Completion of the Highway will mean the residents in each area will be able to take advantage of reduced transportation costs, which reduces the cost of shipping goods to all communities along the Highway. Reducing the cost of living correspondingly improves economic well-being overall for residents in each area.

Again the 2009 study reports that the cost of living is expected to decrease by as much as $15.7 million annually in the Inuvik region, based on the assumption that all of the approximately 5,110 commercial transport trucks currently travelling the Dempster Highway to Inuvik each year would shift to the Mackenzie Valley Highway, thus saving about $3,070 a year per transport load, or about $15.7 million a

year in total. The reduced cost of shipping goods north would result in lower prices for consumers in all communities, including all SSA communities. Sahtu residents now use the winter road to drive to Yellowknife or Edmonton to stock up on non-perishable food items and other household goods so as to avoid paying the much higher prices for products flown or barged in during the rest of the year.

The 2009 study report does not provide detailed calculations for this estimate. The road distance between Edmonton (the assumed origin of the trucks) and Inuvik via the Highway would be 745 km or 23% shorter than the Dempster route (approximately 2,510 km compared to approximately 3,255 km), and other things being equal, this can be estimated to save at least 23% in trucking costs, which would be sufficient economic incentive for the change of route. By extension, communities in Tulita District can also be expected to realize cost savings as a result of greatly decreased transportation costs and regular freight deliveries.

The economic spin-off resulting from residents purchasing more goods with the same amount of money would generate $5.5 million in GDP, create 41 permanent jobs, and increase government revenues by $1.1 million, of which $0.6 million would accrue to the GNWT. This increase in consumer spending would occur annually and therefore would strengthen the economy year after year.

12.1.3 Tourism Impacts

The 2009 study comments on increases in tourism. In the study, Northwest Territories Tourism officials suggest that the Highway would increase tourist visitations by 20%, or 2,500 to 2,700 new tourists each year. 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 throughout the Northwest Territories. 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.

Besides the increase in tourist numbers, the Highway could result in longer tourist stays in the Northwest Territories and Yukon by creating a driving "loop" that traverses north through the Deh Cho, Sahtu and Gwich'in areas, where it connects with the Dempster Highway which tourists can follow into Yukon to drive south. This "loop" route could see a number of tourism-related business start-ups in all areas, including guiding, bed and breakfast accommodations and some gas stations and restaurants.

12.1.4 Impact on the Proposed Mackenzie Gas Project

For the construction of the MGP, the absence of all-weather road access to the pipeline means a majority of the pipe, heavy equipment, and other construction materials will be transported by barge to existing or new barge landing and staging areas. The Highway, even if built before the MGP, is not expected to significantly reduce initial pipeline construction costs (DOT 2009). However, depending on the pipeline construction location and time of year, cost savings could be realized if some winter access roads do not need to be built as a result of the Highway's completion prior to pipeline construction.

In the SSA, there are four locations presently used for barge landings. Three are the community barge landing sites at Tulita, Norman Wells and Fort Good Hope, while the fourth is at Little Chicago, south of the northern boundary of the SSA (in K'ahsho Got'ine District, and which has been used in the past for

supplying oil and gas exploration projects in the area. In the absence of an all-weather highway, construction of the pipeline north of Fort Good Hope to Little Chicago would require access by a new winter road. Completing the Highway in that section prior to pipeline construction could reduce pipeline construction costs given that the Highway and the pipeline are proposed to be constructed within a common Transportation Corridor. Reliable, public, all-weather access to a Transportation Corridor identified for infrastructure development will have both quantifiable and unquantifiable advantages in the development of the MGP.

12.1.5 Positive Changes in the Economic Structure of the Northwest Territories Economy

New economic patterns and structures will emerge to take advantage of the lower costs and lower economic risks provided by the Highway, including the following:

- The Highway can facilitate new oil and gas exploration in the Sahtu through more efficient and cheaper transportation of industrial supplies and equipment. There is presently no all-weather road connecting Sahtu to the rest of the Northwest Territories or southern Canada, so the Highway would open up the Central Mackenzie Valley to more exploration.
- Currently, exploration or development projects in the Sahtu occur in winter to take advantage of the winter road to move supplies and equipment to the project location. The Highway would facilitate year-round activity, thereby reducing the seasonal cyclical intensity and the associated inflationary pressures.
- The potential for Northwest Territories-based businesses, such as locally-owned oilfield logistics companies that can also provide "hotshot" delivery services or locally-owned welding companies, to provide additional supplies and services to the oil and gas sector via the Highway.
- The potential for new business and education opportunities in the SSA through the availability of high-speed, reliable Internet access through installation of the fibre-optic cable.

Although it is difficult to quantify in terms of real savings, the introduction of a reliable public transportation system such as an all-weather highway provides opportunity for the development of other infrastructure and resources in an efficient and sustainable manner. This is specifically relevant to Sahtu where such development may never have occurred otherwise because of the very high transportation costs due to a lack of any all-weather road connection, or that may have occurred in an uncontrolled, damaging, and undesirable manner. Highway development in the SSA can provide access for the orderly development of resources and infrastructure, and also provides opportunity to consolidate that access to a common Transportation Corridor (DOT 2009).

12.2 Impact on Oil and Gas Exploration and Development

As noted earlier, there is not now an all-weather highway connecting Sahtu to the rest of the Northwest Territories or, by extension, to the rest of Canada. As such, the Highway through Sahtu and connecting south, will not only open up the SSA to business and job creation and development, but will also open up the area to resources exploration and development in a way that has not historically been possible. The Highway is a regional and basin-opening project for Sahtu, in the same way the MGP is a basin-opening

project for the Mackenzie Delta and, by extension, the entire Mackenzie Valley. Over the past four decades, several studies produced by or for the DOT, including those referenced in this PDR, have shown repeatedly that the Highway will have a positive economic impact on the economy of Sahtu and its residents.

For example, the Highway will provide better access for MGP-related construction activities, year-round access and support for development along the entire transportation corridor in the Sahtu. This will make it feasible for the Sahtu land corporations to post Sahtu lands for future oil and gas exploration, should they so decide, allowing for royalty revenue collection, joint venture resource development corporations and the long-term development of a professional resource workforce.

The lack of an all-weather Highway in the Sahtu is seen by industry to be a barrier to year round and ongoing oil and gas exploration and development (MNP 2007). There is definite interest in oil and gas exploration and development in the Sahtu as is evidenced from the prices bid for the exploration leases awarded by AANDC in June 2011 on several parcels of Crown land in the area, particularly in the Tulita district. If the Highway was completed, exploratory drilling and subsequent development and production would be more efficient, less costly, less risky and occur year round rather than only in winter. In addition to the possibility of posting Sahtu lands for explorations, the Highway will stimulate local resource-related business development in the Tulita district and throughout the Sahtu.

The MNP 2007 report quantified the impact of the Highway on future oil and gas exploration and development, assuming that the MGP would be built. The objectives of the report were to:

- assess the opportunity costs that a of lack of all-season access to the Mackenzie Valley area has had onregional natural resource development; and
- estimate development opportunities which could result from potential access to remote exploration and production sites in the Mackenzie Valley area.

This report, and the DOT 2009 report, both used consultation with and information from exploration and development companies active in the Northwest Territories. The estimation of impacts and benefits cited are based on currently available cost information and cost structures for exploration wells in the Mackenzie Valley.

The reliance on winter road access for oil and gas exploration and other developments has some obvious disadvantages. First, the developer must spend thousands of dollars to construct a “one time use” road for each individual project. Second, there are uncertainties relative to the number of days a winter road can stay in operation in any particular year, adding risk to exploration program. Historical climate data can be used to make some estimates, but recent experience with winter roads in the Mackenzie Valley and the Slave Geologic Province north of Yellowknife indicates that this is unreliable given the impacts of climate change.

Highway access extends and/or confirms the length of the drilling season, enabling project cost reductions. For example, the Highway will allow rigs to move when drilling is finished on a well, thereby saving the standby and storage costs incurred from waiting for the winter road. It will also allow for longer drilling periods, as a well need not be finished in order to move a rig before the winter road shut-down date. Rig rental costs savings are estimated to be $357 million over the 45-year life of the MGP (Terra-Firma/Pacific Analytics 2009).

The MNP 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 current activity, 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 throughout the Mackenzie Valley 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 yields a potential additional gain of $3.4 billion to government over 25 years. This net gain has the present value equivalent of approximately $1 billion at 5% annual growth.

The MNP 2007 study summarizes the reduction in the cost of drilling exploration and production wells as follows:

- 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.
- 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 MNP 2007 report concluded that the presence of an all-weather highway in the Mackenzie Valley area would serve to materially reduce the cost premiums on exploration and development, thereby stimulating investment in the area and generating significant positive financial and other benefits for the area and for Canadians.

12.3 Economic Benefits for Tulita District

High transportation costs from a lack of all-weather road transportation in the Tulita District have a tremendous impact on the costs of goods and services in the area, driving up costs for residents, for resource exploration and development projects, and for developing and managing any business in the area. By significantly lowering the cost of all freight transportation, the Highway will have a positive economic impact in the Tulita District, and the entire Sahtu, as summarized below in Table 12-1.

Table 12-1: Potential Effects on Local Business with the Construction of the Highway

Category	Potential Overall Effect	Potential Economic Effect
Transportation and Travel	Possible Sahtu transportation infrastructure changes: ▪ Reduction in barge re-supply, air freight and air travel costs. ▪ Increased transport truck services, buses, taxis.	▪ Short-term job/business loss in barge and air services. ▪ Increased regional economic activity will create new short term and long term job and business opportunities such as freight hauling, logistics services, business and personal vehicle sales and maintenance. ▪ Year-round road access for exploration and development projects will reduce the cyclical boom-bust seasonal activity that now occurs. ▪ Community businesses will likely have greater market potential through access to and from other regional communities.
Cost of Living	Reduction in cost of living from lower transportation costs for goods and reduced stockpiling (DOT 2009).	▪ Reduced costs mean more disposable income and rise in standard of living for local residents could provide short-term and long-term boost to local economy and new business creation. (DOT 2009). ▪ Community consultations in Norman Wells July 28, 2010 residents identified reduced freight and travel costs as a benefit
Employment and Revenue	No ice road construction.	▪ Elimination of related jobs or businesses can be offset by potential creation of Highway-related short-term and long-term jobs or businesses from construction, operations and
	Highway construction.	▪ Creation of 7,785 one-time Highway jobs in the Northwest ▪ Territories, including many in Tulita District, leading to short-term increased income and enhanced skills useful for future exploration and development projects. ▪ Income used to purchase goods and supplies at local businesses would boost local economy. ▪ During community consultations in Norman Wells, July 28, 2010, residents identified that increased income for local residents was an expected outcome of the Mackenzie Valley Highway.
	Highway maintenance and operations.	▪ Maintaining and operating the Mackenzie Valley Highway will likely create 128 long-term jobs and create an additional 1,000 new or extended indirect jobs (MNP LLP 2007), including a proportion in Tulita District. ▪ Increased disposable income resulting from increased employment can lead to a more robust local economy and new
Business Markets	New business markets.	▪ During community consultations in Norman Wells, July 28, 2010 residents identified new opportunities for business as an outcome of the Mackenzie Valley Highway. ▪ Highway may lead to new local business opportunities to market local products and services (Nichols Applied Management and J. Knopp 2010). ▪ Highway may facilitate new local business and employment opportunities in the resource exploration and development

Table 12-1: Potential Effects on Local Business with the Construction of the Highway (Continued)

Category	Potential Overall Effect	Potential Economic Effect
Tourism	Increased tourism.	▪ During community consultation in Norman Wells, July 28, 2010 residents identified that the Mackenzie Valley Highway would enhance tourism in the area. ▪ Tourism in the Mackenzie Valley could rise by about 20% per year, (DOT 2009) prompting new related business development or strengthening of existing Sahtu businesses. ▪ Tourists could drive the Highway "loop" from Northwest Territories to Yukon, thereby staying longer in the north.
Recreation	Increased access to recreational areas and facilities.	▪ Business development or diversification potential due to increased demand for recreation facilities and/or services and equipment. ▪ Increased access to recreational facilities in other communities, particularly in Norman Wells, may lead to expanded use.
Traditional Economy	Increased or decreased participation in the traditional economy.	▪ Highway-related employment and business opportunities from construction and operation could reduce or enhance traditional economy activities. (Participation in the wage economy of the diamond mining industry in NWT is linked to higher participation rates in the traditional economy for a variety of reasons) (DOT 2009)
Education and Skills	Increased access to education and training via Internet access through fibre optic cable.	▪ Increased access for residents to distance education and training could enhance local workforce numbers and skills. Business could hire locally instead of from other areas, thereby reducing employment costs.
Natural Resource Exploration and Development	Significantly reduced exploration costs (MNP 2007). Posting of Sahtu lands for exploration.	▪ Reduction in exploration costs will make the area more attractive and further exploration may occur (MNP LLP 2007). ▪ Sahtu land corporations could post Sahtu lands for exploration, possibly earning royalties, developing joint venture exploration corporations, establishing a trained and professional resource
	Increase in natural resource exploration (MNP 2007).	▪ Increased wage economy due to natural resources exploration. ▪ Residents or non-residents workers could purchase goods and services in the communities and further support new businesses. ▪ Business opportunities may develop to support the increased opportunities in the oil and gas and mining sectors.
	Extension of the drilling season (MNP LLP 2007).	▪ Increase in revenue potential for local businesses from a longer period of economic activity and employment. ▪ Cheaper drilling costs for resource companies from reduced standby and transportation costs, more efficient rig utilization, elimination of risk of early winter road closure.
Mackenzie Gas Project (MGP)	Reduced MGP project costs if Highway construction precedes pipeline construction.	▪ Should the MGP proceed, it will facilitate direct and indirect job and business opportunities in Tulita District, and by extension, Sahtu. ▪ Possible long-term pipeline operations jobs and business opportunities.

12.4 Other Benefits

Other benefits, such as installing fibre optic cable in the Highway embankment, are difficult to quantify and include the following.

12.4.1 Cost of Government Program Service Delivery

The Highway will reduce the cost of providing government services and programs to the area through a reduction in travel costs, operation and maintenance costs for health, education, social, and recreational facilities and services, capital programs, and local municipal services and programs. The Highway provides the backbone of an overall Transportation Corridor which, as noted above, could include fibre optic cable. The ability to provide healthcare and education through reliable high-speed Internet access is a very effective means of delivering programs to small remote communities. The GNWT provides some access to health care through the Tele-health program; high-speed Internet access can enhance this service.

12.4.2 Social Benefits

The Highway will provide SSA residents year-round road connection to communities to the North and the South of the Sahtu, as well as to the rest of Canada, thereby allowing cheaper, easier, and safer access to regional facilities, programs, and services in health care, education, and recreation. This will help to promote family, community, and sports events, such as school indoor soccer and hockey tournaments, community feasts and festivals, and make family get-togethers such as weddings or reunions more affordable.

12.4.3 Tourism Benefits

In addition to the quantified benefits the Highway can have for tourism, mentioned above, the Highway could also be utilized to promote a unique tourism experience. The northern section of Mackenzie Valley Highway connects with the Dempster Highway through Yukon, thereby creating a driving "loop" which could likely become an attractive driving adventure through two of the three northern territories for tourists from southern Canada and the United States. The communities along the Highway will become key destination points for services along the way, which could result in related business development opportunities for residents along the route in Northwest Territories and Yukon. .

12.4.4 Identification of a Transportation Corridor

The identification of a transportation corridor through the Mackenzie Valley will be an outcome of the development of the Highway. The concept of a transportation corridor, discussed earlier in this PDR, provides the opportunity to position linear developments within a common corridor along the Mackenzie Valley. This takes advantage of access via the Highway and minimizes the development footprint on the land. Although labeled a "transportation corridor", infrastructure within such a corridor would include pipelines, transmission lines, and communication infrastructure (i.e., future embedding of fibre optic cable in the Highway embankment).

Communication infrastructure in the form of fibre optic cable has considerable advantages and benefits. It provides reliable and cheaper high-speed Web service for the northern communities, allowing access to

information that is relevant to education, healthcare, business activities, and the retention of languages and culture. As well, the introduction of fibre optic cable provides for reliable transmission of data out from future satellite collection or receiving points located in Inuvik.

12.5 Opportunities to Develop a Future Workforce

Throughout the community consultations in the Tulita District associated with preparation of this PDR, the question of training and education opportunities frequently arose. Although this document does not commit any organization or agency to the training and education of a future workforce, it is relevant to identify opportunities that could be undertaken now in preparation for the future. Training and career planning could begin at the high school level in the communities.

Construction of the Highway will present business and employment opportunities for general labourers, heavy equipment operators, transport and light truck drivers, surveyors, environmental monitors, camp staff (cooks, camp managers, custodians), expeditors, engineering and technical staff, and construction administrators, among many others. Although the Highway construction is a one-time opportunity, the result will be a well-trained and educated SSA workforce that can serve the needs of future infrastructure and resource exploration and development, as well as make any exploration and development in Tulita and Sahtu more attractive. The economic and social benefits presented above provide a vision of opportunities beyond the construction of the Highway, relative but not limited to:

- Highway management and operation by DOT (equipment operators, highway patrol, maintenance foremen, expeditors, engineering and technical staff, environmental monitors and administrative staff, expeditors and logistics specialists, etc.);
- land access management by the appropriate authorities in the Tulita District (enforcement, environmental and wildlife monitors, technical planning staff, etc.);
- tourism and associated community-based service businesses (environmental and wildlife monitors, professional guides, tourist accommodations, campgrounds and RV hook-ups, communications and promotions specialists, business administration professionals, chefs, restaurant managers, expeditors, logistics specialists, etc.); and
- resource and exploration opportunities and associated community-based service businesses (environmental and wildlife monitors, technical and engineering specialists, oilfield welding trucks, camp support staff, expeditors, logistics specialists, heavy equipment and transport truck drivers and local administrative and management staff, etc.).

12.6 Other Potential Effects

12.6.1 Infrastructure and Land Use Effects

The Highway is located on Sahtu Settlement Lands, Crown Lands, and Commissioner's Lands (Figure 8-9) within areas zoned for General Use, and Special Management (Figure 8-10). In particular, the alignment passes through the Mackenzie River Special Management Zone, Great Bear River Special Management Zone, and Bear Rock Conservation Zone, as proposed under the draft *SLUP*.

Under the draft SLUP, transportation corridors and infrastructure development are suited to General Use and Special Management Zones, but may be permitted within Conservation Zones if the land use is exempted or meets Conformity Requirement #1 as described in the draft SLUP.

12.6.2 Effects on Existing Infrastructure

Existing transportation infrastructure in the Tulita District includes a winter road right-of-way, several bridges along the winter road, community airports, and barge landing sites. As noted above, there is presently no all-weather road through the Sahtu connecting the area with the rest of the Northwest Territories or Canada. The Project will significantly improve transportation infrastructure to Tulita and Norman Wells and other communities in Sahtu and other areas, enabling easier, year-round transportation of goods, services, and people within the area. Furthermore, it will facilitate recreational, commercial, and industrial access to the area.

Highway construction is primarily proposed to occur during winter months, which could affect the winter road operations and may disrupt seasonal access between communities along the Mackenzie Valley until the all-season Highway is completed.

Project effects on housing and accommodations will include direct demands for short-term accommodation which can be partially met by providing project construction camps. As some of the labour supply will be primarily from Sahtu communities, limited short-term pressures may occur only during the construction phase. No long-term pressures for accommodation are expected to arise during the long-term maintenance and operation phase.

12.6.3 Community Wellness

As reported in the MGP Environmental Impact Statement (MGP 2004), the proposed pipeline project, if it takes place, is likely to have some project-related effects on community wellness in Sahtu communities. Some may result if community residents take construction jobs with the MGP, and other effects may occur as a result of intrusive and intense construction activity near each community along the pipeline corridor.

The MGP EIS stated that residents in some Sahtu communities expressed concerns about possible project-related effects including increased alcohol-related personal and domestic violence and property damage. Residents in Norman Wells were concerned enough to produce a proposal to mitigate negative effects entitled “Breaking Down Barriers, a Proposal for Community Partnership and Action.” The program in this proposal was proposed to address a number of problems including poor money management, effects on youth from substance abuse, sexual assault and teenage parenting (MGP 2004).

Although the MGP is a much larger project and will take longer to build than the Highway, both will occur within the proposed transportation corridor, meaning that both will follow a similar route through the Sahtu. The Highway is likely to have similar effects on community wellness as the MGP, as both projects will feature periods of intense winter construction activities, sometimes close to communities, and both will hire local construction workers where available.

Increased effects on community wellness could likely mean that Health and Social Services (HSS) workers in communities could experience a heavier workload than usual from alcohol and drug-related problems including gambling, domestic violence and other conflicts. Further, workers who do not find new jobs to go

to after the Highway construction is completed may experience some stress from a lack of income. More HSS workers may need to be hired by GNWT HSS to undertake more community wellness programs, as the need arises (MGP 2004).

Unlike the MGP, the Highway could possibly also have long-term effects on community wellness. Concerns raised during community consultations in Norman Wells and Tulita focused on the impacts from increased personal income and increased access to drugs and alcohol. Additionally, concerns were raised about impacts to valued components such as wildlife and areas of traditional cultural importance.

In both Norman Wells and Tulita, the idea of developing a Transportation Corridor Management Group was raised as a way for residents to try to mitigate these possible negative impacts. The concept of the group is that it would include representation from the communities, government and industry, working together to identify and define solutions for future impacts, and allow communities to have input in the delivery of those solutions. While no formal association with related procedures has been developed, residents are looking to work with territorial and policing agencies to try to establish this group.

Some of these effects will likely ease when the project is completed and the camps are dismantled. Some social problems will persist; however, because the Highway will provide a year-round connection to other communities where alcohol and drugs can be purchased and taken back to Sahtu communities, some of which have restricted alcohol availability. Community-based solutions and programs that include local police services, HSS services and community leaders will be needed to mitigate the long-term effects of the Highway in the Tulita District and throughout the Sahtu.

12.6.4 Traditional Harvesting

The proposed Highway construction period is scheduled to occur primarily in winter, with some grading, compacting, surfacing, selective culvert installation and adjustment activities taking place in spring or summer. As such, the construction activities should have little to no effect on traditional harvesting activities that occur during spring, summer and fall. However, Highway construction may affect the local distribution of some wildlife during the winter months. Wildlife may avoid areas under construction due to human activity and vehicle movement. Harvesting areas are identified in the figures presented in Section 8.0 of this PDR.

The presence of the Highway is expected to provide easier access to harvesting areas, heritage value areas, and traditional trails located near the alignment. This may be considered either a positive or a negative effect, depending on the extent of the impact from increased access. The Highway will allow local residents and visitors to access the harvesting areas or heritage value areas year-round. Increased harvesting may be an indirect effect of the Highway.

An additional benefit of the Highway will be that it will provide a single route of effects; that is, during summer and winter months, people will be encouraged, and will likely find it more convenient, to use this main route for travel rather than traveling across the land on new trails. It will serve to localize the effects of travel rather than creating a “spider-web” of effects across the area, such as may currently occur.

Workers employed during the construction of the Highway may have less time to harvest. Any potential effects on the time available to harvest would be short-term in nature, and likely limited to the construction phase. Due to the proximity of the project site to workers’ communities (i.e., Tulita and Norman Wells), it is

anticipated that employees will continue their traditional harvesting pursuits during the days that they are not working on the project.

12.6.5 Tourism

As noted above, all-weather highway access is expected to attract more tourists to the Tulita District, and generate positive economic effects for existing businesses and commercial activities over the long term, in particular those in the local hospitality and tourism sector. Increased tourist visits to Norman Wells and Tulita will provide new and greater opportunities for the community to market their local crafts or provide other services such as bed and breakfast accommodation, restaurants or other tourism-related facilities. Air, water and land-based tours are currently offered within the Sahtu by a variety of business operators.

Both Norman Wells and Tulita are likely to be the most affected by increased tourism within the Tulita District, although Deline, while not situated close to the Highway, may also benefit from increased tourism and/or marketing goods to tourists.

The construction of the Highway is not anticipated to displace tourists from local accommodations as local residents will be targeted to work on the project. Workers will be temporarily accommodated at the construction camps during winter, or will be transported to the work site during summer, as necessary.

12.6.6 Material Resources

Potential material sources are discussed in Section 6.0 of this PDR. The construction material required for the Highway would use only a small portion of the available resources. Once constructed, the Highway will facilitate year-round access to material resources for the MGP, community use and for future development. Use of the material sources will represent ongoing sources of royalty income for the Sahtu.

12.6.7 Commercial Activities

The Highway is expected to reduce overhead transportation costs and provide opportunity for year-round business activities in the Tulita District. Highway construction is also expected to create various spin-off business opportunities or expanded services, such as gas service stations and Highway maintenance services, and will allow businesses located along the Highway to compete for resource-related and government business opportunities in the area. Business development is predicted to increase after construction is completed. An expanding commercial sector could possibly lead to the availability of higher quality products and lower cost services for consumers in general, and government, distribution, and resource development organizations. As well, the creation of new business opportunities could possibly also provide important employment and training opportunities for local residents.

The airline and barging sectors in the area may be negatively affected once the Highway is constructed, as residents and businesses may switch to ground transportation due to the high costs of air freight and the seasonal nature of barge deliveries. The potential effects could include a reduction in local airline staff, and/or more competitive pricing to attract or maintain customers, while barge services may be considerably reduced. Residents and businesses in communities not located along the Highway will continue to rely on air or barge transportation for movement of goods and people.

12.7 Mitigation Measures

Table 12-2: Potential Effects and Mitigation Strategies for Land Use

Main Area of Potential Effects	Potential Effects	Enhancement or Mitigation Measures
Community wellness	Potential positive and negative effects from increased employment and related income.	▪ Community-based HSS programs to teach Highway workers to manage and save money, to train workers for post-Highway construction jobs.
Community wellness	Potential effects from increased alcohol and drug use.	▪ More GNWT HSS workers to deliver community based programs for youth and adults for drug and alcohol abuse, family violence and sexual assault etc.
Heritage sites and harvesting areas	Potential direct disturbance of culturally important sites.	▪ Avoid small sites through minor realignments or footprint adjustments.
Heritage sites and harvesting areas	Increased access to the land during Highway construction.	▪ Construction workers would be required to stay on authorized access roads and the construction area, and not to access the land. ▪ Monitor and control access to lands adjacent to the Highway.
Heritage sites and harvesting areas	Increased access to the land during Highway operation.	▪ Monitor and control access to lands adjacent to the Highway. ▪ Public awareness initiatives to encourage Highway users to stay on the designated Highway and raise the profile of cultural value of the land. ▪ May create potential tourism opportunities for local businesses.
Traditional harvesting activities	Less time to harvest if employed by the Project.	▪ Wages earned during employment of the Highway may be used to purchase food or harvesting equipment. ▪ Workers will have days off in which they may choose to conduct harvesting activities.
Traditional harvesting activities	Continued access to harvesting areas.	▪ Work with local hunter and trapper groups to allow access to harvesting areas and traditional trails.
Traditional harvesting activities	Disruption of wildlife movement in the area.	▪ The majority of construction activities will occur during winter months. ▪ The Highway alignment is not located within areas designated as conservation zones.
Traditional harvesting activities	Worker safety near harvesting areas.	▪ Work with local hunter and trapper groups to ensure that harvesting activities occur a safe distance away from construction workers and activities.
Local business activity	Shortage of accommodation for tourists and business travelers.	▪ Hire local workers. ▪ Accommodate workers in construction camps outside of the community.
Continued use of winter road during Highway construction	Potential disruption of movement along the winter road.	▪ Minor delays may occur but contractors will work with local DOT staff to maintain public travel and safety during construction.

Table 12-2: Potential Effects and Mitigation Strategies for Land Use (Continued)

Main Area of Potential Effects	Potential Effects	Enhancement or Mitigation Measures
Granular material availability	Less granular materials available.	▪ The Highway will use only a small portion of the available resources, and will not use resources identified for use by the MGP or communities.
Granular material availability	Increased access to granular materials.	▪ The Highway will provide year-round access to material sources for future developments. ▪ Royalties from the use of material sources will create revenue for the Sahtu.
Improved infrastructure	Increased access to the Sahtu area.	▪ Opportunities for increased commercial, industrial and recreational activities. ▪ Easier and cheaper to transport goods and people. ▪ Cheaper to access services available in larger communities.
Improved infrastructure	Decreased business for airline activity.	▪ May create more competitive pricing among airlines to transport people to communities. ▪ Potential increase in business opportunities in the area may ultimately maintain the required level of service from the airline industry.

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13.0 CUMULATIVE EFFECTS

Cumulative effects are those effects (biophysical, socio-cultural or economic) that result from the effects of a proposed development in combination with other past, present, or reasonably foreseeable future developments (MVEIRB 2004).

An assessment of cumulative effects provides a more complete understanding of what might happen to VCs (as outlined in Section 11.0) beyond the influence of the project alone. This is useful for regulatory decision-makers and land and resource managers as they review and plan future development. Thus, an assessment of cumulative effects provides a glimpse into environmental and socio-economic conditions now and how they may change in the future with development. This contributes to a better understanding of what might or might not happen if the project proceeds.

Typically, cumulative effects assessments address effects that:

- extend over a larger area;
- are of longer term duration;
- act in conjunction with other projects/activities on the same VCs; and
- are reasonably probable, considering possible future projects/activities and impacts.

Cumulative effects assessment typically involves the application of the following four basic steps:

- identifying the valued parts of the environment that are potentially affected by the proposed development;
- determining what other past, present or reasonably foreseeable future developments will affect these parts of the environment;
- predicting the effects of the proposed development in combination with these other developments; and
- identifying ways to manage the combined impacts.

Since the term "environment" in the *MVRMA* is defined to include biophysical, socio-economic and cultural components, scoping may identify purely social or cultural issues, in addition to ecological ones (MVEIRB 2004).

For the Highway in the Tulita District, the following assessment of cumulative effects has involved the application four basic questions:

- Is the project likely to have negative environmental effects on VCs in the SSA?
- If so, will the residual negative environmental effects that remain after mitigation combine with the effects of other projects, past, present, or future?
- What is the significance of the overall cumulative environmental effects, including the effect of the project?

- If this project, in combination with other projects in the area, is likely to create a "significant negative cumulative effect", are there further mitigation measures that could reduce or eliminate the project's contribution to these effects so that the combined effect does not threaten the VC?

13.1 Spatial Boundaries

For purposes of this cumulative effects assessment, the spatial boundaries include the portion of the northern Mackenzie Valley in the general vicinity of the Highway extending through the Tulita District within the SSA (Figure 13-1). Since the Highway generally parallels the proposed alignment of the MGP, the spatial boundary selected was adopted from the cumulative effects assessment conducted for the MGP (IOL et al. 2004).

The spatial boundary for the MGP generally involves a 30 km wide buffer area along both sides of the proposed pipeline, representing a 60 km wide area. This general area encompasses the entire Highway, the range of environments that could be impacted by the Highway, and the past, present and future projects that may have a potential to contribute to potential cumulative effects.

13.2 Temporal Boundaries

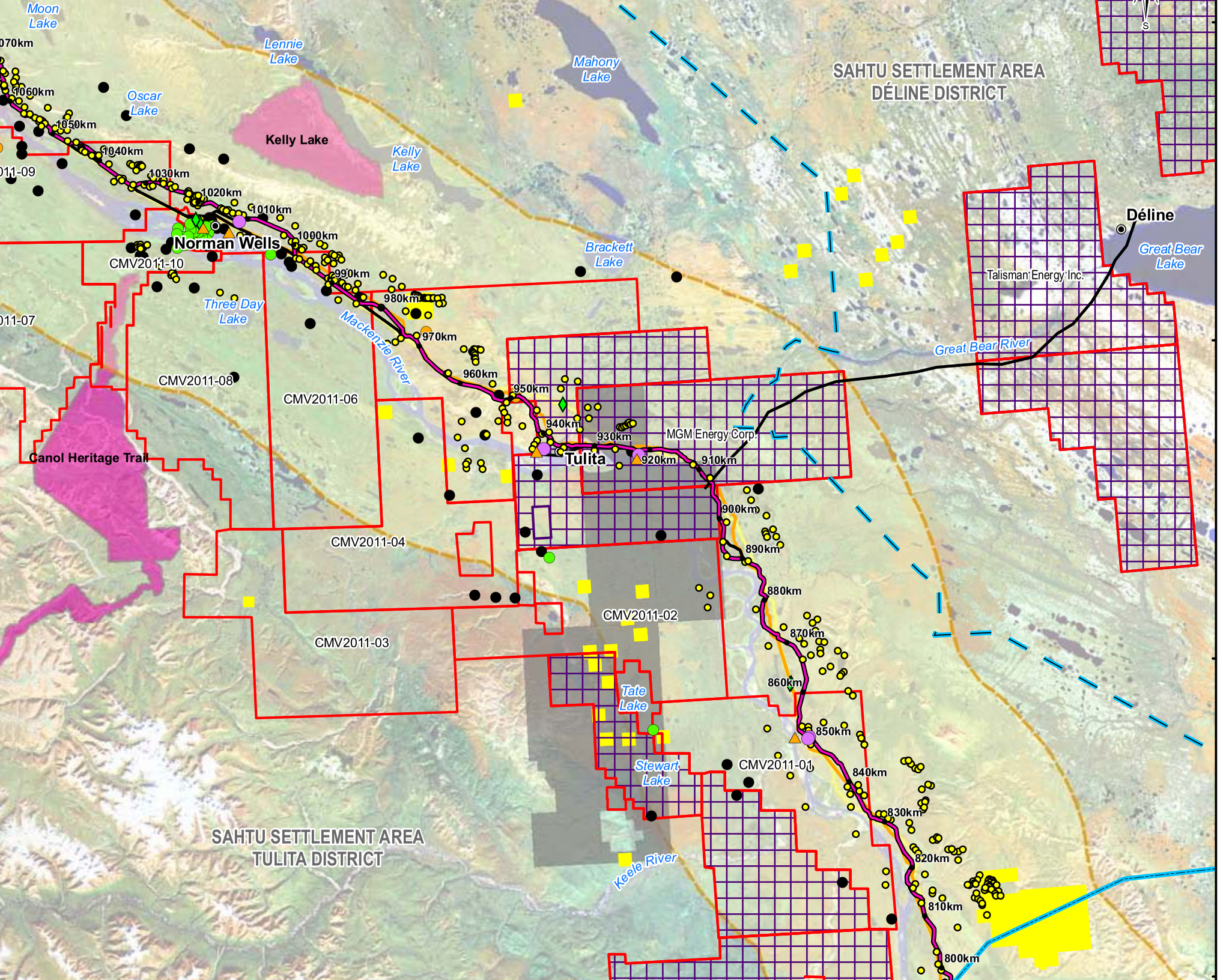
For purposes of this cumulative effects assessment, the temporal (time frame) for the assessment will be the next forty (40) years. The Highway is anticipated to be constructed and in operation for many years during this time frame. It remains unknown at this time whether construction of other proposed future projects, in particular the MGP, will proceed before or after construction of the Highway has been completed.

13.3 Valued Components

Since this cumulative effects assessment draws heavily on the cumulative effects assessment completed for the MGP, the VCs are consistent with those used for the MGP cumulative effects assessment and those used throughout this PDR. The major biophysical disciplines for which VCs were identified include: air, noise, groundwater, hydrology, water quality fish and fish habitat, soils, landforms and permafrost, vegetation and wildlife (IOL 2004).

The socio-economic VCs employed for the MGP cumulative effects assessment and adopted for Highway are:

- the economy, including demographics;
- infrastructure and community services;
- individual, family and community wellness;
- non-traditional land and resource use; and
- heritage resources.


Moon Lake
Lennie Lake
Mahony Lake
SAHTU SETTLEMENT AREA
DÉLINE DISTRICT
Oscar Lake
Kelly Lake
Kelly Lake
Déline
Great Bear Lake
Brackett Lake
Norman Wells
CMV2011-10
Talisman Energy Inc.
Three Day Lake
Mackenzie River
Great Bear River
CMV2011-08
CMV2011-06
MGM Energy Corp.
Tulita
Canol Heritage Trail
CMV2011-04
CMV2011-02
CMV2011-03
Tate Lake
Stewart Lake
CMV2011-01
SAHTU SETTLEMENT AREA
TULITA DISTRICT
Keele River
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13.4 Past, Present and Future Projects/Activities Considered

The MGP cumulative effects assessment noted that potential cumulative effects of the MGP components, such as pipeline segments and infrastructure, which would be located in both disturbed and relatively undisturbed areas, are not expected to act cumulatively with effects from other land uses. This is because there are essentially no other land uses to interact with and because of the limited duration and geographic extent of the MGP effects (IOL et al. 2004).

For the purposes of this PDR, the past, existing and potential future projects considered in this preliminary cumulative effects assessment include:

- Past and Existing Projects:
  - existing winter road;
  - community users of the land;
  - existing Enbridge oil pipeline;
  - Norman Wells oilfield; and
  - current exploration leases and significant discovery leases.
- Potential Future Projects:
  - MGP;
  - Great Bear River Bridge; and
  - Great Bear Hydroelectric Project.

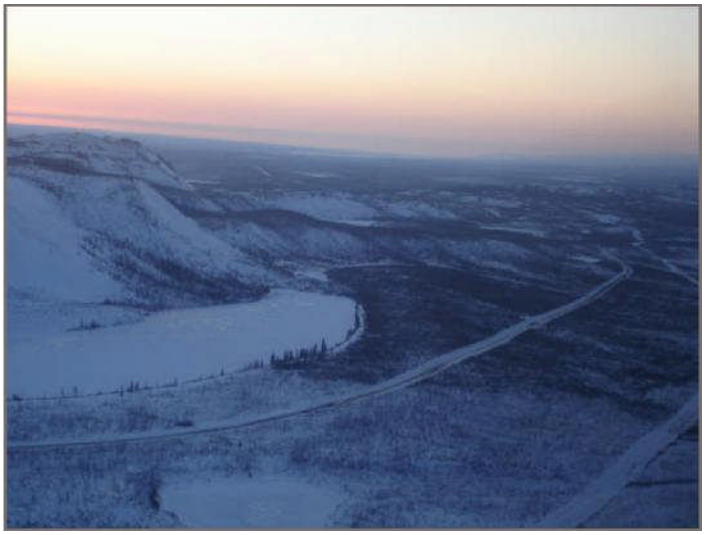
Brief descriptions of each of these past, existing and potential future projects and activities and how they may contribute to a possible cumulative effect in relation to the proposed construction and operation of the Highway are provided in the following sections.

13.4.1 Past and Existing Projects

13.4.1.1 Mackenzie Highway Winter Road

The existing Mackenzie Highway winter road extends from Wrigley at km 690 to Fort Good Hope at km 1,172. The winter road, constructed primarily of compacted snow, is built annually every winter over the land on the east side of the Mackenzie River in close proximity to the proposed alignment of the MGP. The winter road is typically open from December to March and includes many permanent bridges, most of which will be incorporated into the Highway.

Incorporation of a large proportion of the existing winter road and bridges into the alignment of the Highway and the endorsement by the Proponent and the Tulita District Land Claim and Aboriginal Groups of a common transportation corridor to accommodate all existing and proposed linear developments, including the proposed MGP and a future installation of fibre-optic cable, will help to minimize the overall environmental footprint and effects of these linear developments.



Photograph 13-1
Mackenzie Valley Winter Road, March 2011, Northwest of Tulita

13.4.1.2 Enbridge Oil Pipeline

During the winter seasons of 1983-84 and 1984-85, Interprovincial Pipe Line Ltd. [IPL, now Enbridge Pipelines (NW) Inc.] constructed a 324 mm diameter oil pipeline extending 869 km from the oil fields and refinery at Norman Wells, to connect with another pipeline at Zama in northern Alberta. The Norman Wells Pipeline, in operation since 1985, was and remains the first completely buried oil pipeline located in permafrost terrain in Canada (NRCan 2011).

Many unique design features and mitigative measures were adopted to minimize disturbance to the thaw sensitive permafrost terrain and to ensure pipe integrity for the Norman Wells line. The small diameter pipeline operates as an ambient temperature line; oil is chilled at the surface and the average annual temperature of the oil entering the line is near -1°C.

Since 1985, annual field monitoring of the pipeline has been conducted by IPL/Enbridge to determine the effect of the pipeline construction and operation on the environment, right-of-way and pipeline (Arctic Institute of North America 2011). The results of the ongoing monitoring have been reported annually to the National Energy Board and have been used to guide annual maintenance activities intended to ensure the integrity of the pipeline and protection of the environment.

The Enbridge pipeline right-of-way extends south from Norman Wells through to and beyond the southern boundary of the Tulita District and is situated be in the proposed common transportation corridor envisioned for the Highway and other developments.

13.4.1.3 Norman Wells Oilfield

Norman Wells exists as a result of Canadian government encouragement of oil exploration in the 1880s. Alexander Mackenzie had reported in the late 1700s that the Dene used oil seeps along the Mackenzie to waterproof their canoes. But the region was remote and there was little interest until 1911 when prospector J.K. Cornwall investigated the oil seeps and discovered they consisted of high quality crude oil.

Soon, Imperial Oil obtained leases and sent a drilling crew north. In 1920 they struck oil near the current site of Norman Wells (Norman Wells Historical Society 2009).

The Norman Wells oilfield supplied regional communities and mining interests through the 1920s and 1930s. It also helped to support the development of aviation in the Mackenzie Valley with a ready supply of fuel and lubricants.

During the Second World War, the United States military built the Alaska Highway, and connected the Norman Wells oilfield, via a 4-inch diameter pipeline (Canol project), to Yukon and Alaska. Although the Canol project was shut down and abandoned a year after it opened, outside interest in Norman Wells crude oil supplies continued to grow. By 1980, plans for oilfield recovery included construction of six artificial drilling islands in the Mackenzie River and a 12-inch pipeline to Alberta.

The construction of the Norman Wells Oilfield Expansion and Pipeline Project was undertaken during the period 1982 to 1985. Photo 13-2 shows the current status of the Norman Wells area, including the existing oil field facilities, the six artificial islands in the Mackenzie River, the Norman Wells airport, and the quarry developed for construction of the artificial islands.

Over the past 90 years, Esso's Norman Wells oilfield has produced more than 226 million barrels of sweet crude oil. Since start-up of the pipeline in mid-1985, all of this production has been shipped to southern Canada (Norman Wells Historical Society 2009).

Photograph 13-2
Norman Wells, NT, March 2011

13.4.1.4 Current Exploration Leases and Significant Discovery Leases

Other activities include exploration and discovery of for oil and gas, coal and other minerals. Area of interest including specific leases are shown on Figure 13-1.

13.4.2 Potential Future Projects

13.4.2.1 Mackenzie Gas Project (MGP)

The proponents of the proposed MGP are Imperial Oil Resources Ventures Limited Partnership (IOL), ConocoPhillips Canada (North) Limited (ConocoPhillips), ExxonMobil Canada Properties (ExxonMobil), Shell Canada Limited (Shell) and Mackenzie Valley Aboriginal Pipeline Limited (MVAPL) partnership.

The purpose of the proposed MGP is to develop three onshore natural gas fields (anchor gas fields) in the Mackenzie Delta and to transport natural gas and natural gas liquids (NGLs) by pipeline to market down the Mackenzie Valley. The pipeline components of the MGP include a 460 km natural gas liquids pipeline from a proposed Inuvik gas processing facility to Norman Wells where the liquids would be tied into the existing Enbridge oil pipeline and a 1,200 km natural gas pipeline to the existing North American grid in northern Alberta.

The MGP received approval from the National Energy Board in December 2010 and the Canadian government in March 201l. At the 2011 Inuvik Petroleum Show, IOL reported that the earliest possible schedule leading to a decision to construct was late 2014 (IOL 2011). This would be followed by four winters of construction leading to the earliest possible project start-up in late 2019.

However, there remains considerable uncertainty as to when the MGP may proceed. In particular, as indicated by IOL (2011), an appropriate fiscal framework still needs to be developed with the Canadian government, and negotiations with the Deh Cho on benefits and access agreements need to be completed. In addition, a number of other critical factors, including economic, market and strategic priority considerations, could potentially affect the implementation of the MGP.

As indicated in this PDR, to minimize the overall environmental footprint and effects of the Highway, the DOT has endorsed the strategy of the single Transportation Corridor to accommodate existing and proposed linear developments such as the existing Mackenzie Highway winter road and the proposed MGP.

13.4.2.2 Great Bear River Bridge

The proposed Great Bear River Bridge Project, when constructed will be the largest bridge of the Mackenzie Valley Winter Road Bridge Program. The Great Bear River crossing is considered by DOT to be one of the major bottlenecks along the current Mackenzie Valley Winter Road. The residents of Tulita and other users of the winter road have long been concerned about the safety of the existing winter road across the Mackenzie River around the Great Bear River. The construction of the Great Bear River Bridge would address these important issues.

This bridge is proposed to cross the Great Bear River at km 938 of the Mackenzie Valley Winter Road, near the community of Tulita, at 64°54'N Latitude and 125°34'W Longitude (DOT 2006).

The total length of the proposed bridge between the North and South abutments is approximately 460 m (1,500 ft). The three spans over the navigation channel of the Great Bear River are ~100 m (300 ft) and the bridge will have a 15 m (50 ft) clearance above the navigation high water level at elevation 52.5 m (172 ft)

The most current bridge configuration consists of:

- two earth-fill approach embankments, one on each side of the river, located above the high water level at the top of the riverbanks;
- two reinforced concrete bridge abutments supported on driven piles, with approach slabs and concrete wing-walls to contain the embankment fill;
- four reinforced concrete piers to support the bridge superstructure;
- three lines of steel plate girders extending across five spans;
- cast-in-place precast concrete deck panels; and
- guard-rails, drains and bridge lighting.

Although the Great Bear River Bridge was initially proposed to address safety concerns related to ongoing winter road traffic in the area, it was understood that this bridge would eventually become part of the Mackenzie Valley Highway. Sahtu Land and Water Board Water License S06L8-001 dated June 16, 2006 was issued for construction of the bridge but the bridge construction program continues to be on hold at this time.

13.4.2.3 Great Bear Hydroelectric Project

Sahdae Energy Ltd. (Sahdae) is a wholly-owned subsidiary of the Northwest Territories Hydro Corporation, which was established to develop the Great Bear Hydroelectric Project with Aboriginal partners (Sahdae 2007). The Great Bear Hydroelectric Project is a proposed to design, build, operate and maintain hydro-electric generation and transmission facilities to supply and deliver electricity to the MGP and communities located in close proximity to these facilities. The proposed facilities would include a run-of-river 27 m high earth-filled dam on the Great Bear River near the St. Charles Rapids site, a 126 Mw hydroelectric station, 600 km of 237 kV transmission line, and associated substations. It is uncertain whether this project will proceed.

13.5 Cumulative Effects Assessment

A detailed cumulative effects assessment was conducted for the MGP for the entire proposed pipeline corridor, including the area to be traversed by the Highway. As it is envisioned that the Highway and the MGP share a common transportation corridor, it is worthwhile to begin this assessment with a review of the MGP's primary findings and conclusions.

The environmental impact assessment conducted for the MGP involved a comprehensive assessment of the available information, including the gathering of several years (2001-2004) of scientific field survey data, community consultations and Traditional Knowledge studies, with detailed descriptions of the importance and value of wildlife and wildlife habitat to the local residents (IOL et al. 2004).

Based on their assessment, it was determined that the MGP would likely have some minor effects on wildlife and wildlife habitat at the local level that could last throughout the life of the project, and in some cases beyond. Noise from facilities and flares might also affect wildlife during operations (IOL et al. 2004).

Their assessment determined that some local wildlife movements might be affected near the project, but no effects on the seasonal movements or migration patterns of wildlife would occur, with the possible exception of the movements of Bluenose West Caribou in fall and winter during the pipeline construction phase. No other possible effects on the seasonal distribution of barren-ground caribou were expected to occur (IOL et al. 2004).

Table 13-1 adapted from the cumulative effects assessment for the MGP summarizes the predicted significance for cumulative effects of past, current and reasonably foreseeable land uses on all of the biophysical VCs assessed (IOL 2004).

Table 13-1: Summary of Significance for Cumulative Effects of Past, Current and Reasonably Foreseeable Land Uses and the MGP

Discipline	Key Indicators or Valued Components	Interaction[1]	Cumulative Effect[2]		Significance	
			Project	Overall	Project	Overall
Air	NO_2	Yes	3	3	n/s	n/s
	SO_2	Yes	3	3	n/s	n/s
	CO	Yes	3	3	n/s	n/s
	$PM_{2.5}$	Yes	3	3	n/s	n/s
	Benzene	Yes	3	3	n/s	n/s
	BTEX	Yes	3	3	n/s	n/s
	PAI	Yes	3	3	n/s	n/s
Noise	Sound Level	No	NE	NE	n/s	n/s
Groundwater	Groundwater quantity and flow patterns	Yes	3	3	n/s	n/s
	Groundwater quality	Yes	3	3	n/s	n/s
Hydrology	Runoff amount and drainage patterns	Yes	3	3	n/s	n/s
	Water levels and flow velocities	Yes	3	3	n/s	n/s
	Sediment concentration	Yes	3	3	n/s	n/s
	Channel morphology	Yes	3	3		
Water Quality	Wastewater releases	Yes	3	3	n/s	n/s
	Suspended sediments	Yes	3	3	n/s	n/s
Fish and Fish Habitat	Habitat	Yes	3	3	n/s	n/s
	Health	Yes	3	3	n/s	n/s
	Abundance and distribution	Yes	3	3	n/s	n/s
Soils, Landforms and Permafrost	Ground stability	Yes	3	3	n/s	n/s
	Uncommon landforms	Yes	3	3	n/s	n/s
	Soil quality	Yes	3	3	n/s	n/s
Vegetation	Abundance and distribution of vegetation species and associations	Yes	3	3	n/s	n/s
	Health of vegetation species	Yes	3	3	n/s	n/s
Wildlife	Habitat availability	Yes	3	3	n/s	n/s
	Movements	Yes	3	3	n/s	n/s
	Mortality	Yes	3, 2 for grizzly bear	3	n/s	n/s

Notes:

1. *YES* indicates the project causes a residual effect that might interact measurably with other land uses on the same KI or VC. *No* indicates no cumulative effect interaction.

2. Indicates the class of the cumulative effect. *Project* is that project's contribution to cumulative effects. *Overall* is the overall cumulative effect of and considers all past, current and reasonably foreseeable land uses.
   - Class 1 – the predicted trend in the VC under projected levels of development could threaten its sustainability in the regional study area and should be considered a management concern. Research, monitoring and recovery initiatives should be considered under an integrated resource management framework.
   - Class 2 – the predicted trend in the VC under projected levels of development will likely result in its decline to lower than baseline, but stable, levels or quality in the regional study area after MGP decommissioning and abandonment, and into the foreseeable future. Regional management actions such as research, monitoring and recovery might be required if additional land use activities are proposed for the study area before project closure.
   - Class 3 – the predicted trend in the VC under projected levels of development could result in no change or could decline in the regional study area during the life of the MGP, but its level or quality should recover to baseline after decommissioning and abandonment. No immediate management initiatives, other than requirements for responsible industrial operational practices, are required
   - NS - indicates no significant cumulative effect.
3. Conclusions for all species assessed unless indicated otherwise.
4. Source: IOL 2004 (Table 12-26).

The key biophysical and socio-economic conclusions of the comprehensive cumulative effects assessment conducted for the MGP (IOL et al. 2004) were as follows:

- The MGP would not contribute significantly to cumulative effects.
- There were no significant overall cumulative effects.
- Based on the project footprint, the project would disturb a negligible proportion of the regional study area, and therefore, also a negligible proportion of the Northwest Territories.
- The MGP would contribute to two potential cumulative effects of management concern:
  - competition for qualified northern goods, services and labour, which could be addressed with diligent monitoring and management by responsible parties; and
  - direct grizzly bear mortality, which could be addressed with diligent monitoring and management by responsible parties.
- Demand for qualified northern content in projects is expected to use all available northern capacity, which will limit the extent of both potential increased benefit and social costs among northern residents. However, it could marginally increase the temporary attraction of speculative in-migration, and associated social costs in the regional and commercial centres of Inuvik and Norman Wells.
- The MGP might encourage other development, particularly gas exploration and production in the Northwest Territories; however, information to adequately assess potential cumulative effects contributions from such possible developments was not yet available.

The effect of any future hydrocarbon development, such as additional production fields, on the communities would likely be similar to effects predicted for current and reasonably foreseeable land use. Those developments would be subject to their own environmental impact assessment, including cumulative effects.

These conclusions indicated that, despite the size and duration of operations, the contribution to cumulative effects by the MGP on the regions and communities of the Northwest Territories were not expected to be significant. The conclusions also meant that there was no reason to believe, based on available information and the assessment method, that in the future there would be an issue of

management concern associated with cumulative effects on a particular valued component from this project. These conclusions were based on the assumption that appropriate management and monitoring programs, as outlined in the MGP Environmental Impact Statement would be carried out (IOL et al. 2004).

As previously indicated, it remains unknown at this time whether construction of other proposed future projects, in particular, the MGP, will proceed before or after construction of the Highway has been completed.

At this time it is perhaps more likely that the Highway will be constructed and be in full operation before construction of the MGP proceeds. Under this circumstance, construction of the Highway would be the only significant linear development activity being undertaken in the Transportation Corridor and it would not operate in a cumulative manner with the proposed MGP.

In addition, incorporation of portions of the existing winter road and bridges into the Highway, and the endorsement of a single Transportation Corridor to accommodate all existing and proposed linear developments including the proposed MGP, will help to minimize the overall environmental footprint and effects, including possible contributions to cumulative effects by these linear developments.

As noted in the Section 11.0 Potential Environmental and Social Effects and Mitigation, it has been determined that with the application of proposed mitigation measures, for all environmental VCs, the residual environmental effects associated with the construction and future operation of the Highway are anticipated to be low in magnitude and localized in extent.

From a socio-economic perspective, the construction of the Highway will result in significant employment, training, business and other economic opportunities, particularly during the Highway construction phase, and similar opportunities and benefits during the long-term operations and maintenance phase.

Completion of the entire Highway is also expected to dramatically decrease the cost of living for residents of Tulita, Norman Wells and all of the other communities in the Mackenzie Valley. In addition, once the overall Mackenzie Valley Highway is constructed, this is expected to create significant stimulus to the tourism industry.

Assuming that the overall Mackenzie Valley Highway is in operation before construction of the MGP proceeds, the significantly improved access provided by the Highway is expected to facilitate the construction of the MGP and contribute to reduced construction costs for the MGP.

14.0 CLOSING REMARKS

The idea of building an all-weather highway through the Mackenzie Valley originated in the 1960s. Through the following decades the federal and territorial governments have undertaken a variety of studies and engineering work in the development of the Mackenzie Valley Highway from Wrigley to Inuvik. Today the all-weather highway terminates at Wrigley. The link to Wrigley, Tulita, Norman Wells, and Fort Good Hope is currently only by winter road. Beyond Fort Good Hope, there is no overland link to the Dempster Highway.

As noted in the introductory section of this PDR, in 2010, an MOU was signed between the 5658 NWT Ltd. and DOT to set the terms for the completion of this PDR for the construction of the Highway. This action, and DOT's determination to partner with each land claim group along the proposed Highway route, have reinvigorated the dream of building the Mackenzie Valley Highway.

The Mackenzie Valley Highway will decrease travel times from the communities in the Tulita District to points in the Northwest Territories and southern Canada. It will improve residents' access to health care, as well as employment and educational opportunities. The Mackenzie Valley Highway will support year-round social, cultural, business and recreational opportunities and will enable family, community and social interaction that were not previously available. The Mackenzie Valley Highway will also provide the spine or backbone of an overall Transportation Corridor that will support future and unrelated infrastructure development (i.e., fibre optic cable, pipeline), while minimizing the footprint on the land.

This PDR builds on the work that was completed previously for the Mackenzie Valley Highway and the available information on the work that was done for the MGP. The Highway itself, utilizes over half of the existing the existing winter road alignment and almost all of the existing bridge structures. This PDR provides a preliminary design for the Highway in the Tulita District, assesses its associated effects and identifies appropriate mitigation to enable the Highway to be constructed. The PDR has been prepared specifically to be included as part of the overall Mackenzie Valley Highway submission to the MVLWB for preliminary screening – the first stage of the regulatory process.

This PDR also demonstrates the viability and importance of the Highway, builds on work done in previous studies and describes how the anticipated effects of the Highway are manageable. This finding is derived from the scientific and engineering assessments conducted for this PDR and from the knowledge shared and views expressed by the communities, boards, councils and agencies in the Tulita District. Consultations revealed a general satisfaction with the approach to the location, design, and construction of the Highway contained within this PDR.

5658 NWT Ltd. and DOT have strong support from the land corporations and the Dene Band in the Tulita District for this PDR and the future initiative. DOT is committed to continued partnering with land claim and other aboriginal groups in the ongoing development of the Highway. We trust this PDR provides the information required for the MVLWB to successfully complete the preliminary screening of the construction of the Mackenzie Valley Highway through the Tulita District.

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Sahtu Dene and Metis Comprehensive Land Claim Agreement Northwest Territories Water Act

Northwest Territories Waters Regulations

Mackenzie Valley Land Use Regulations

APPENDIX A

APPENDIX A MAP BOOK

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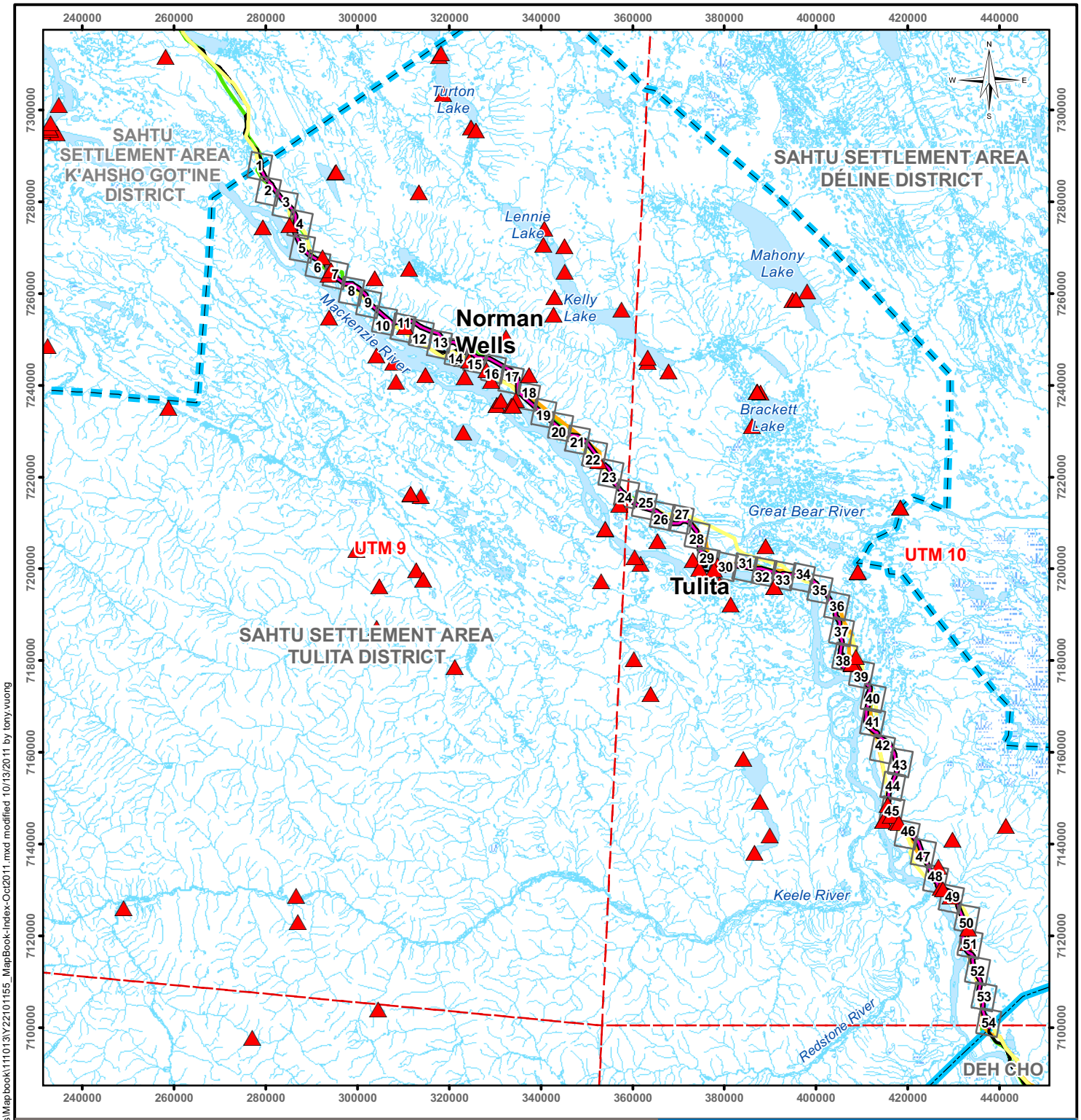

LEGEND

- Communities
- Heritage Value Site
- MVH Concept - EBA June 2011 (Preferred Alignment)
- MGP - Proposed Alignment
- PWC - 1974 Alignment
- DOT - Public Winter Road
- Enbridge Oil Pipeline
- Settlement Area Boundary
- District Boundary
- UTM Zone
- Watercourse
- Wetland
- Water Body
- 1 Map Sheet

NOTES:
Base data sources:
MVAP Contours, PWC 1974, Orthotiles and MGP data: Northwest Territories Centre for Geomatics, (Mackenzie Gas Project), Heritage Value Site (Figure 8-3) NTS 1:50,000 (Watercourse, Waterbody and Wetland)

MACKENZIE HIGHWAY - SAHTU SETTLEMENT AREA TULITA DISTRICT

1:25,000 Map Book Index Map

PROJECTION: Data: UTM Zones 9 & 10, Map prj: Zone 10		DATUM: NAD 83	
1:1,200,000 (0 10 20 30 40 50 Kilometres)			
FILE NO.: Y22101155_MapBook-Index-Oct2011.mxd			
PROJECT NO.: Y22101155	DWN: TV	APVD: MS	REV: 0
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5658 NWT Ltd.

A TETRA TECH COMPANY

Index Map

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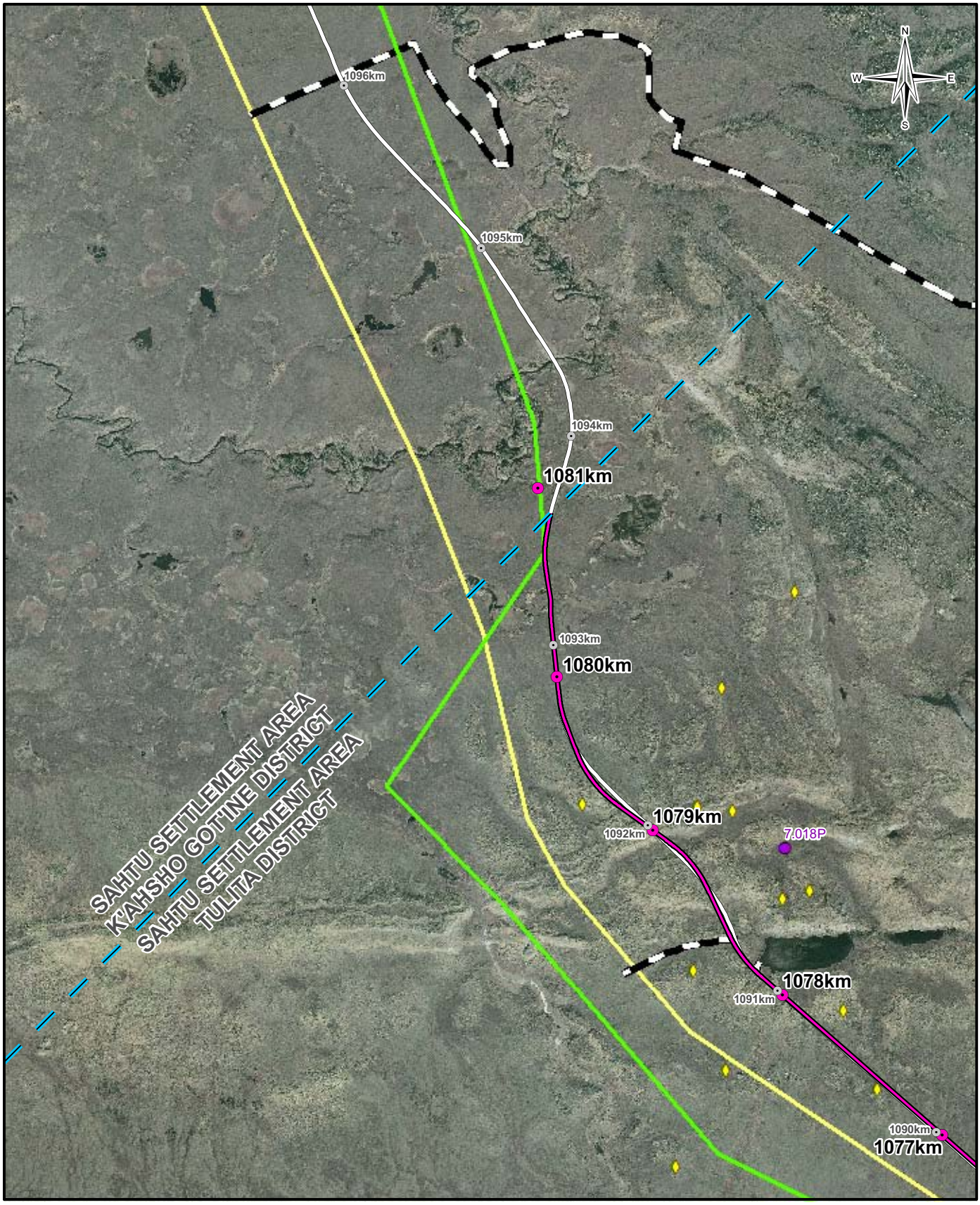

Legend

- Community
- Heritage Value Site
- Preferred Material Source
- Potential Material Source (AAND)
- Existing Bridge
- New Bridge
- Culvert
- MVH Concept - EBA June 2011 km Marker
- DOT - Public Winter Road km Marker
- MVH Concept - EBA June 2011 (Preferred Alignment)
- DOT - Public Winter Road
- Mackenzie Gas Project Corridor
- PWC 1974 Highway Concept Route
- Proposed All-Weather Road - MGP
- Proposed Winter Road - MGP
- Municipal Boundary
- Major Contour (10 m)
- Settlement Area Boundary
- District Boundary

MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

1:25,000 Map Book

Scale: 1:25,000 (0, 250, 500 Metres)

UTM Zone 8
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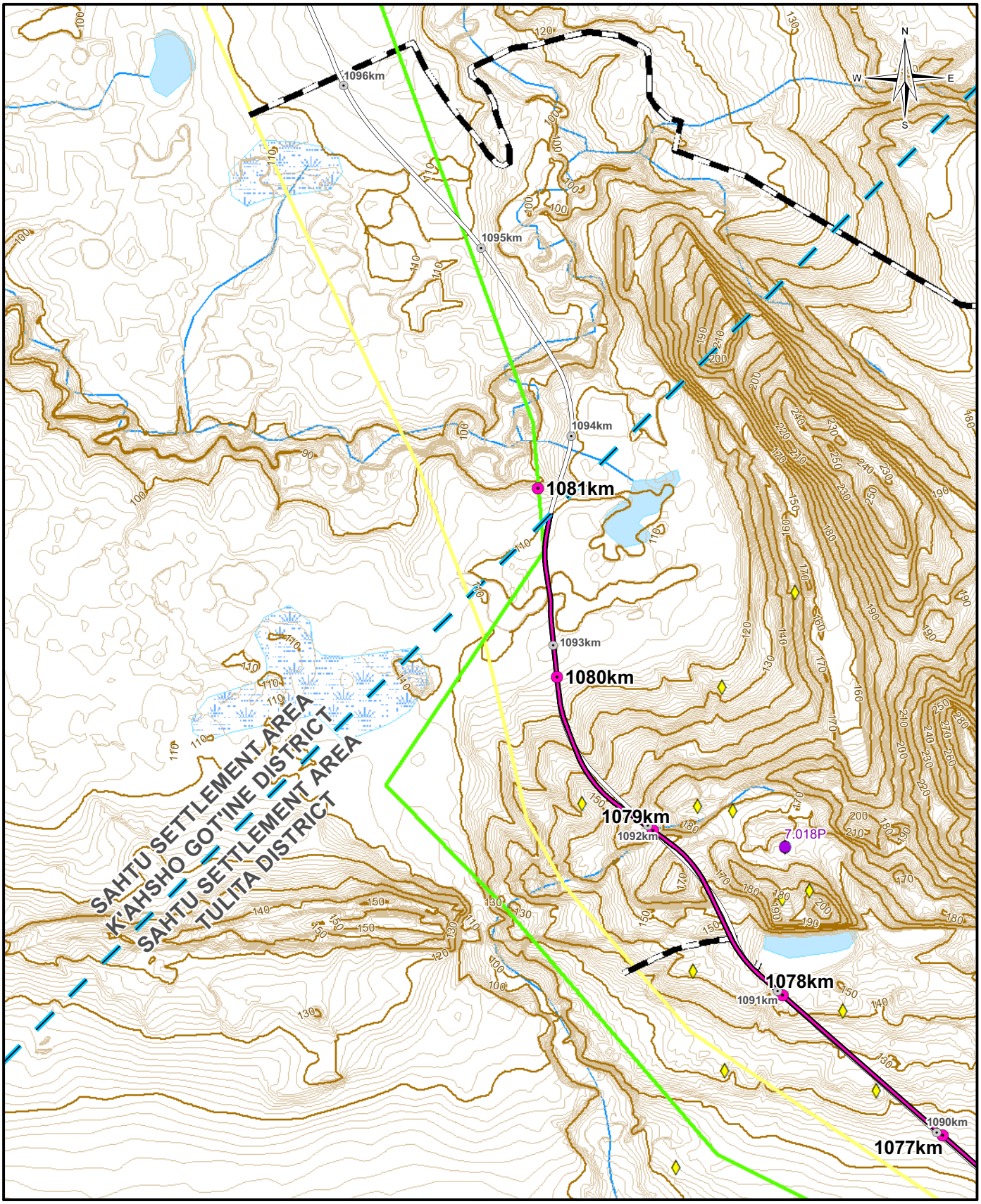
FILE NO. Y22101155_MapBook-Imagery-Oct2011.mxd
PROJECT NO. Y22101155 DATE October 14, 2011

Map 01



Legend

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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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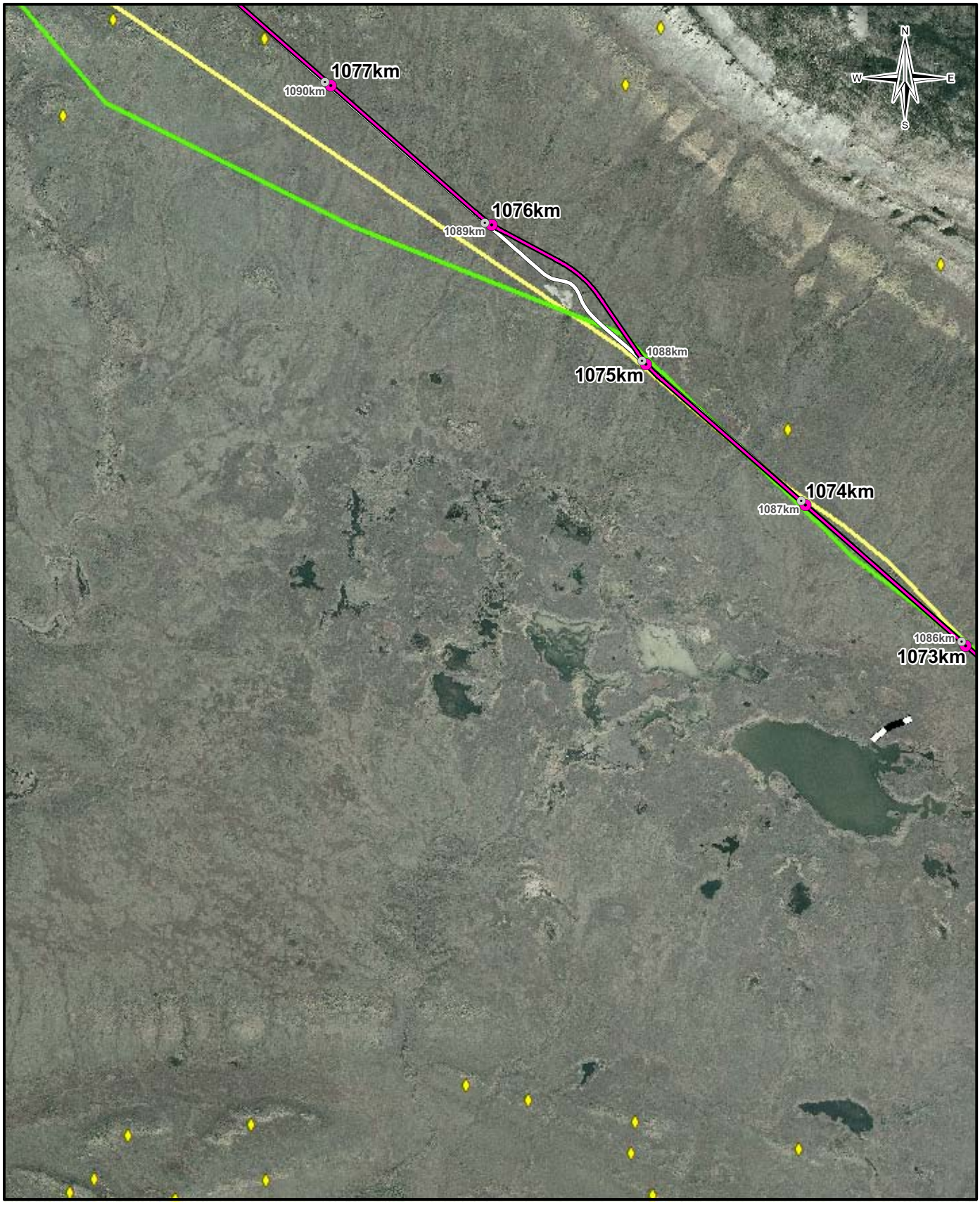

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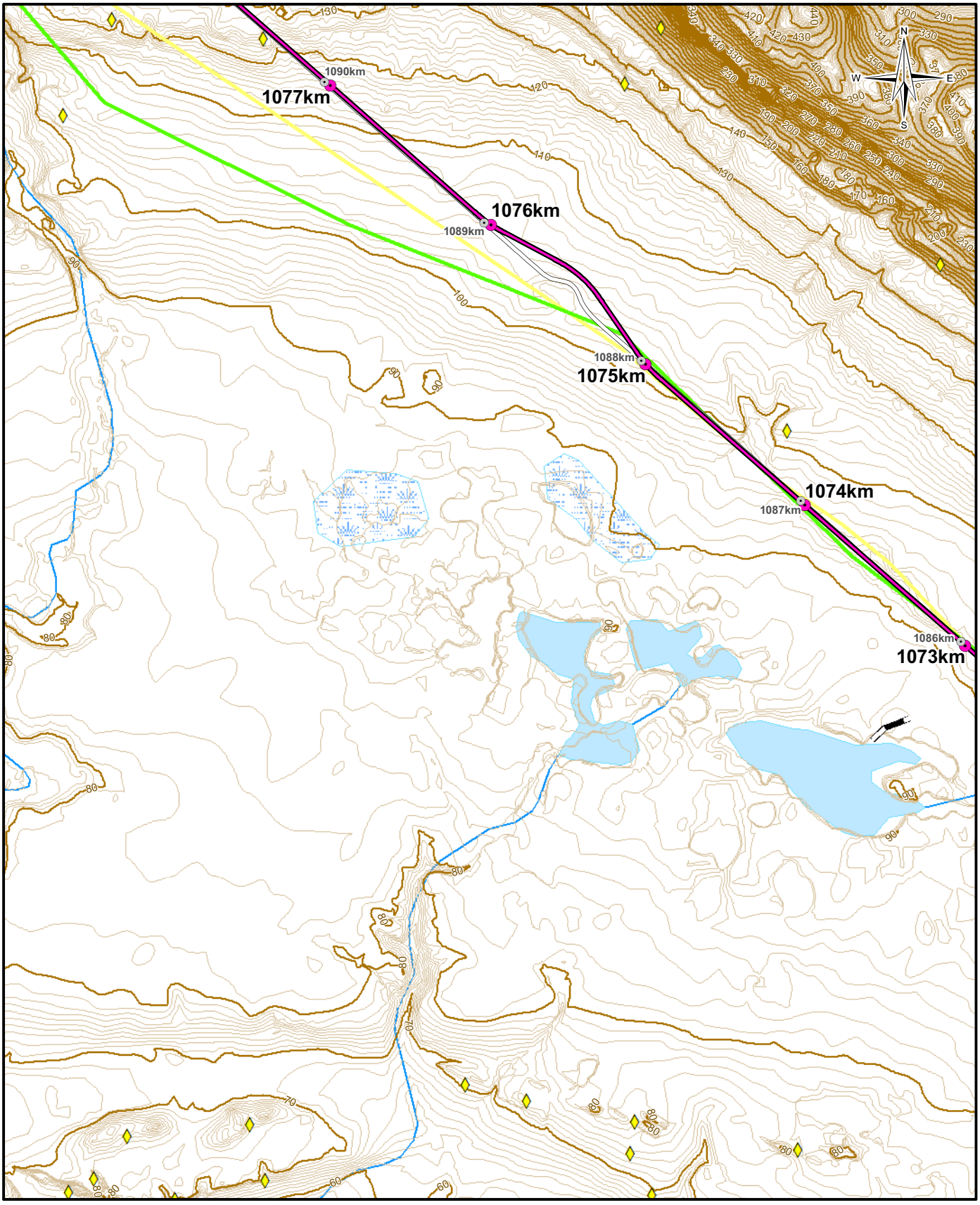
Map 02



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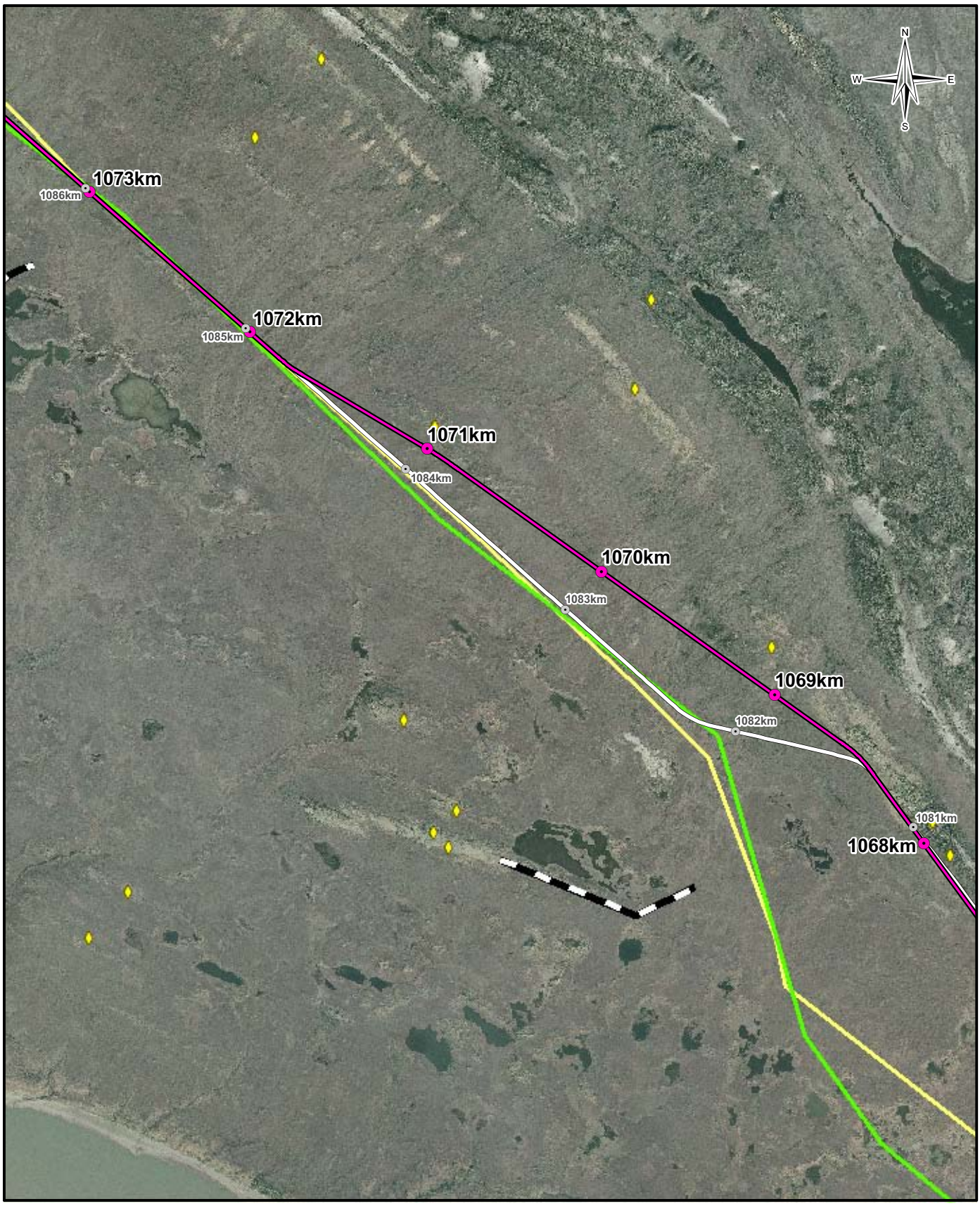

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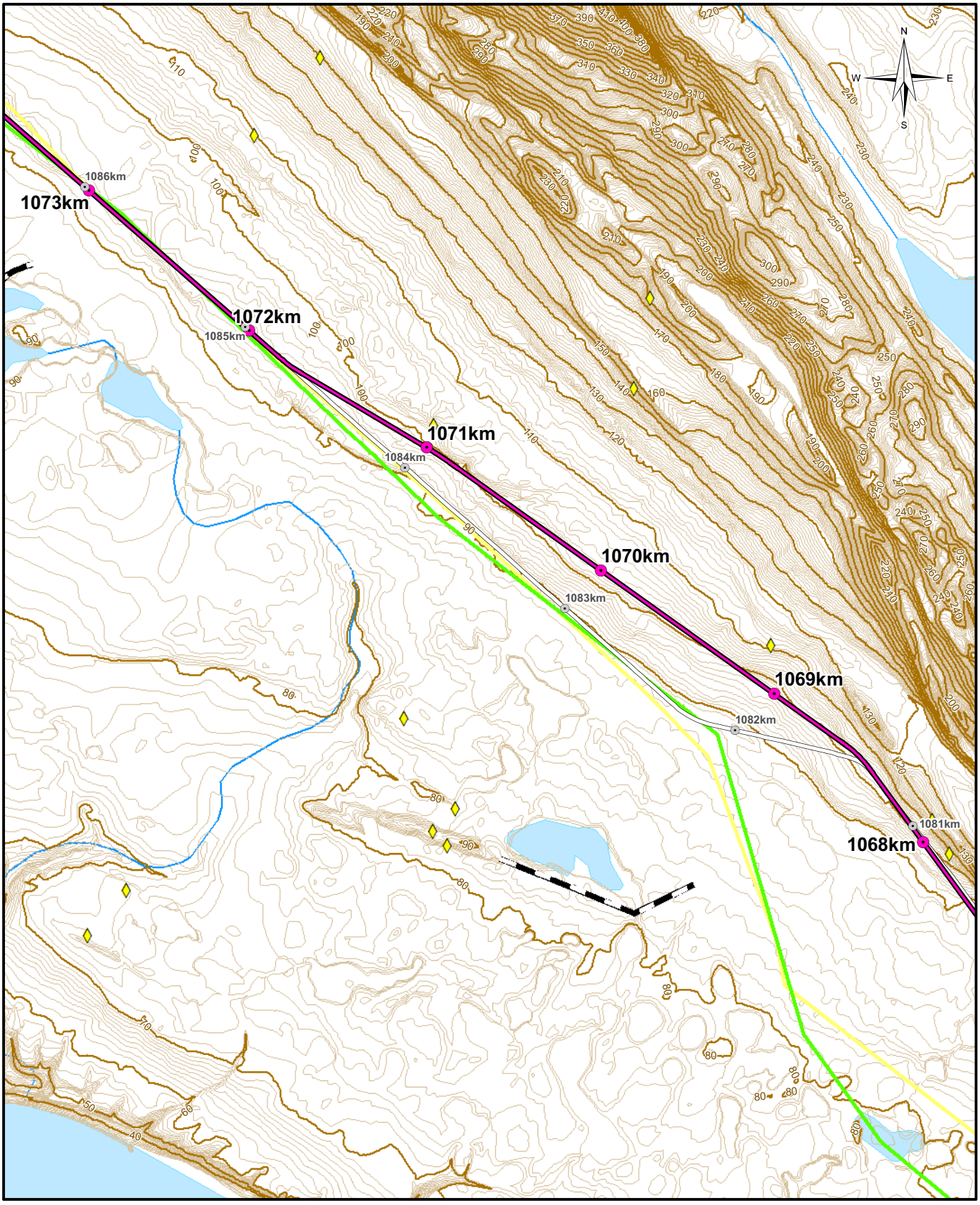
Map 03



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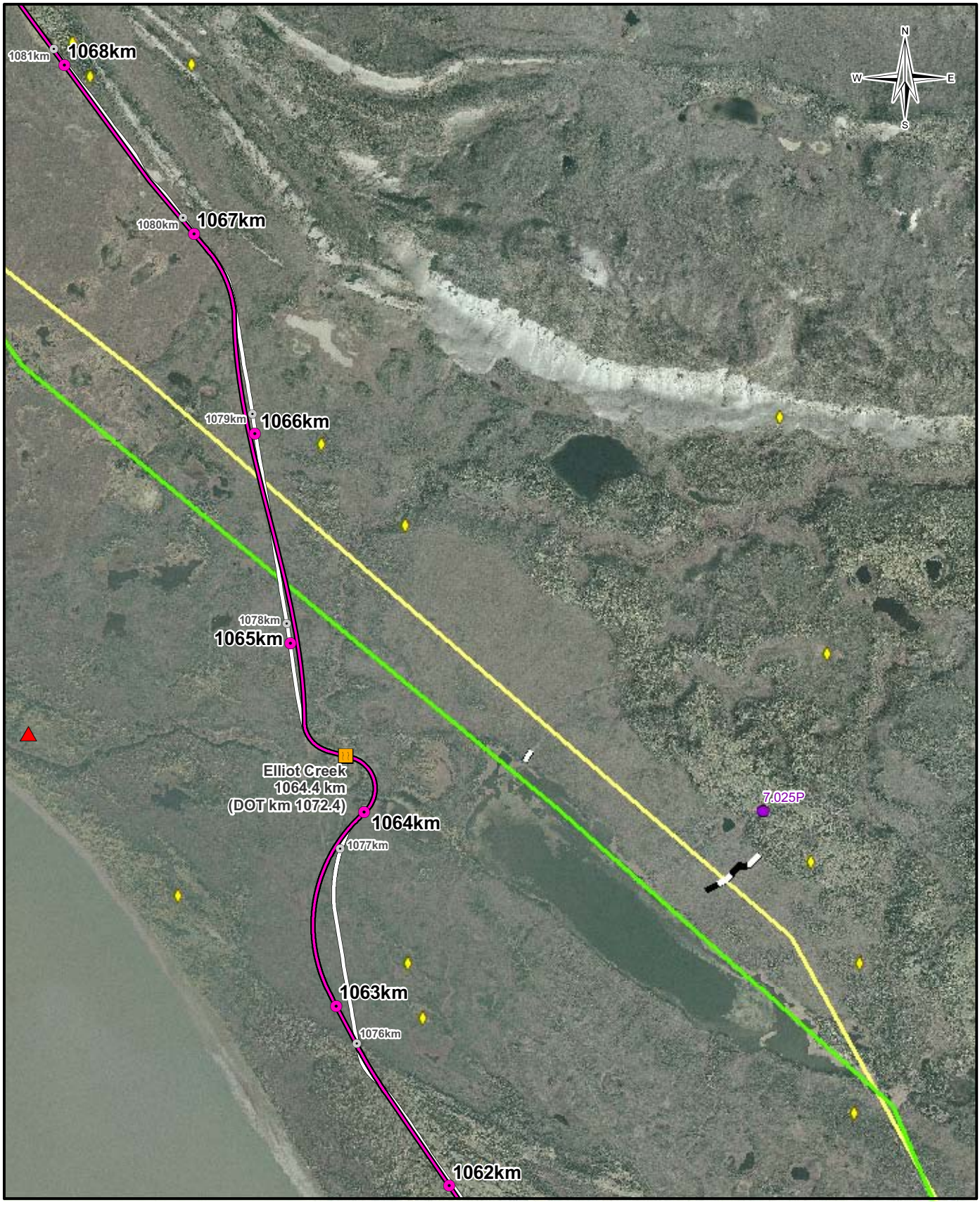

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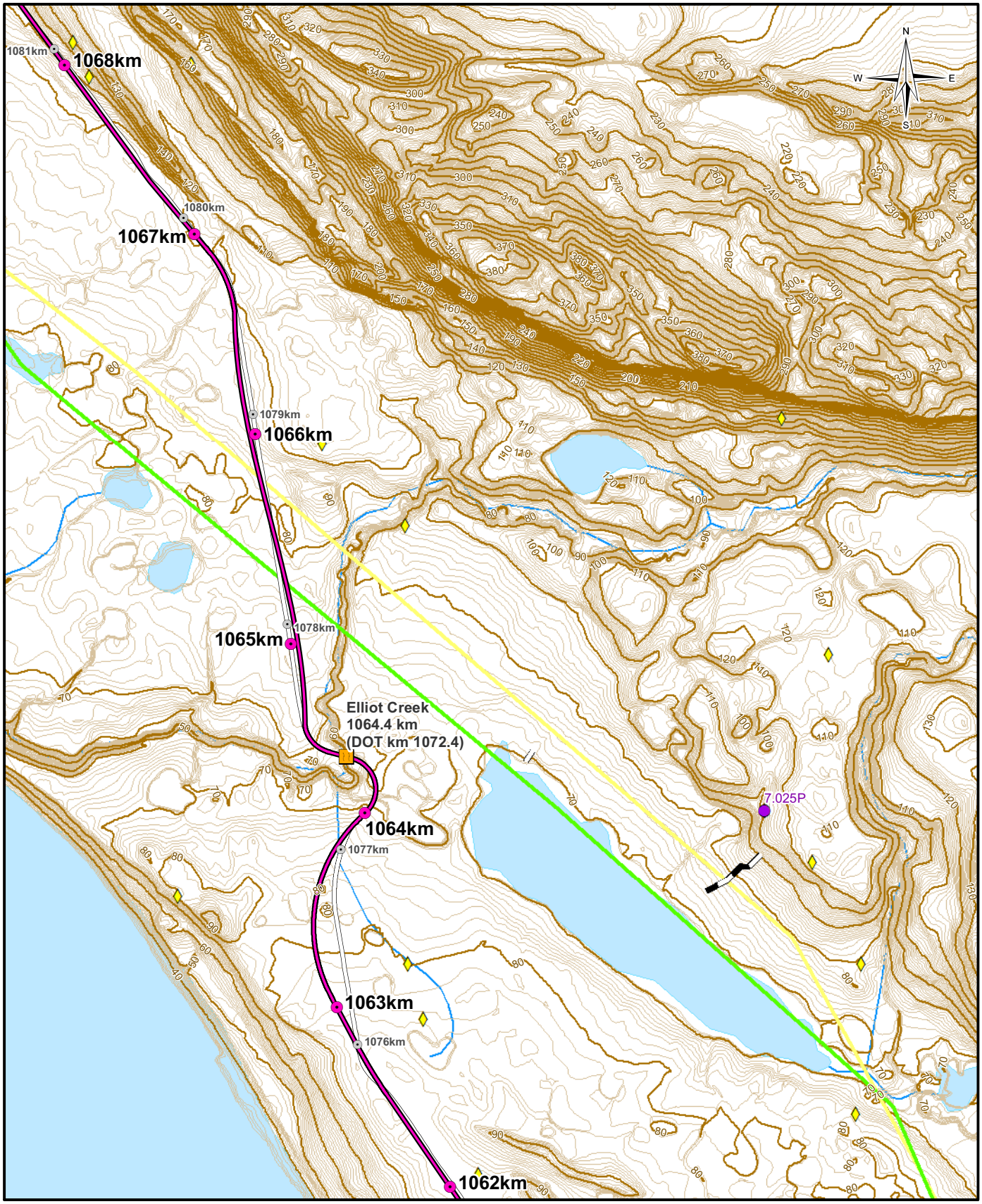
Map 04



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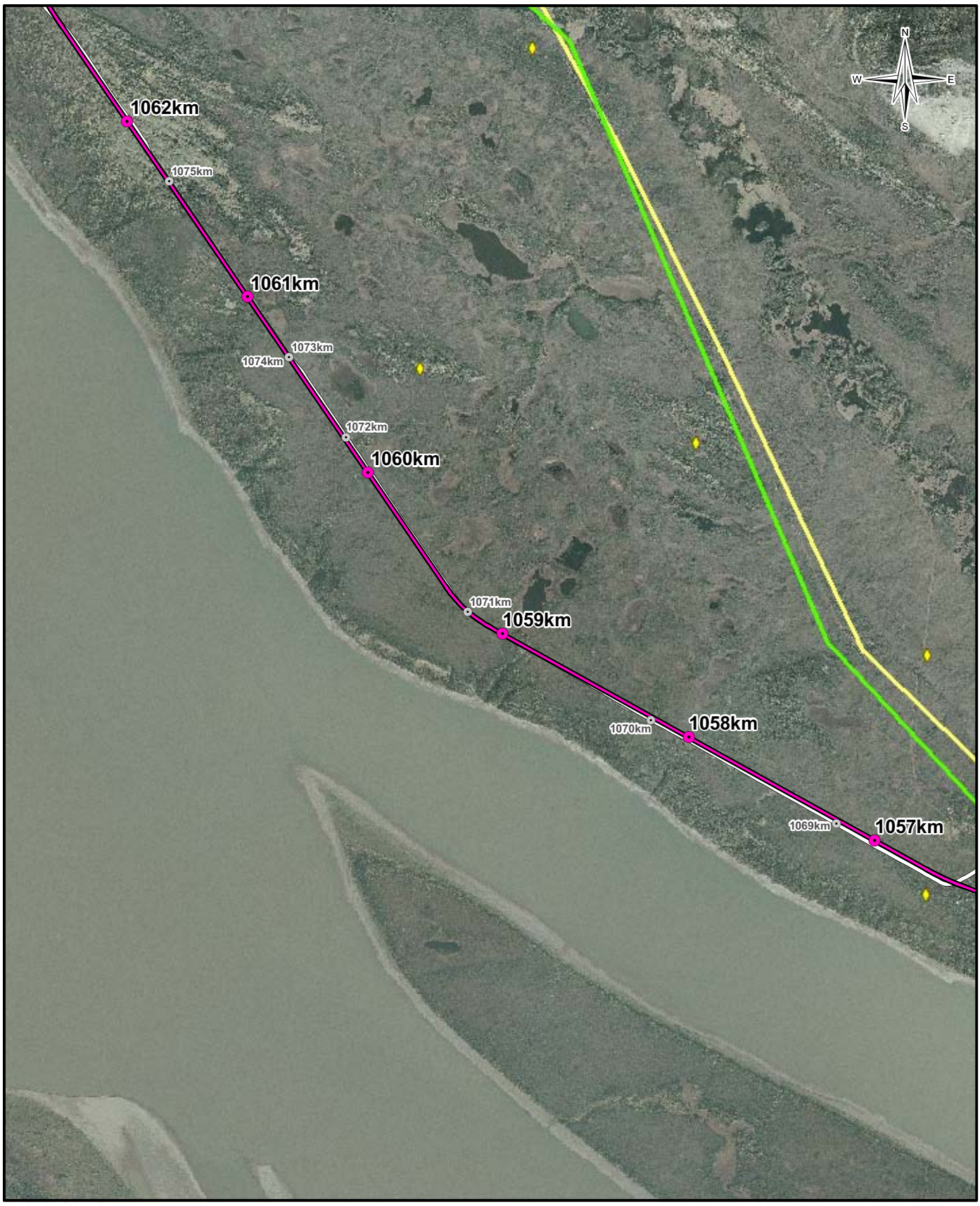
Map 04



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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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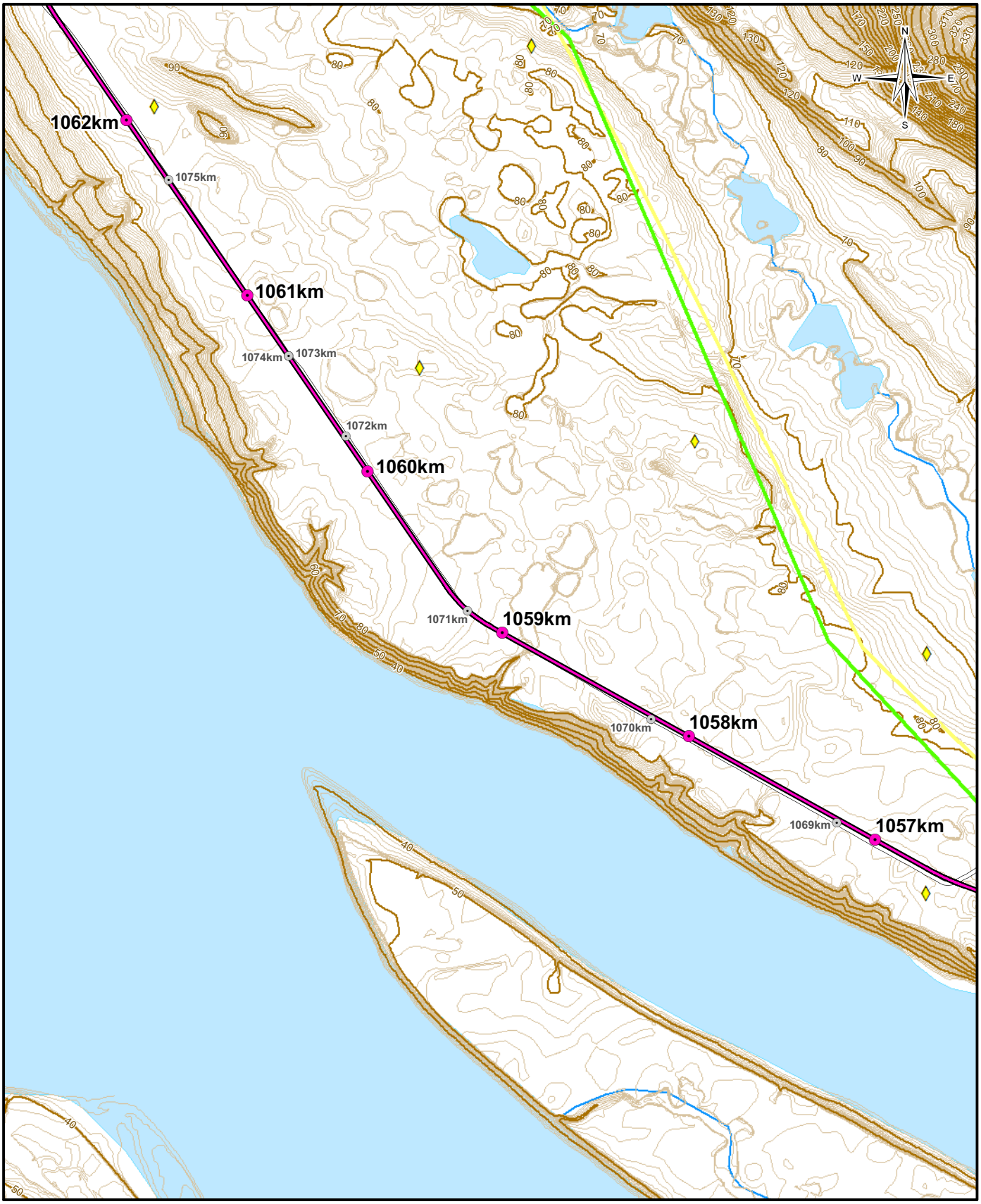
Map 05



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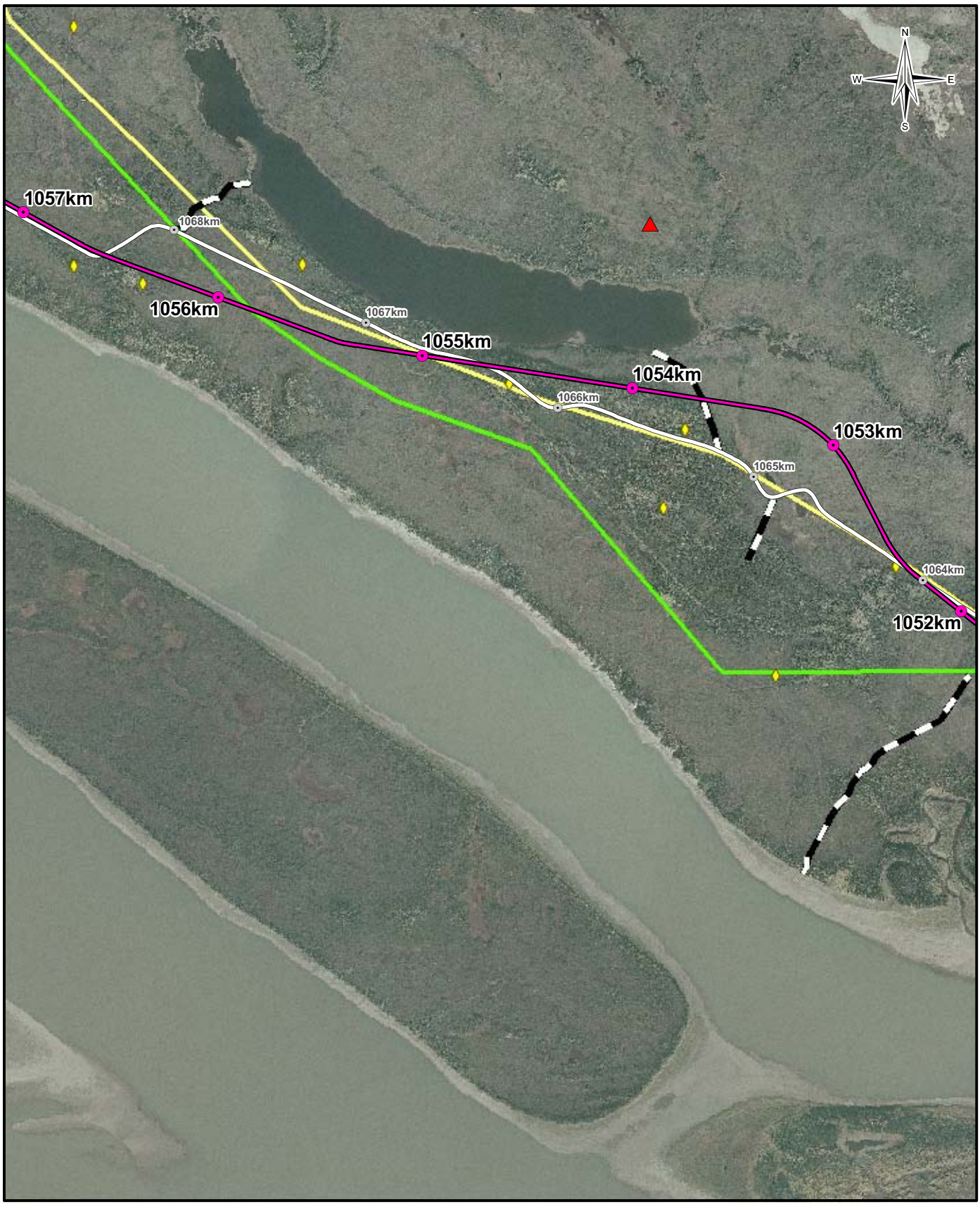
Map 05



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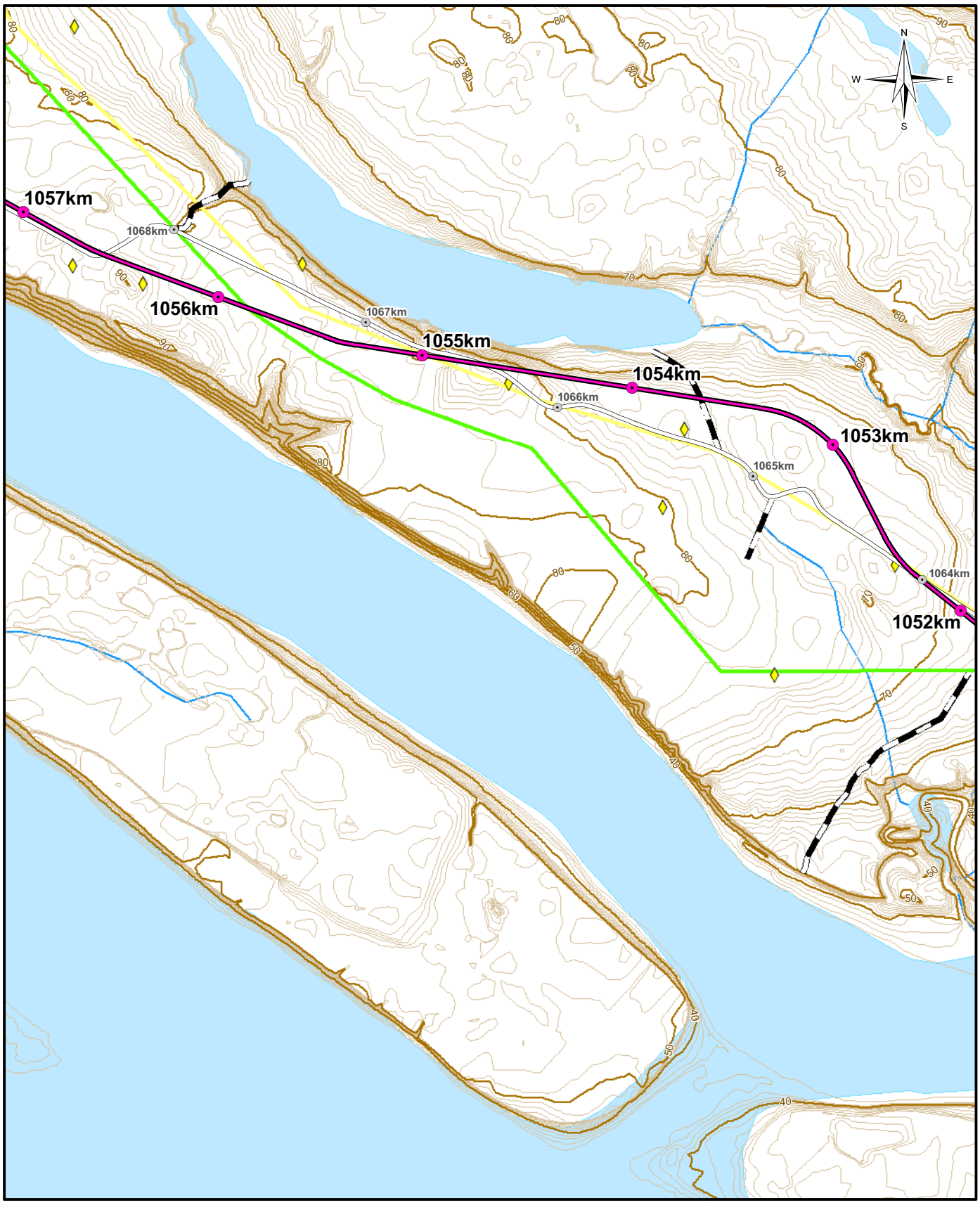
Map 06



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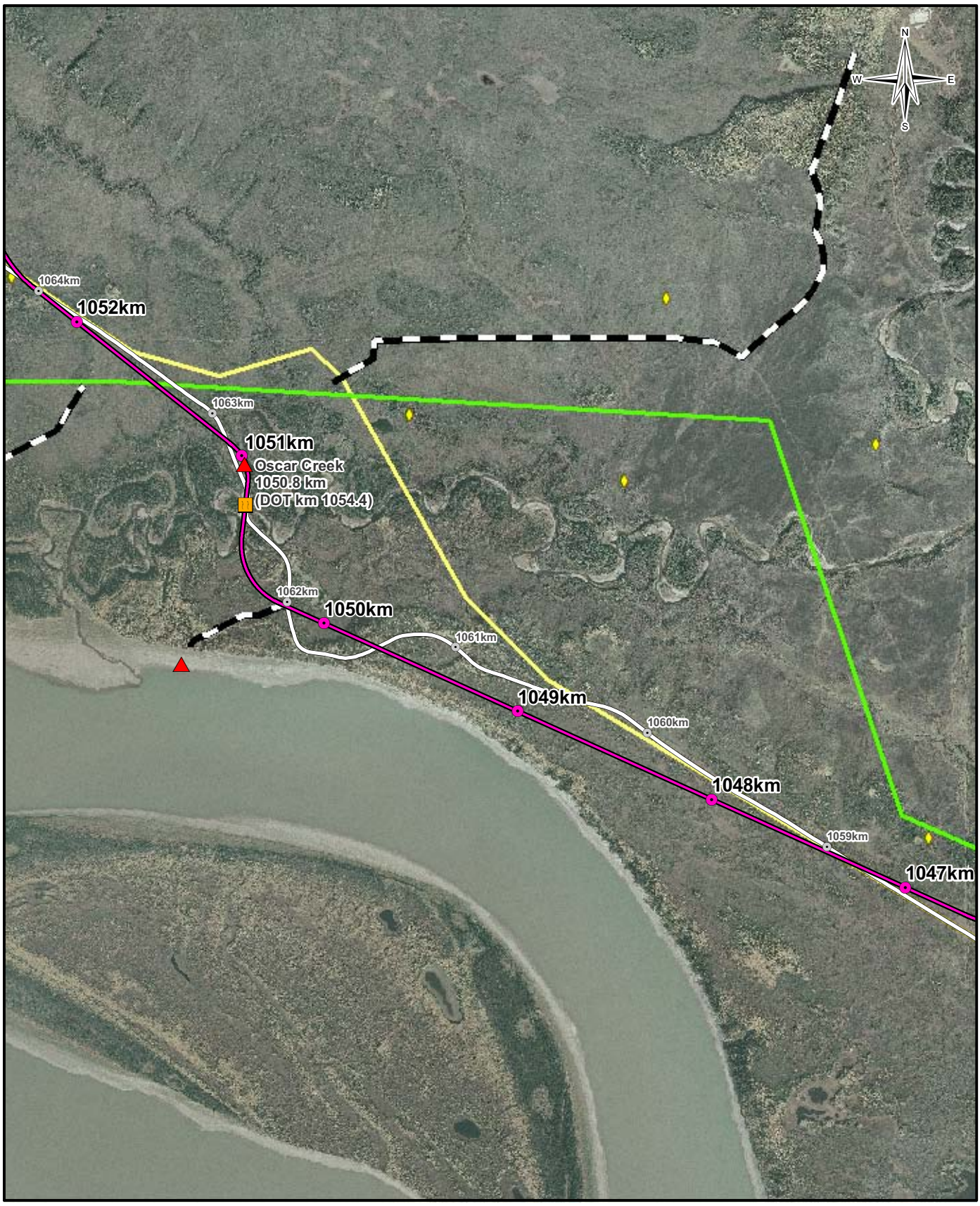

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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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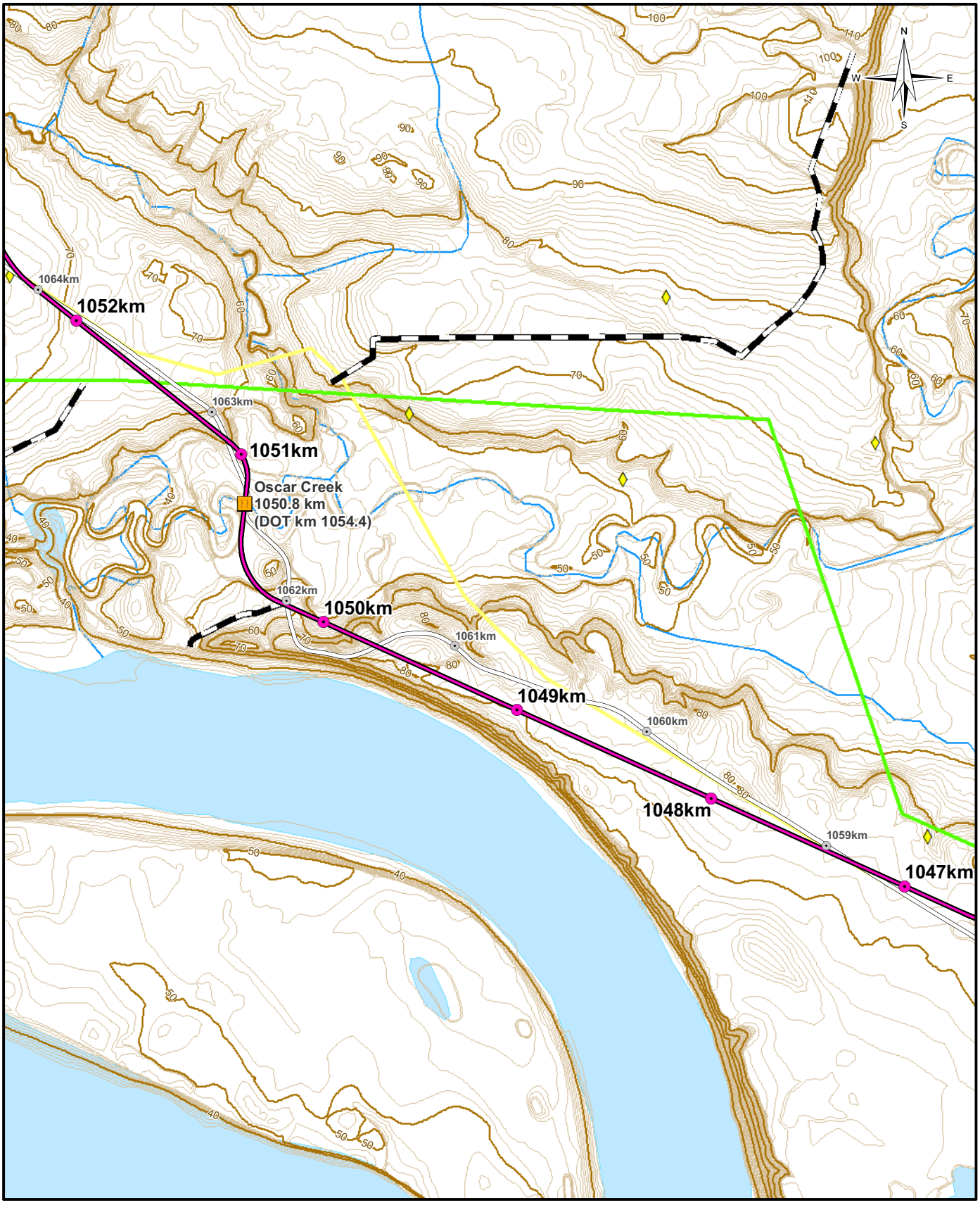
Map 07



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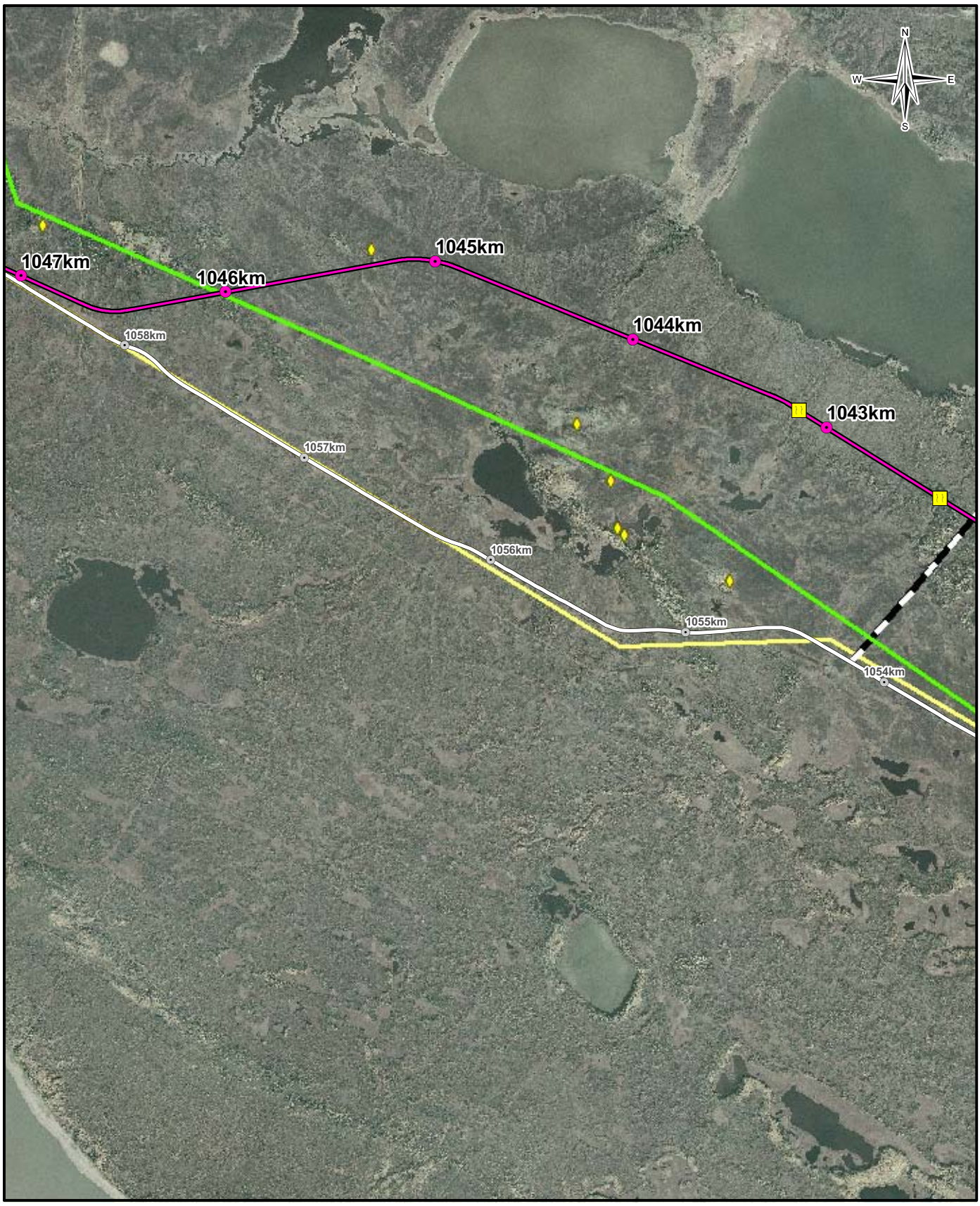

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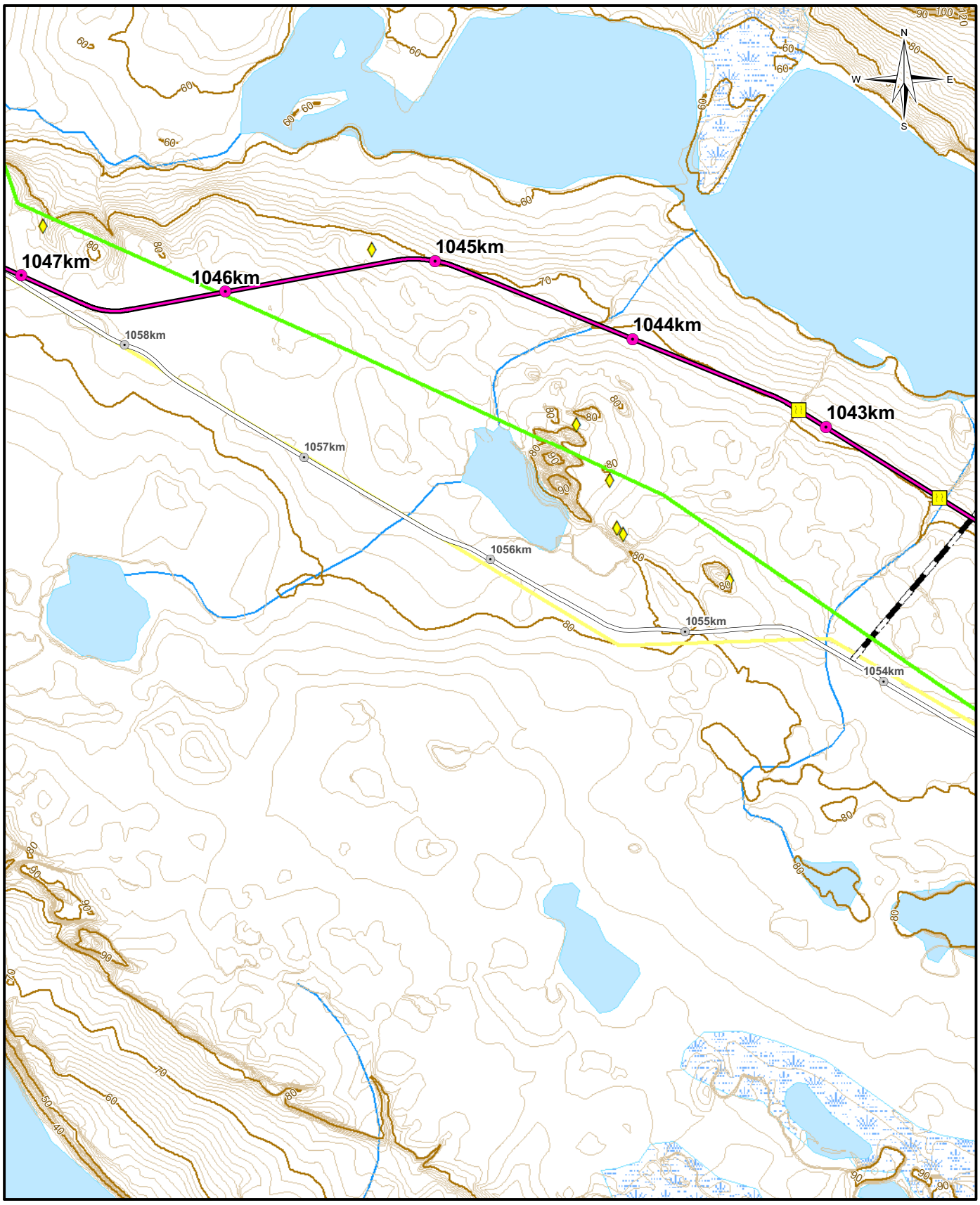
Map 08



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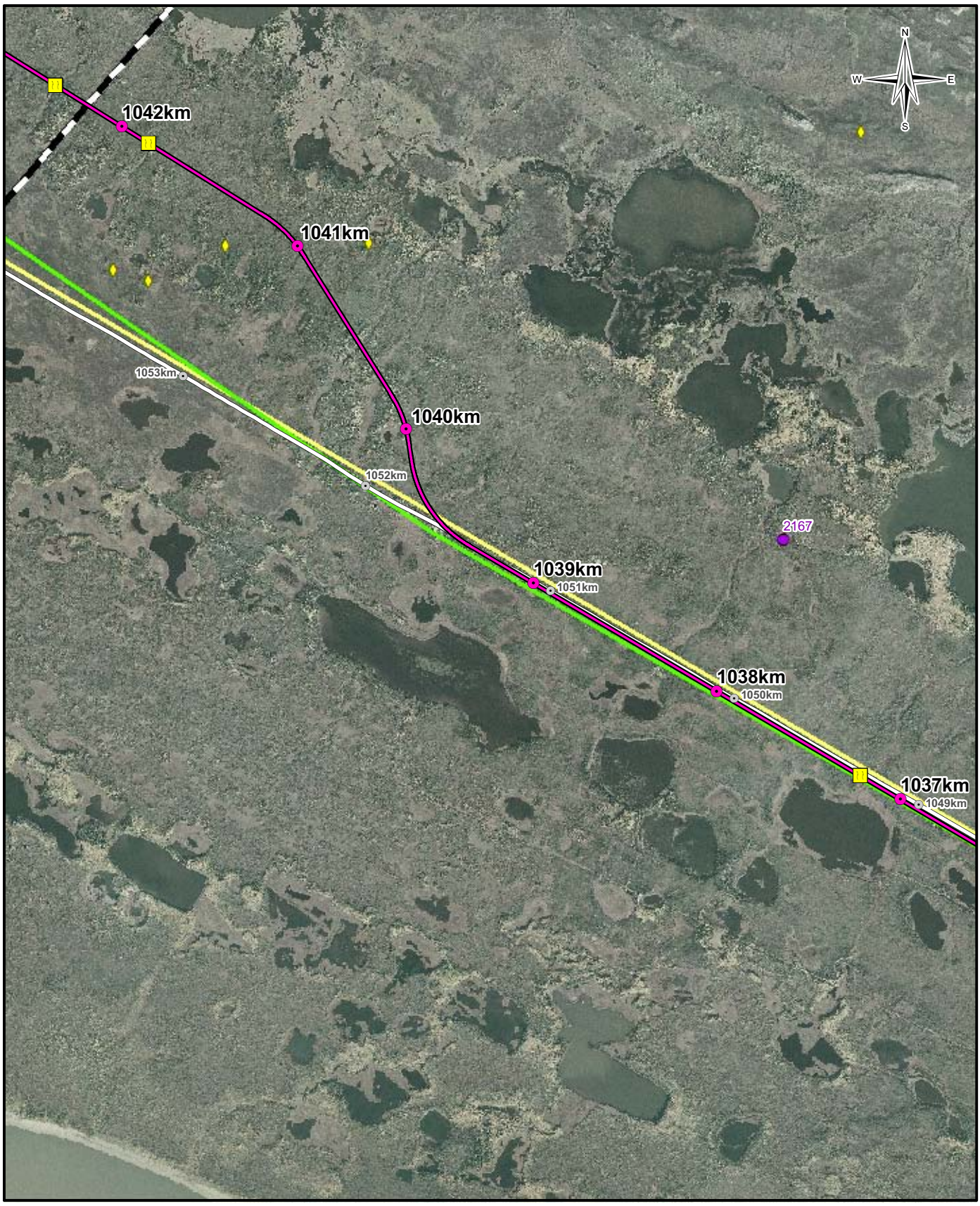

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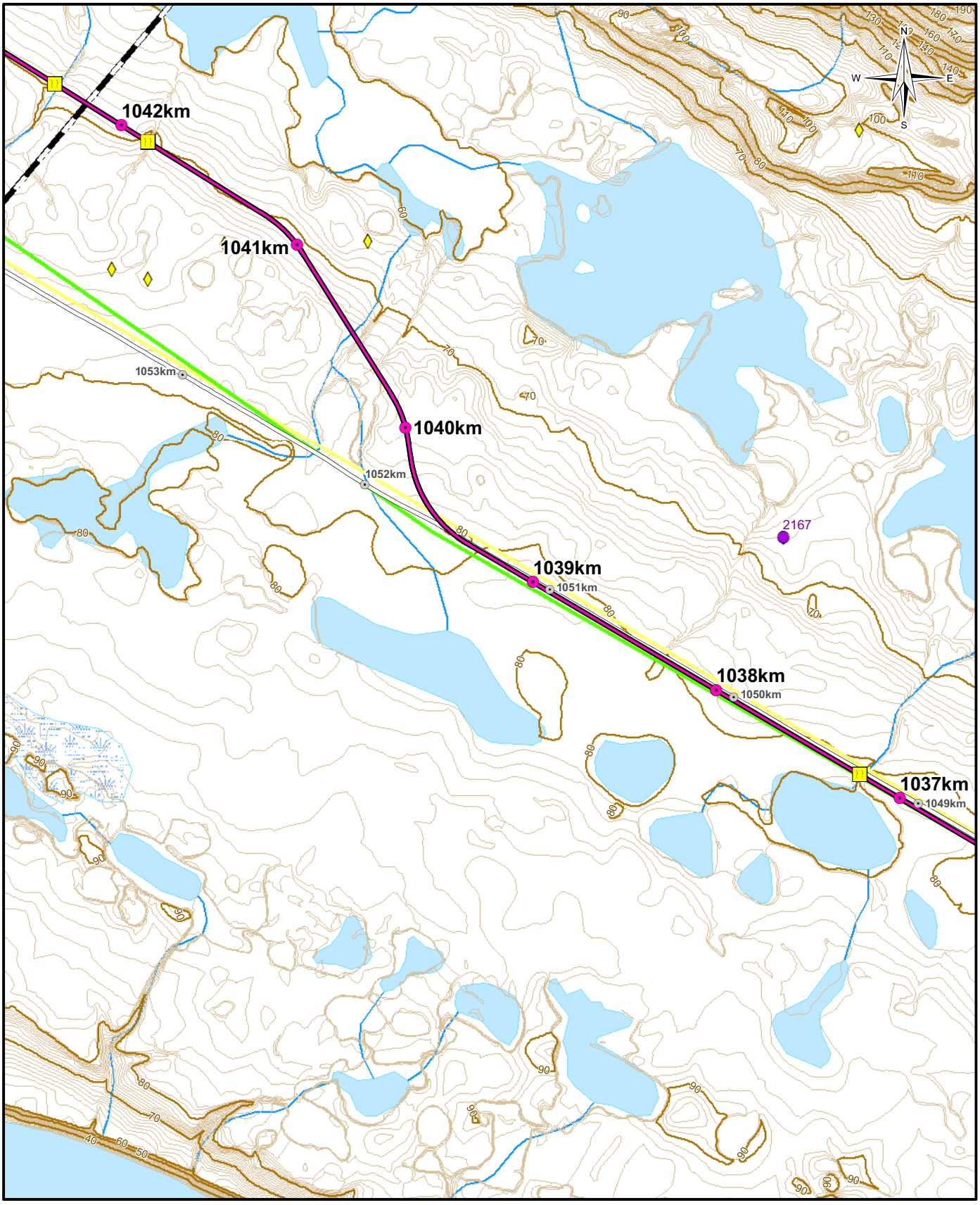
Map 09



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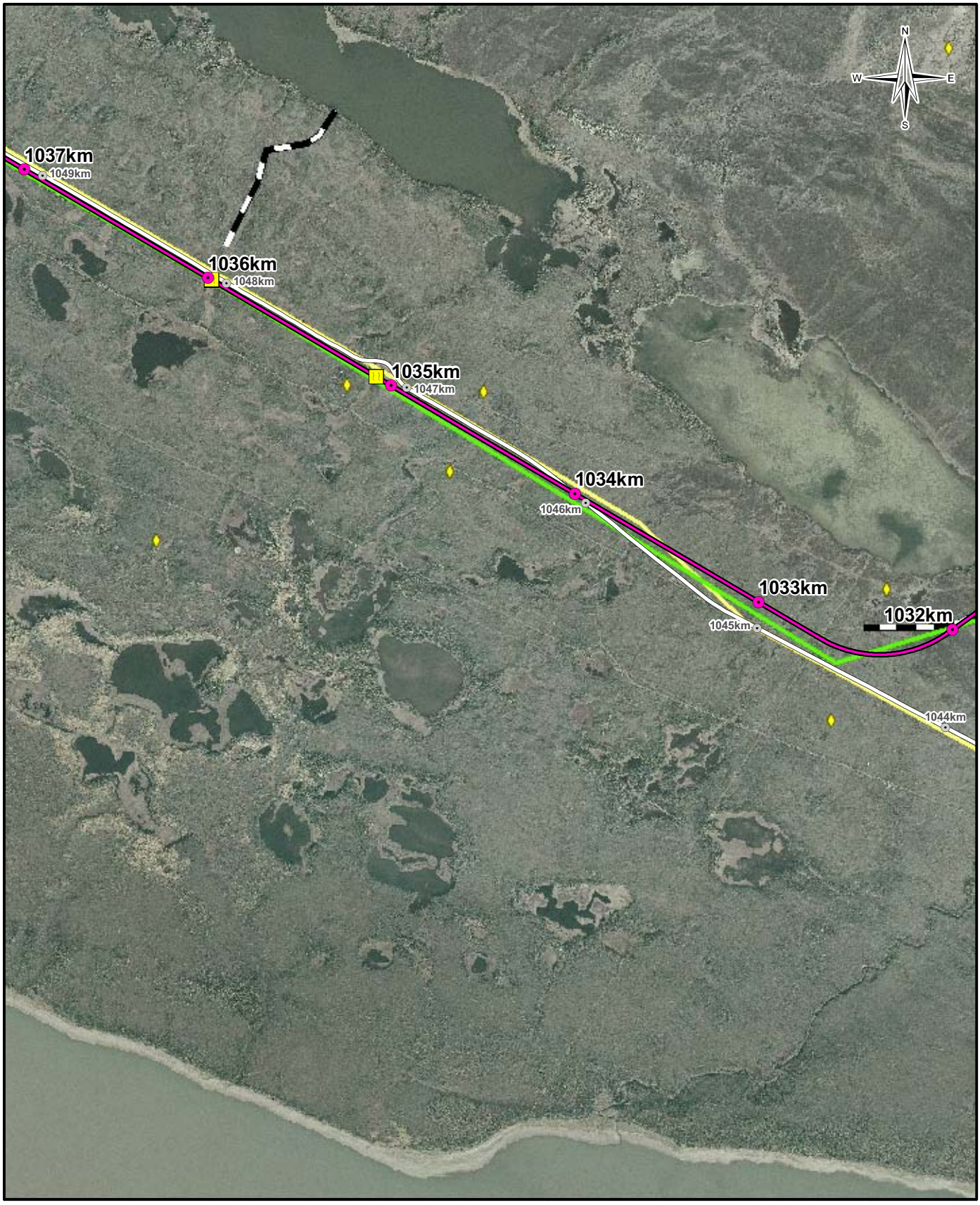

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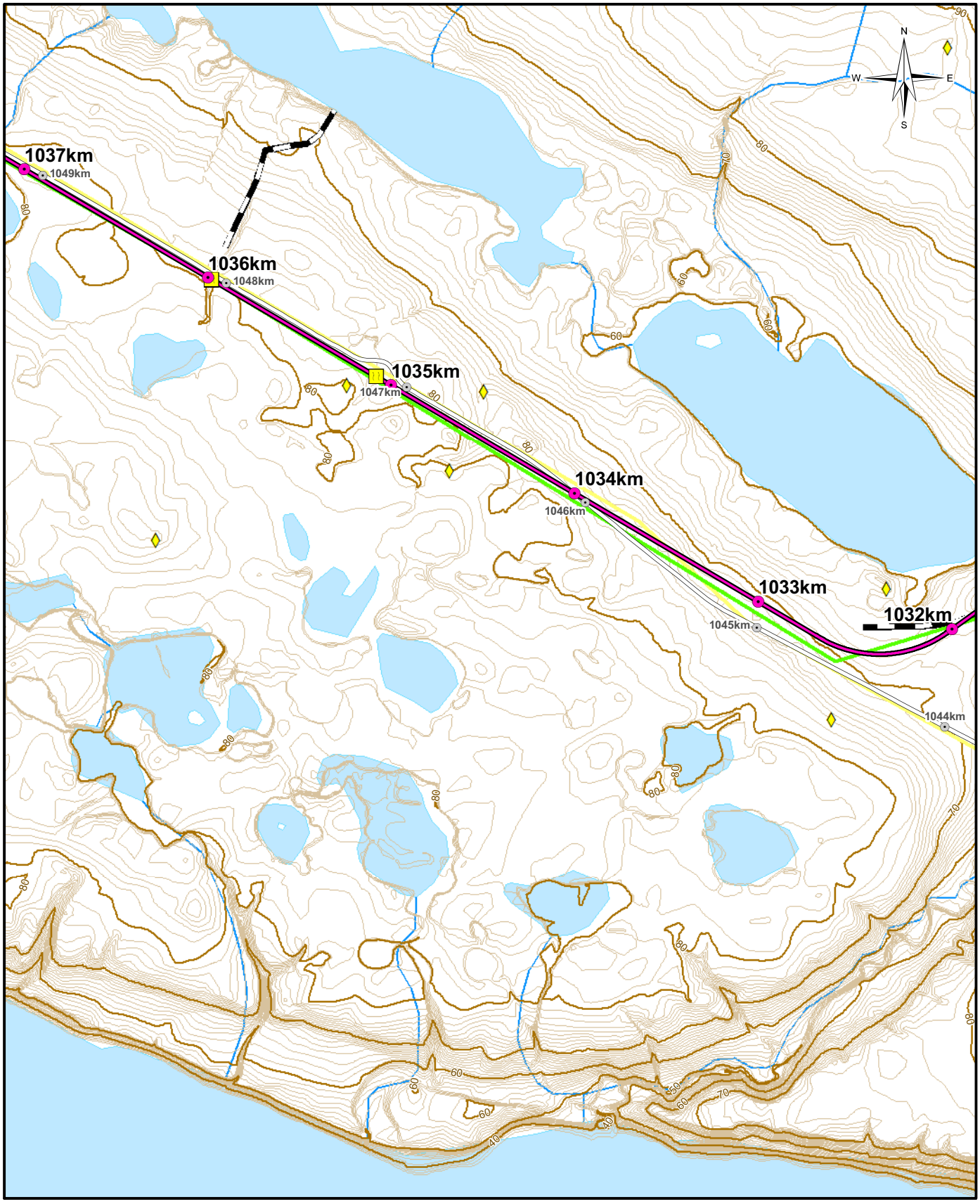
Map 10



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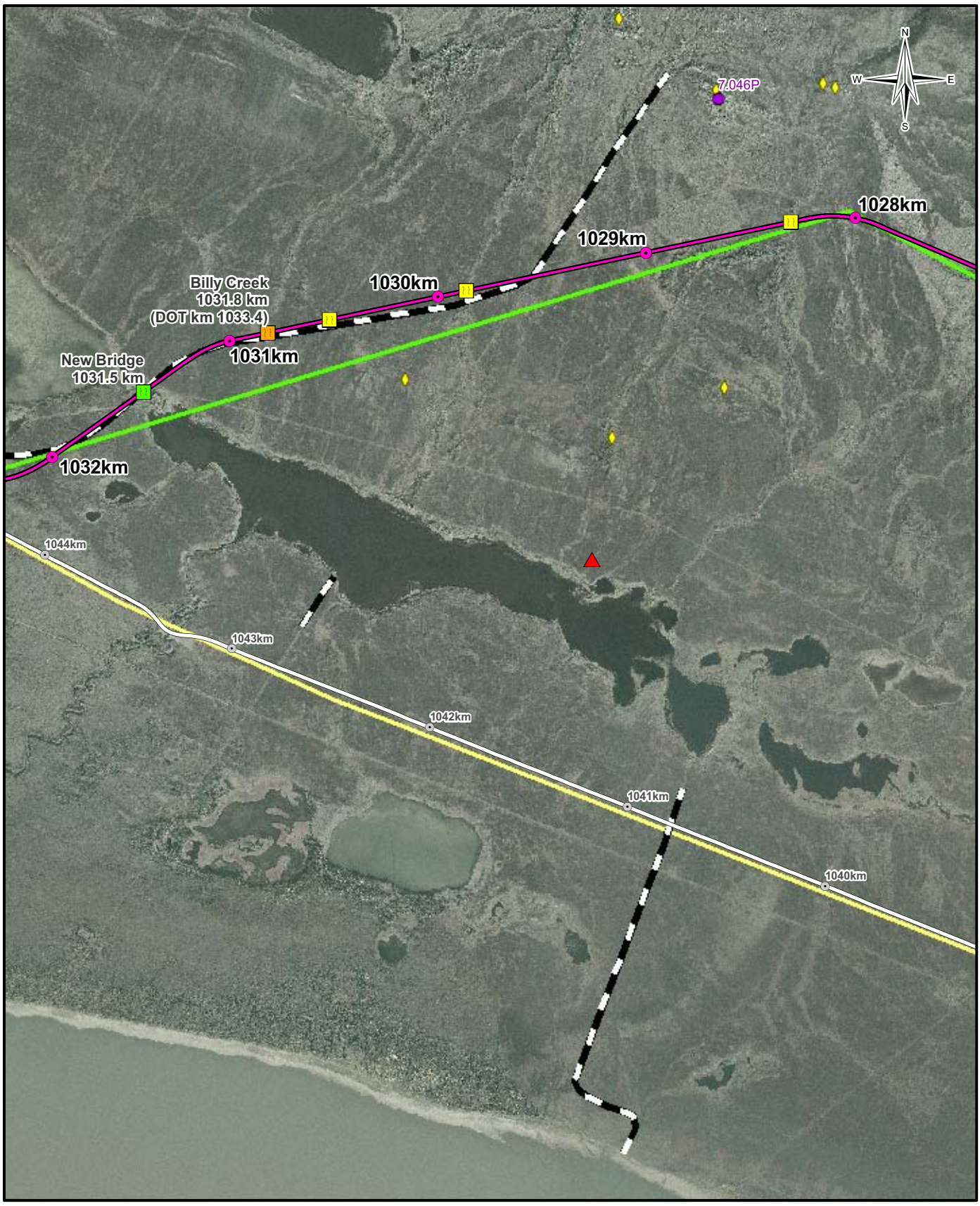
Map 10



Legend

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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

1:25,000 Map Book

Scale: 1:25,000 (0, 250, 500 Metres)

UTM Zone 8
NAD83

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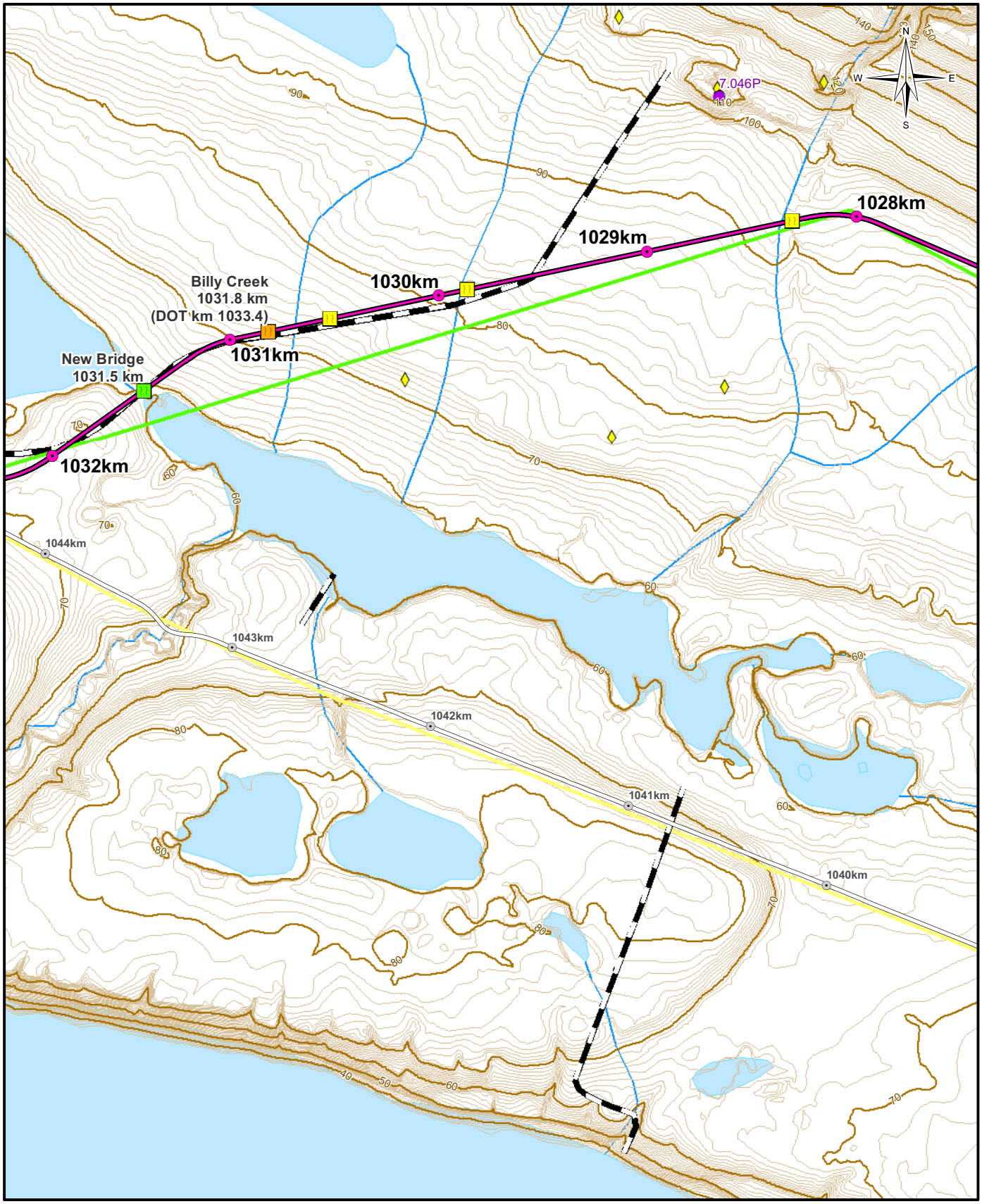
FILE NO. Y22101155_MapBook-Imagery-Oct2011.mxd
PROJECT NO. Y22101155 DATE October 14, 2011

Map 11



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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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Metres

UTM Zone 8
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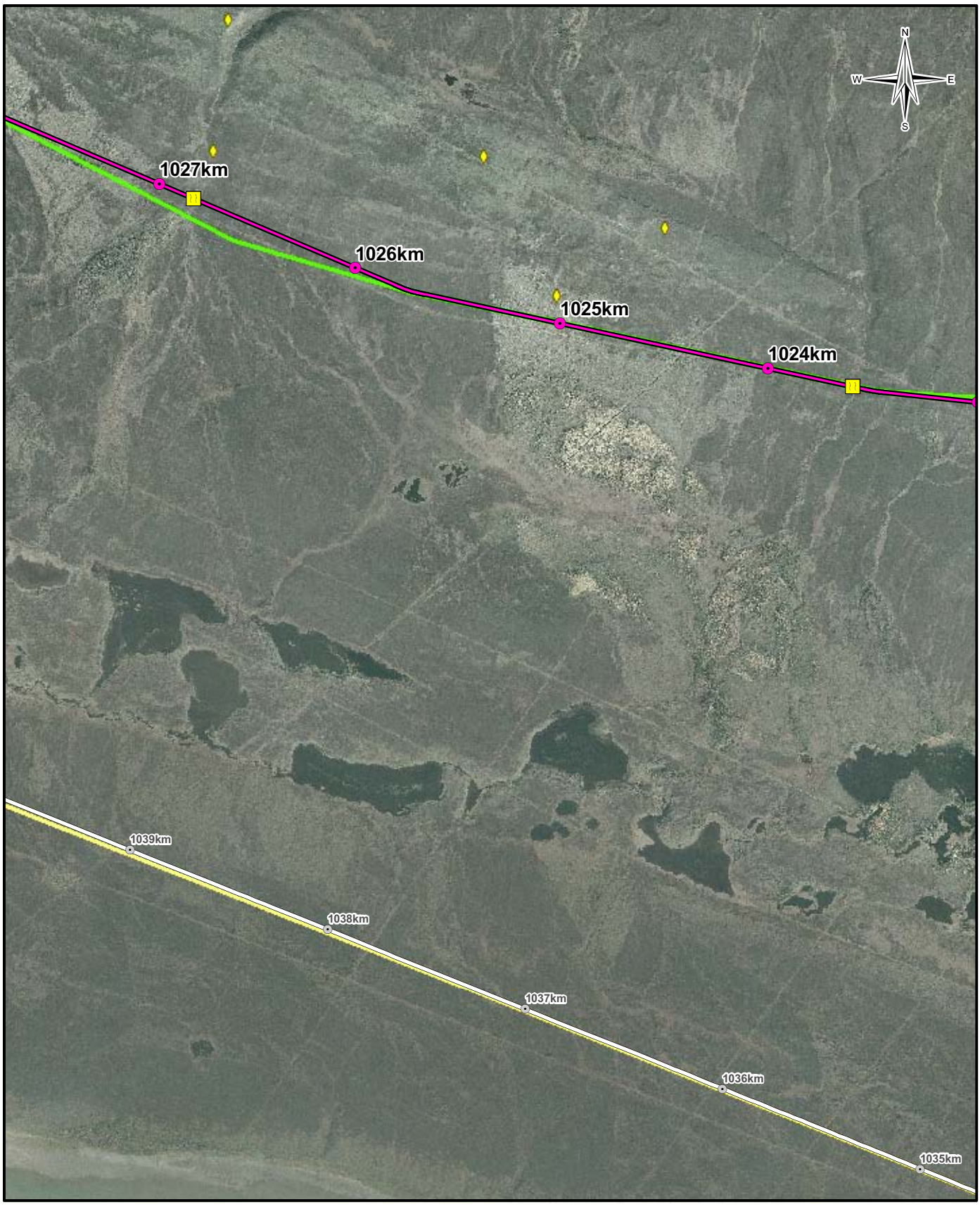

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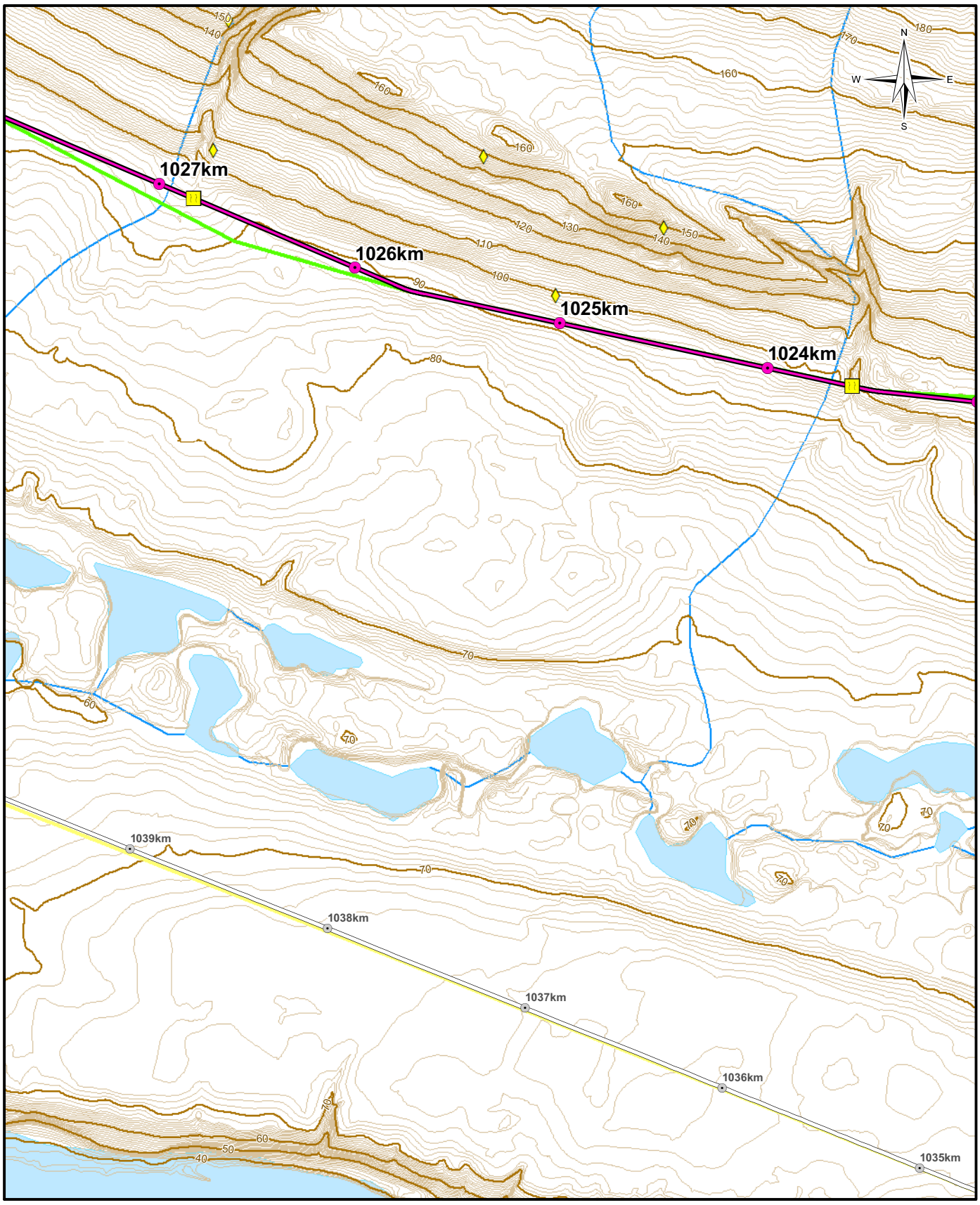
Map 12



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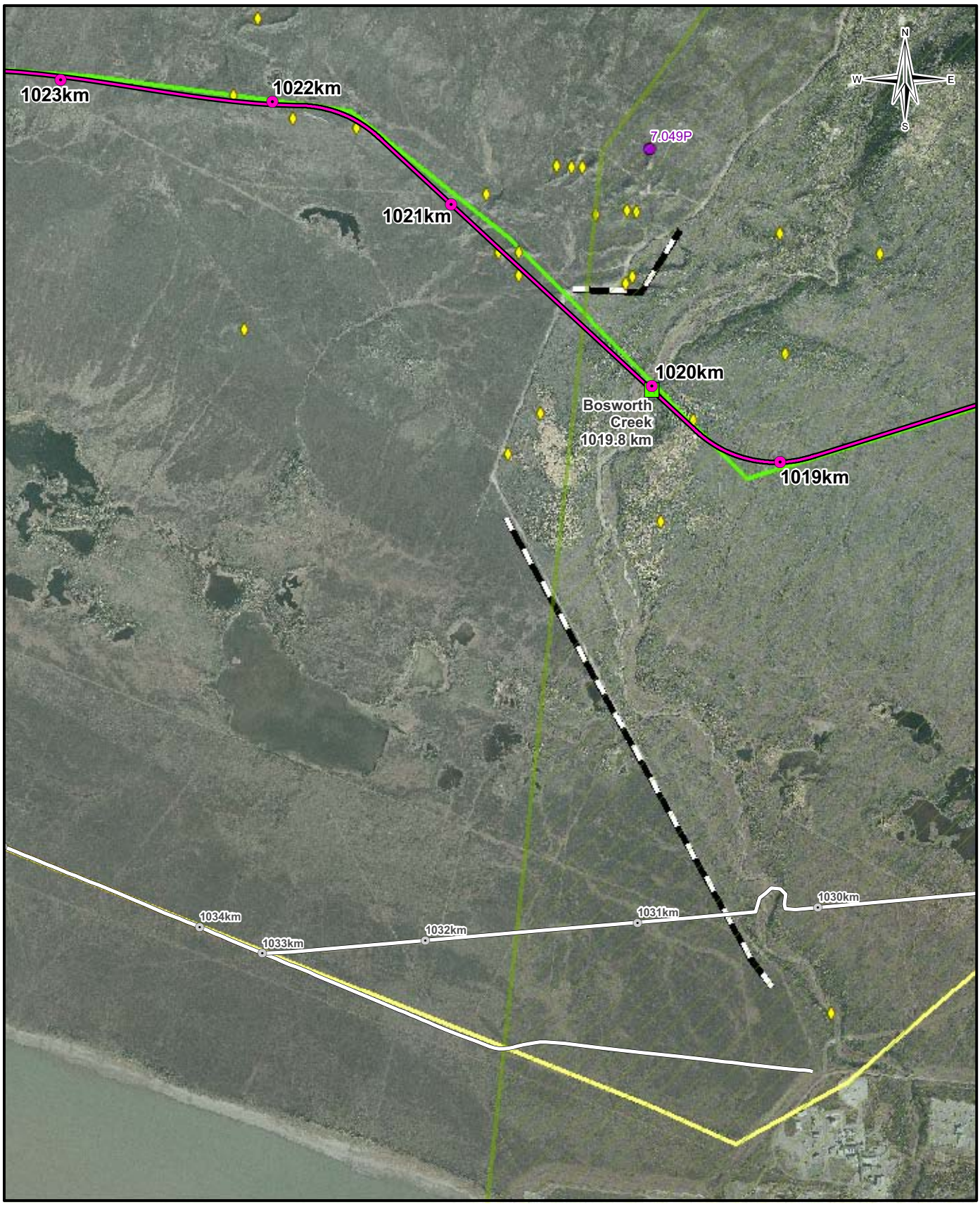

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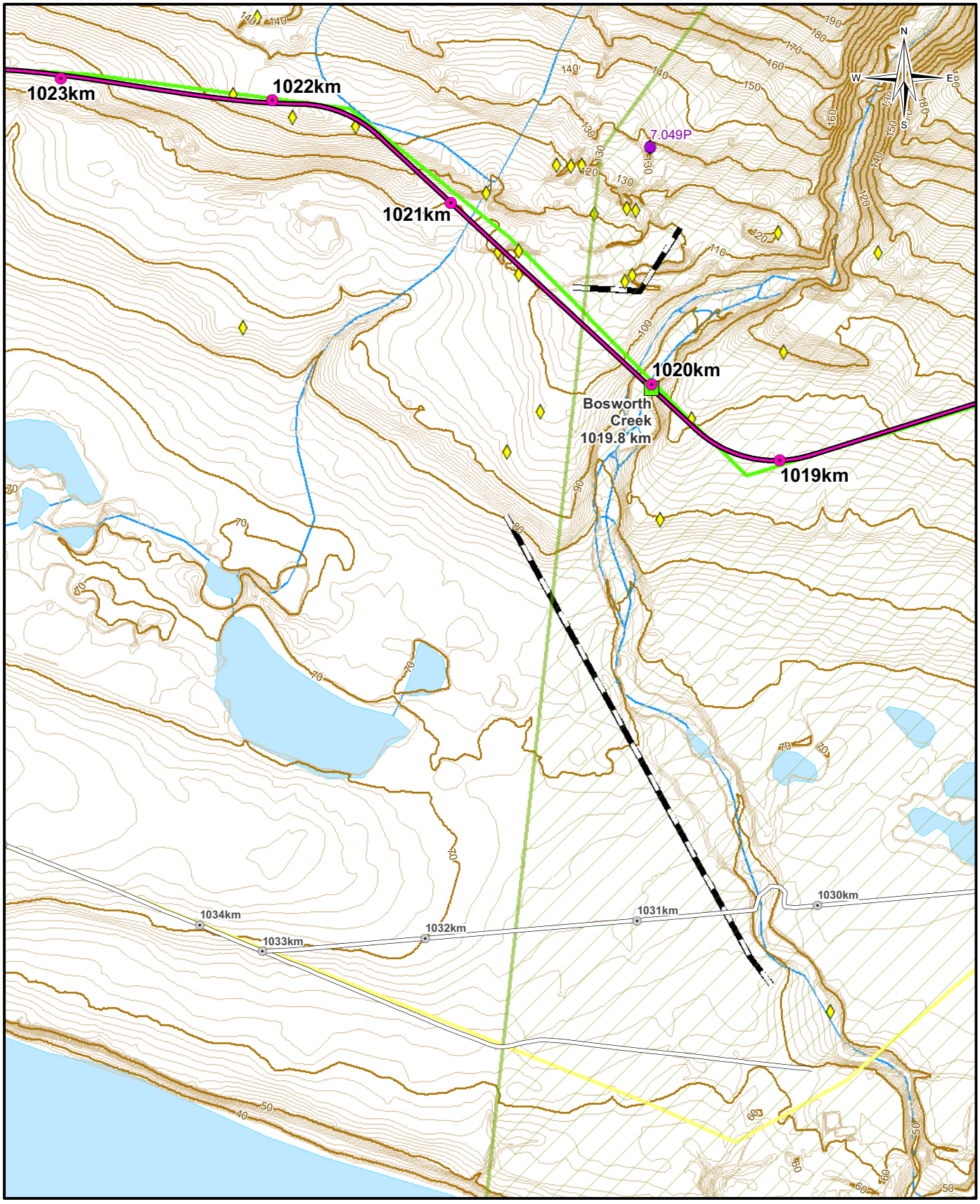

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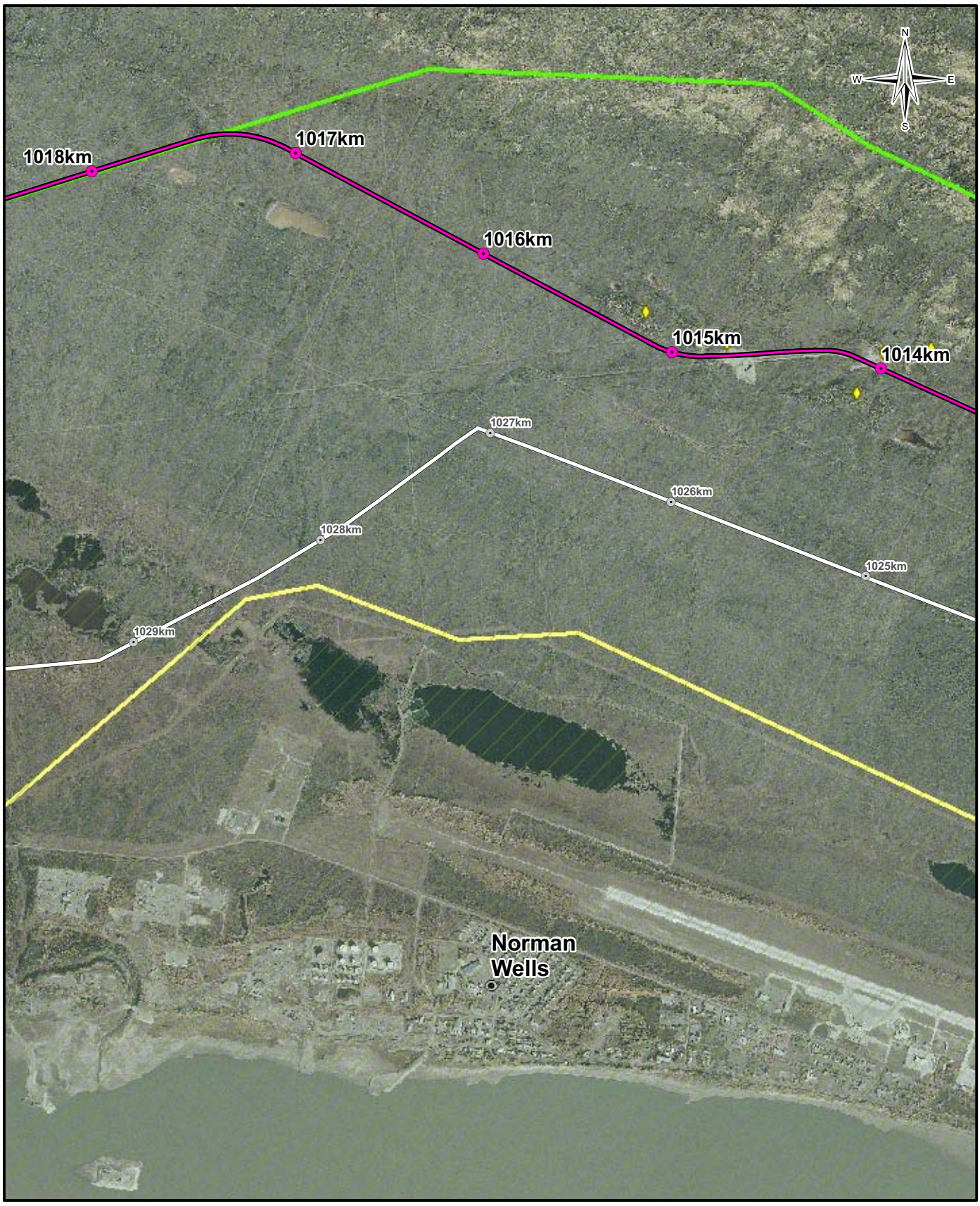

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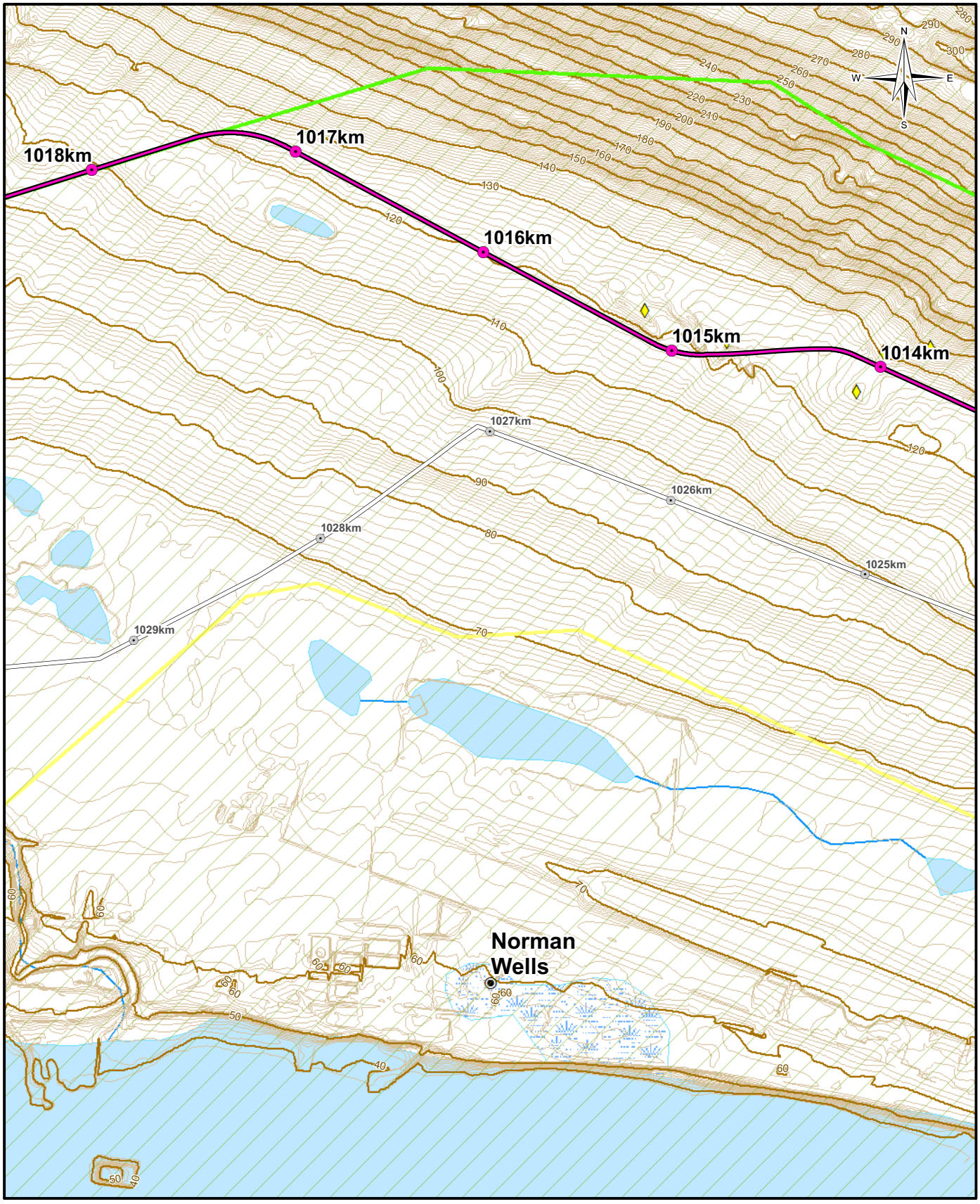
Map 14



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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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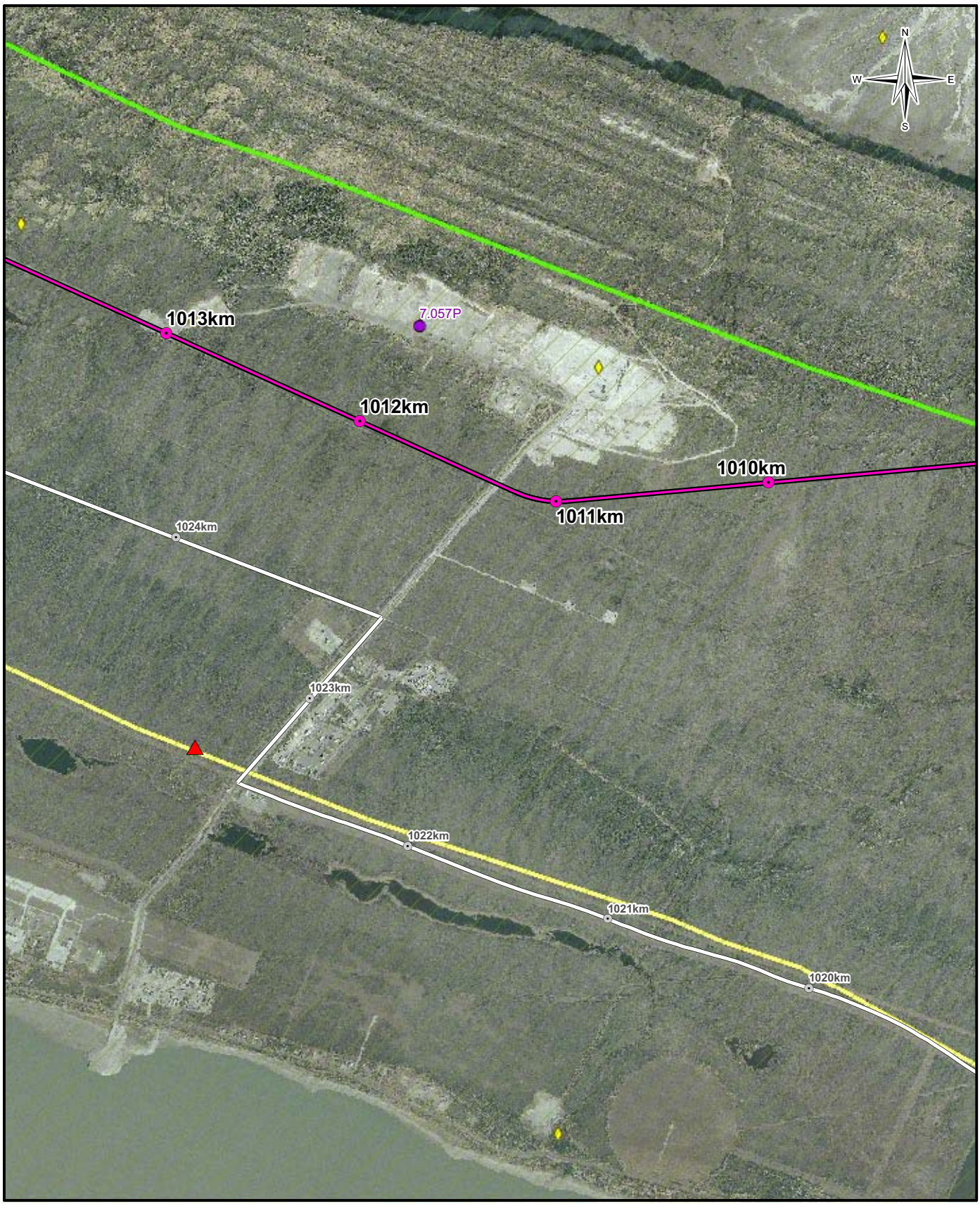

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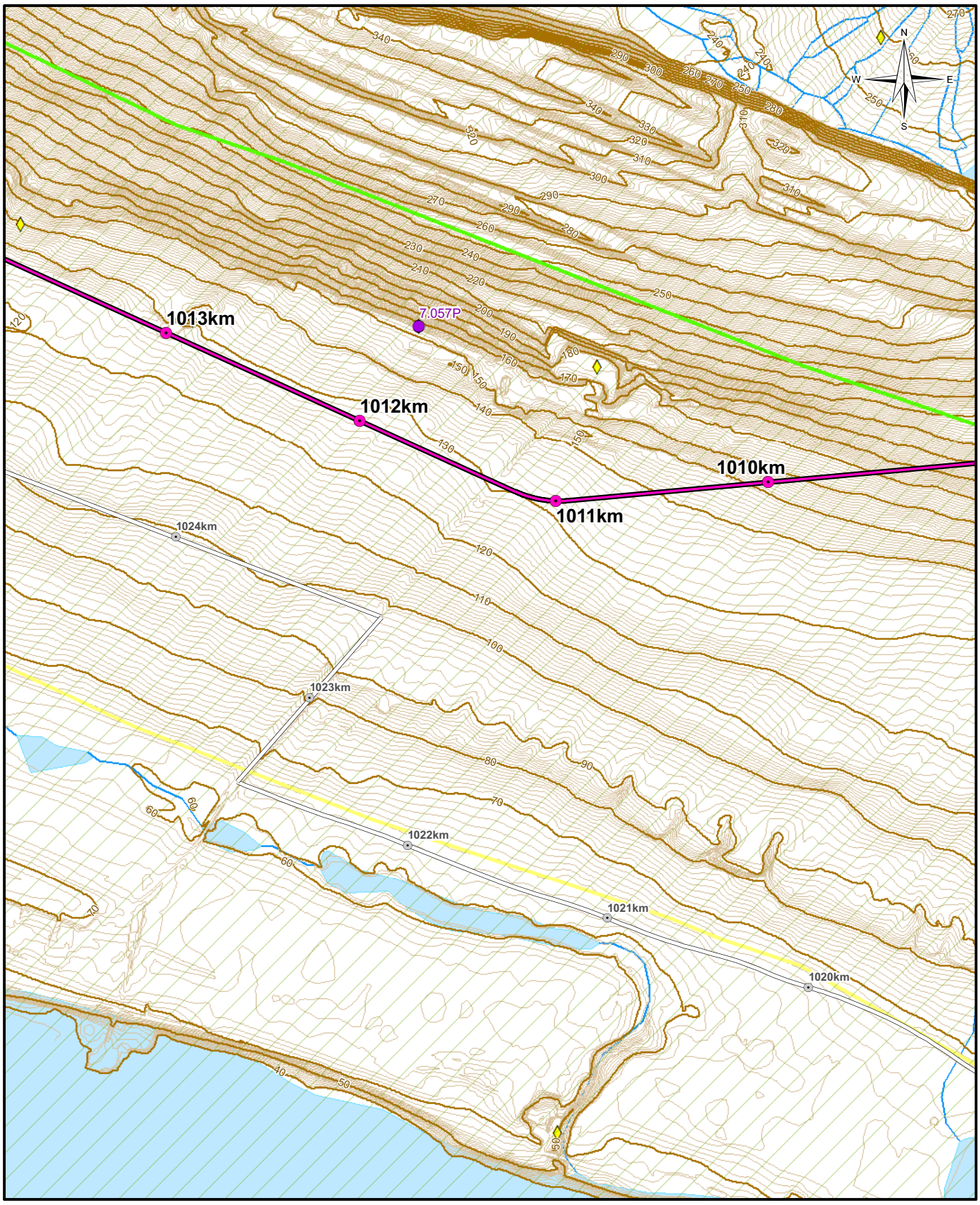
Map 15



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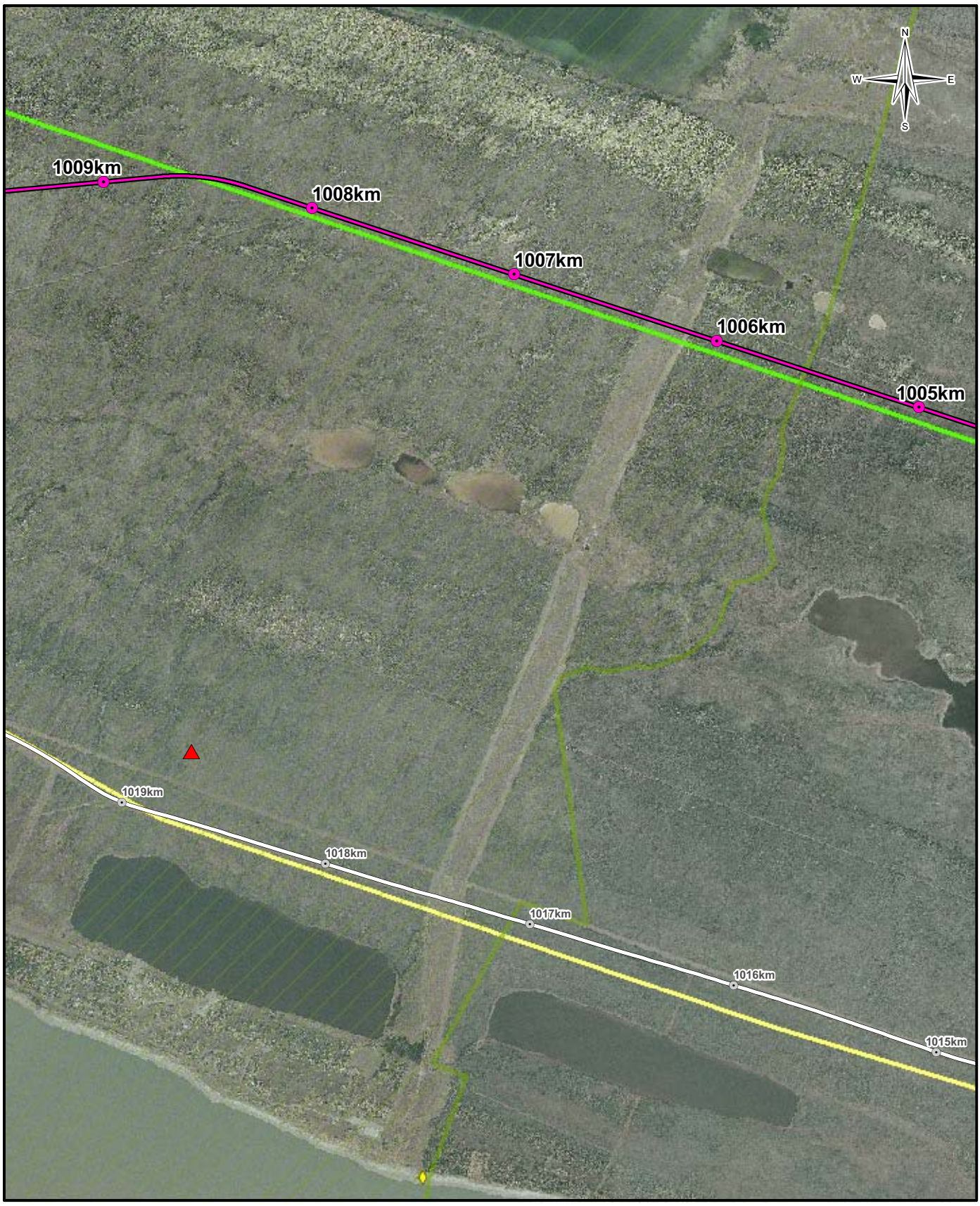
Map 15



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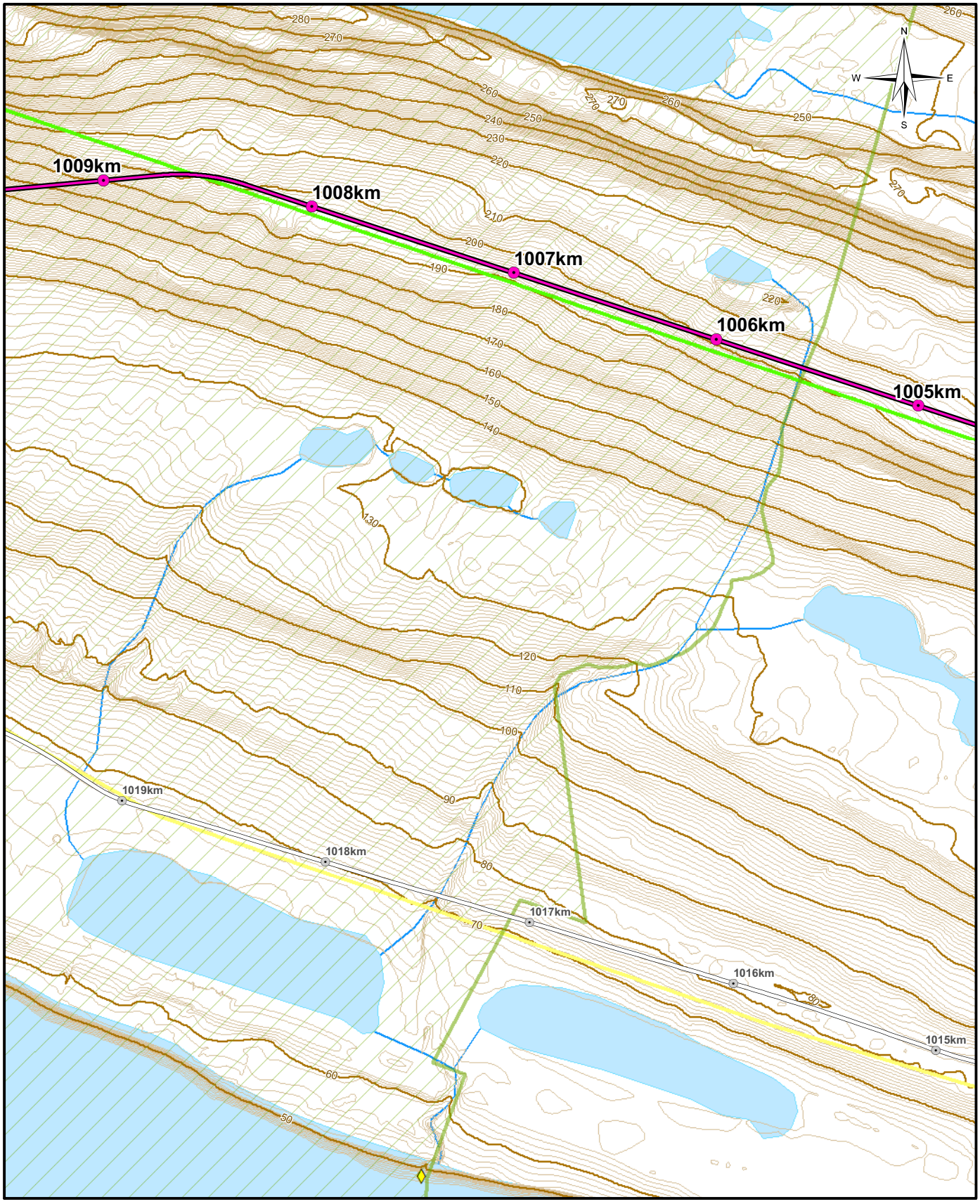
Map 16



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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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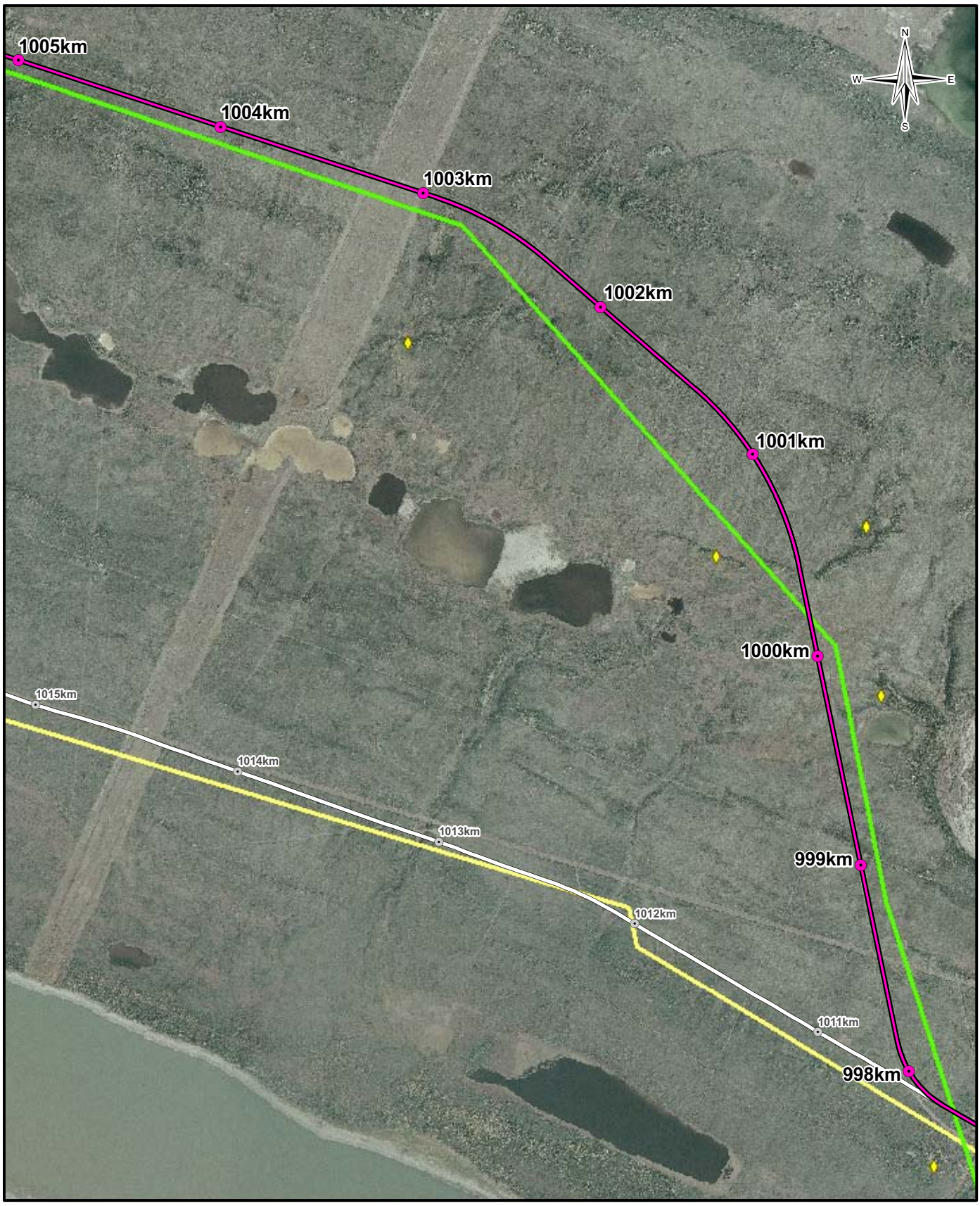

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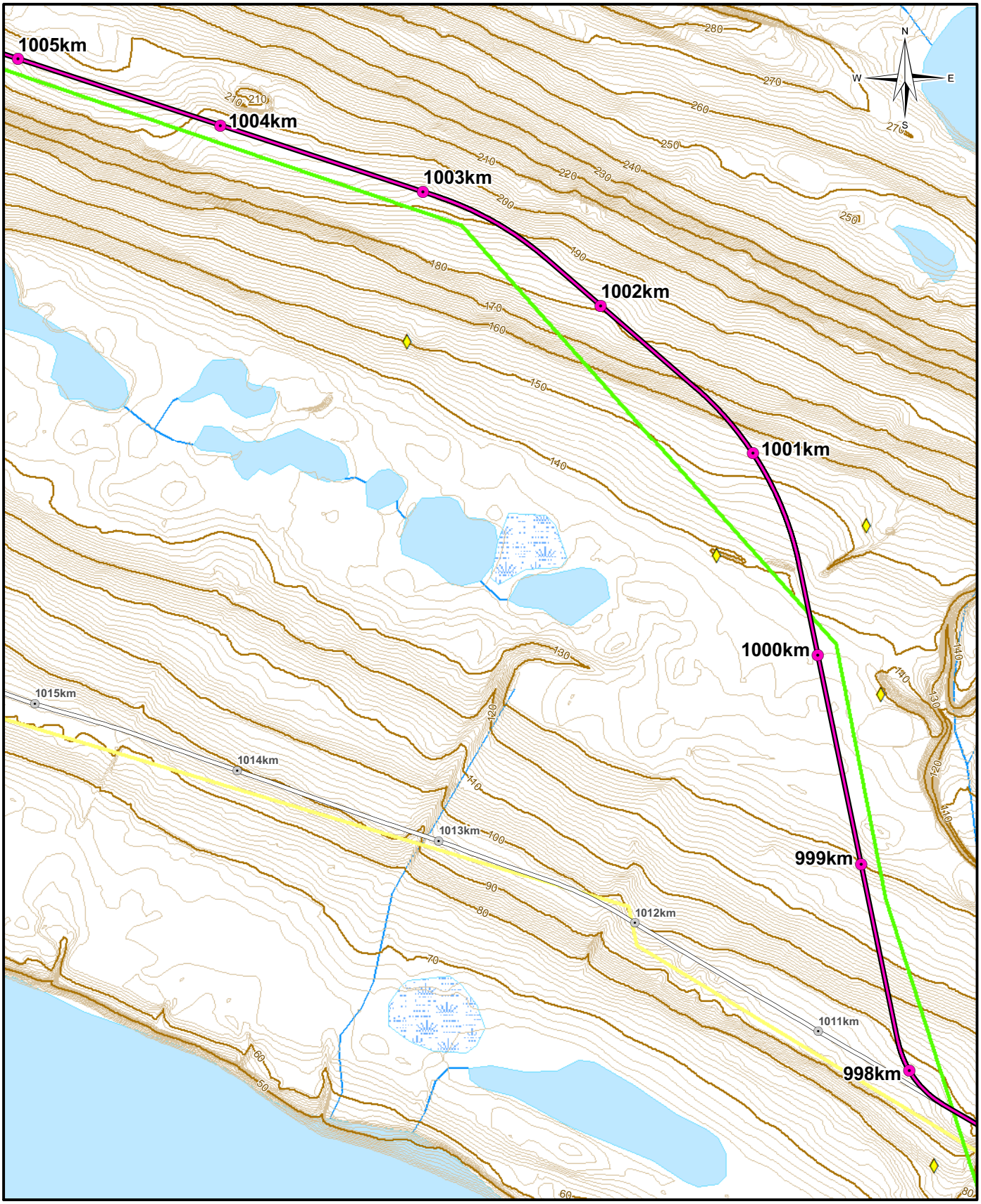

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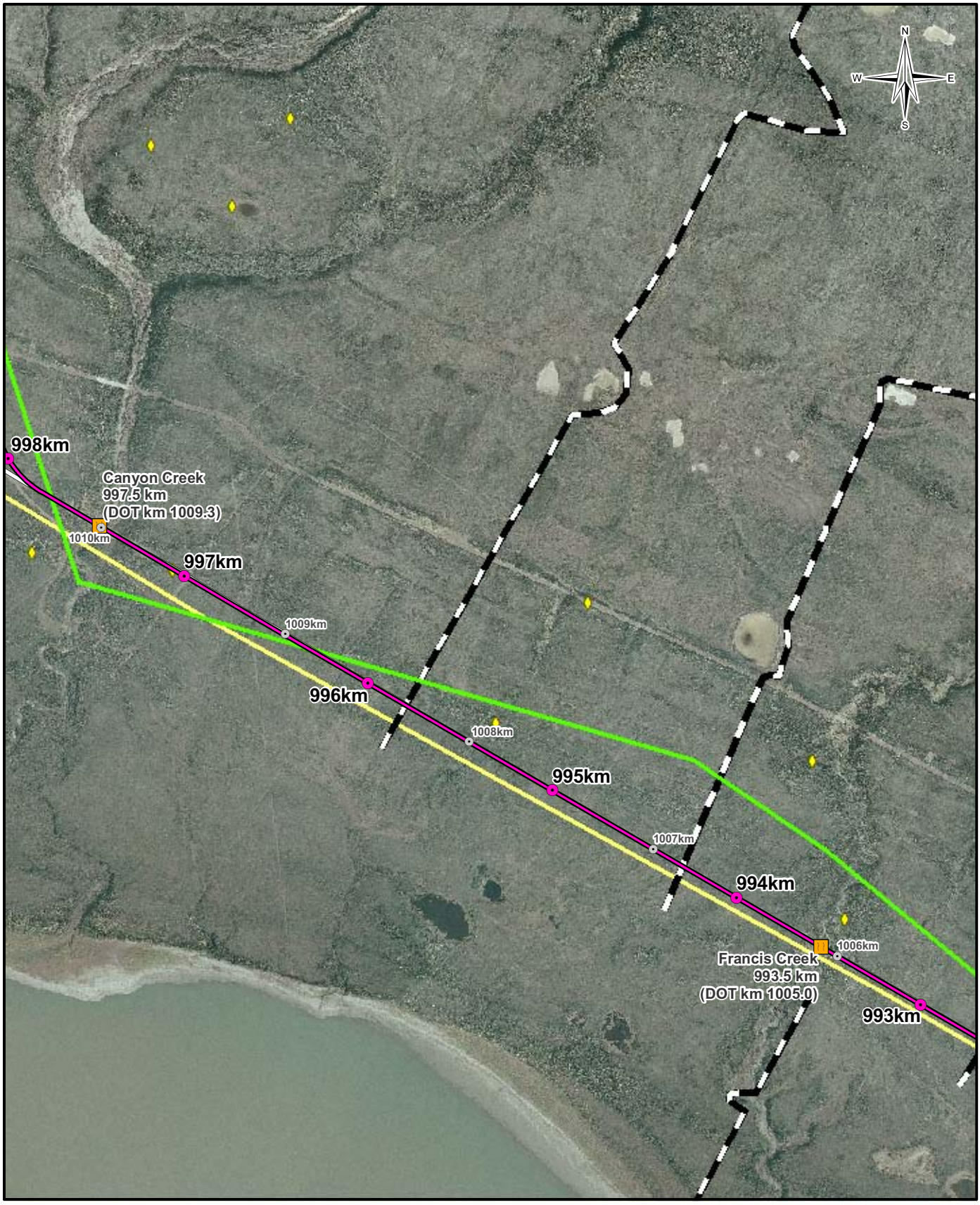

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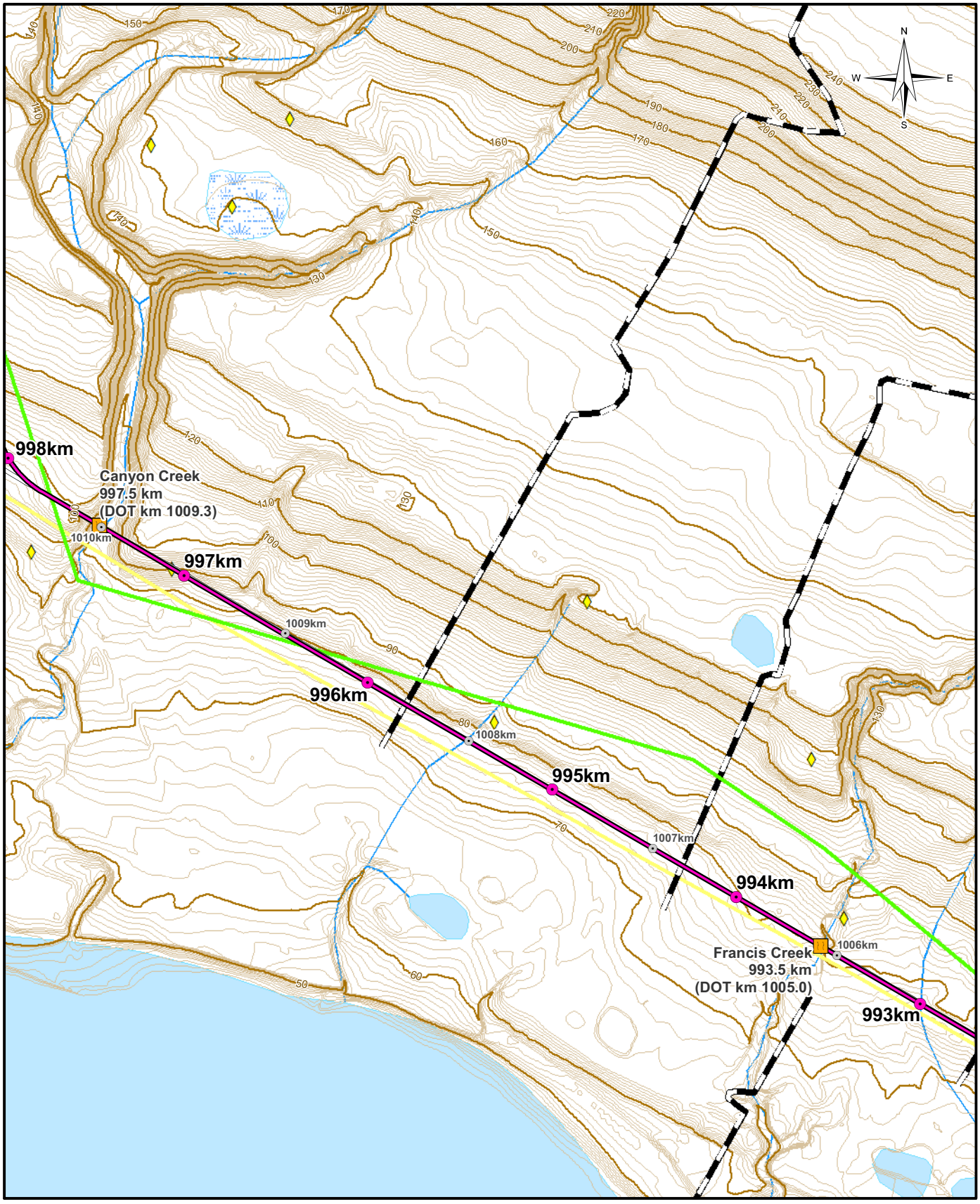
Map 18



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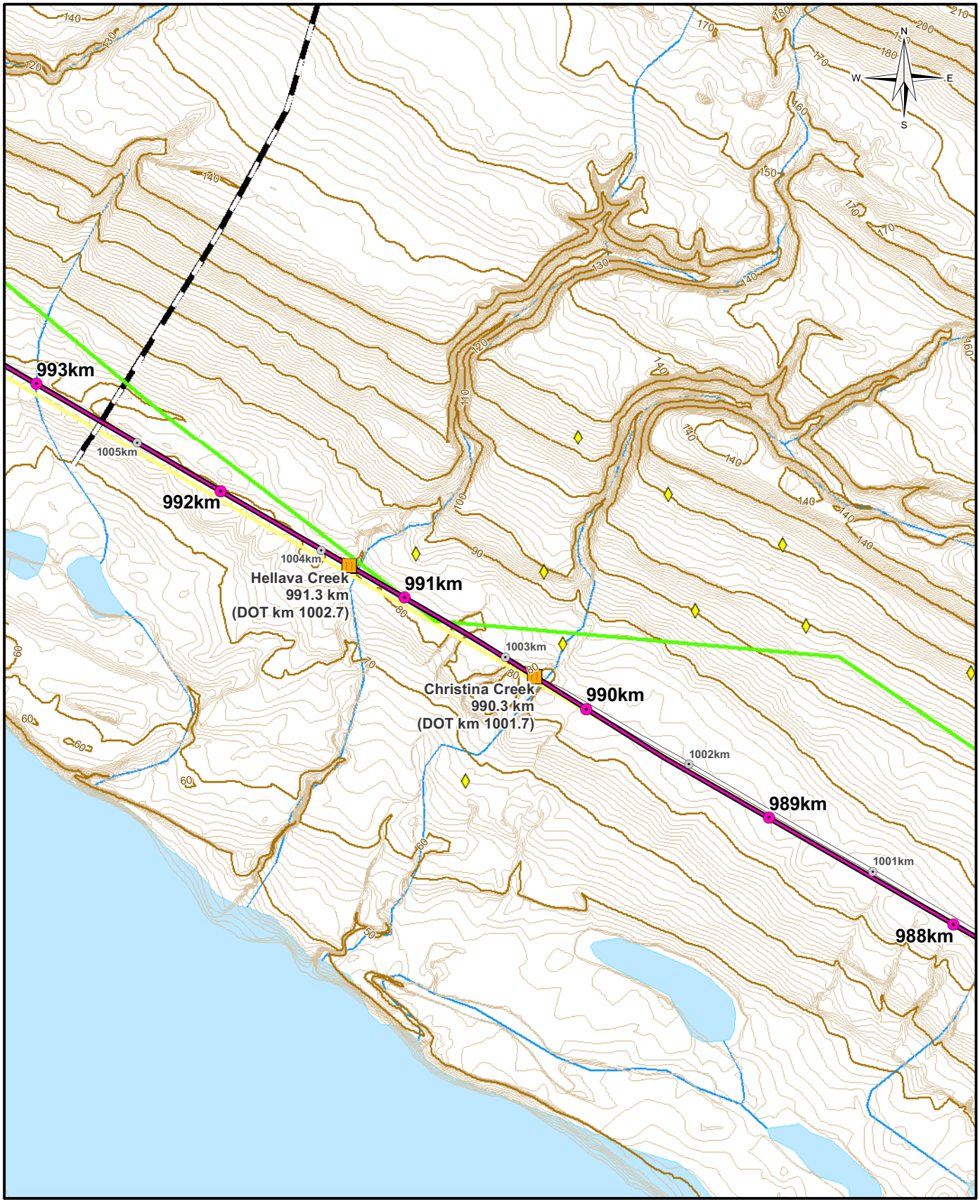
Map 19



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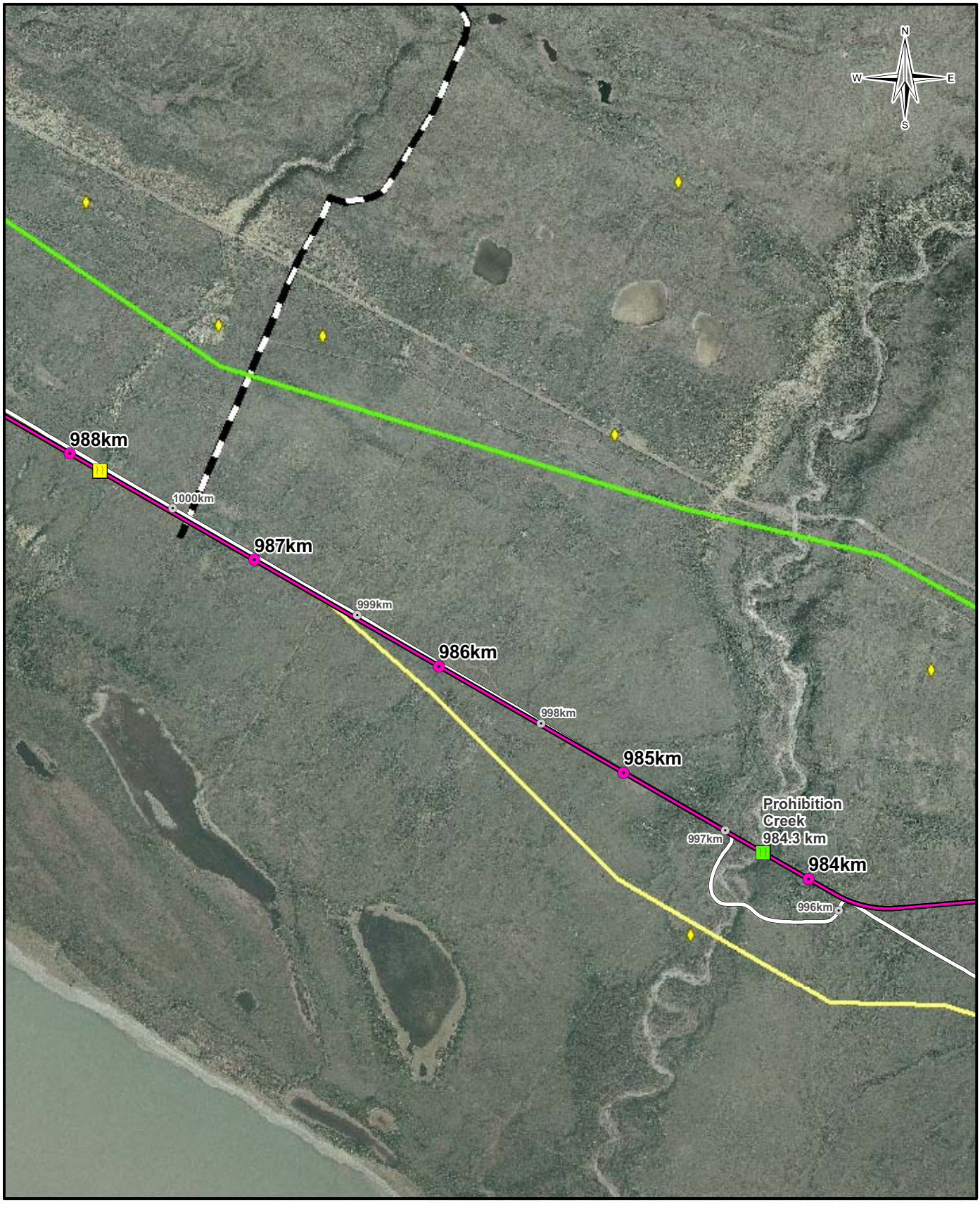

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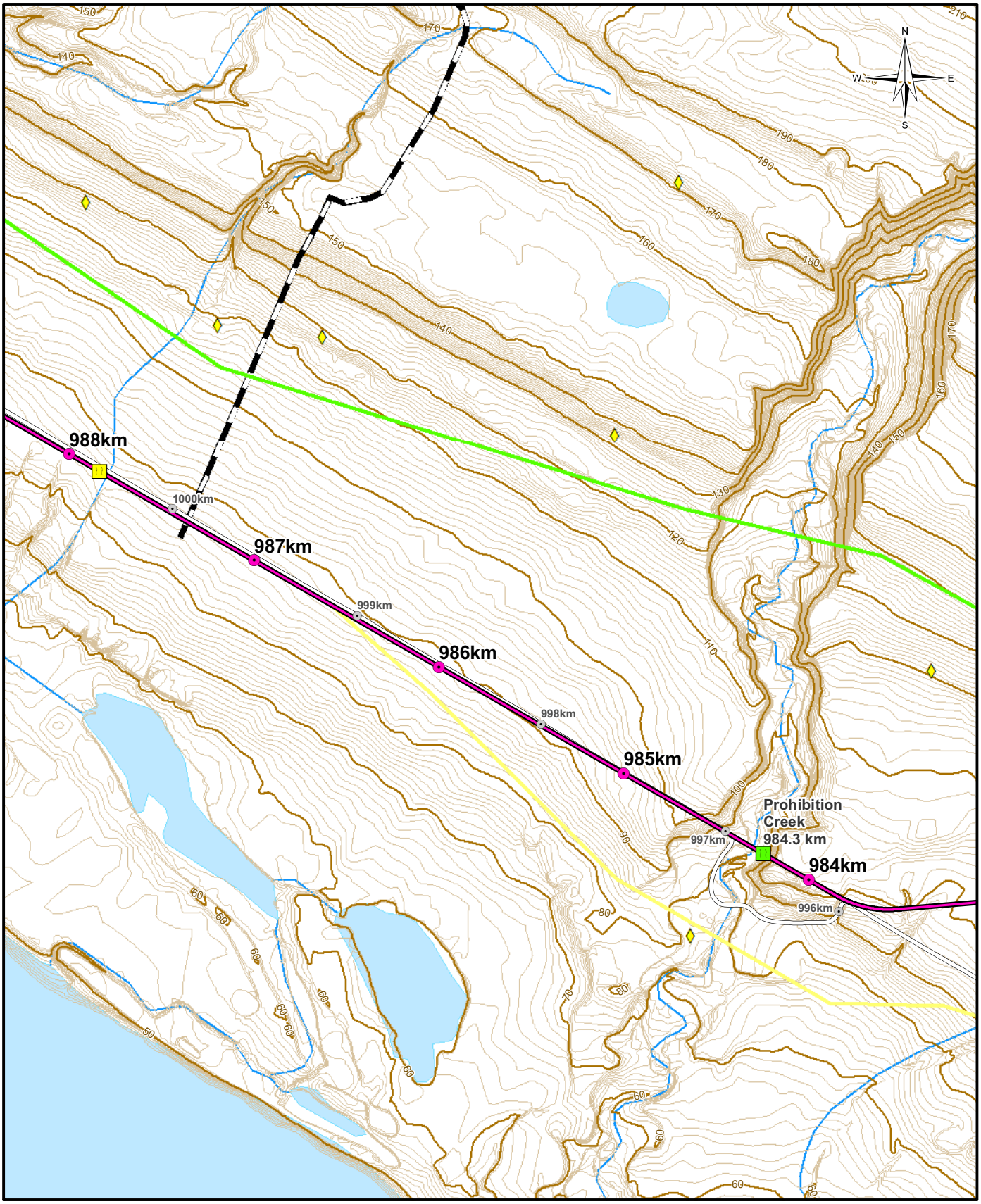
Map 20



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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

1:25,000 Map Book

Scale: 1:25,000 (0, 250, 500 Metres)

UTM Zone 8
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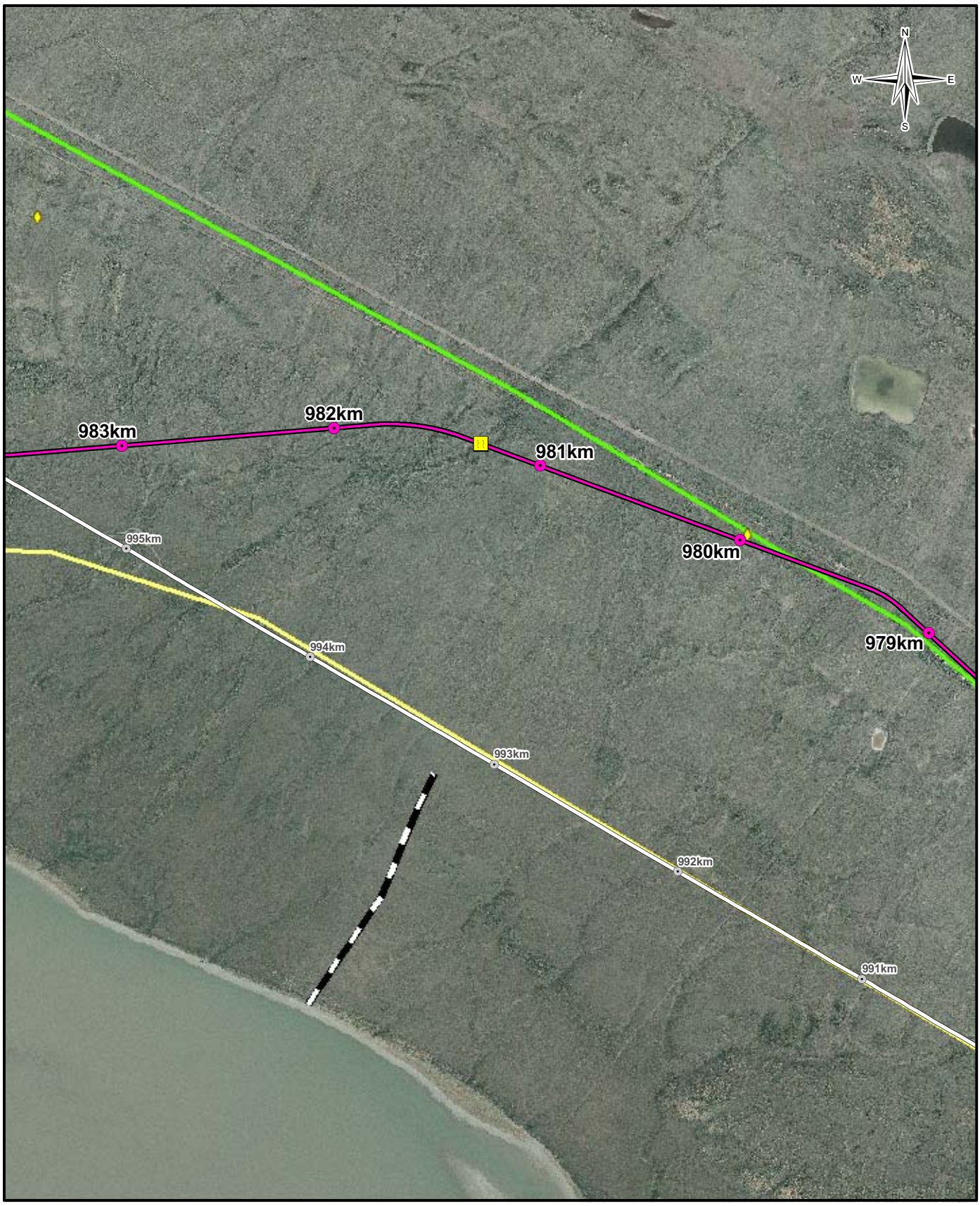
FILE NO. Y22101155_MapBook-NTS-Oct2011.mxd
PROJECT NO. Y22101155 DATE October 14, 2011

Map 20



Legend

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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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UTM Zone 8
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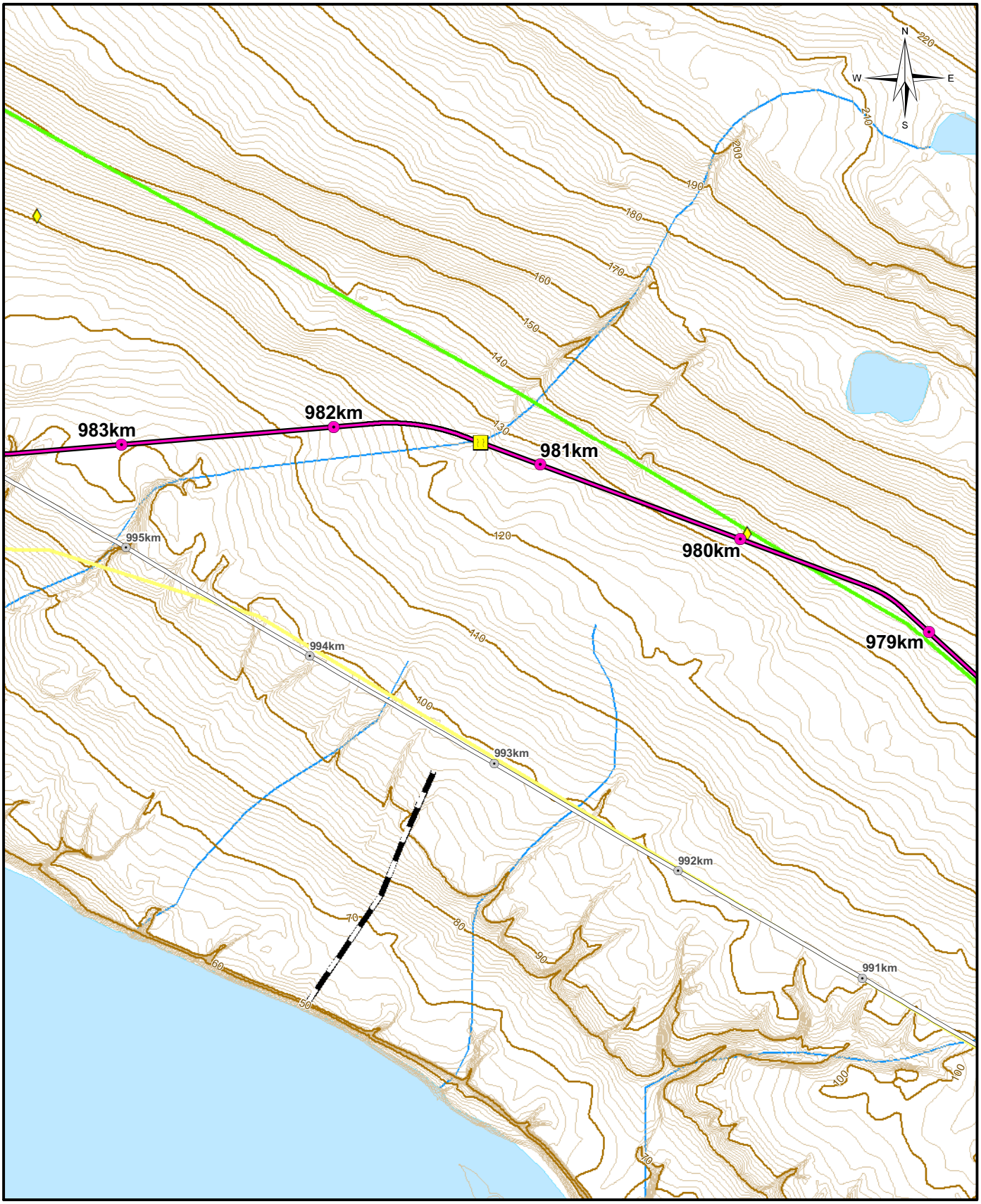
FILE NO. Y22101155_MapBook-Imagery-Oct2011.mxd
PROJECT NO. Y22101155 DATE October 14, 2011

Map 21



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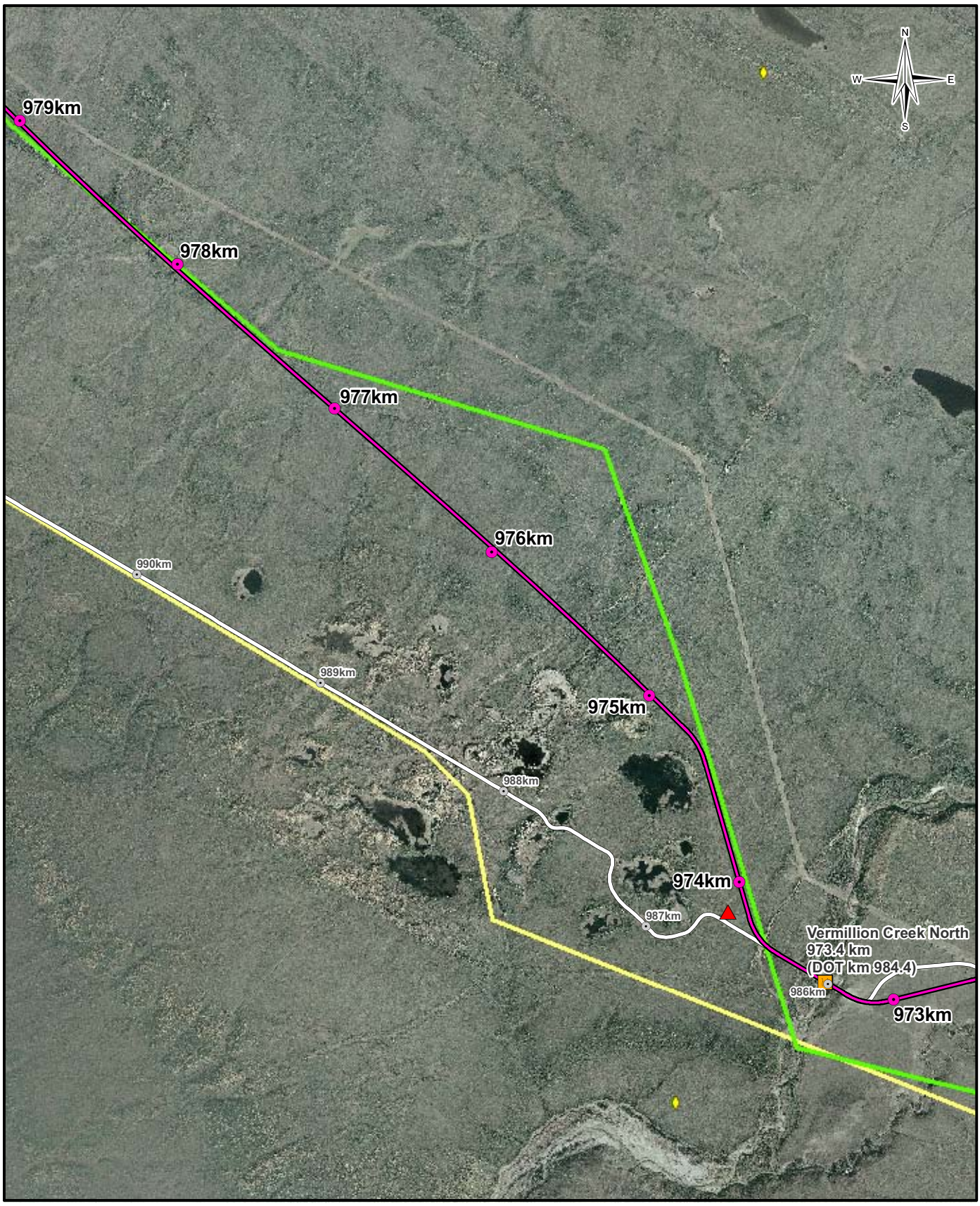

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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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UTM Zone 8
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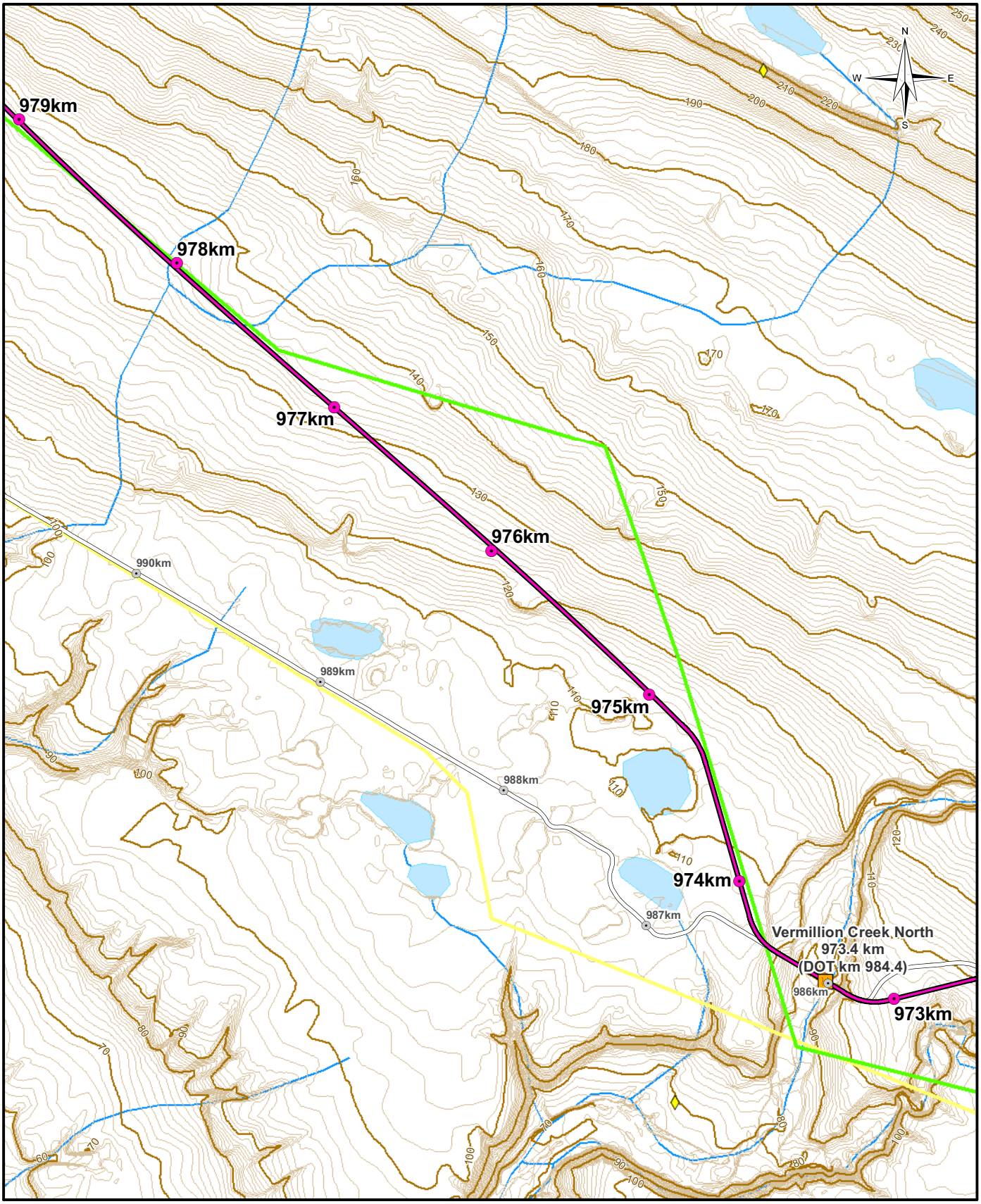
Map 22



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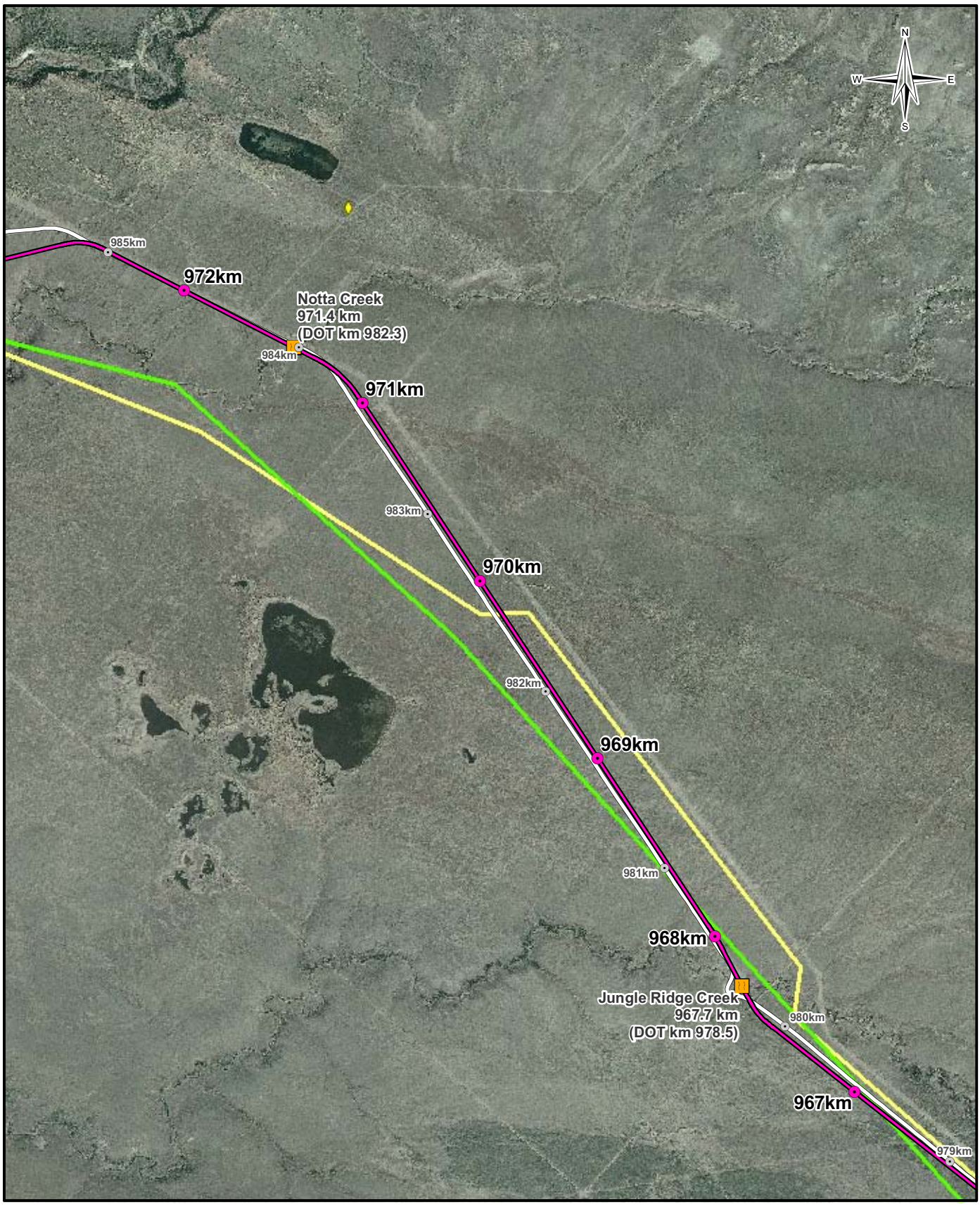

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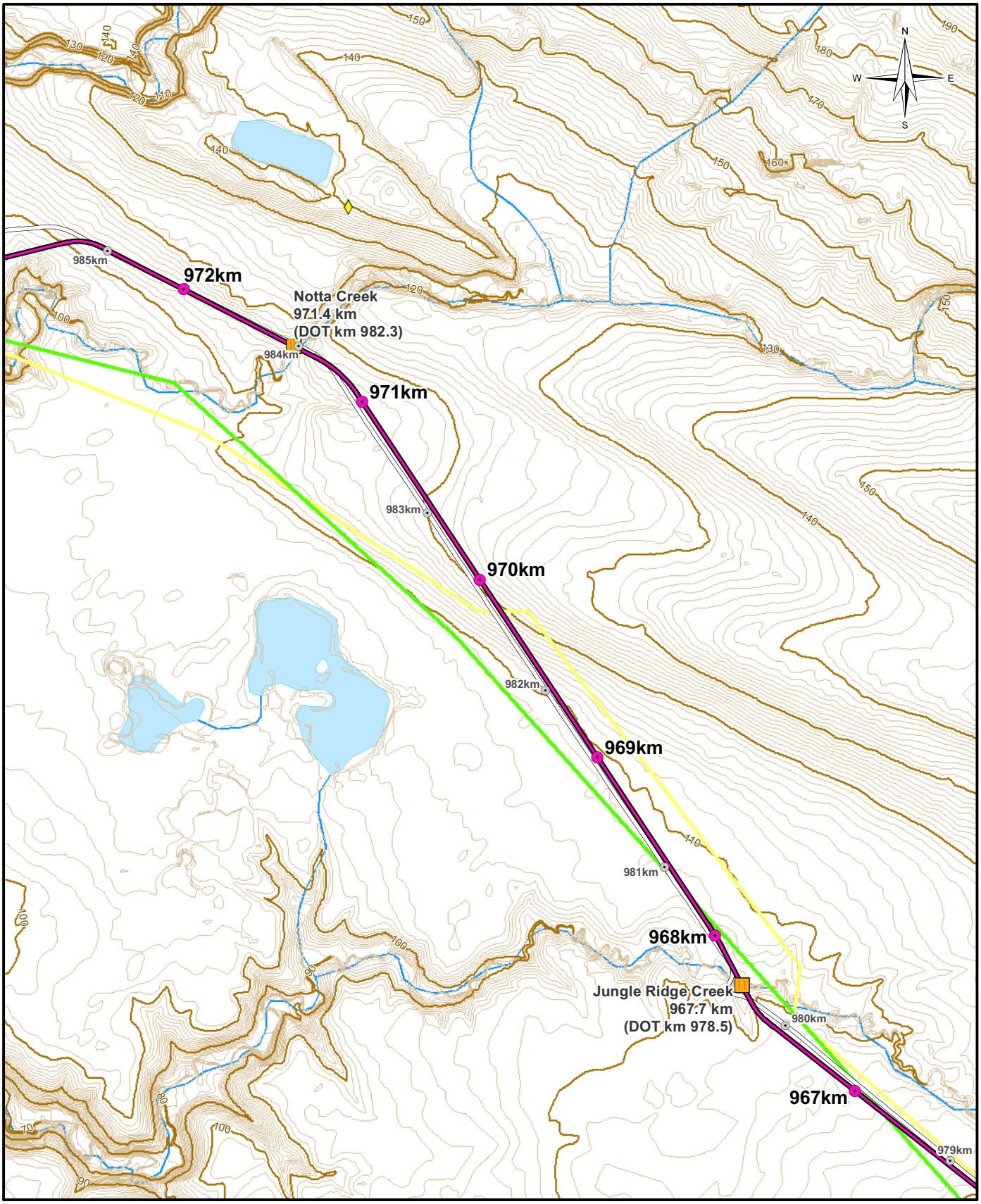
Map 23



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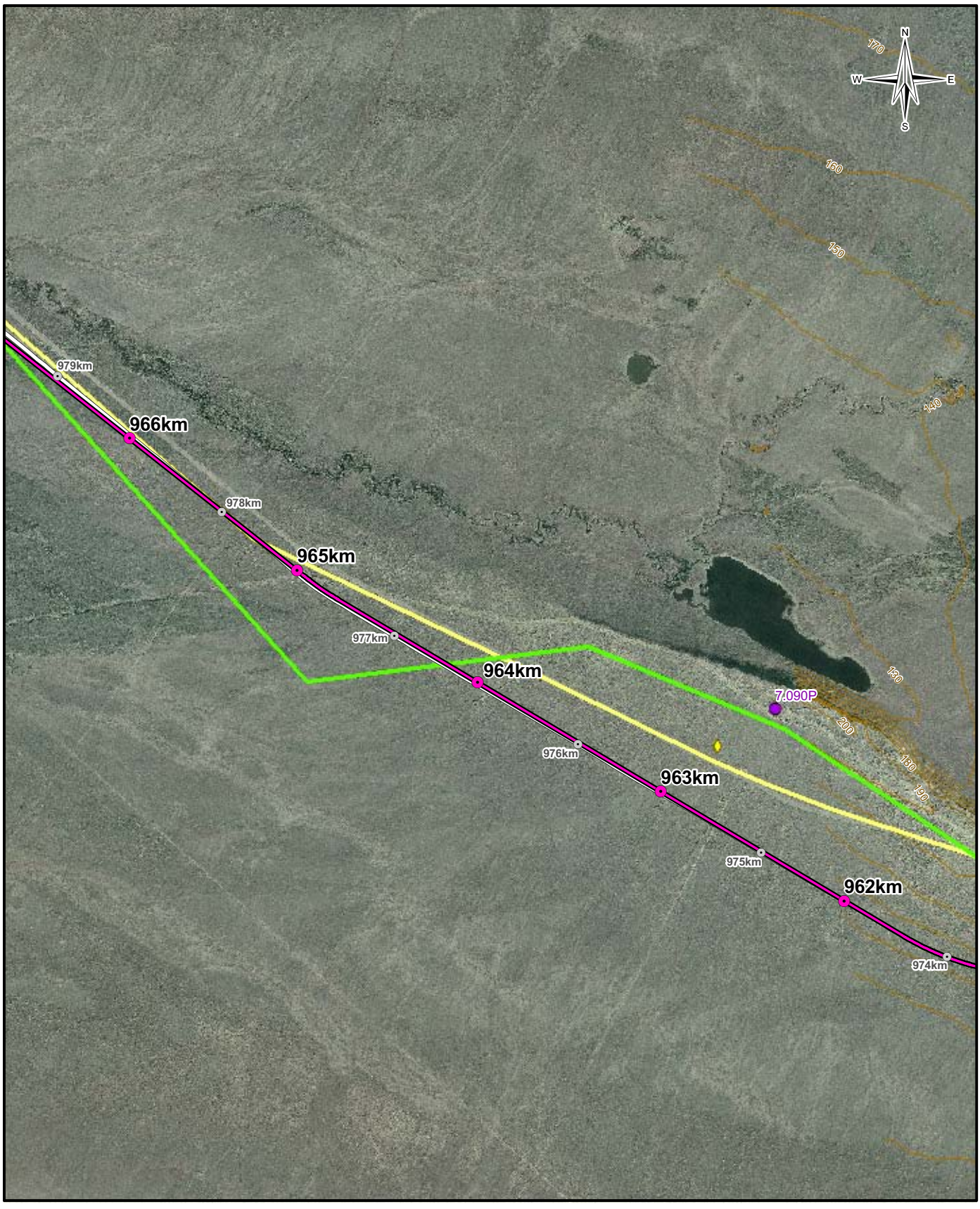

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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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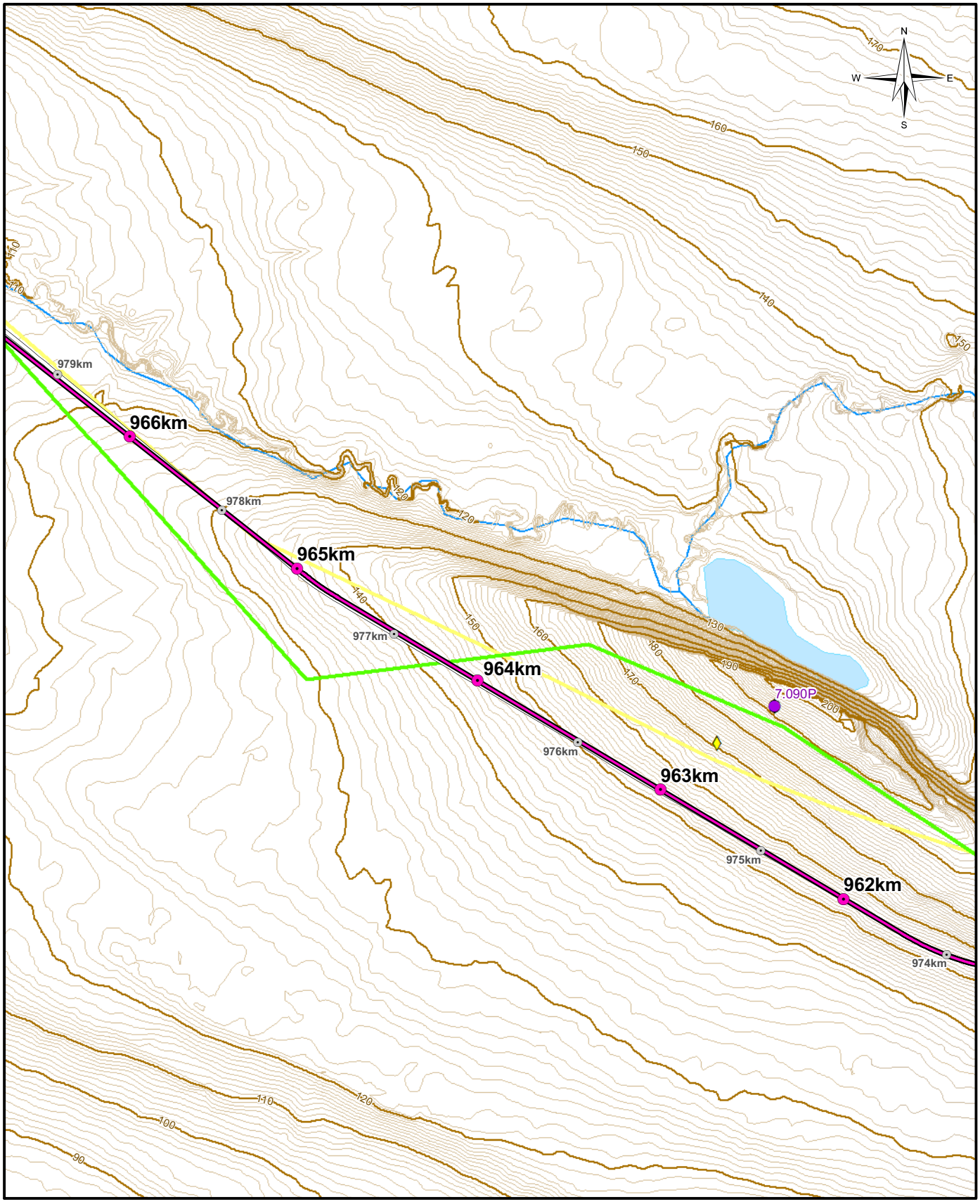
Map 24



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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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Metres

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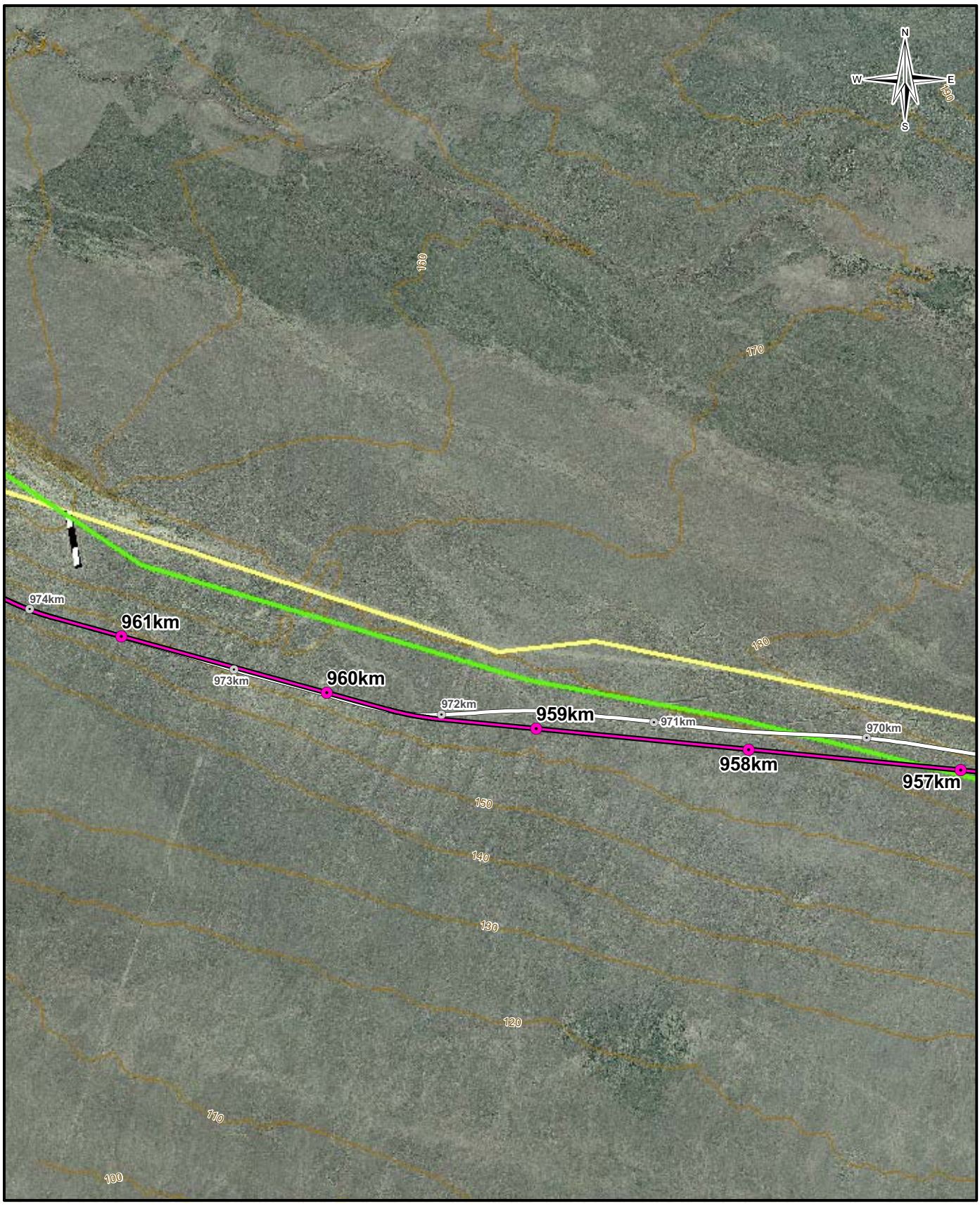

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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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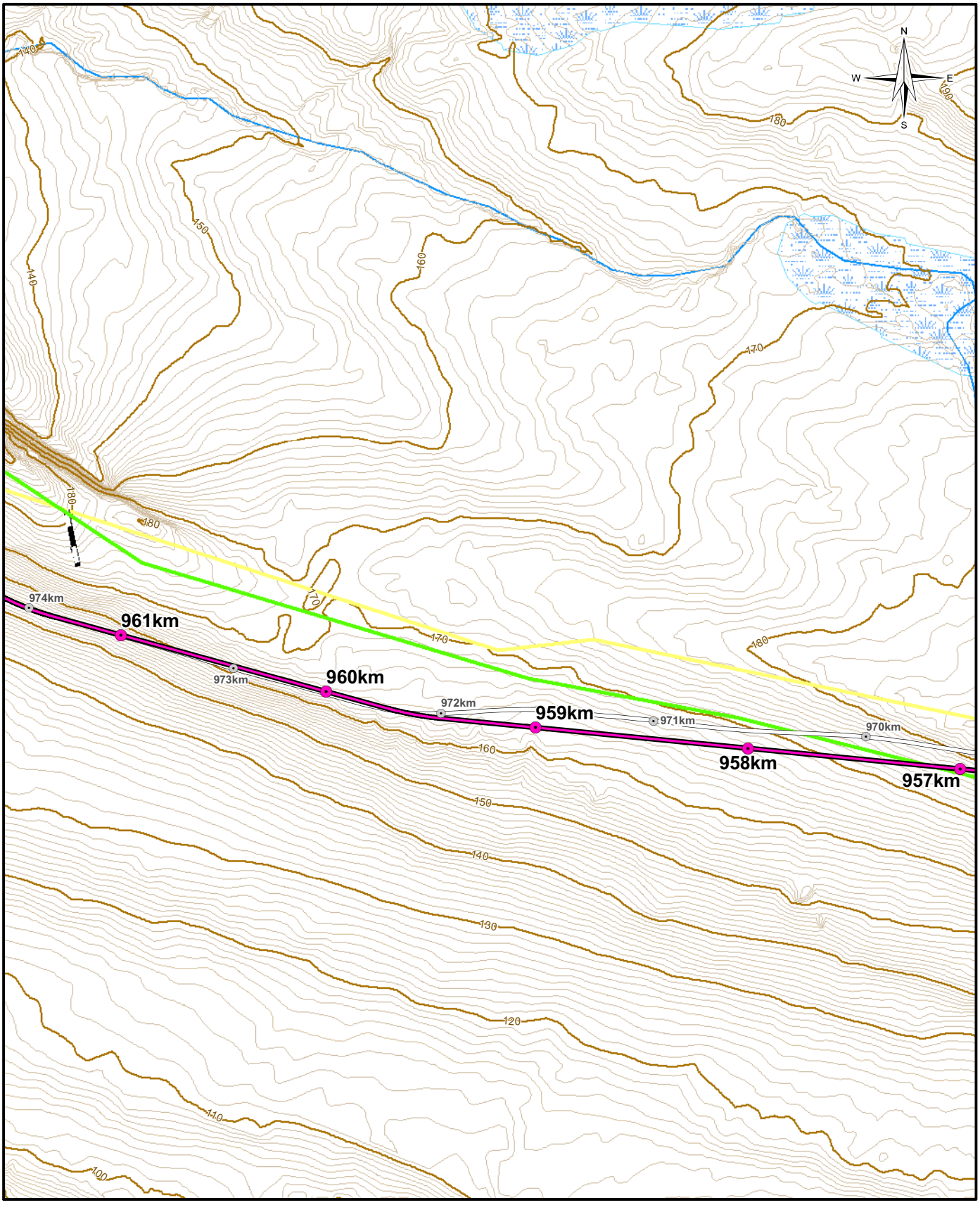
Map 25



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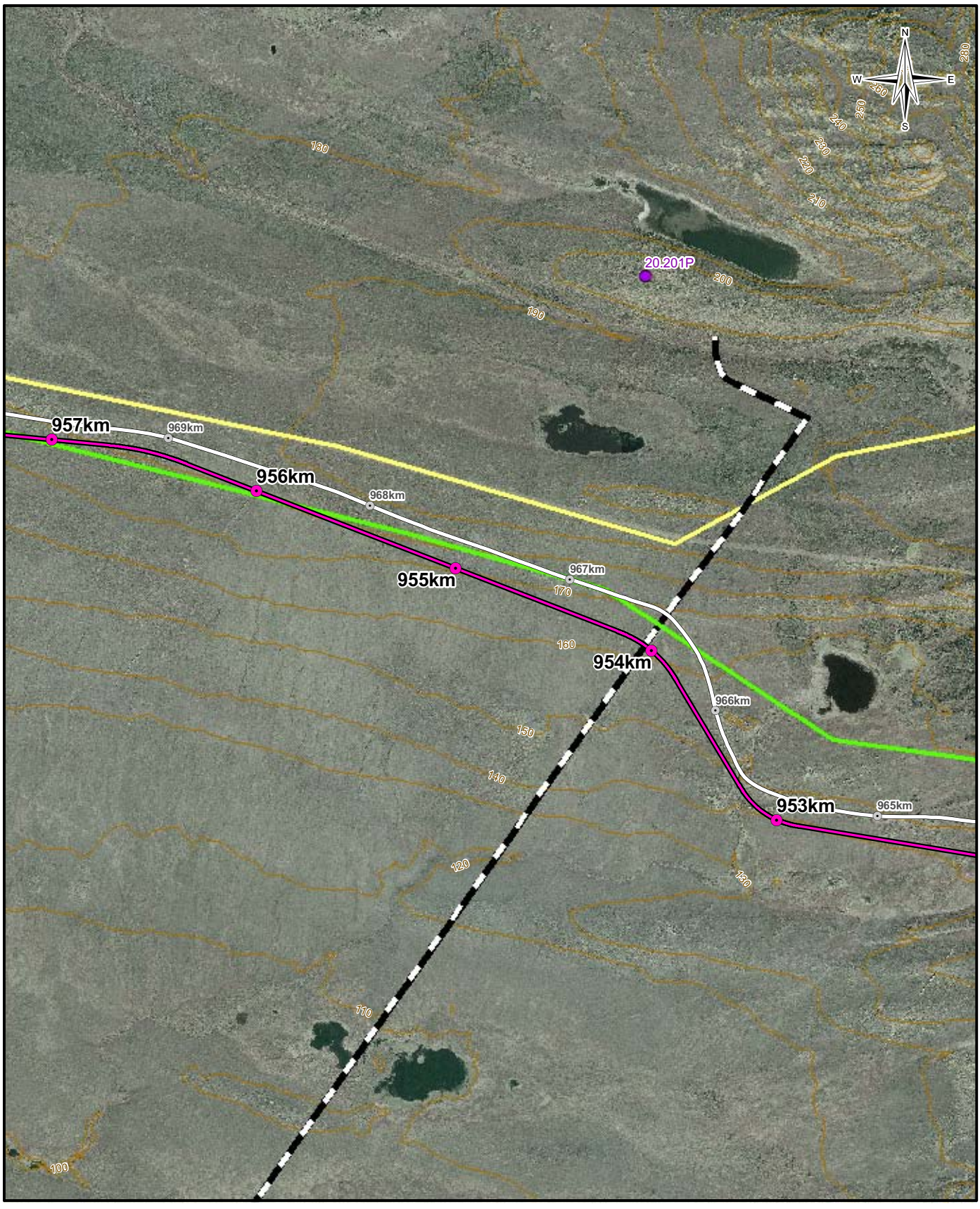
Map 25



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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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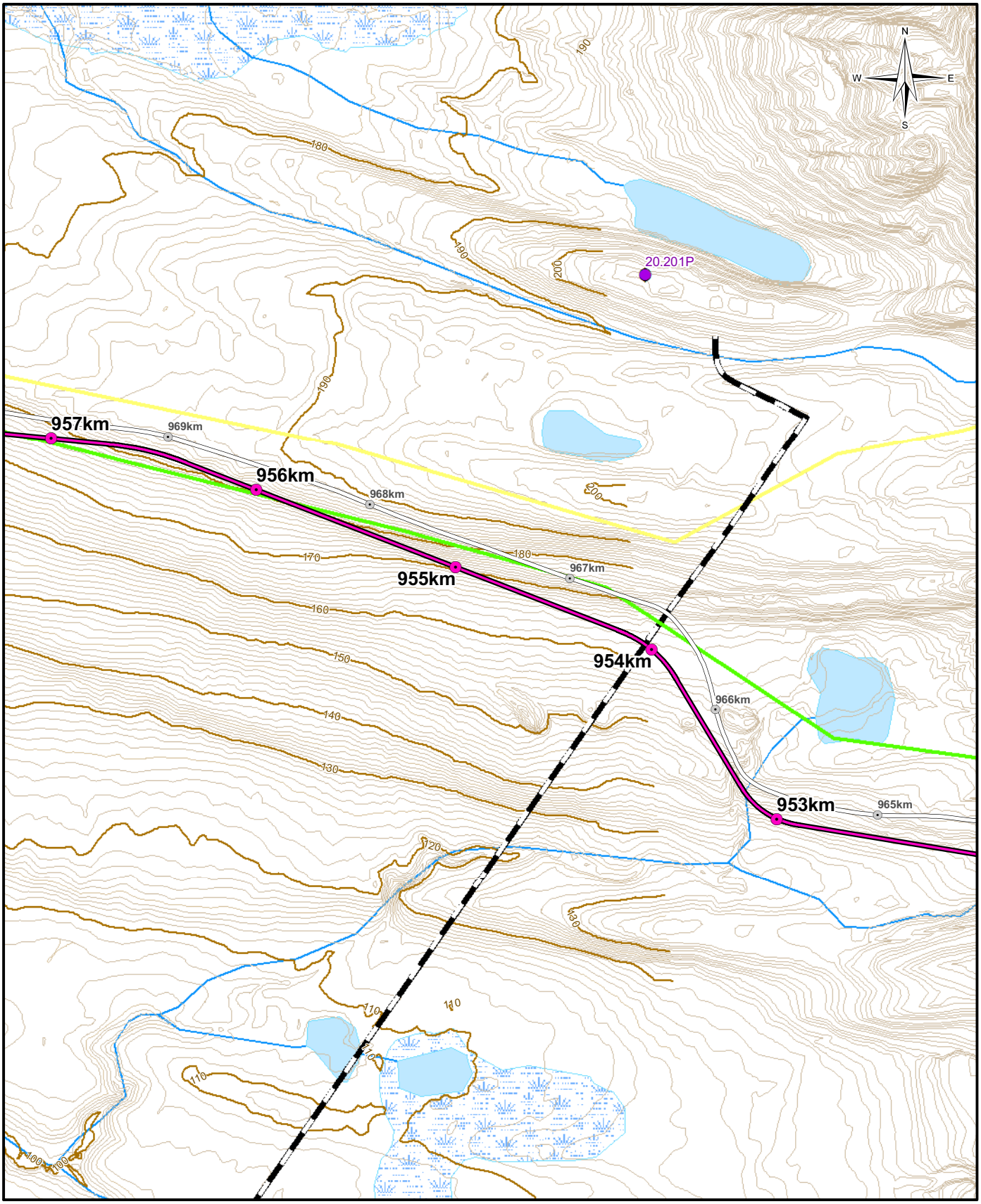
Map 26



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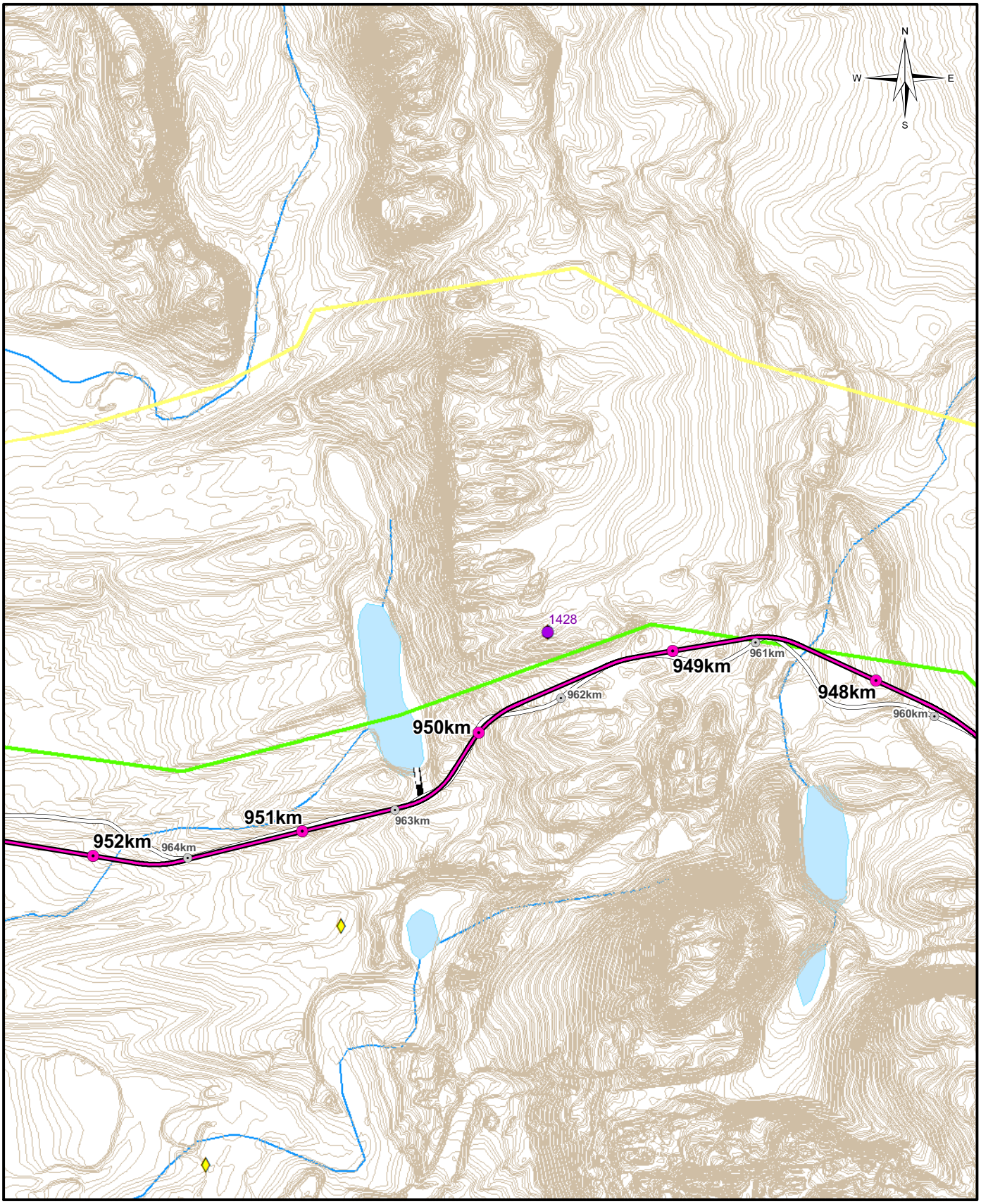
Map 27



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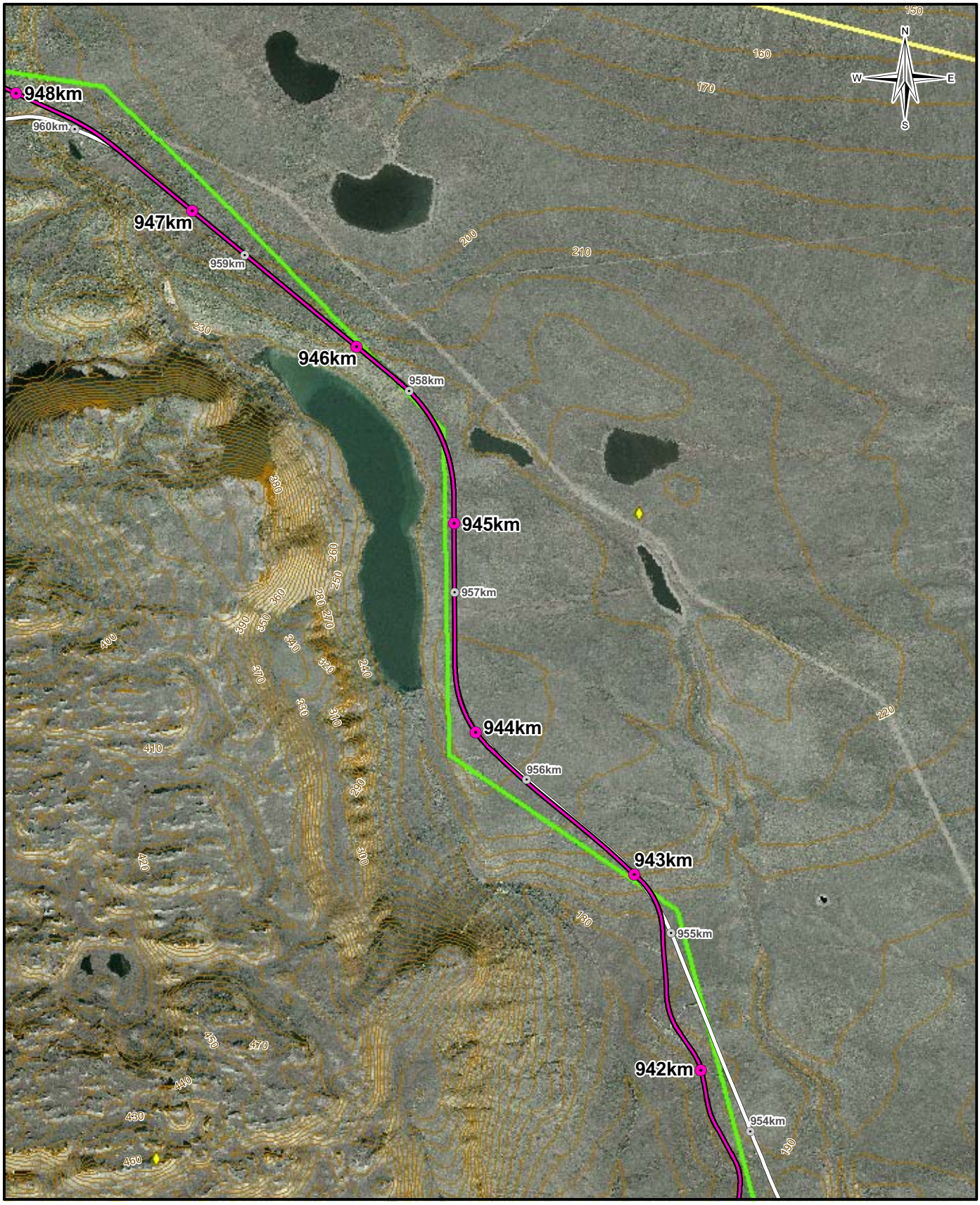

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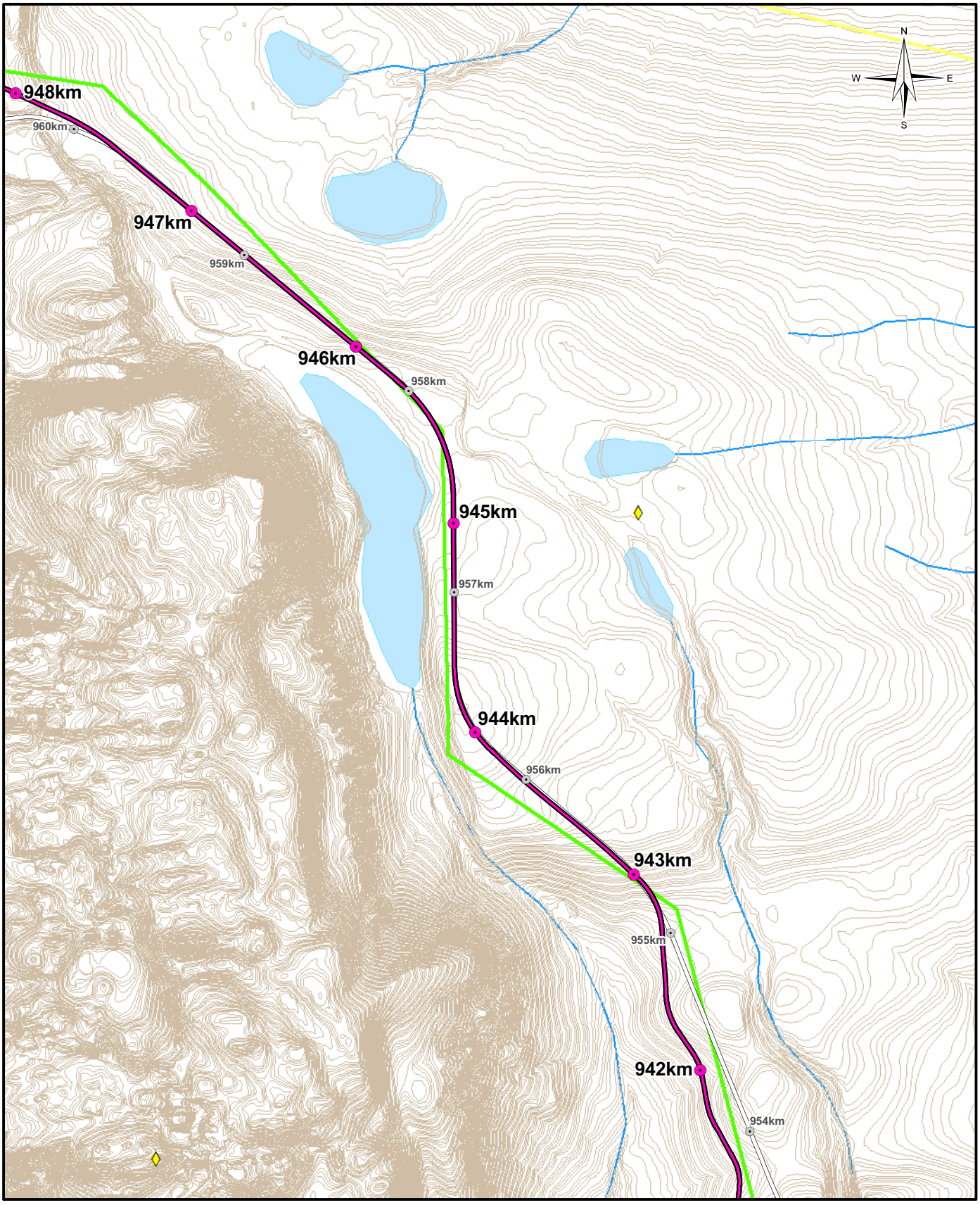
Map 28



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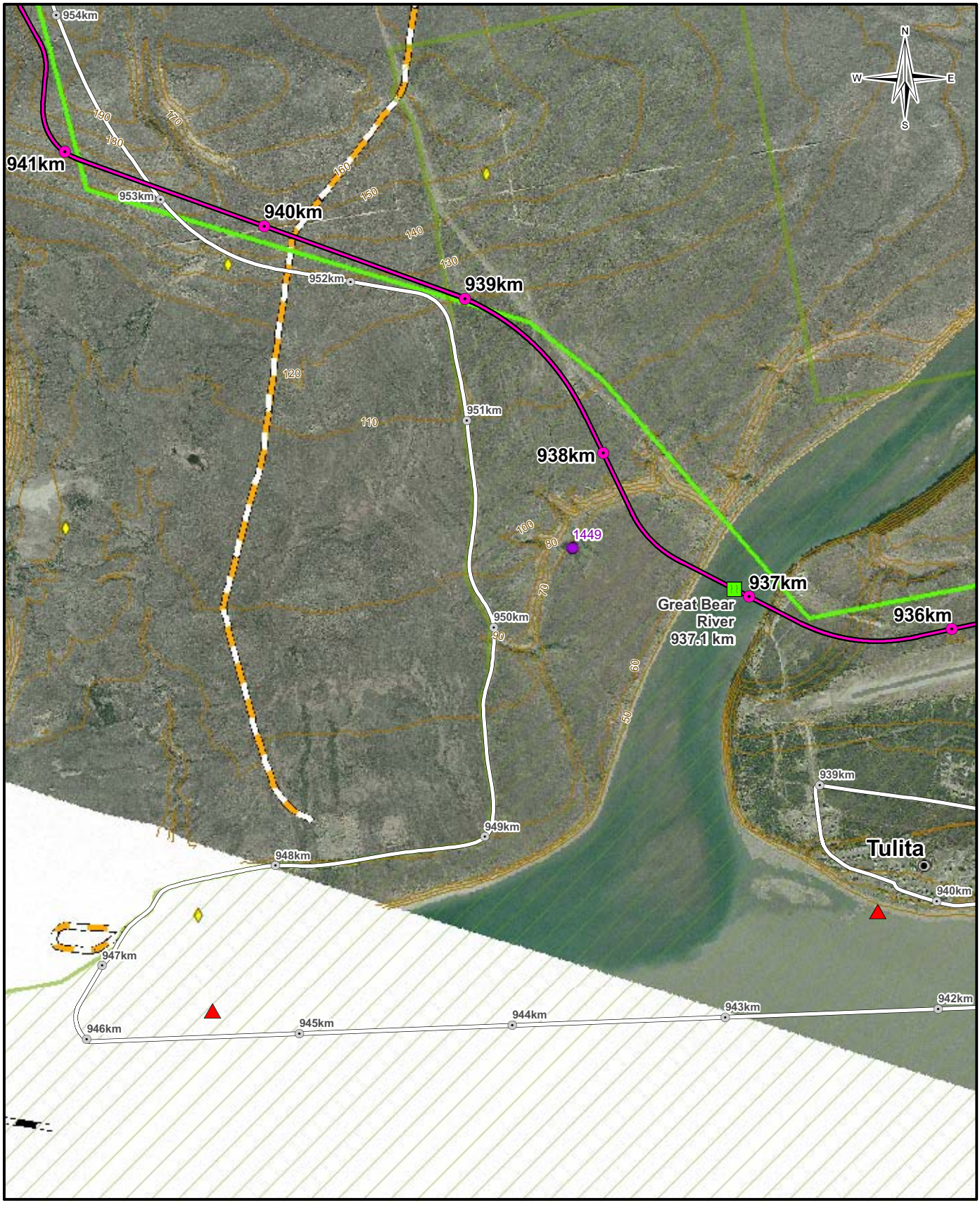

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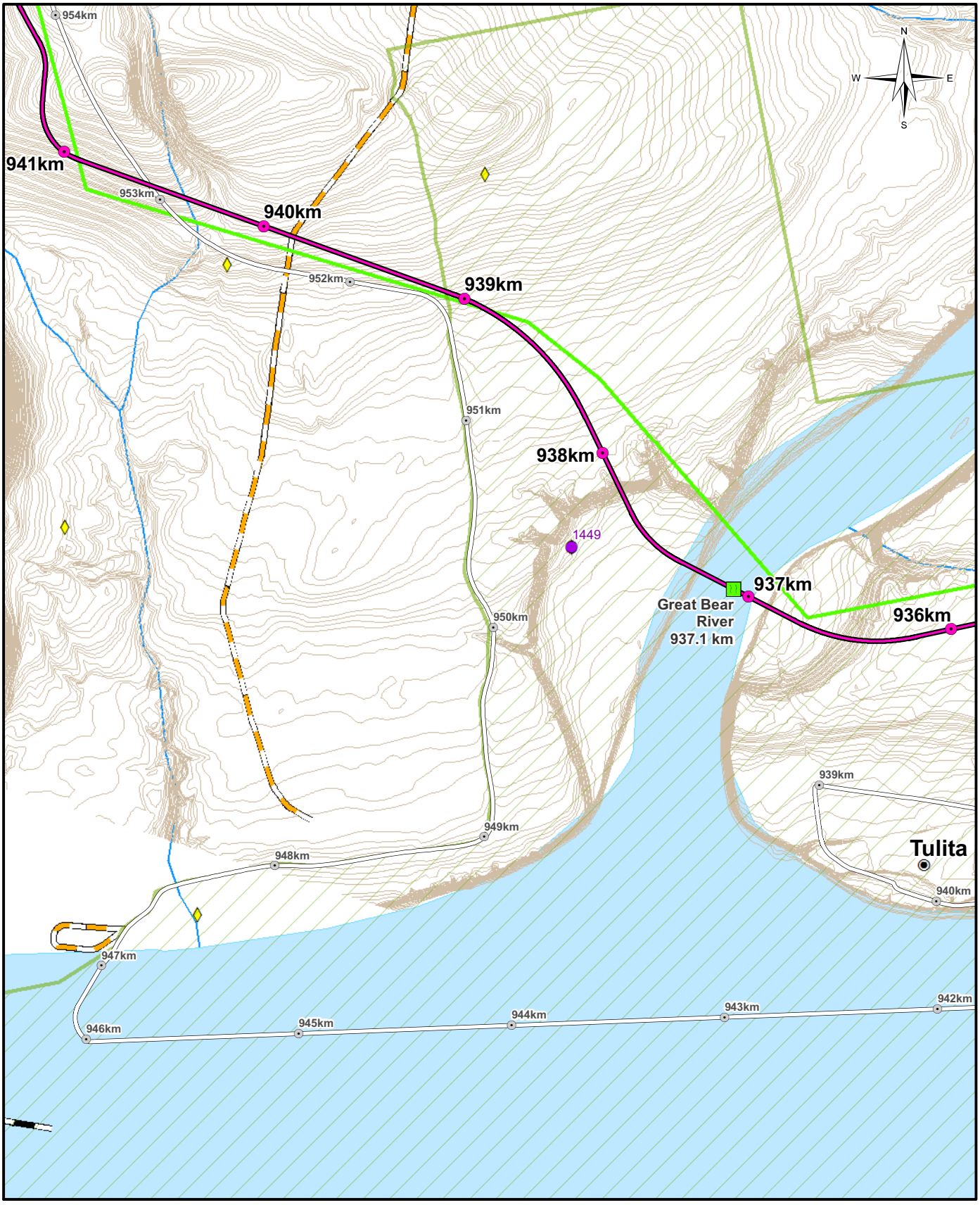

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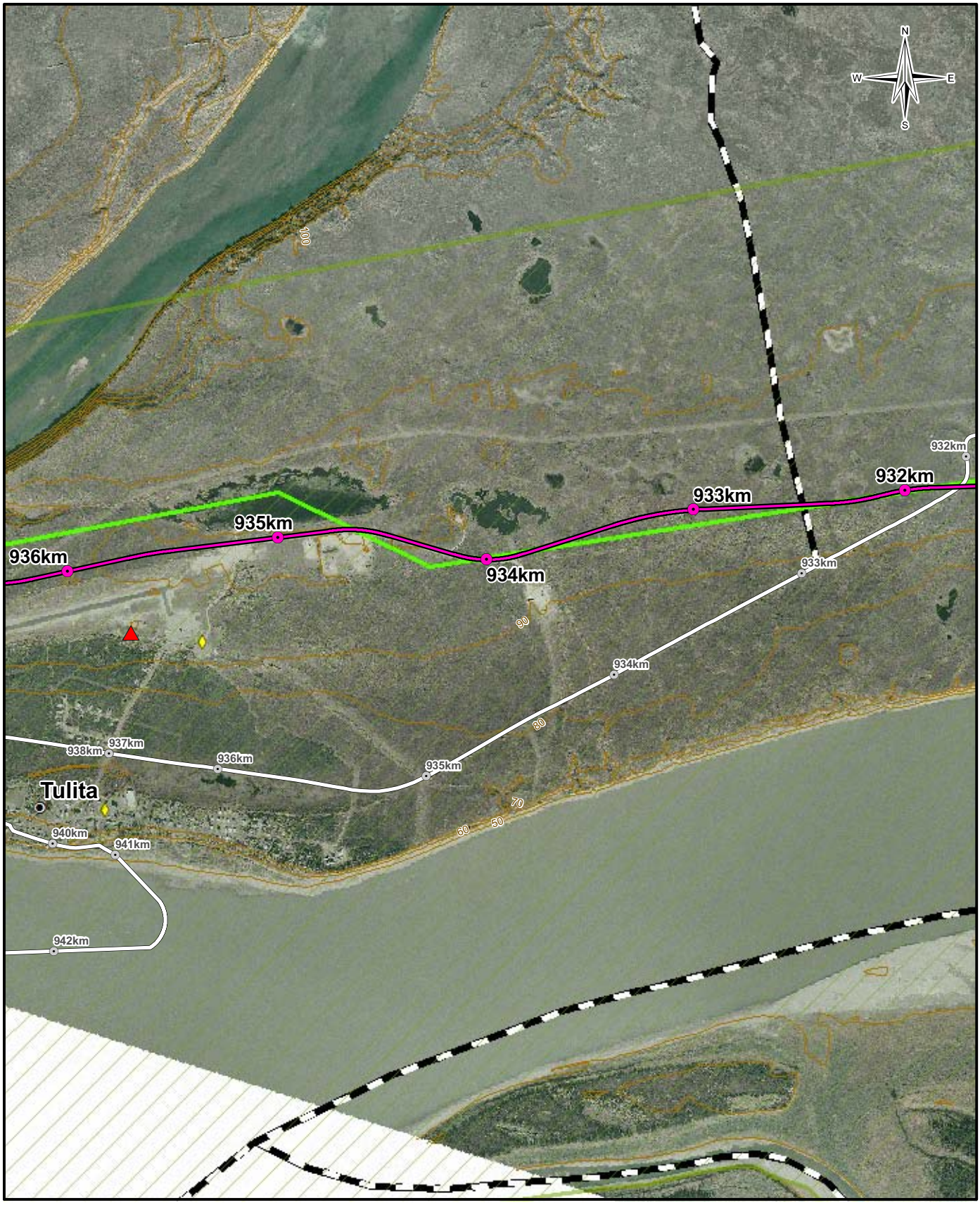

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Metres

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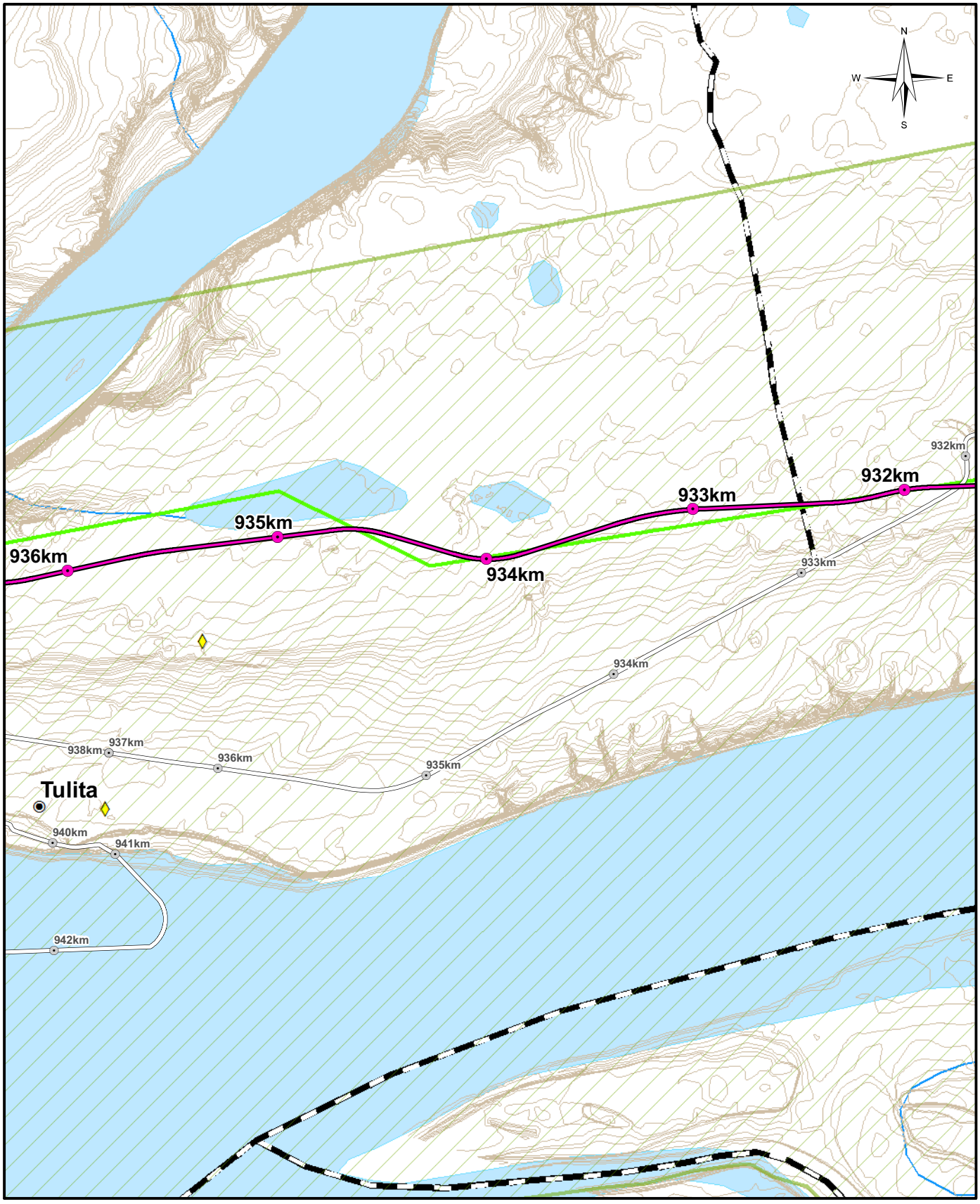
PROJECT NO. Y22101155 DATE October 14, 2011

Map 30



Legend

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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

1:25,000 Map Book

Scale: 1:25,000 (0, 250, 500 Metres)

UTM Zone 8
NAD83

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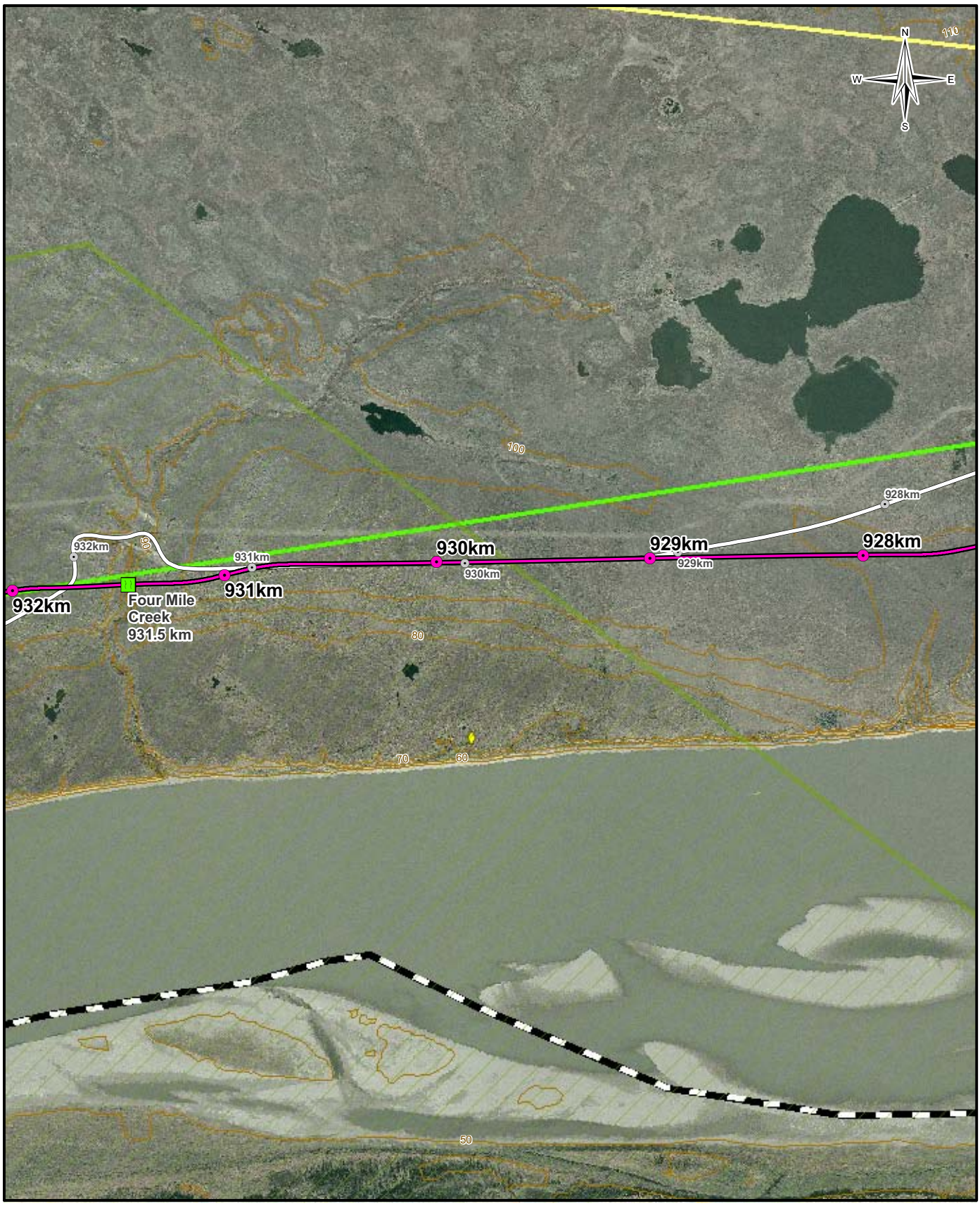
PROJECT NO. Y22101155 DATE October 14, 2011

Map 30



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UTM Zone 8
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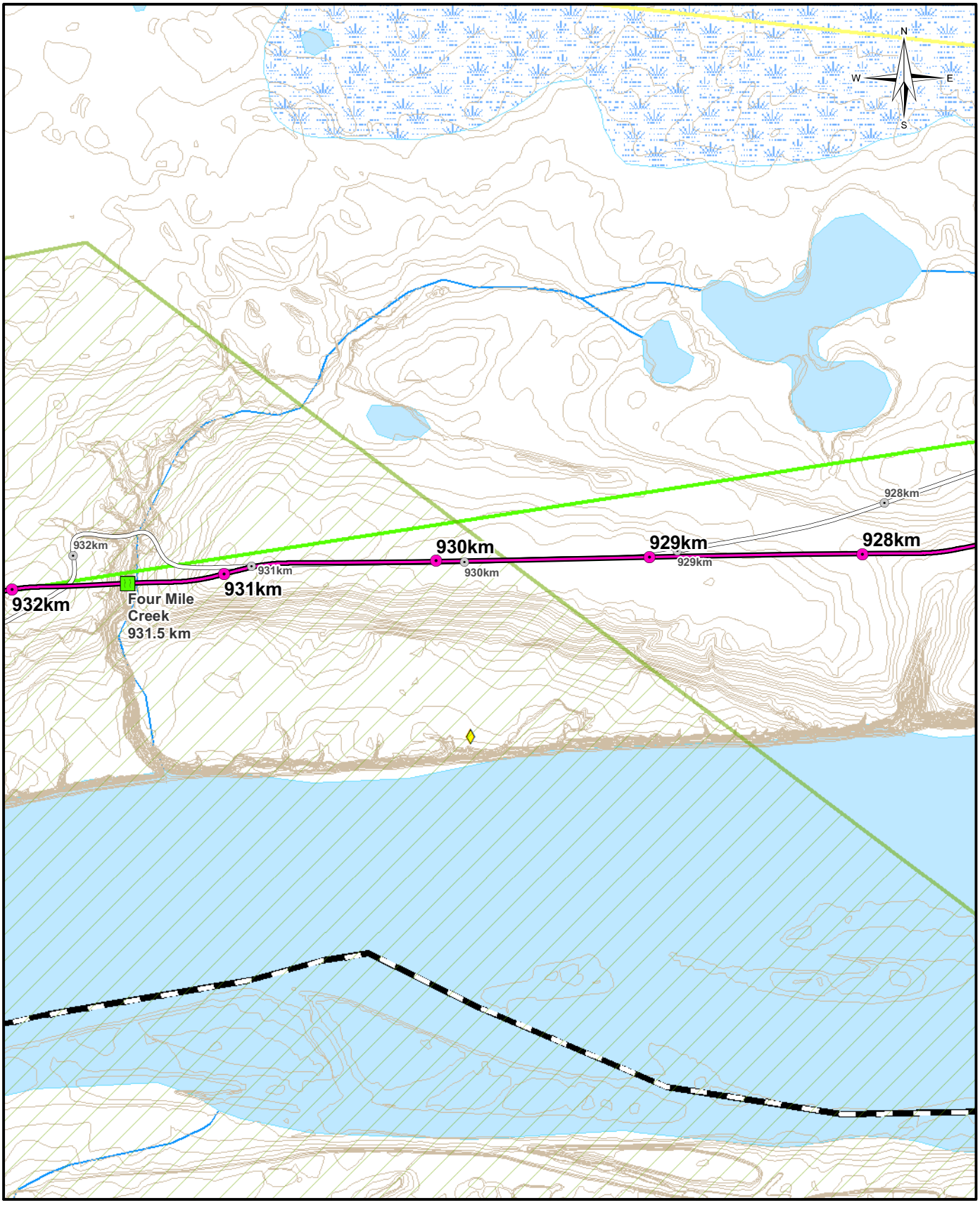
PROJECT NO. Y22101155 DATE October 14, 2011

Map 31



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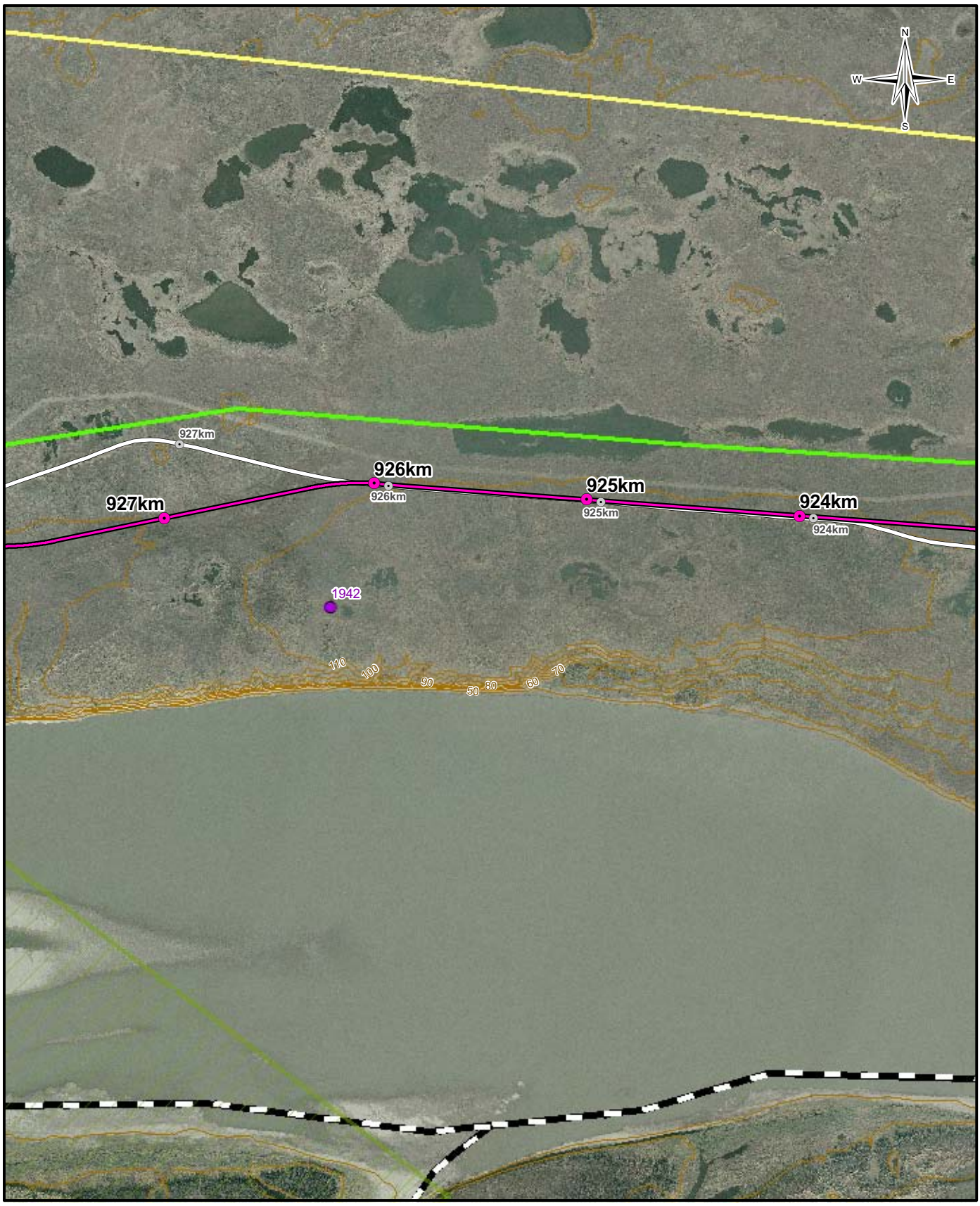

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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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Metres

UTM Zone 8
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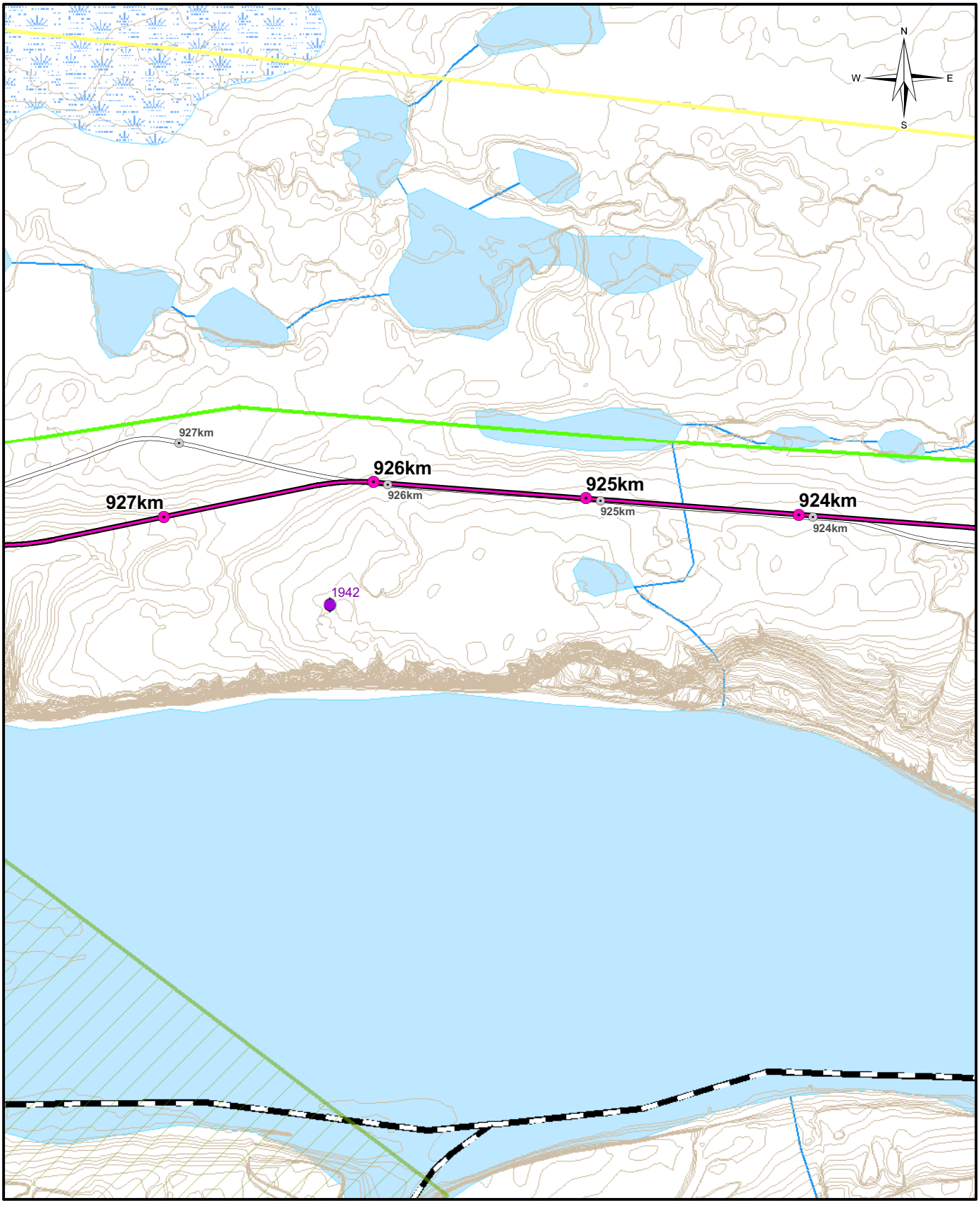
Map 32



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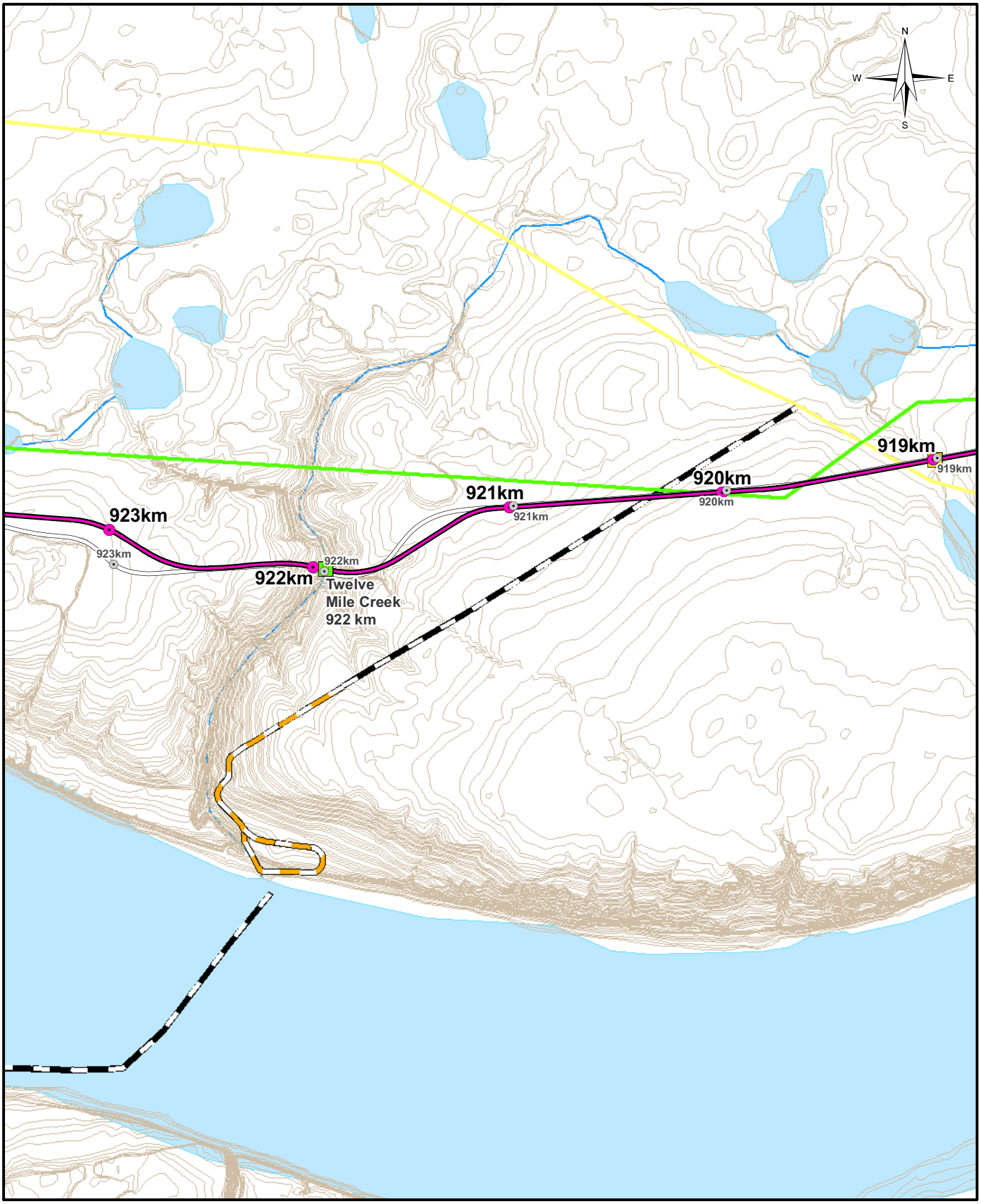
Map 33



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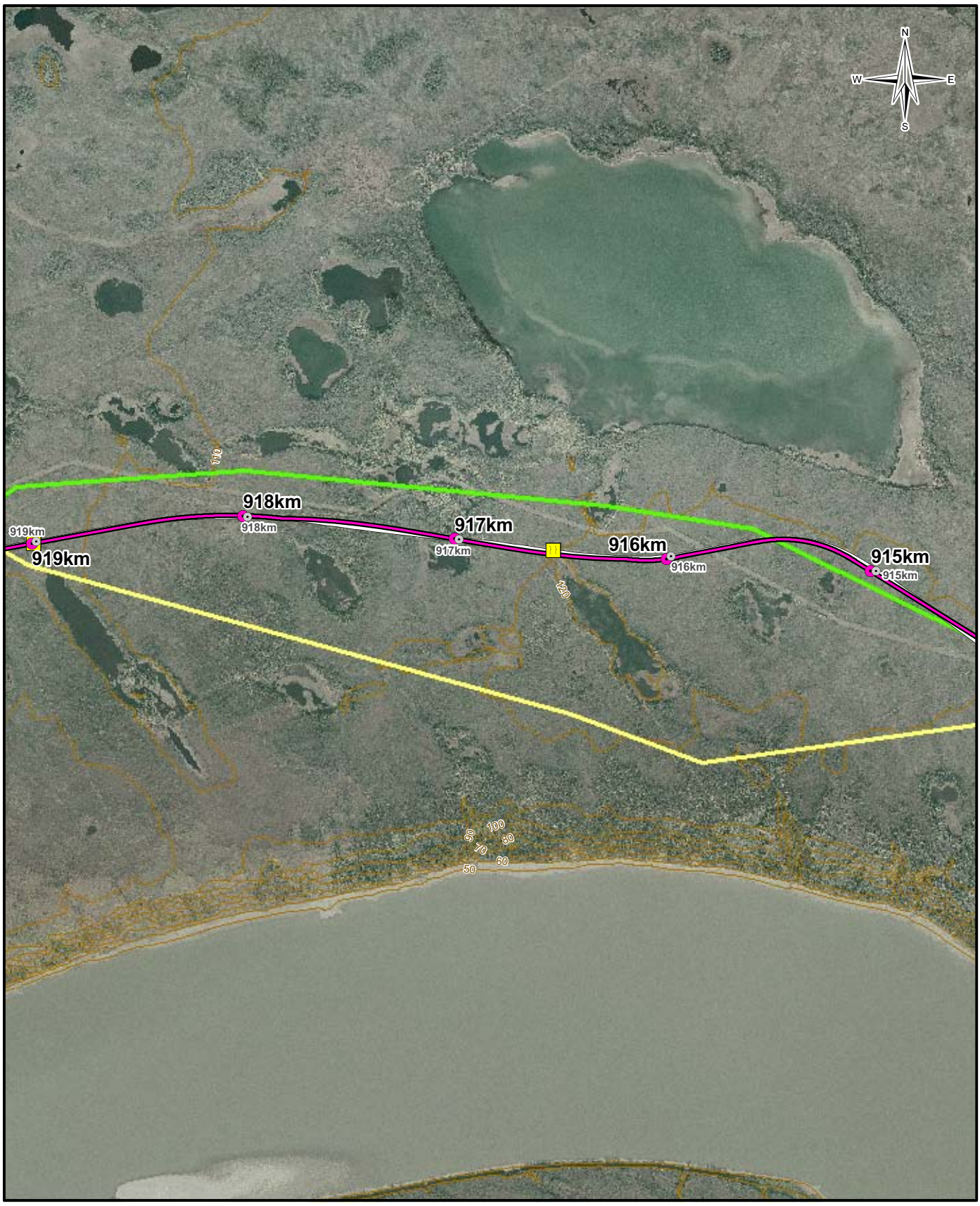

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0 250 500
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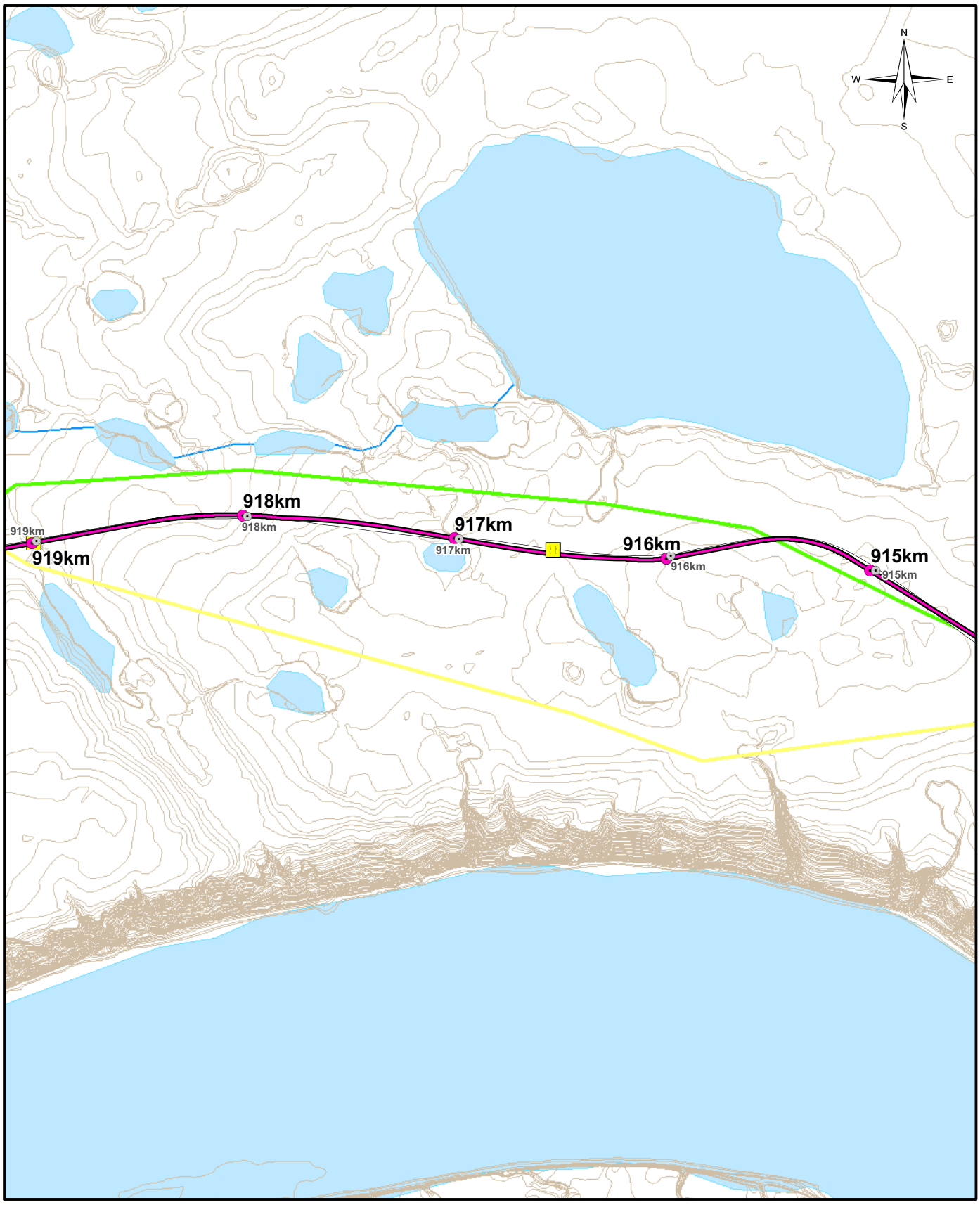
Map 34



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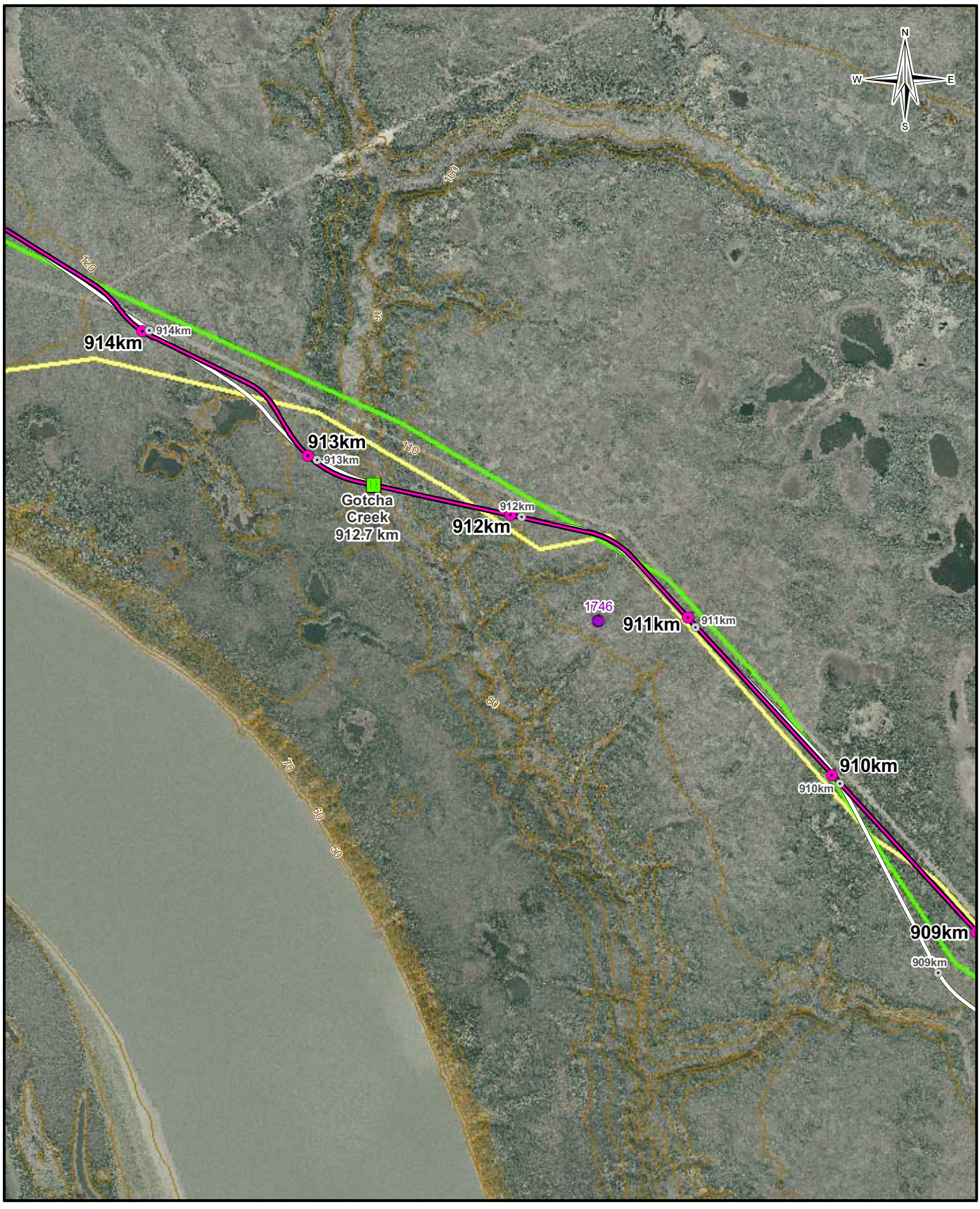

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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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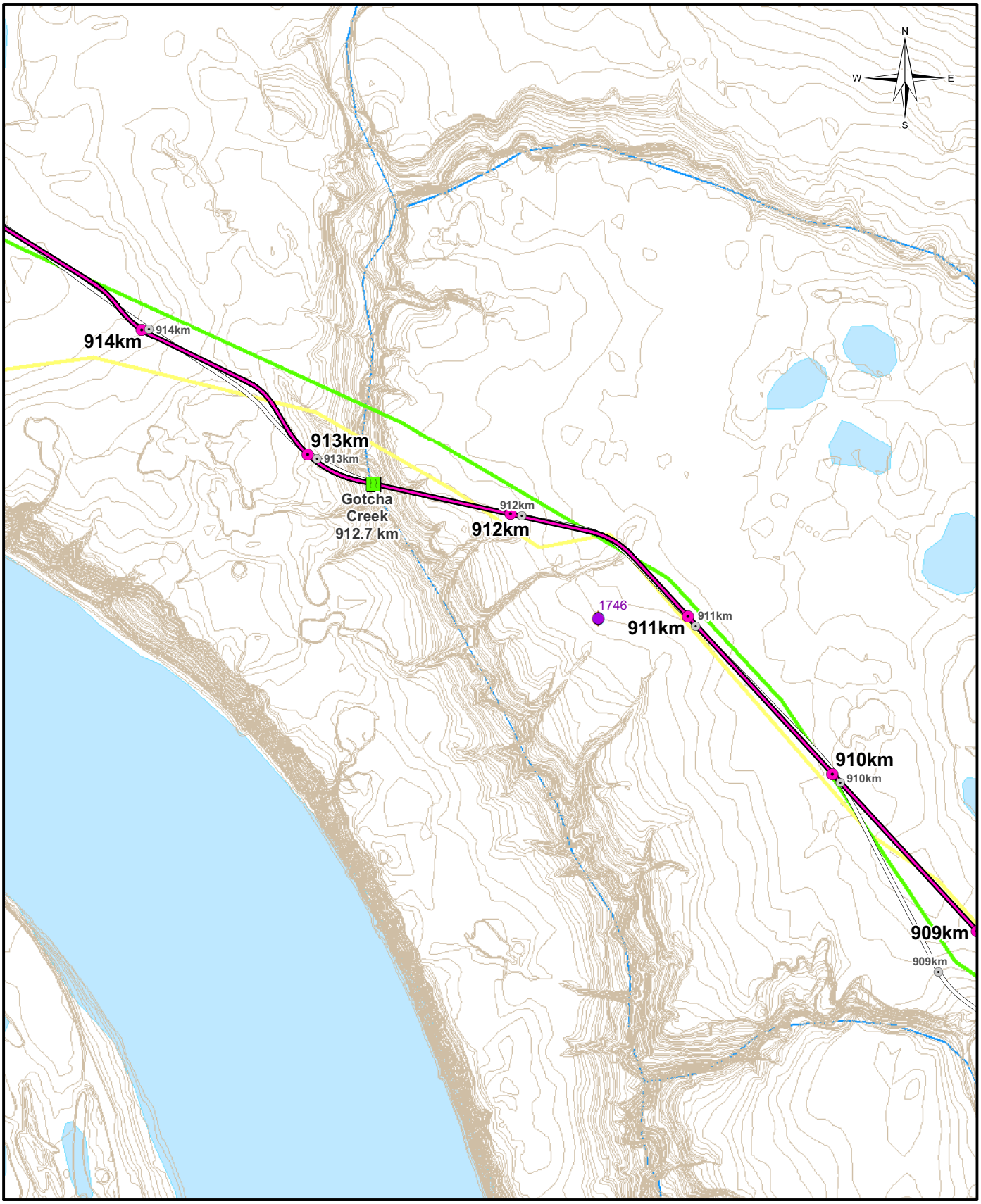
Map 35



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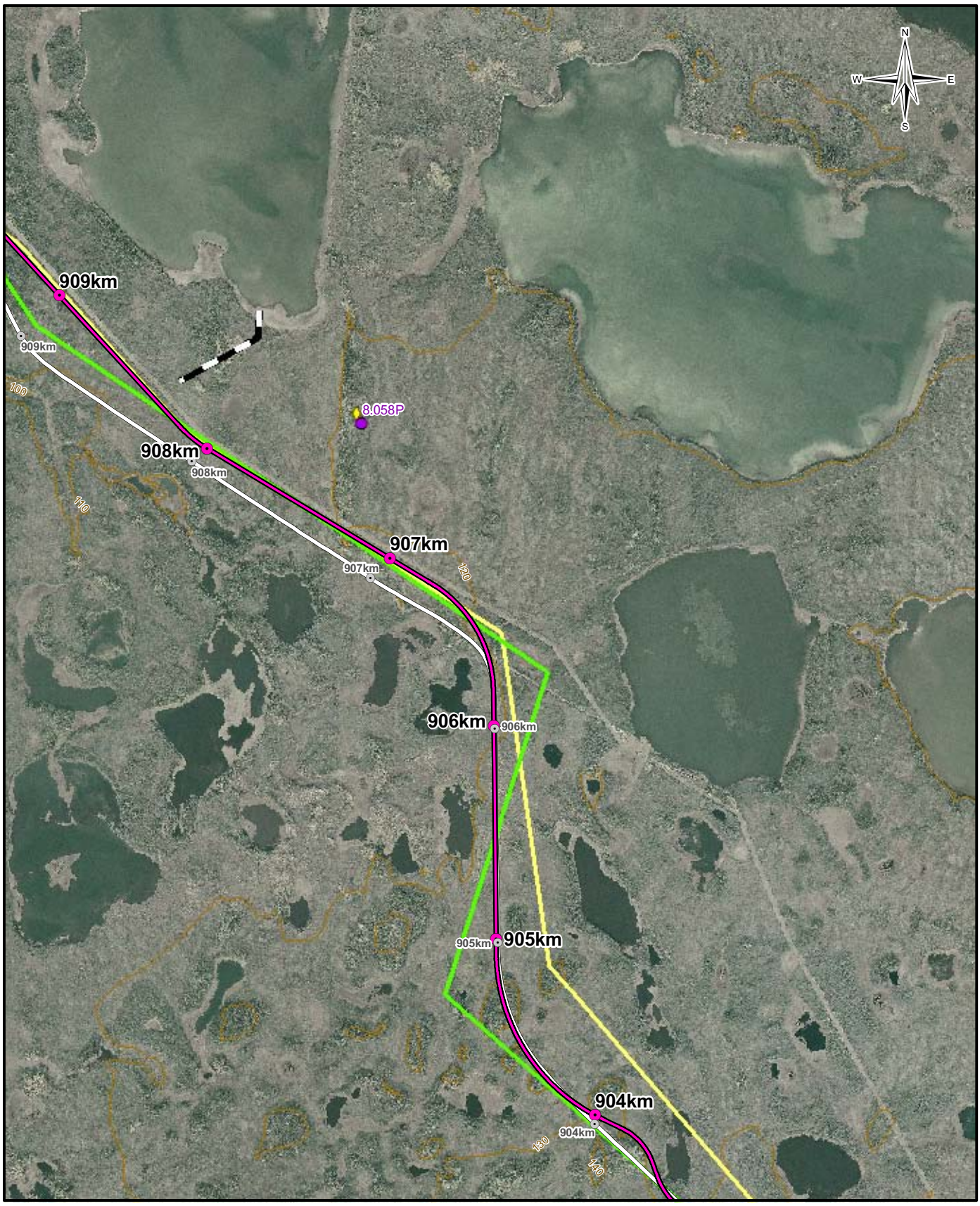

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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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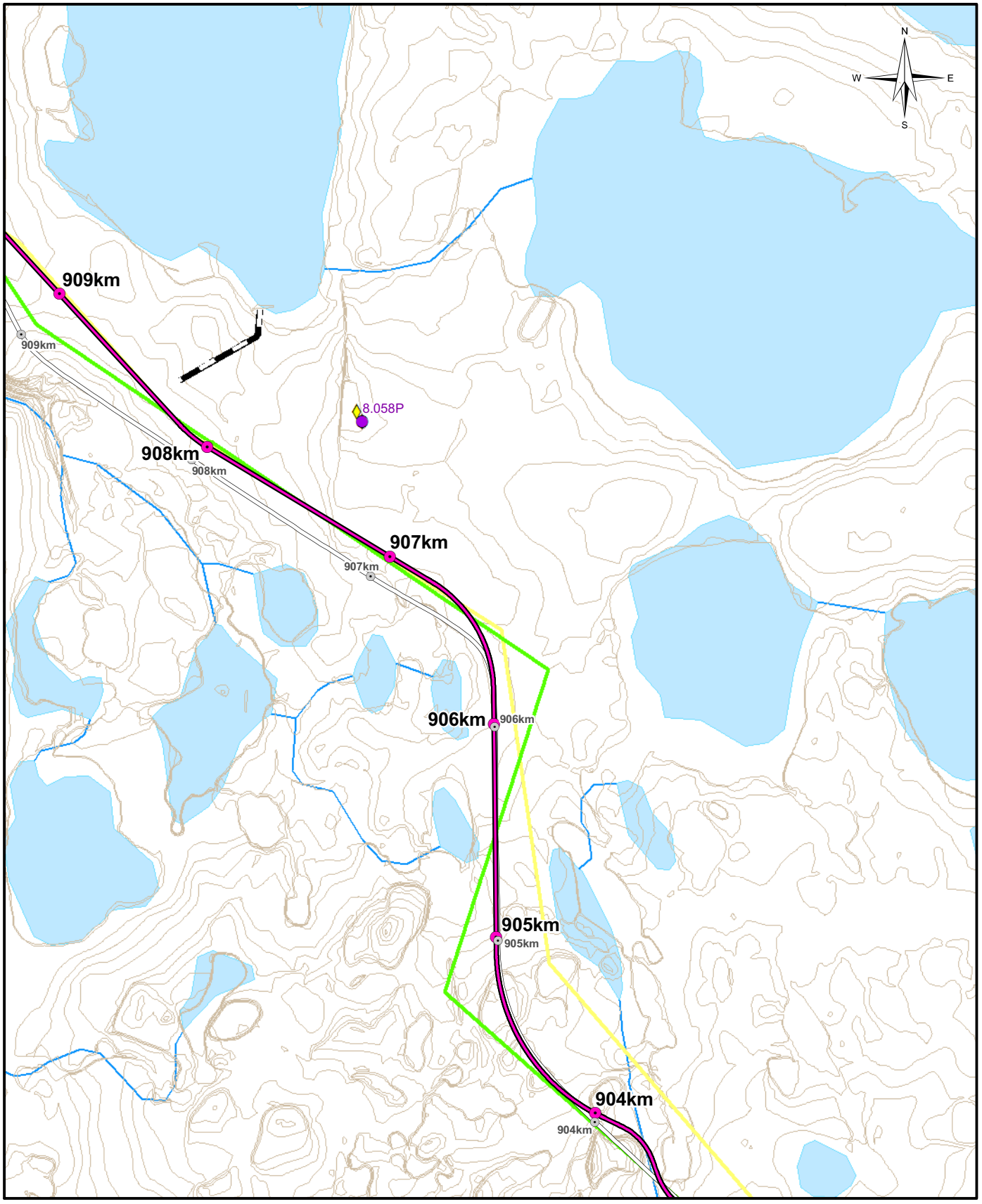
Map 36



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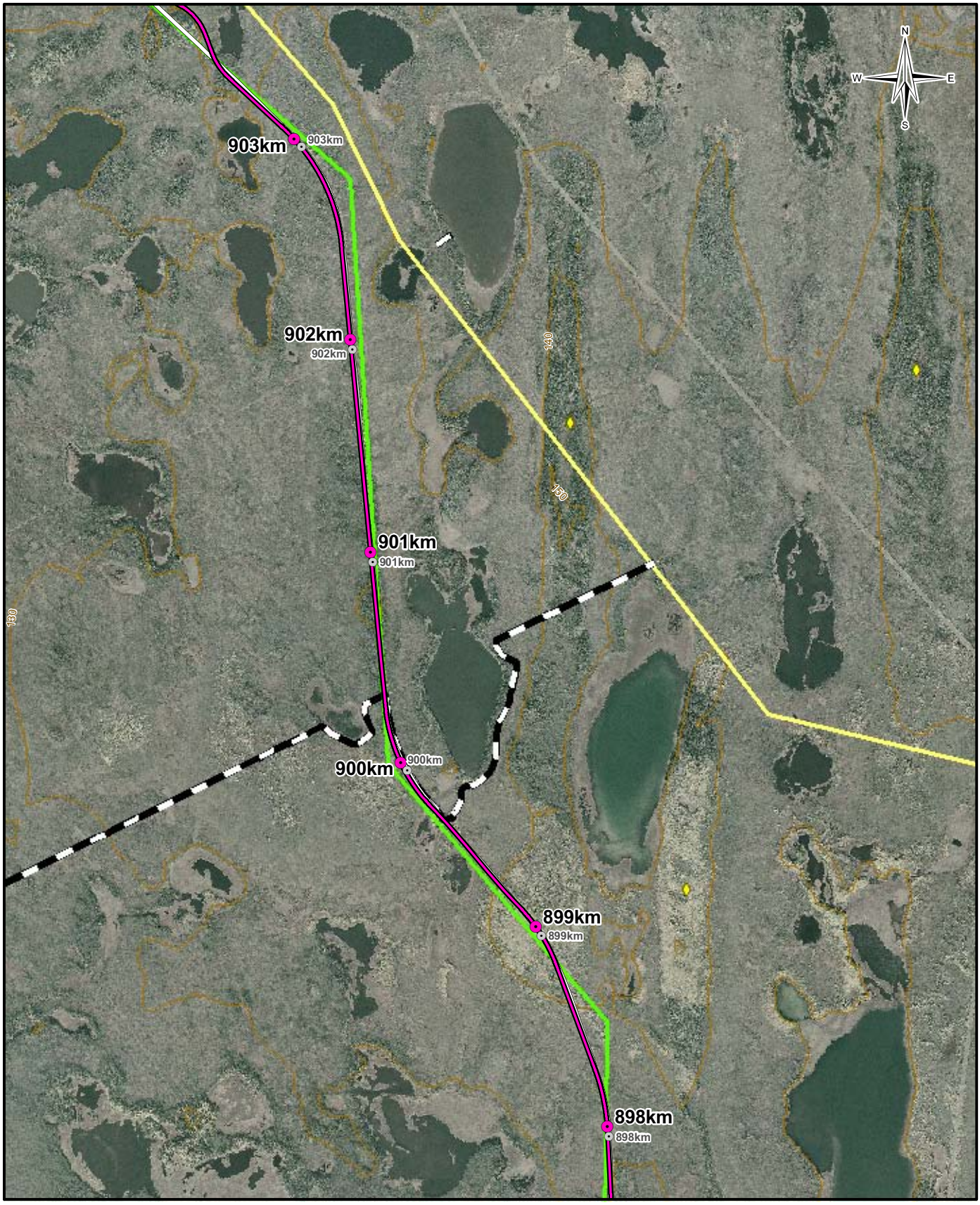

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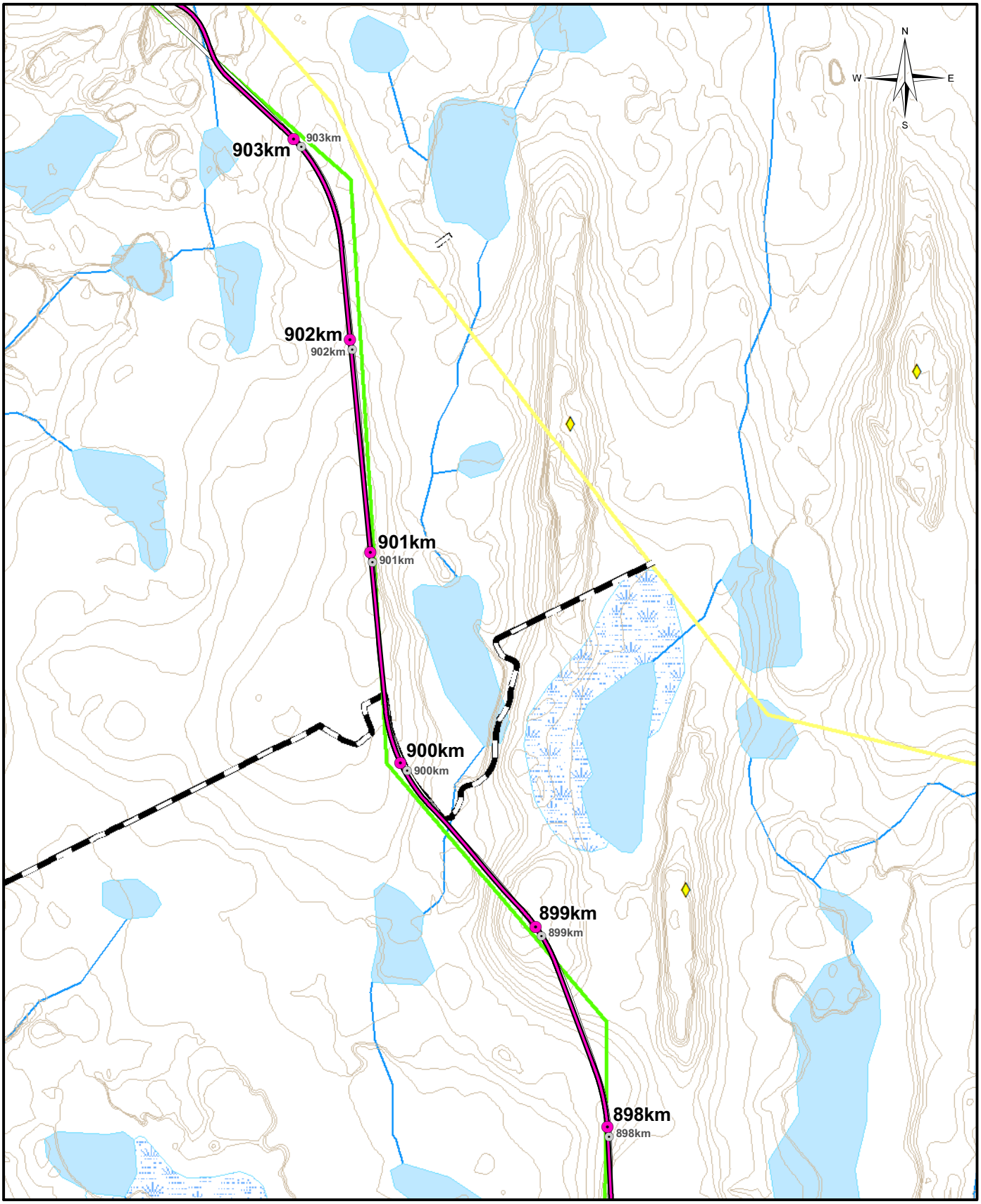
Map 37



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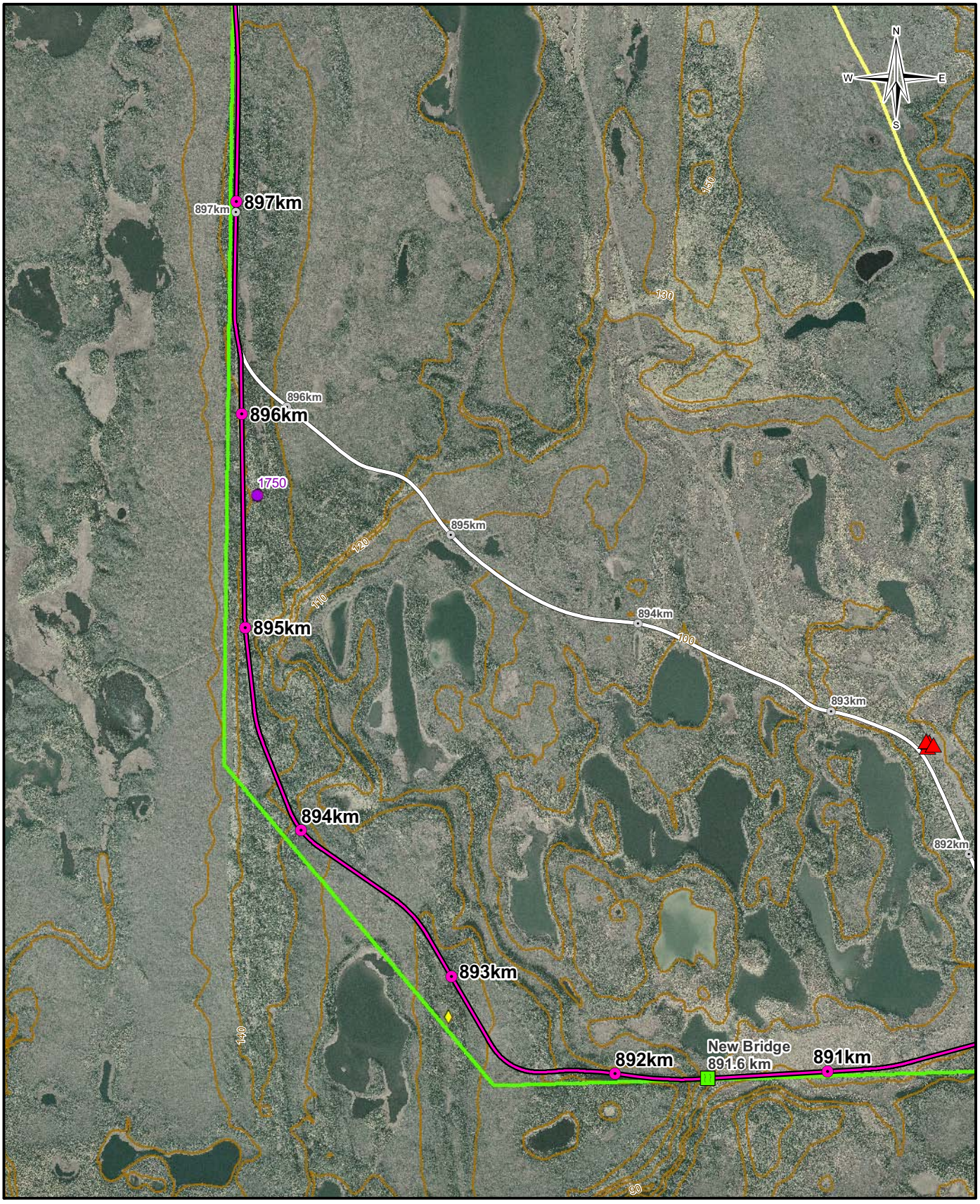

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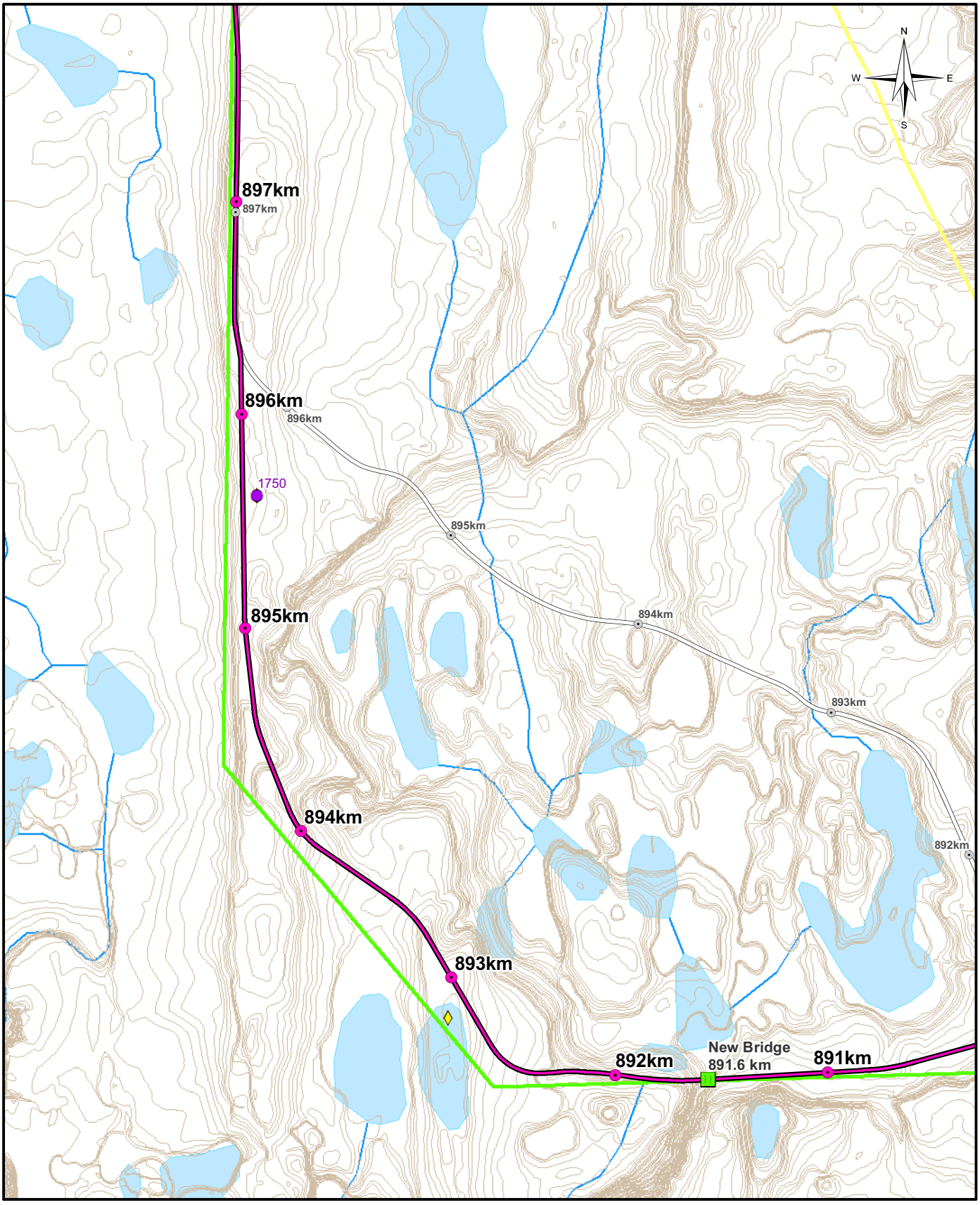

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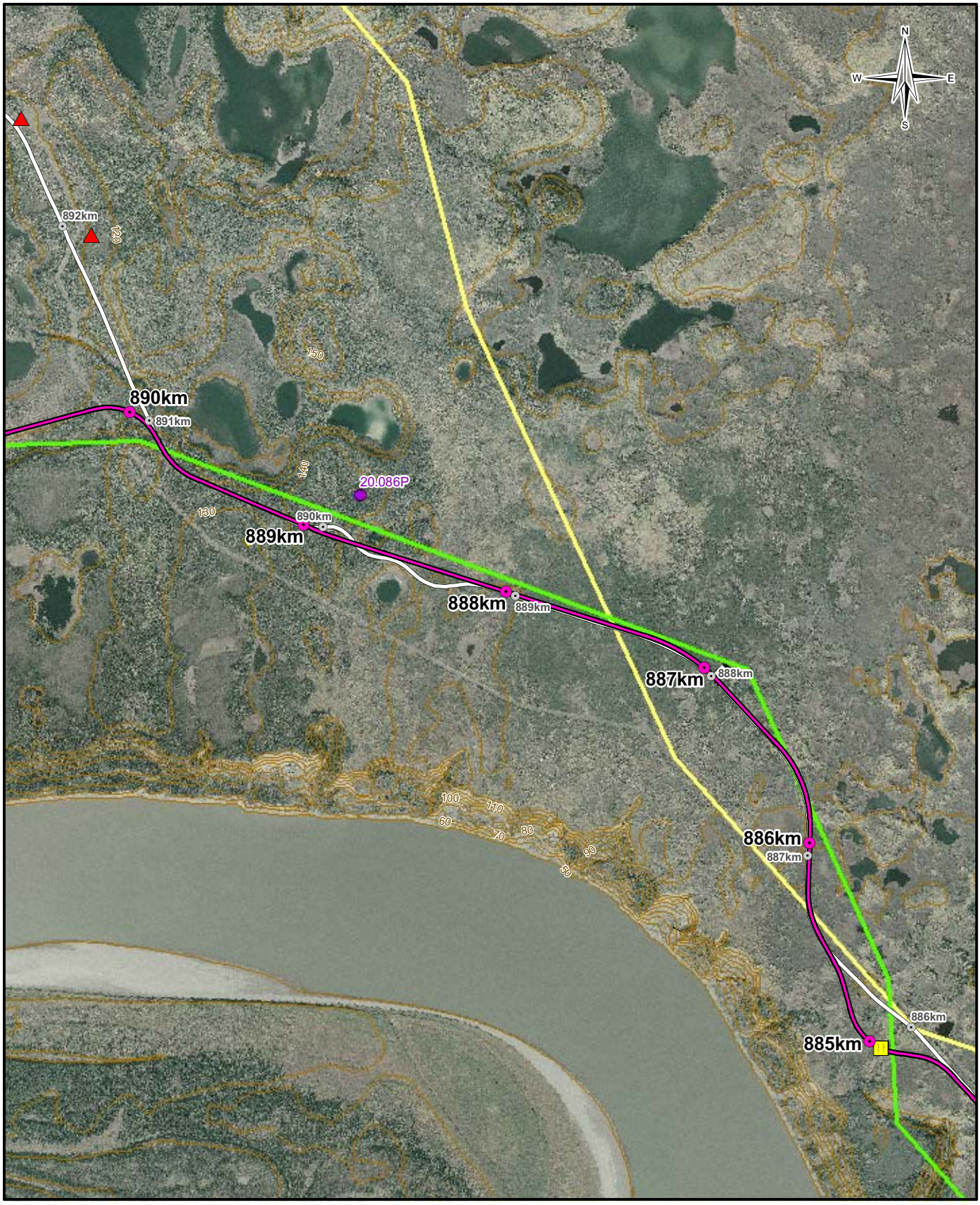

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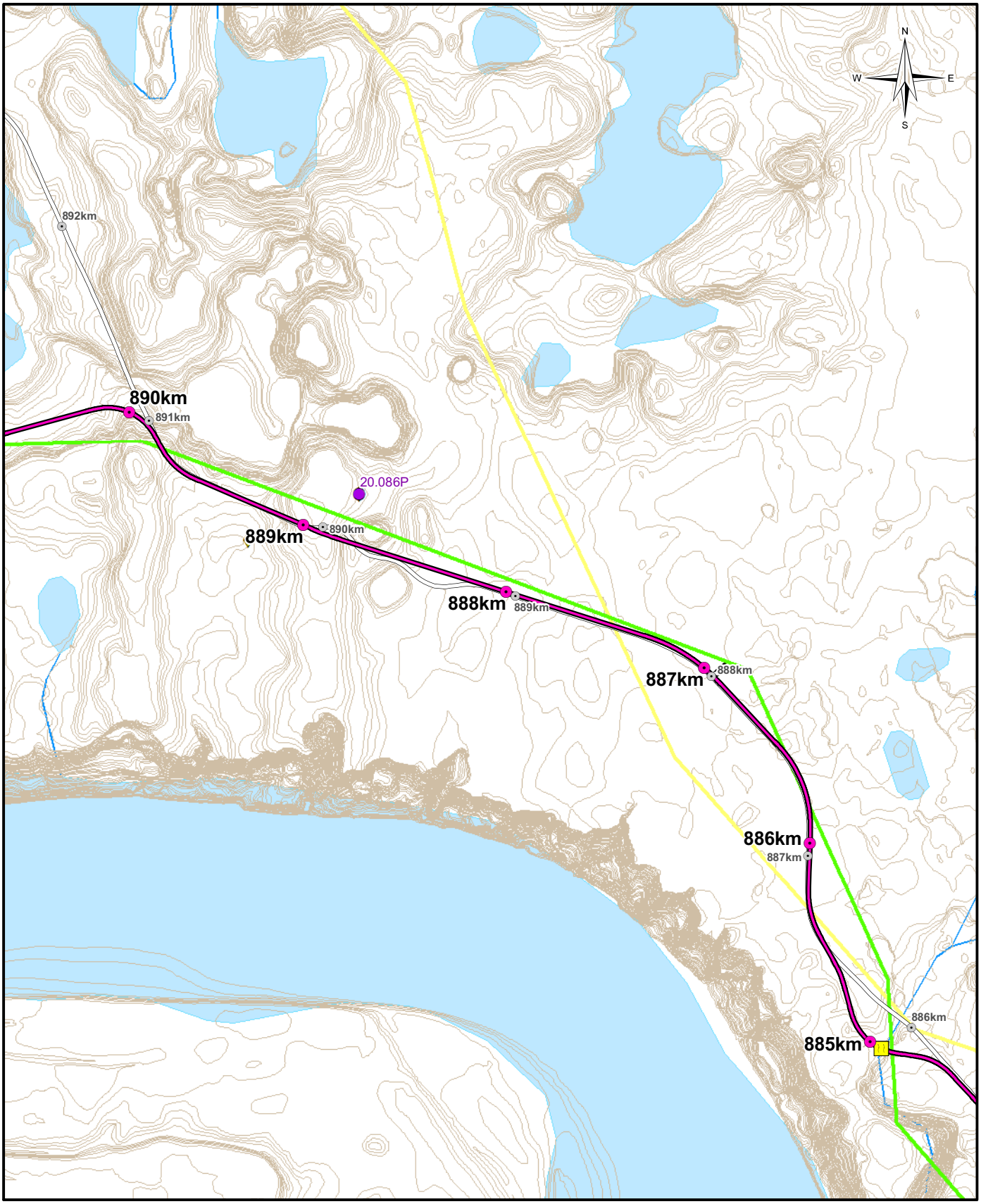

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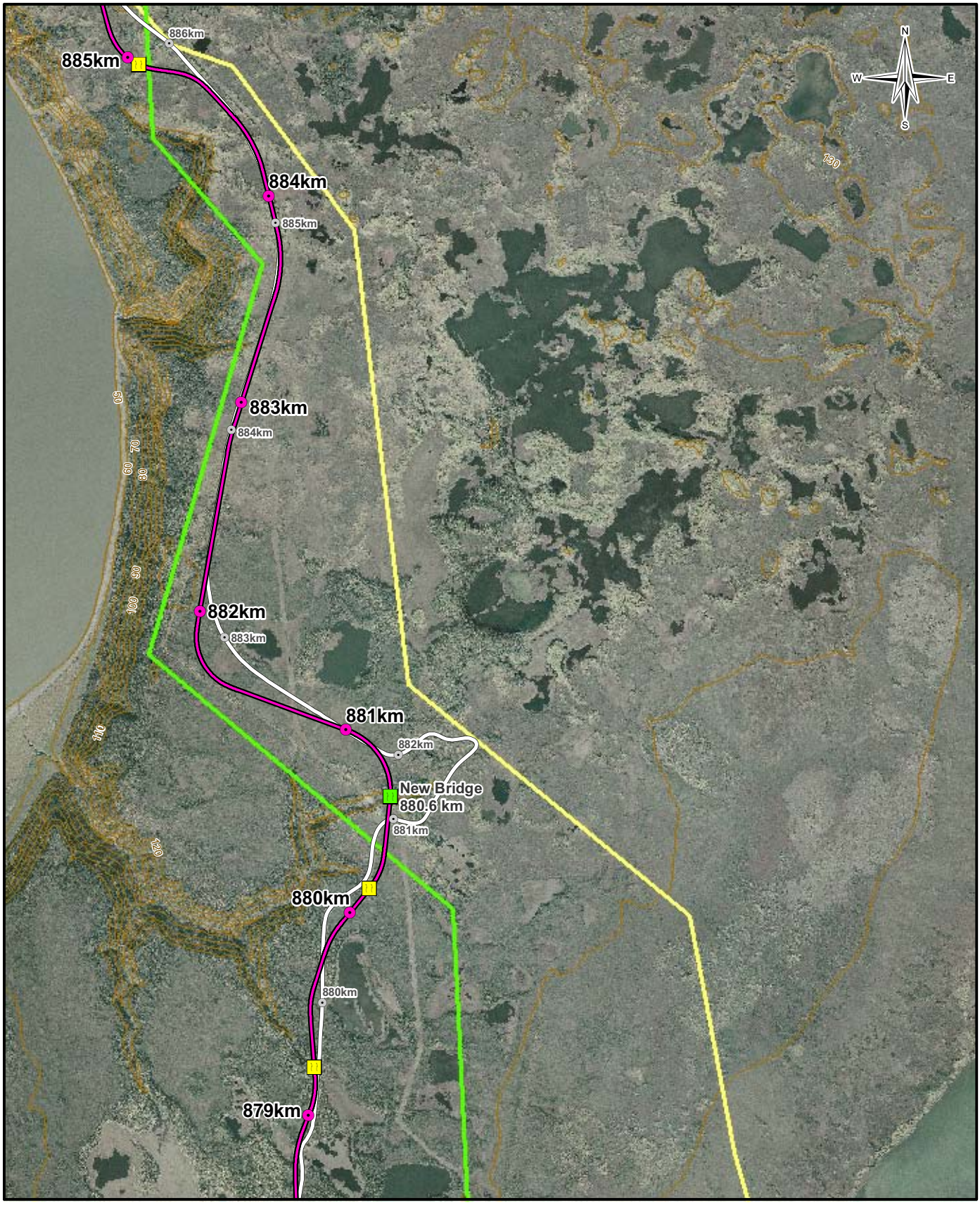

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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

1:25,000 Map Book

Scale: 1:25,000 (0, 250, 500 Metres)

UTM Zone 8
NAD83

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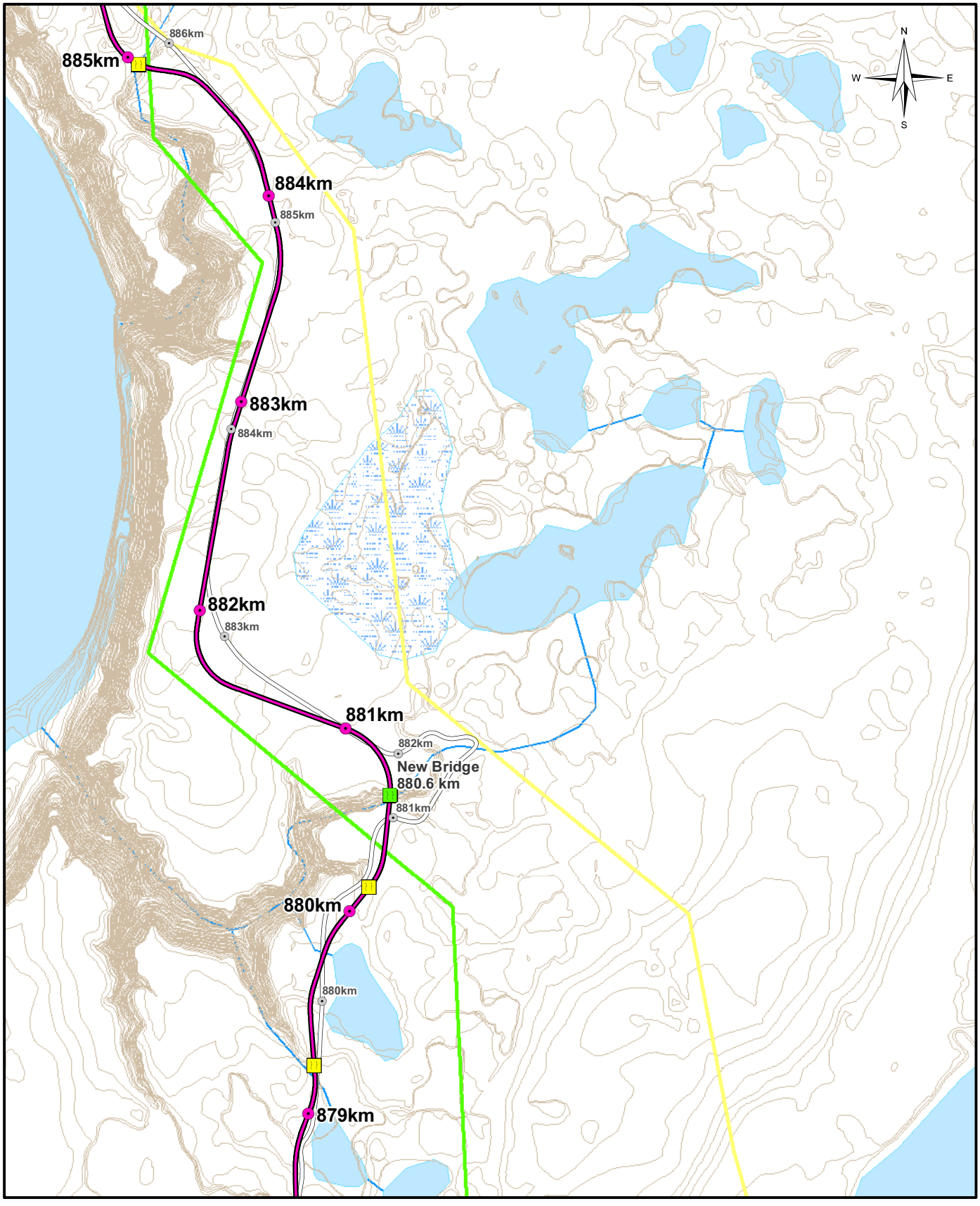
FILE NO. Y22101155_MapBook-Imagery-Oct2011.mxd
PROJECT NO. Y22101155 DATE October 14, 2011

Map 40



Legend

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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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Map 40

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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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Metres

UTM Zone 8
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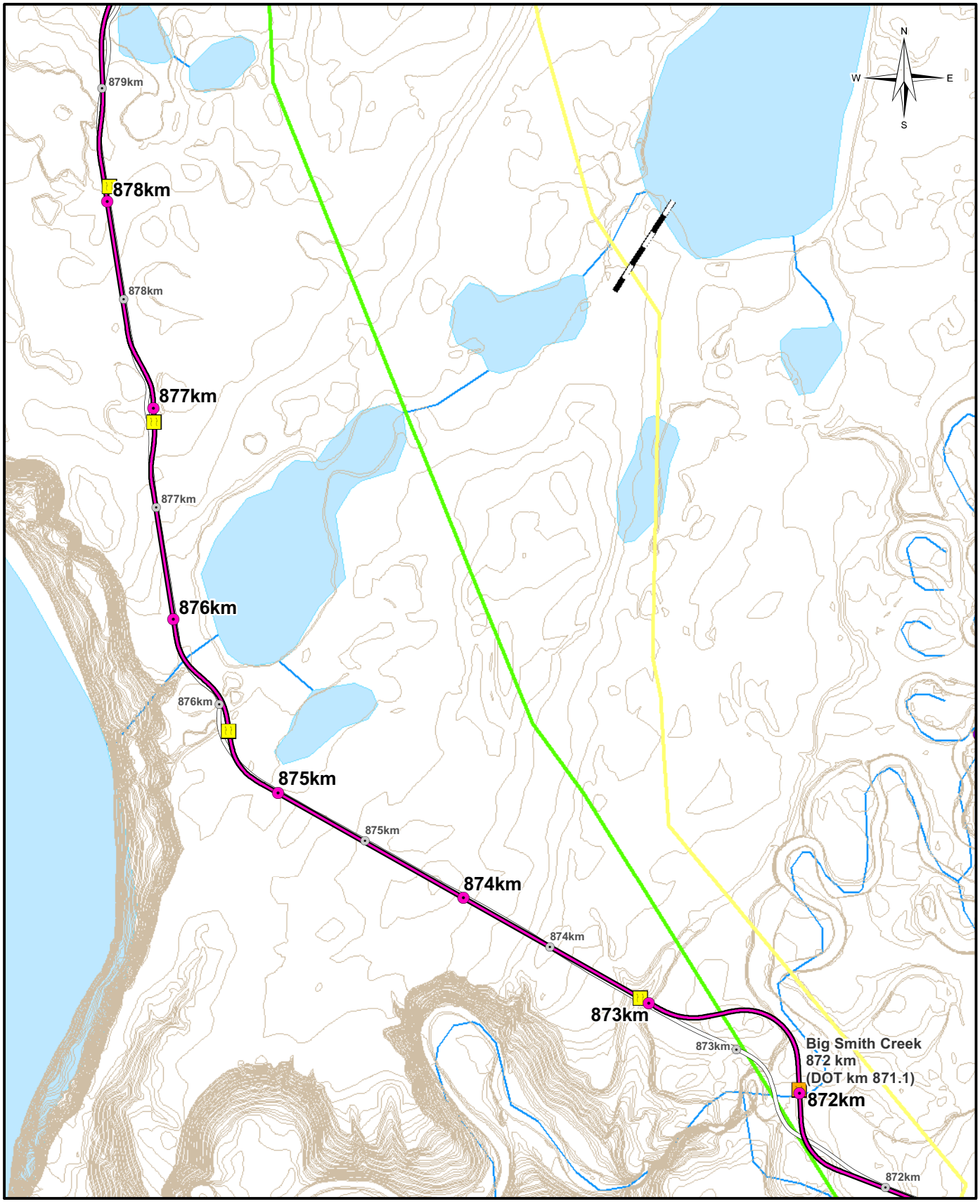
PROJECT NO. Y22101155 DATE October 14, 2011

Map 41



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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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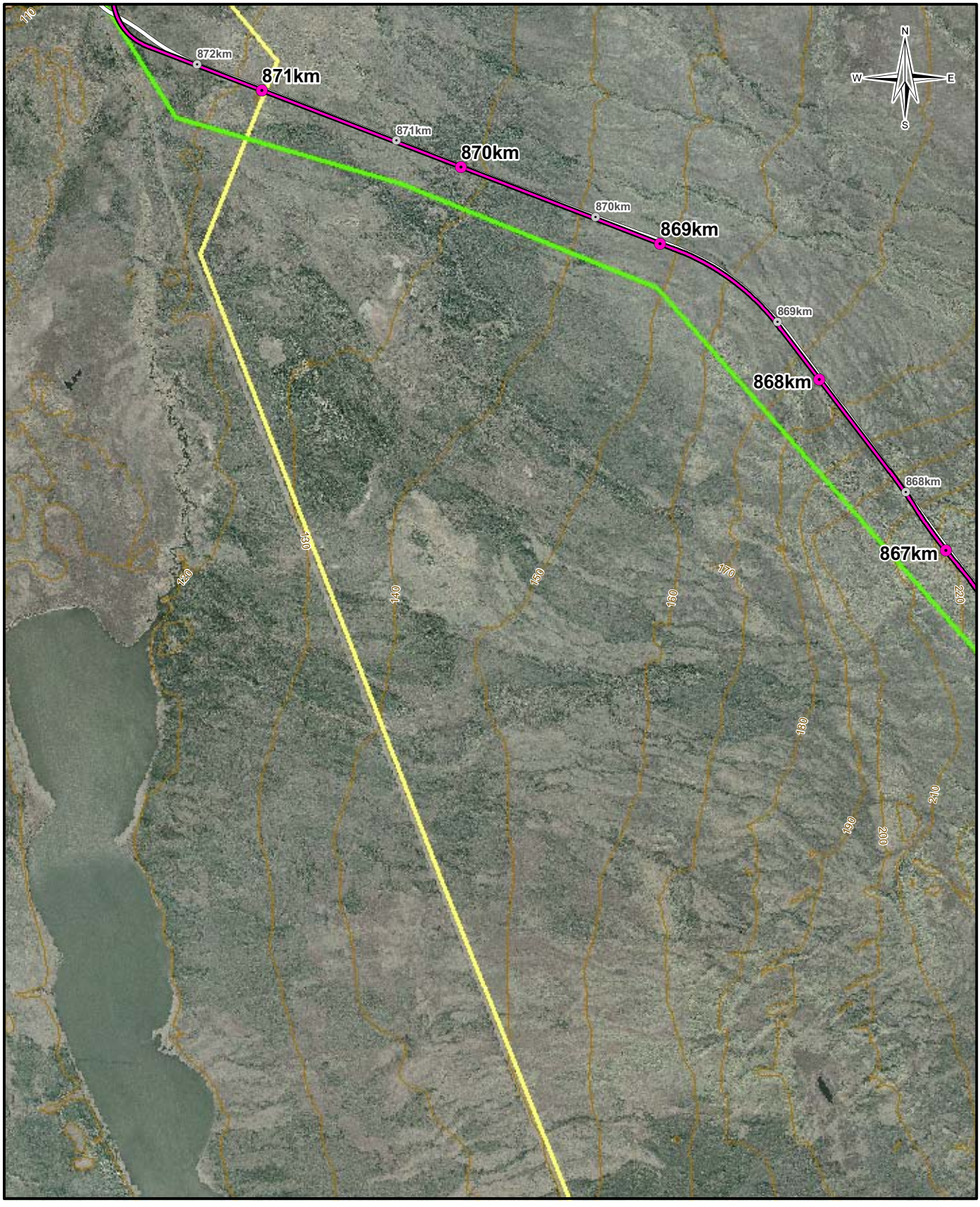

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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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Metres

UTM Zone 8
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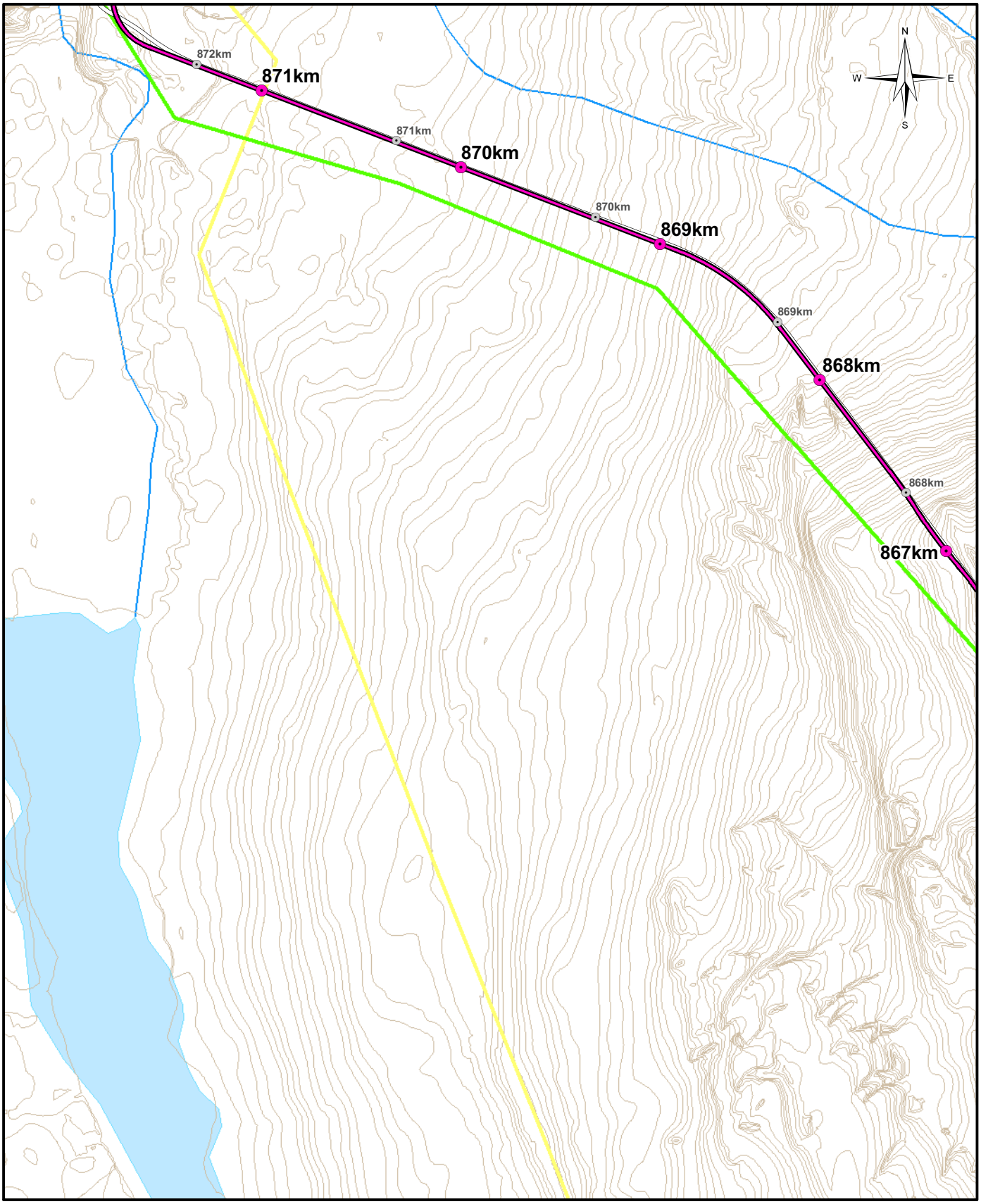
Map 42



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Metres

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Map 42

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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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Metres

UTM Zone 8
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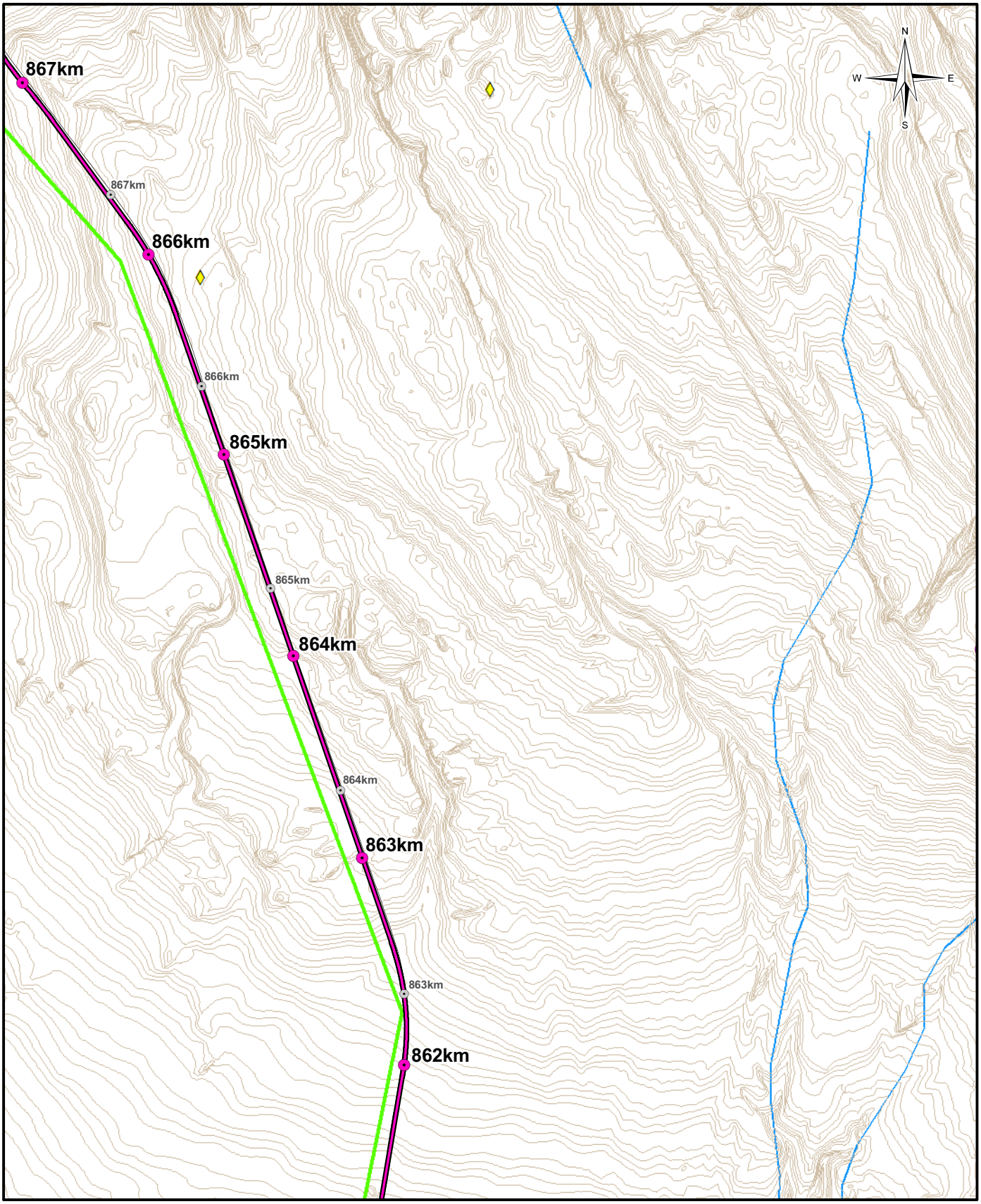
PROJECT NO. Y22101155 DATE October 14, 2011

Map 43



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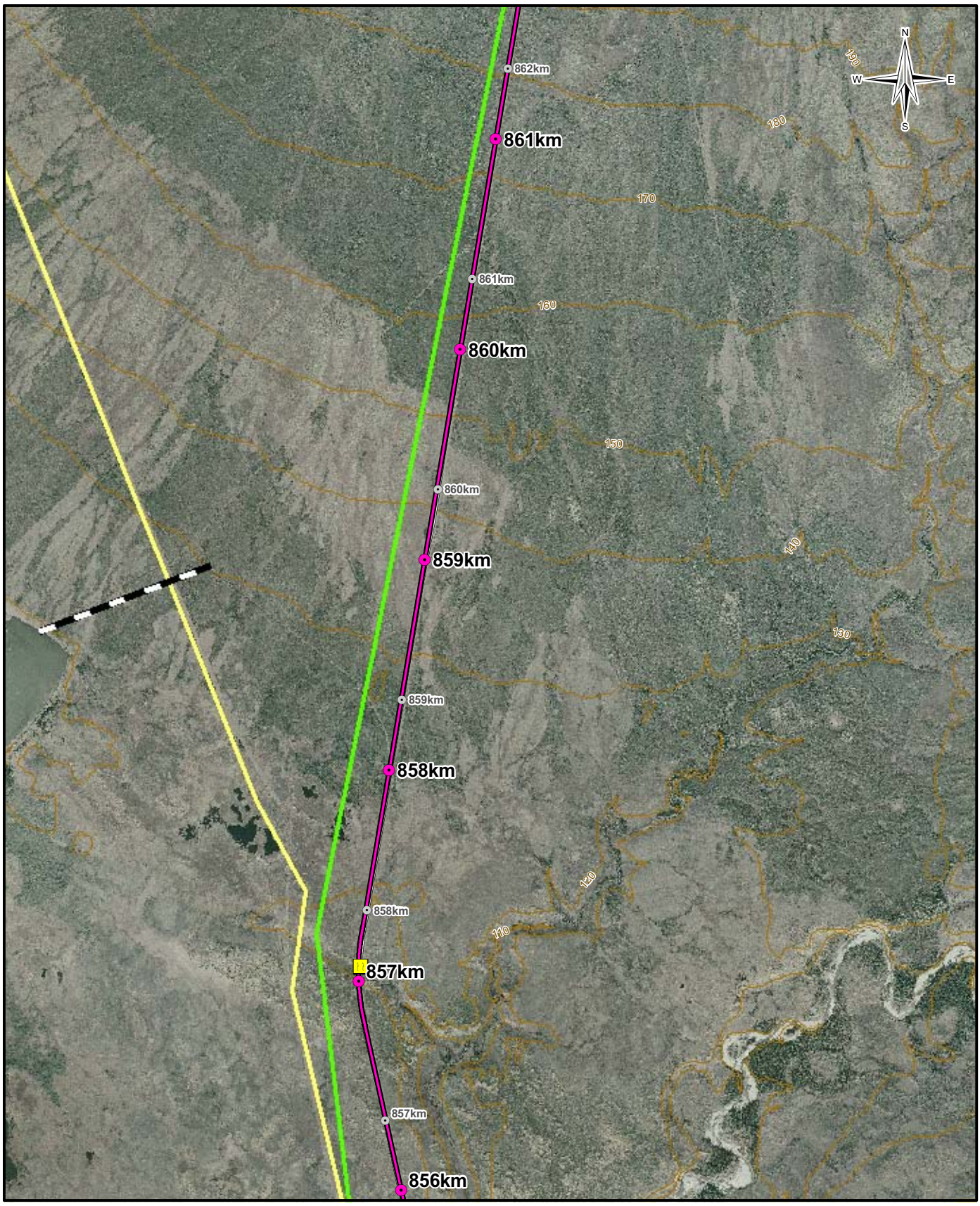

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Metres

UTM Zone 8
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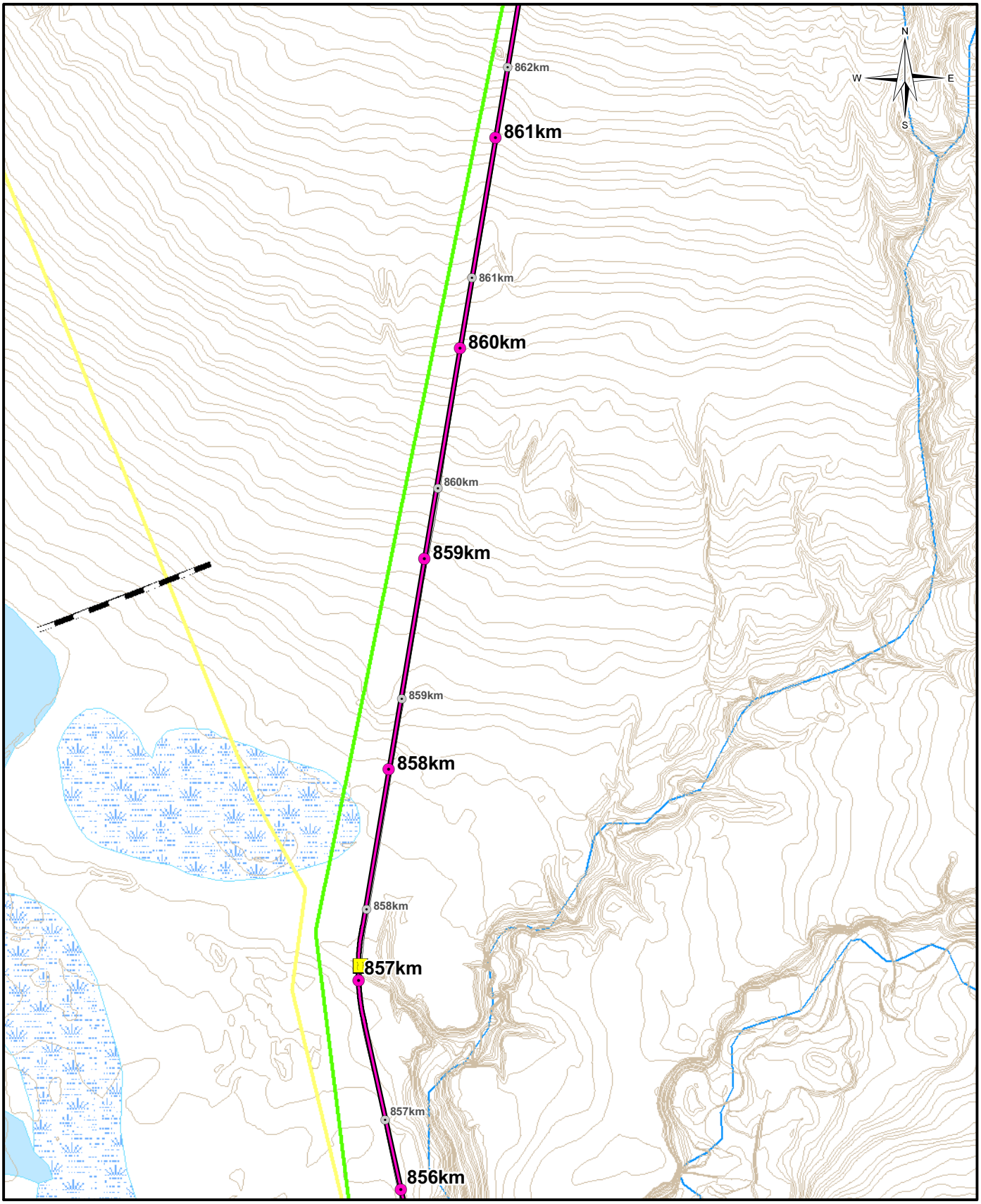
Map 44



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Metres

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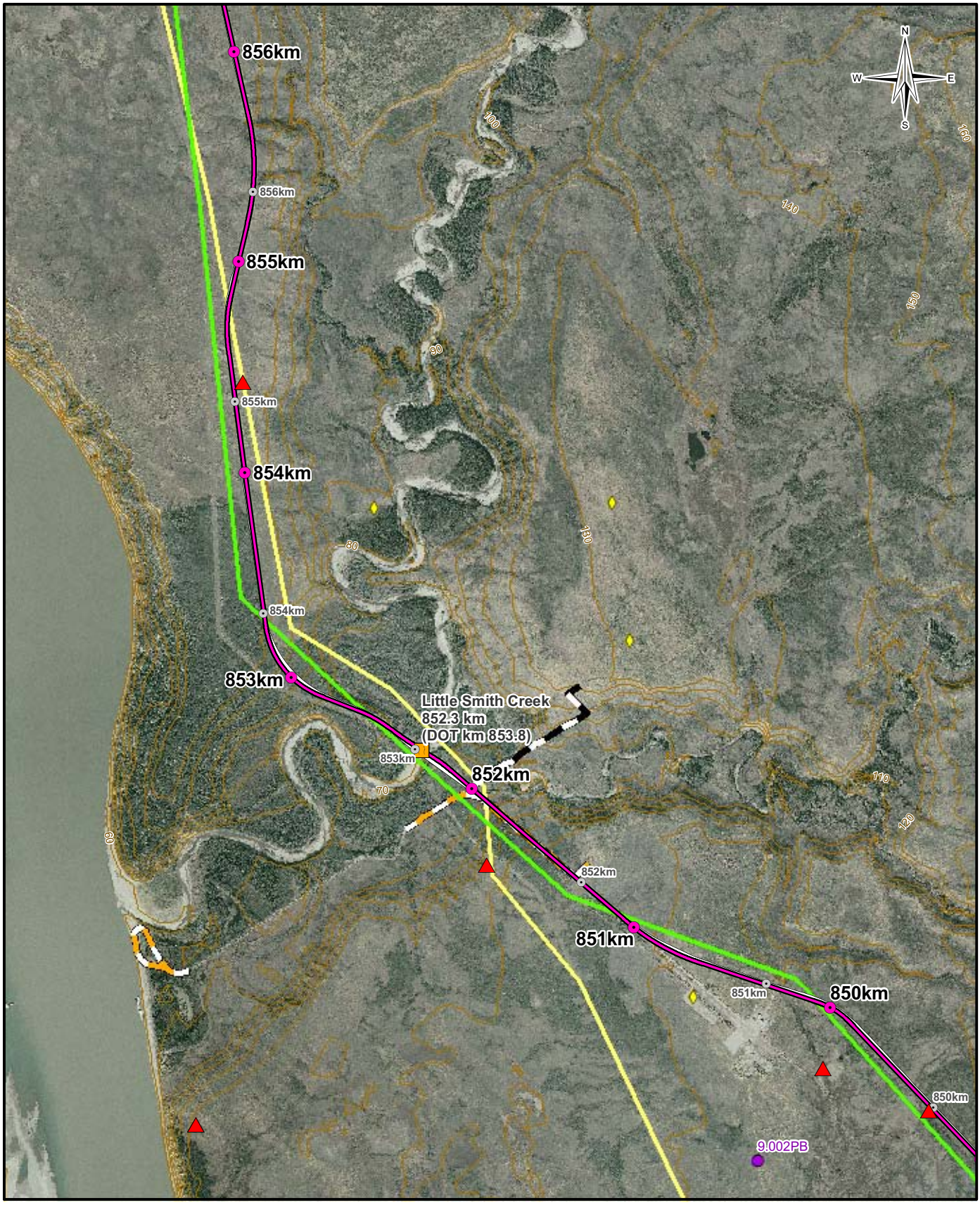

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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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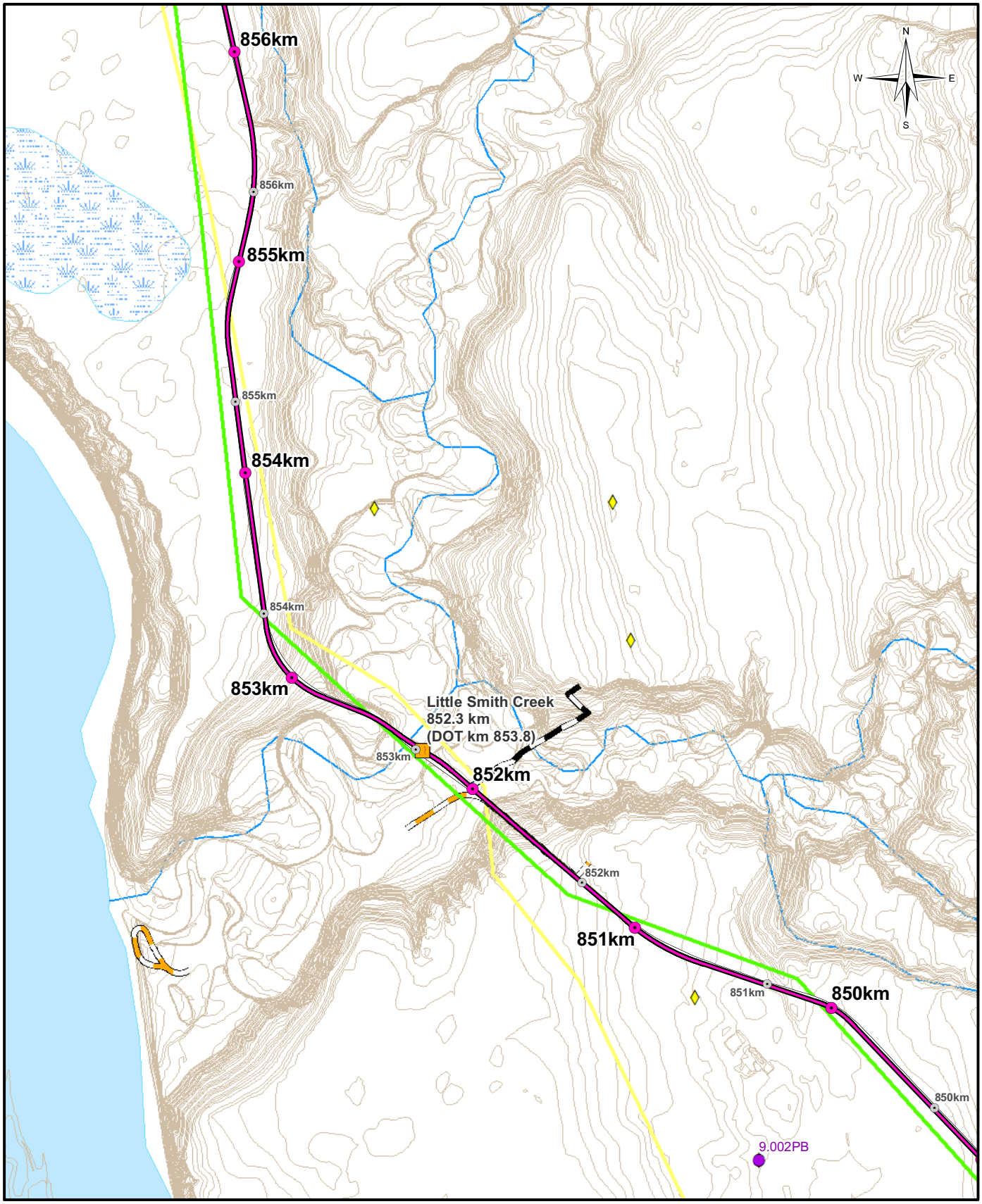
PROJECT NO. Y22101155 DATE October 14, 2011

Map 45



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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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Metres

UTM Zone 8
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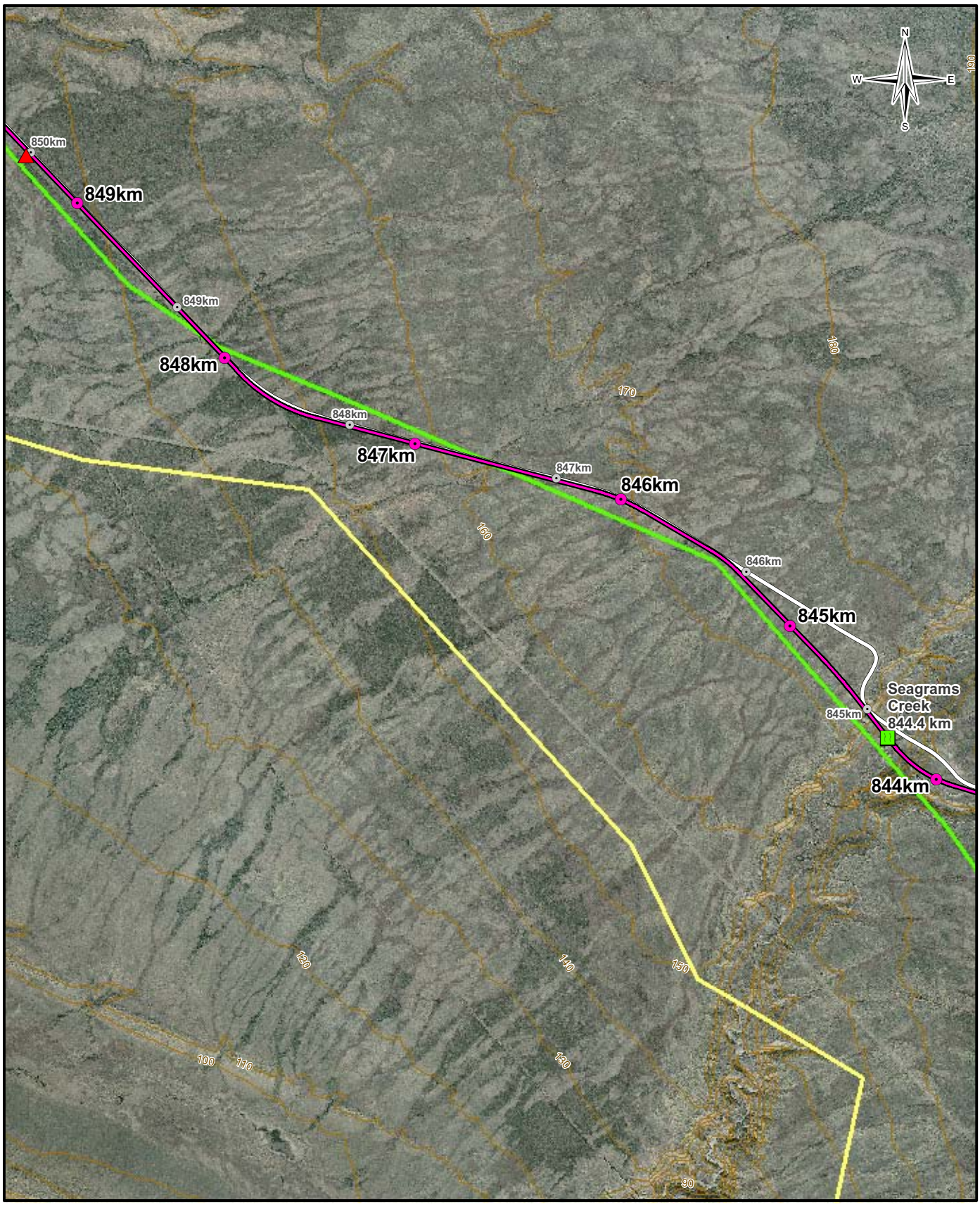

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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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NAD83

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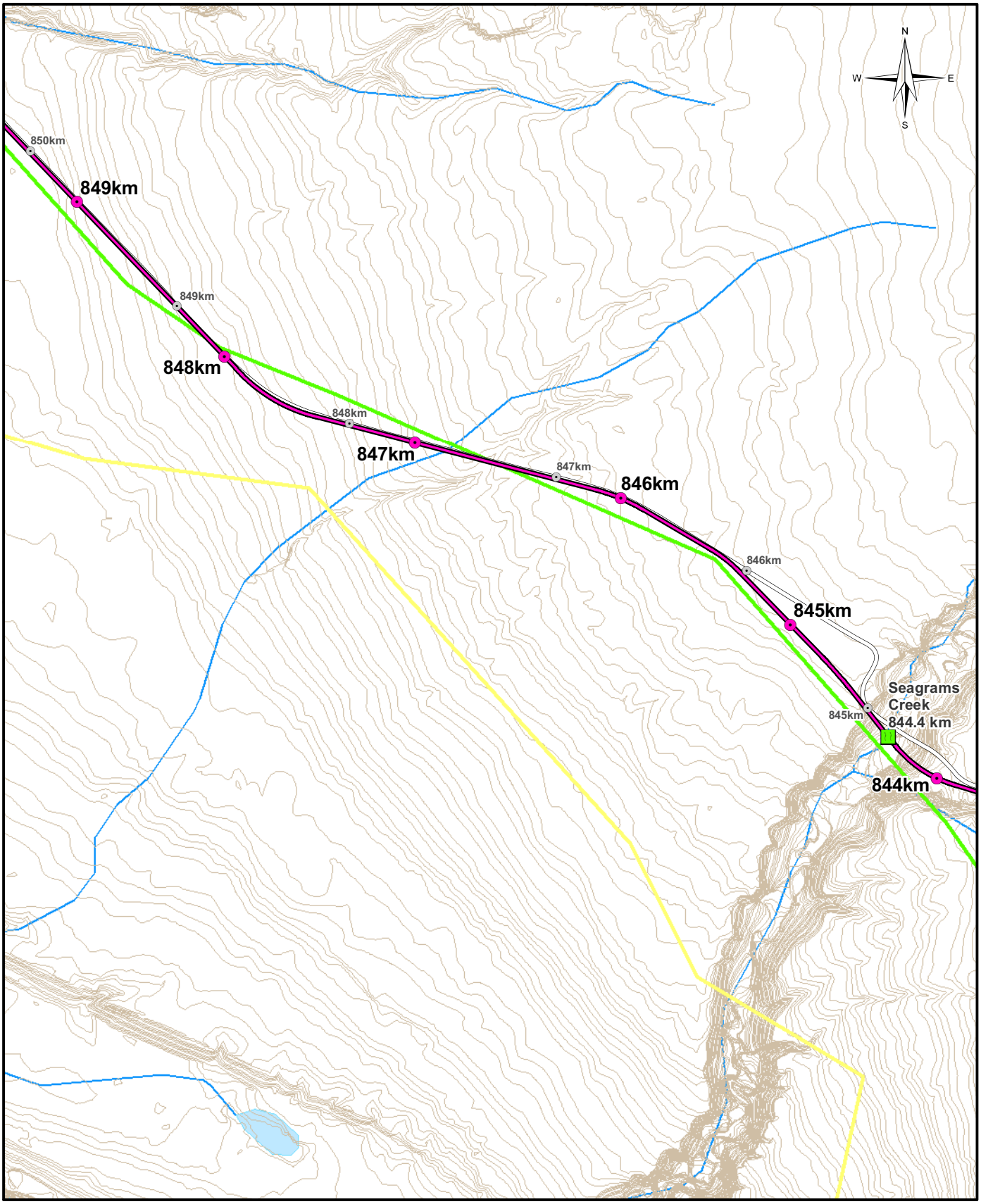
Map 46



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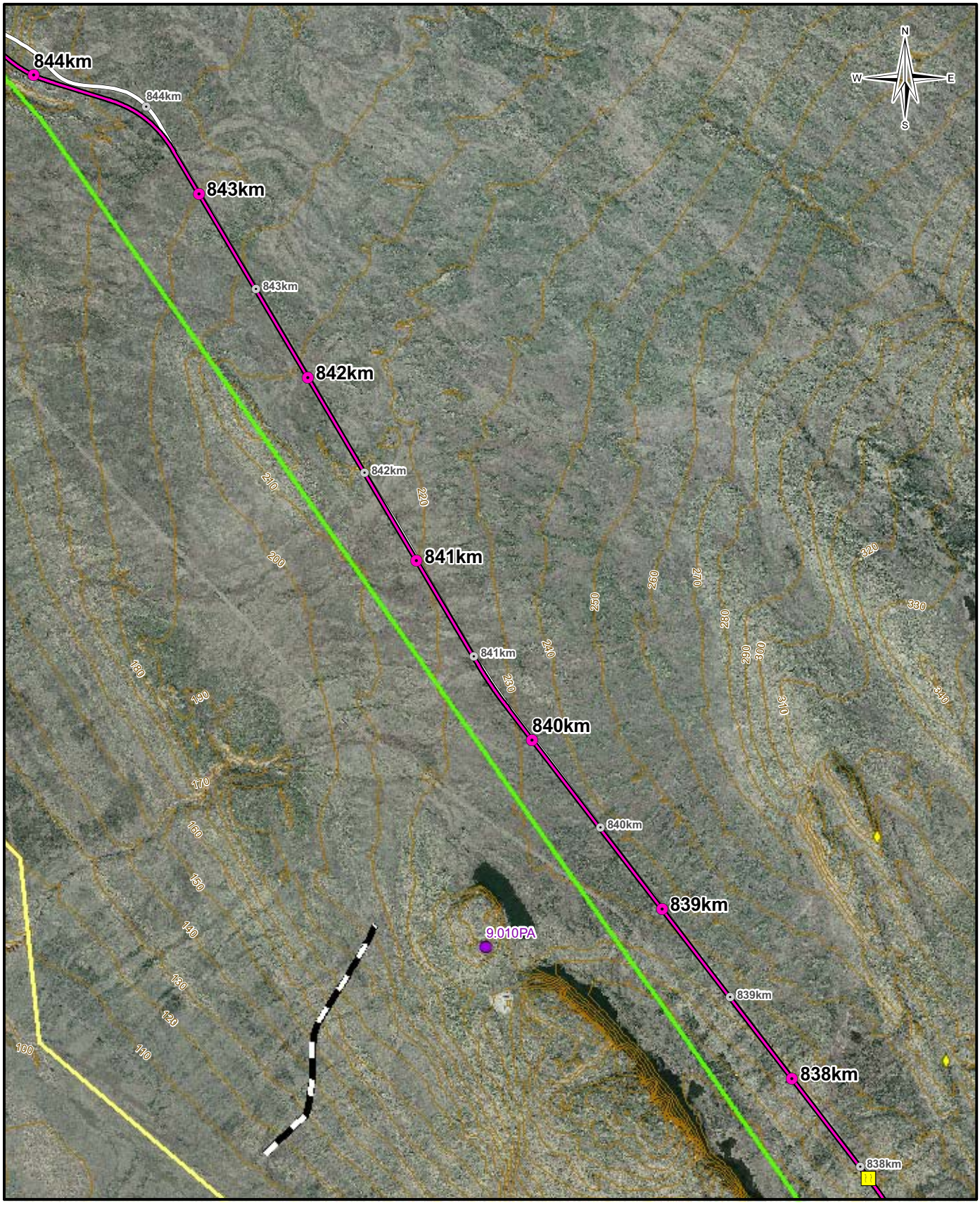

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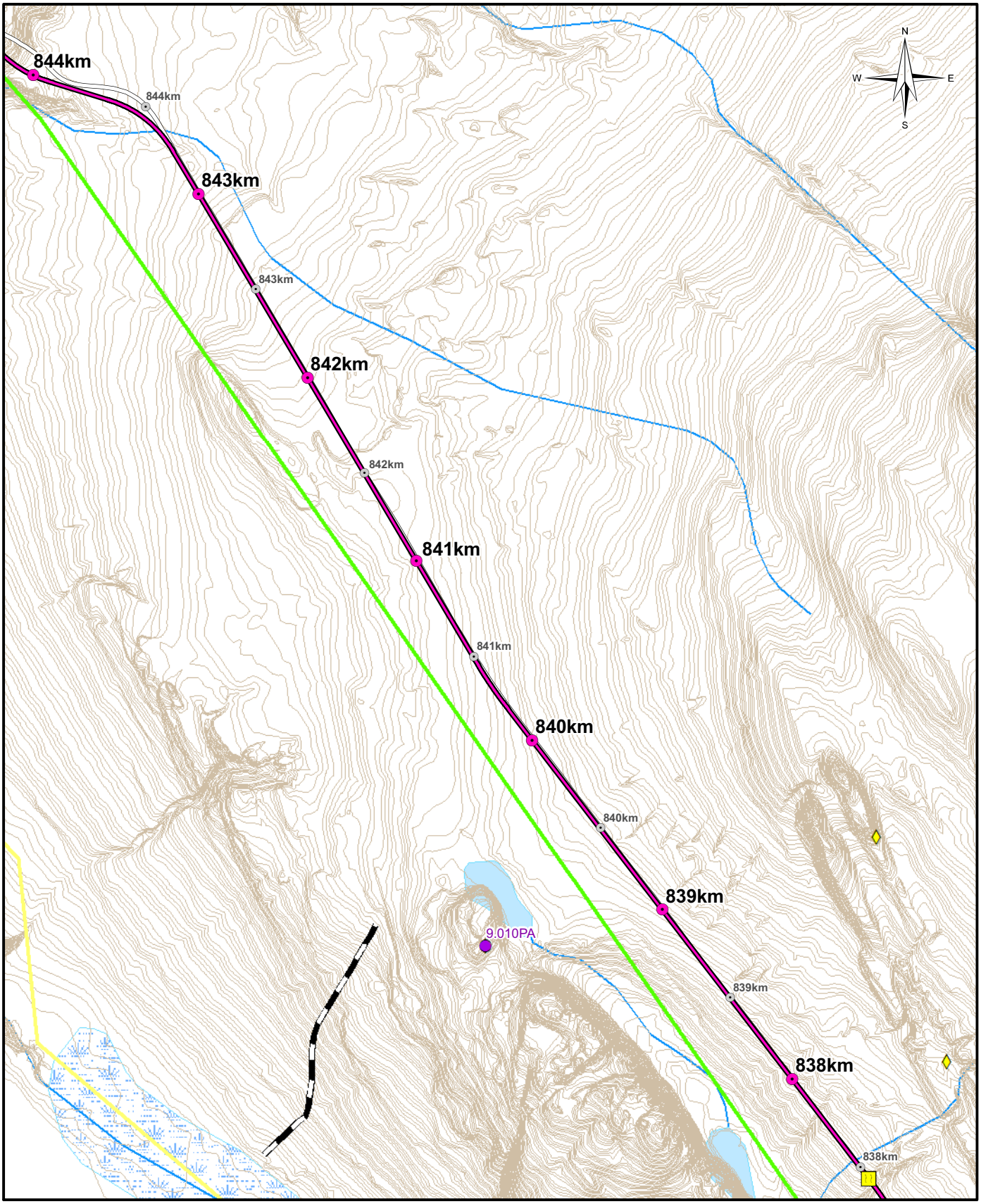
Map 47



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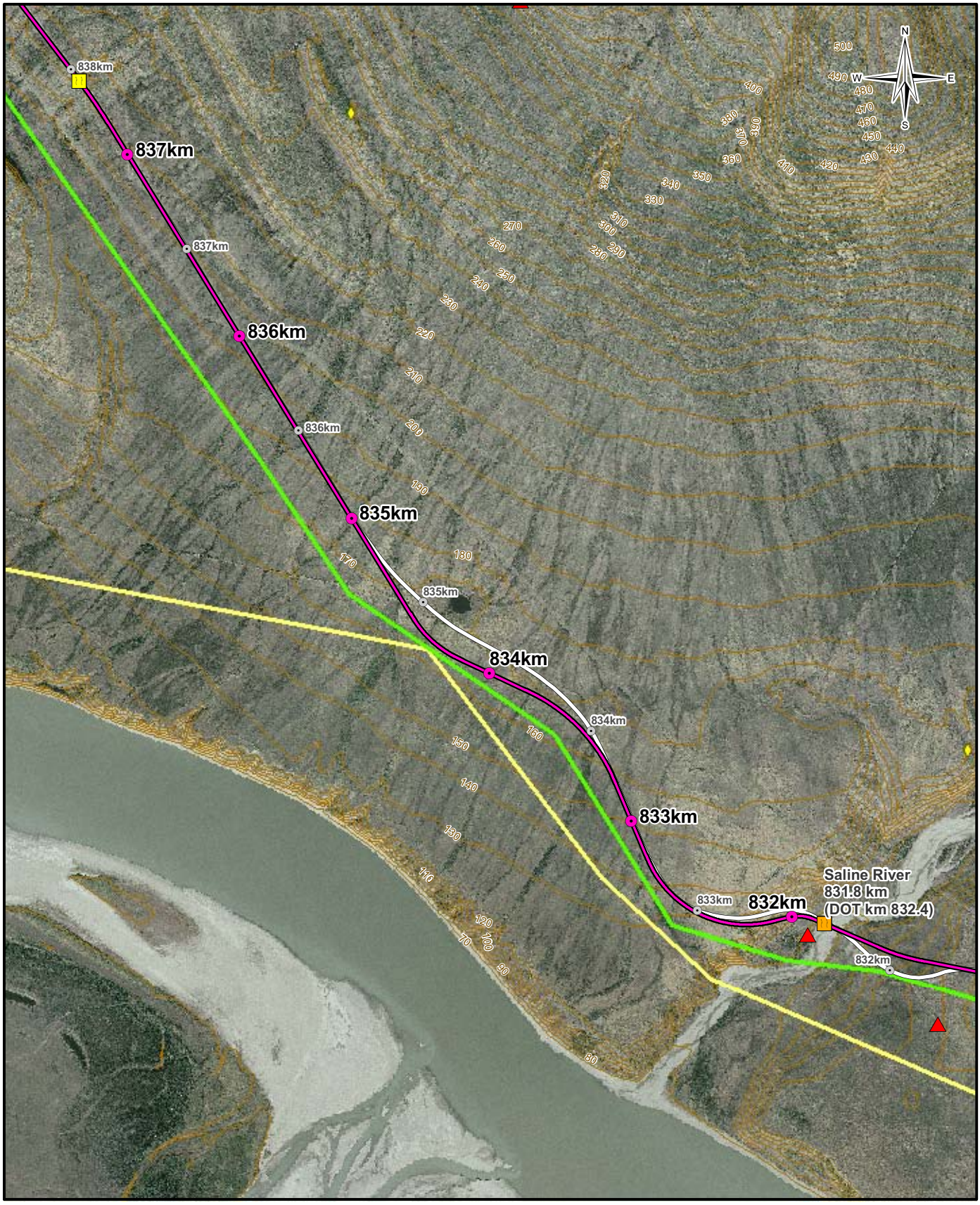

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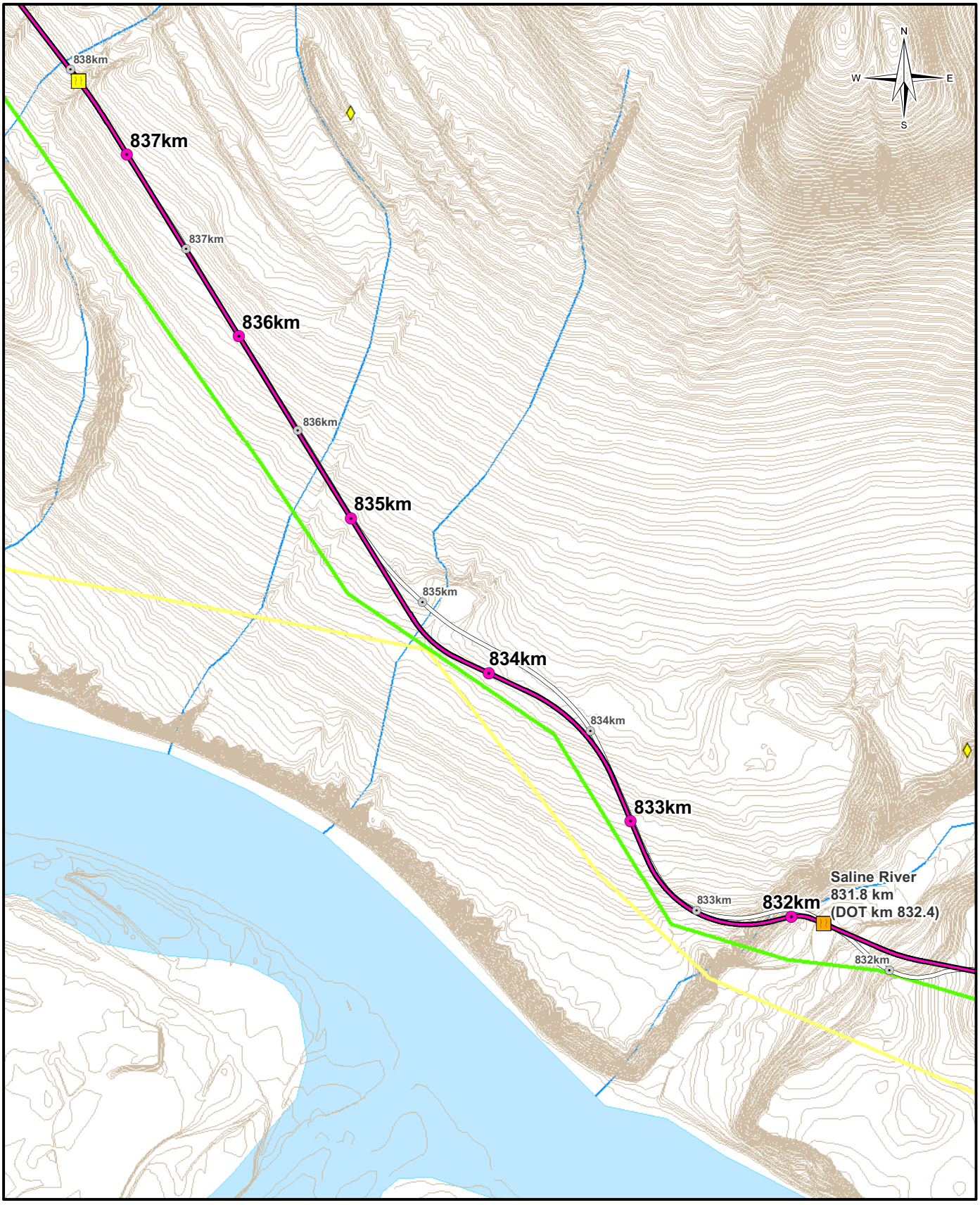
Map 48



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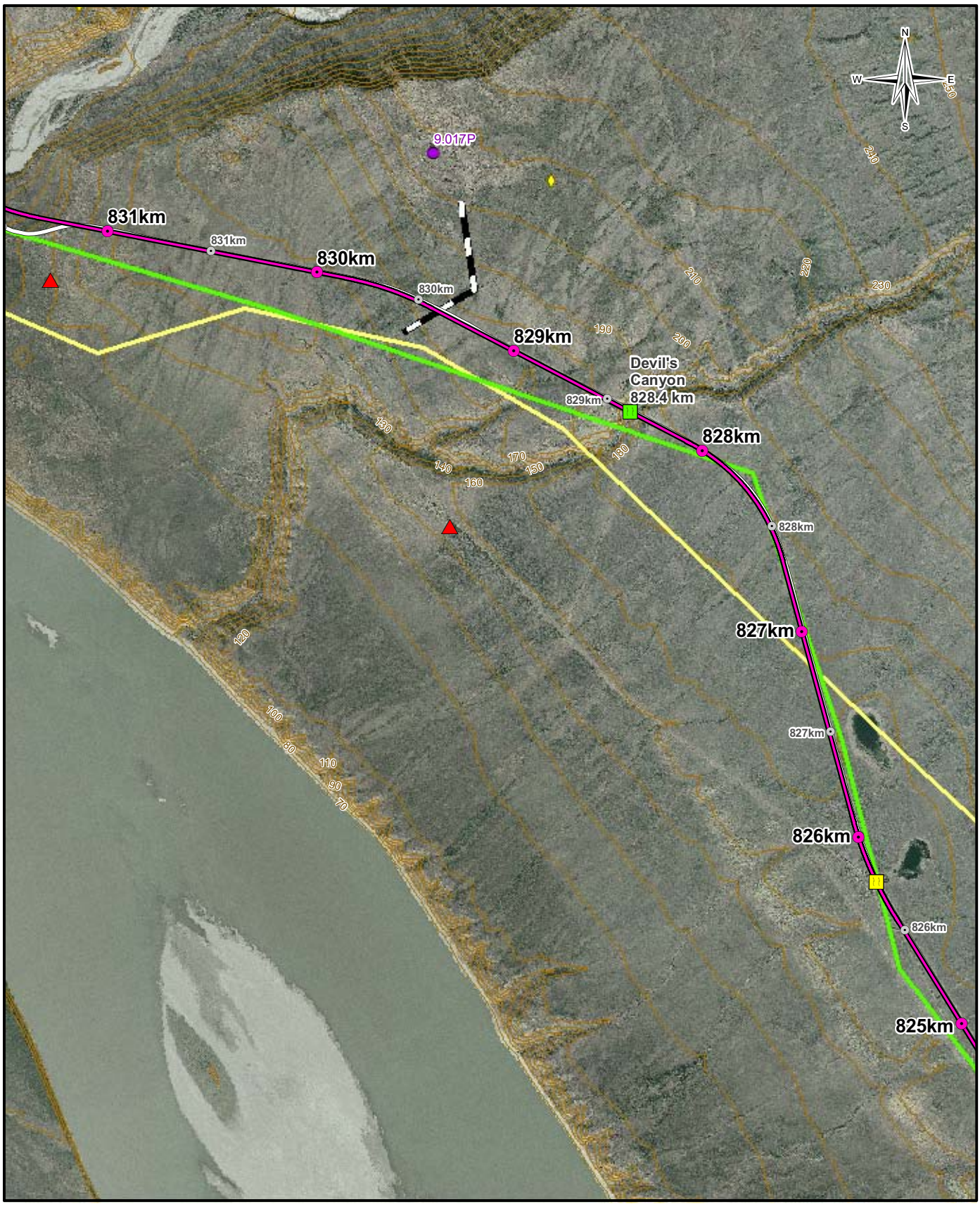

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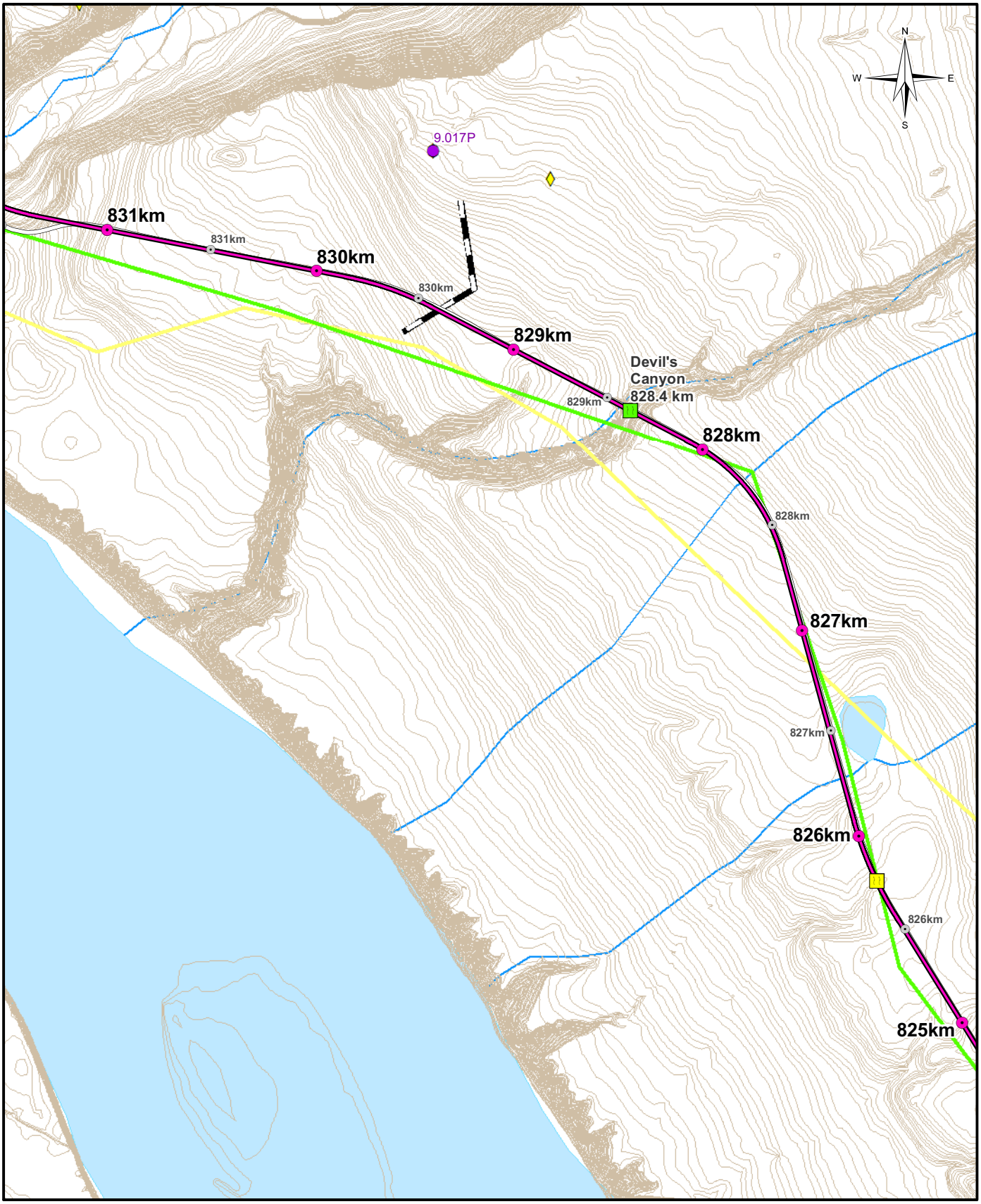
Map 49



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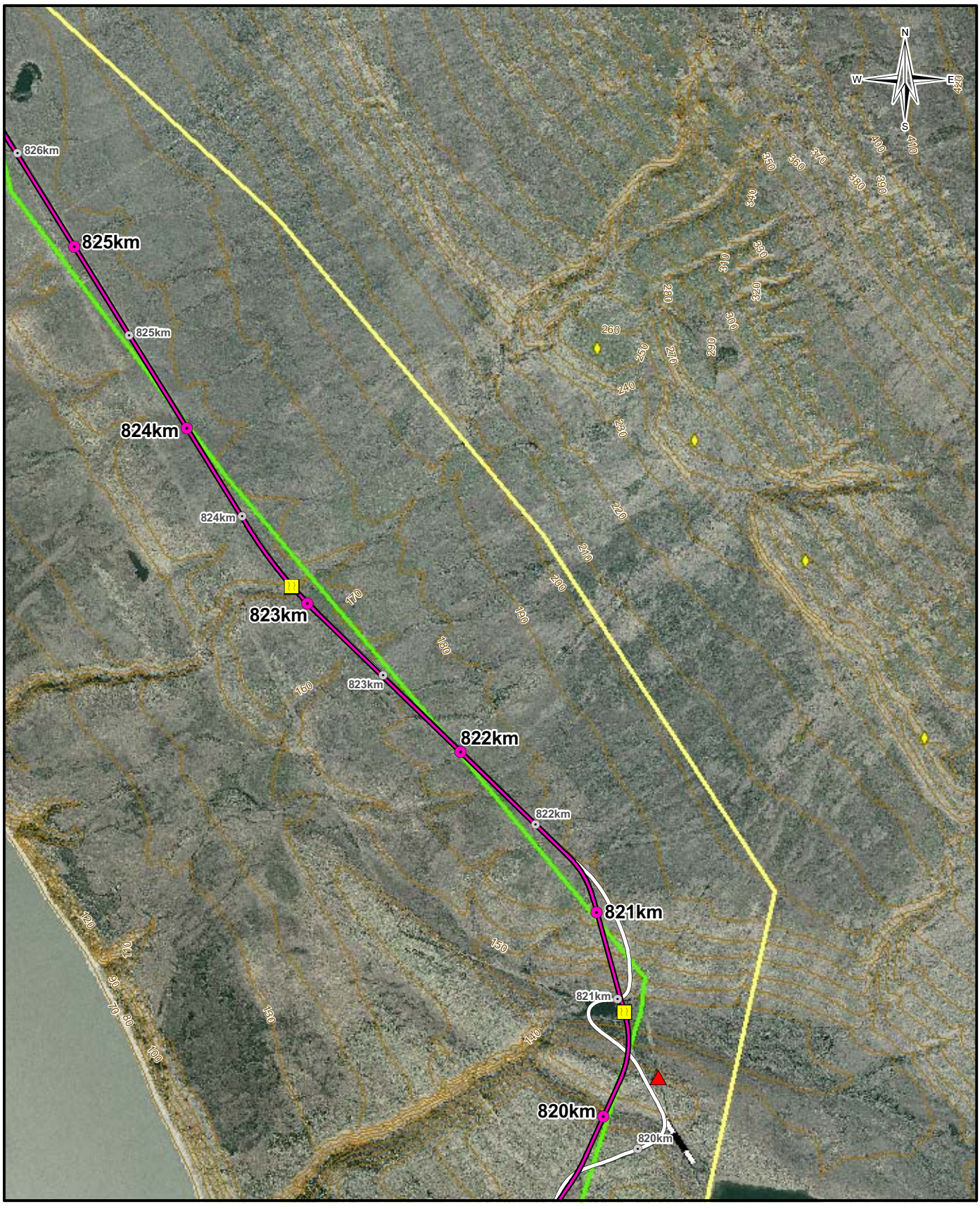

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- Proposed Winter Road - MGP
- Municipal Boundary
- Major Contour (10 m)
- Settlement Area Boundary
- District Boundary

MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

1:25,000 Map Book

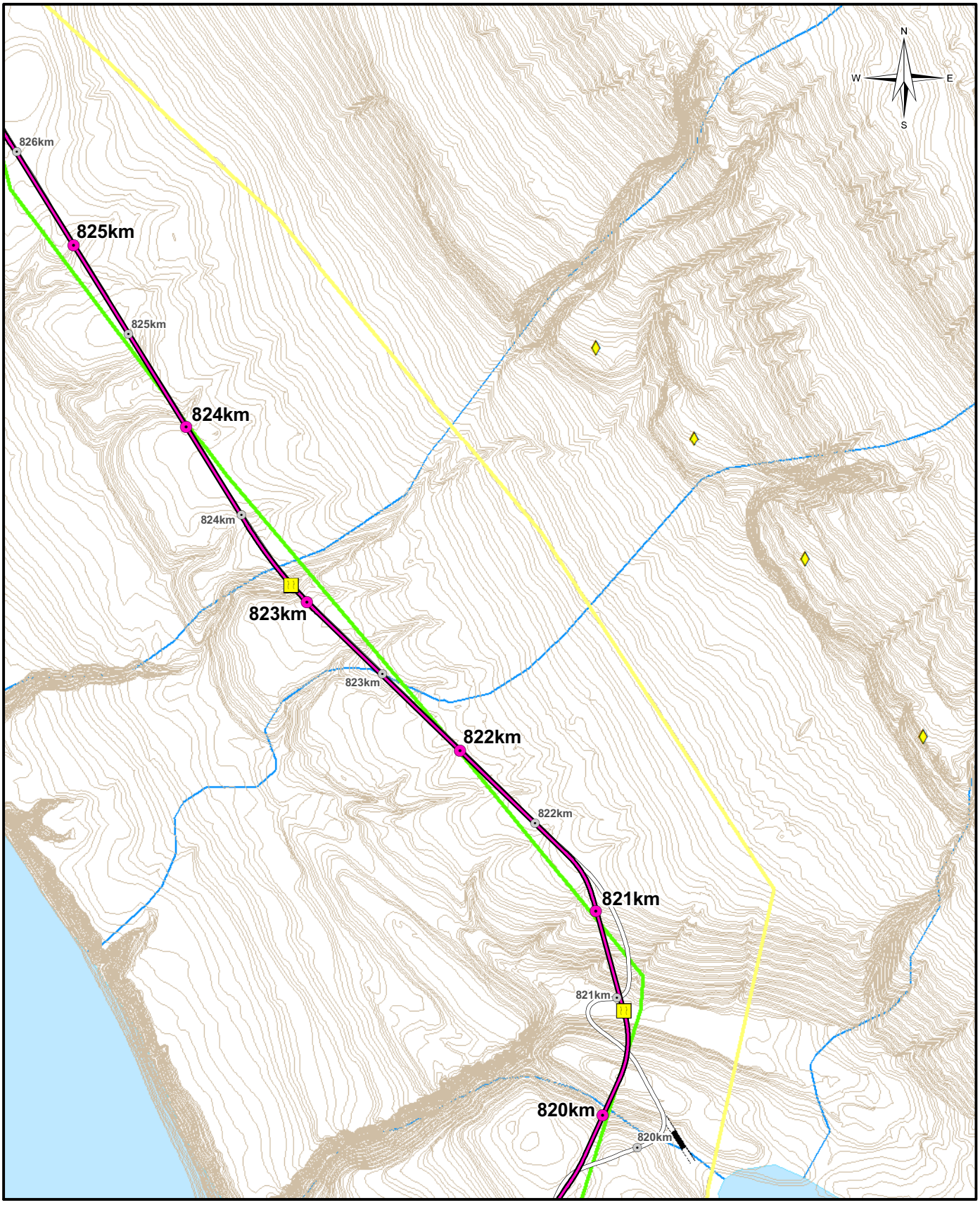
Scale: 1:25,000
0 250 500
Metres

UTM Zone 8
NAD83

5658
NWT Ltd.

FILE NO. Y22101155_MapBook-Imagery-Oct2011.mxd
PROJECT NO. Y22101155 DATE October 14, 2011

Map 50



Legend

- Community
- Preferred Material Source
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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

1:25,000 Map Book

Scale: 1:25,000
0 250 500
Metres

UTM Zone 8
NAD83

5658
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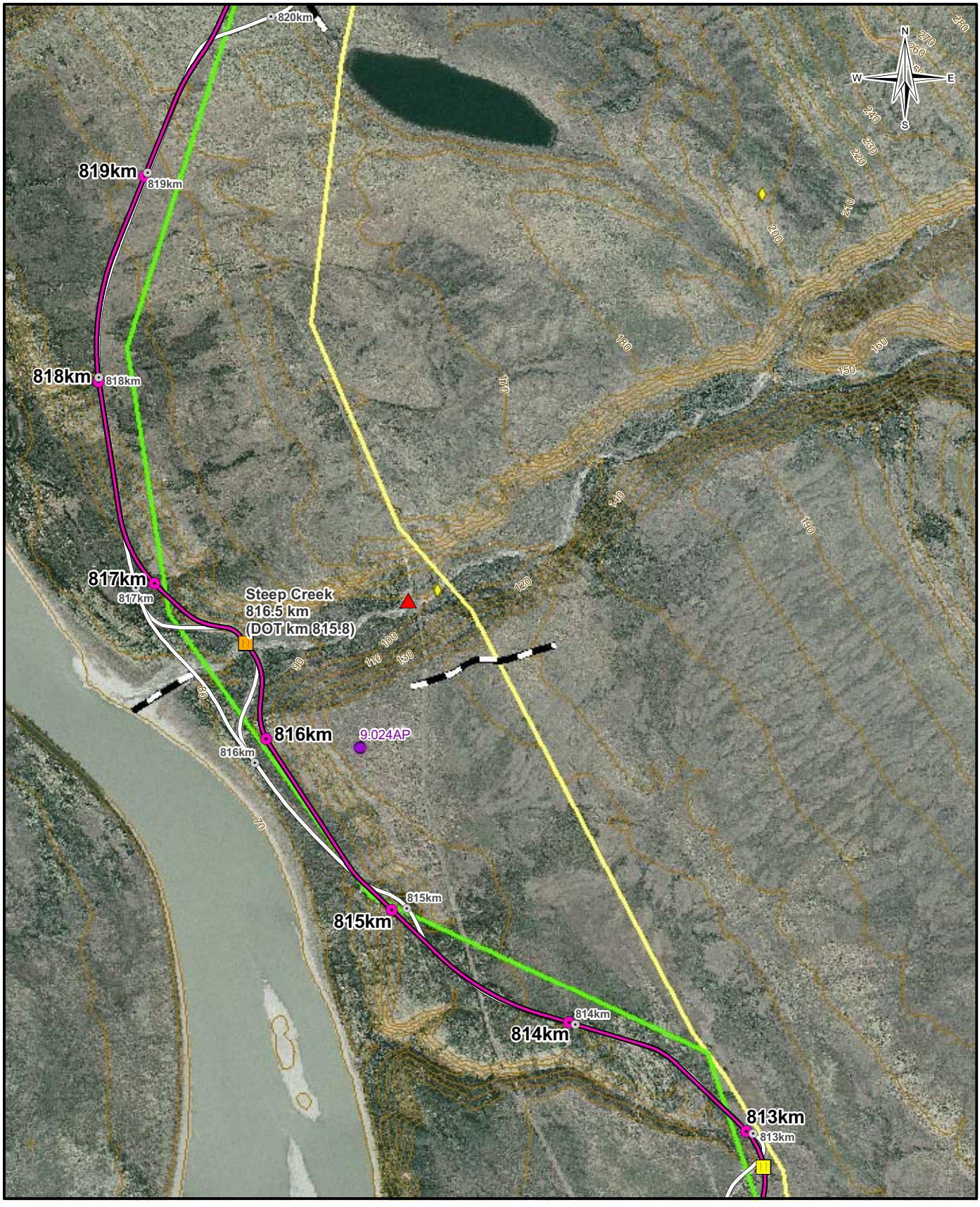
FILE NO. Y22101155_MapBook-NTS-Oct2011.mxd
PROJECT NO. Y22101155 DATE October 14, 2011

Map 50



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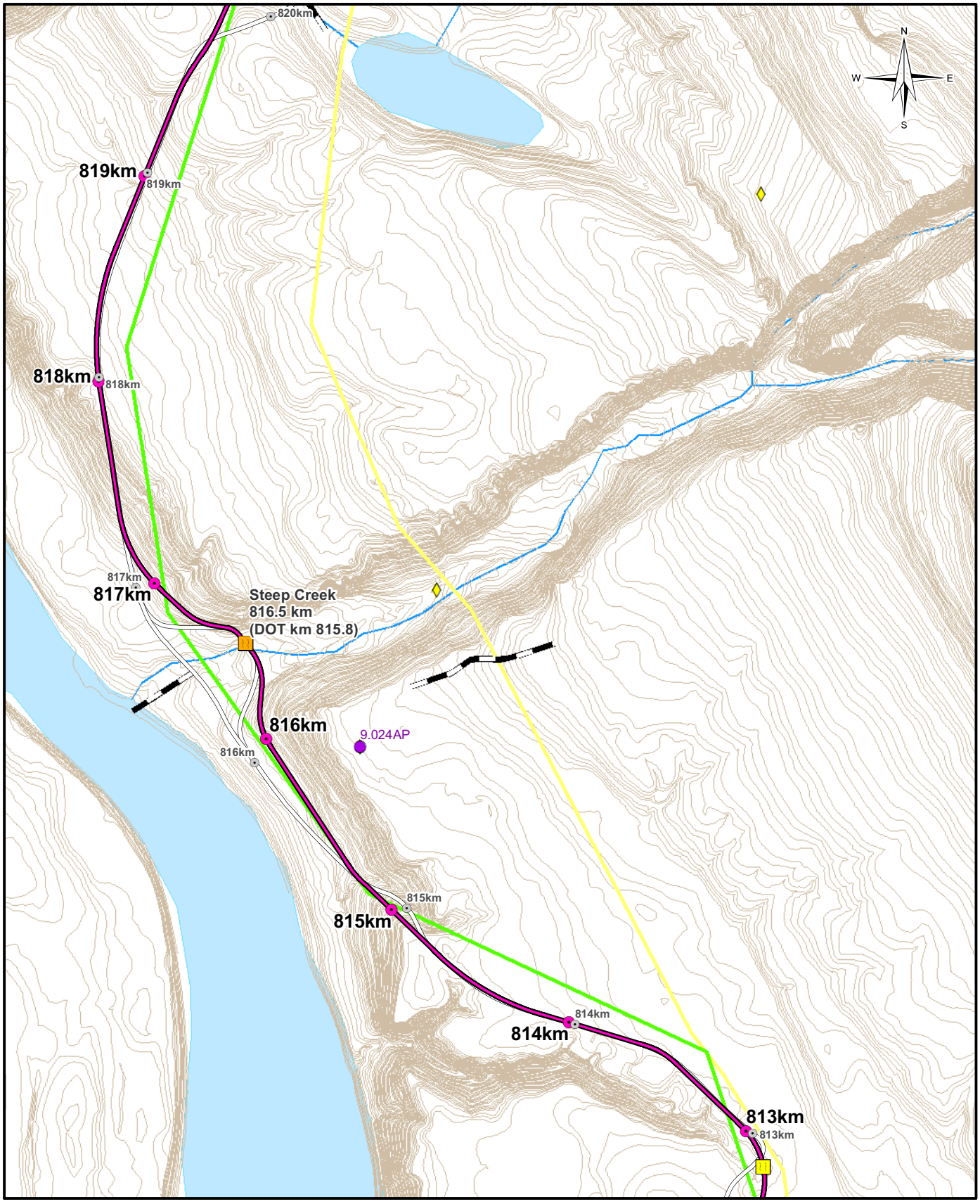
0 250 500
Metres

UTM Zone 8
NAD83

5658
NWT Ltd.

FILE NO. Y22101155_MapBook-Imagery-Oct2011.mxd
PROJECT NO. Y22101155 DATE October 14, 2011

Map 51



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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

1:25,000 Map Book

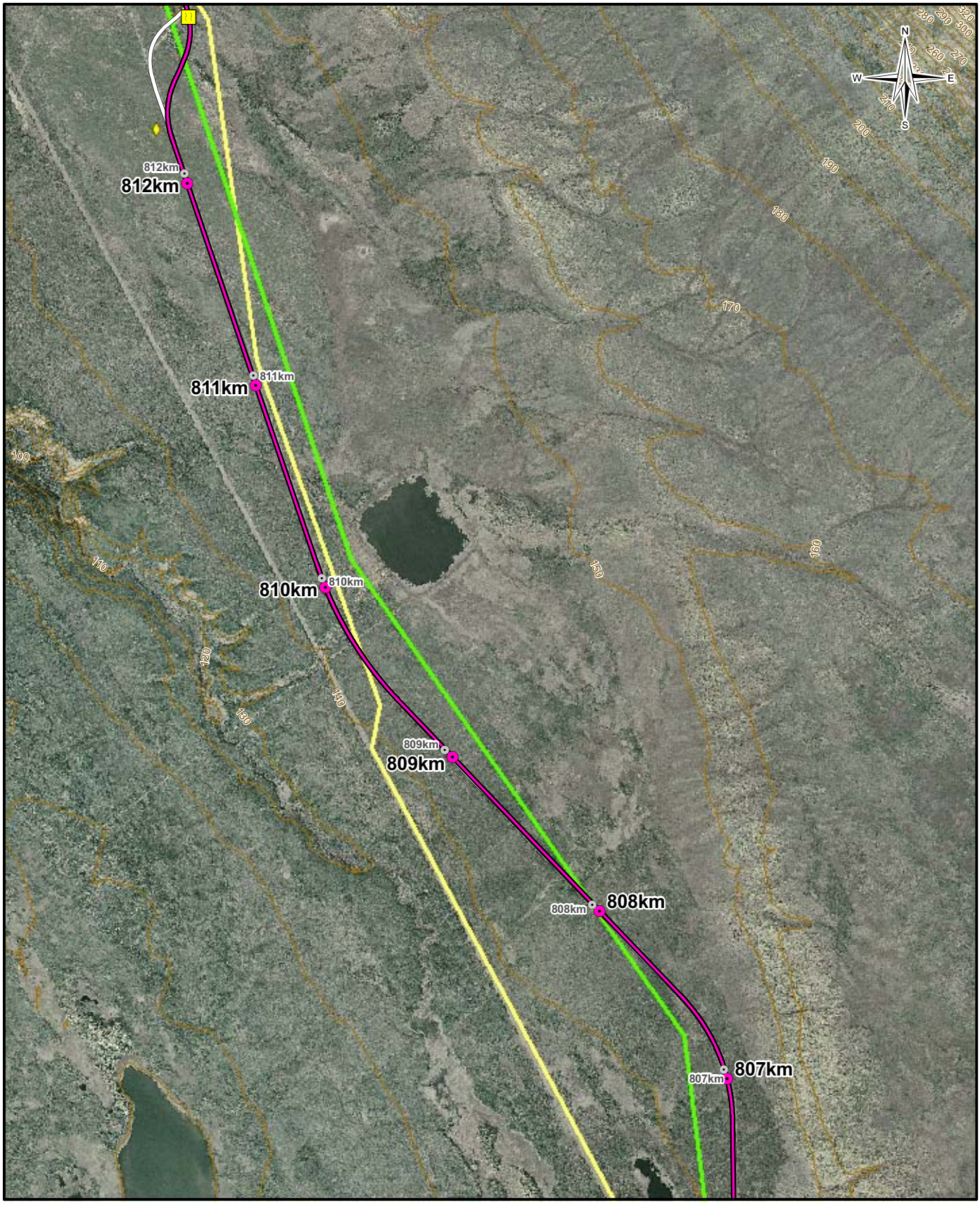
Scale: 1:25,000 (0, 250, 500 Metres)

UTM Zone 8
NAD83

5658 NWT Ltd.

FILE NO. Y22101155_MapBook-NTS-Oct2011.mxd
PROJECT NO. Y22101155 DATE October 14, 2011

Map 51



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1:25,000 Map Book

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0 250 500
Metres

UTM Zone 8
NAD83

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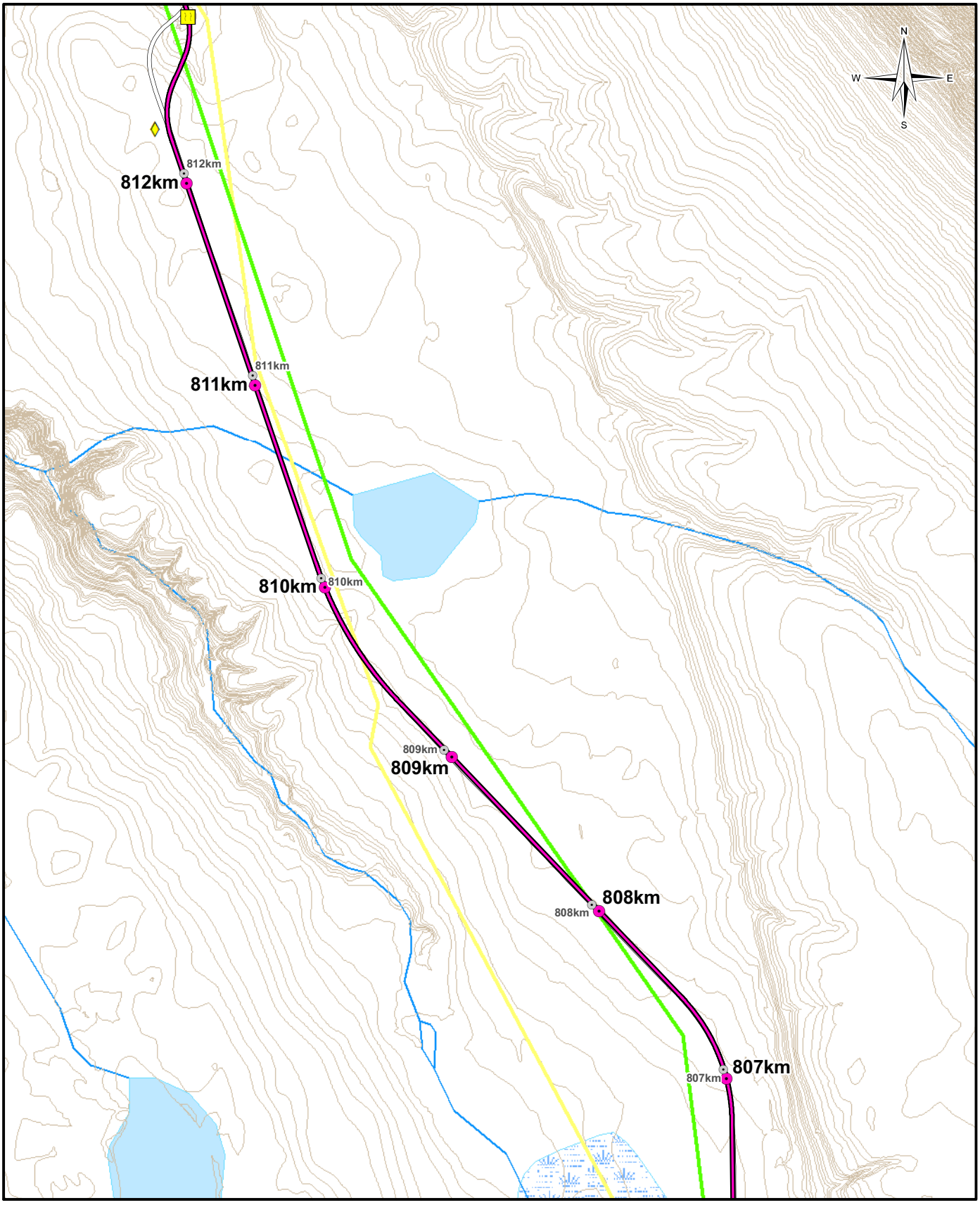
FILE NO. Y22101155_MapBook-Imagery-Oct2011.mxd
PROJECT NO. Y22101155 DATE October 14, 2011

Map 52



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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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UTM Zone 8
NAD83

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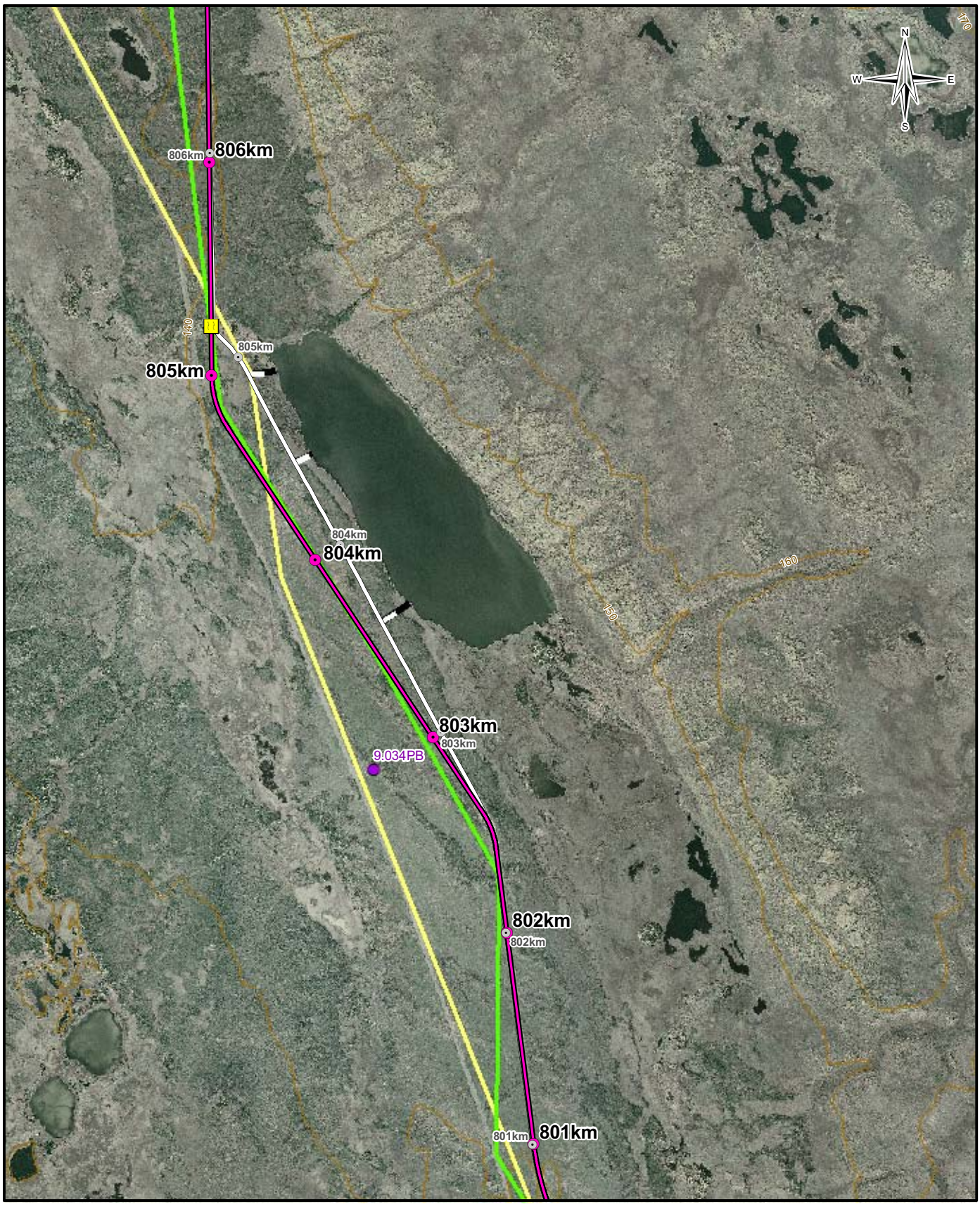
FILE NO. Y22101155_MapBook-NTS-Oct2011.mxd
PROJECT NO. Y22101155 DATE October 14, 2011

Map 52



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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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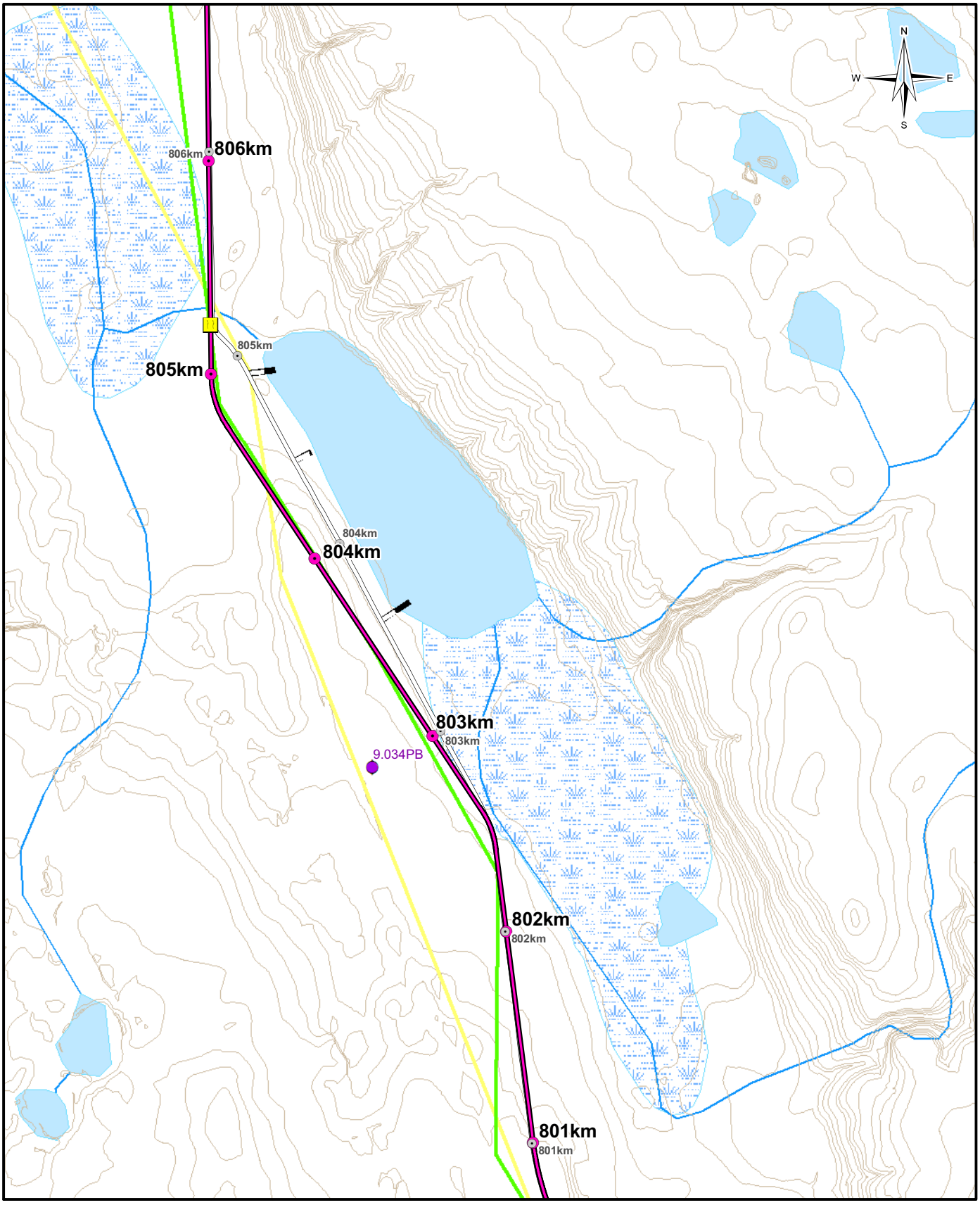
UTM Zone 8
NAD83

5658
NWT Ltd.

FILE NO. Y22101155_MapBook-Imagery-Oct2011.mxd
PROJECT NO. Y22101155 DATE October 14, 2011

Map 53



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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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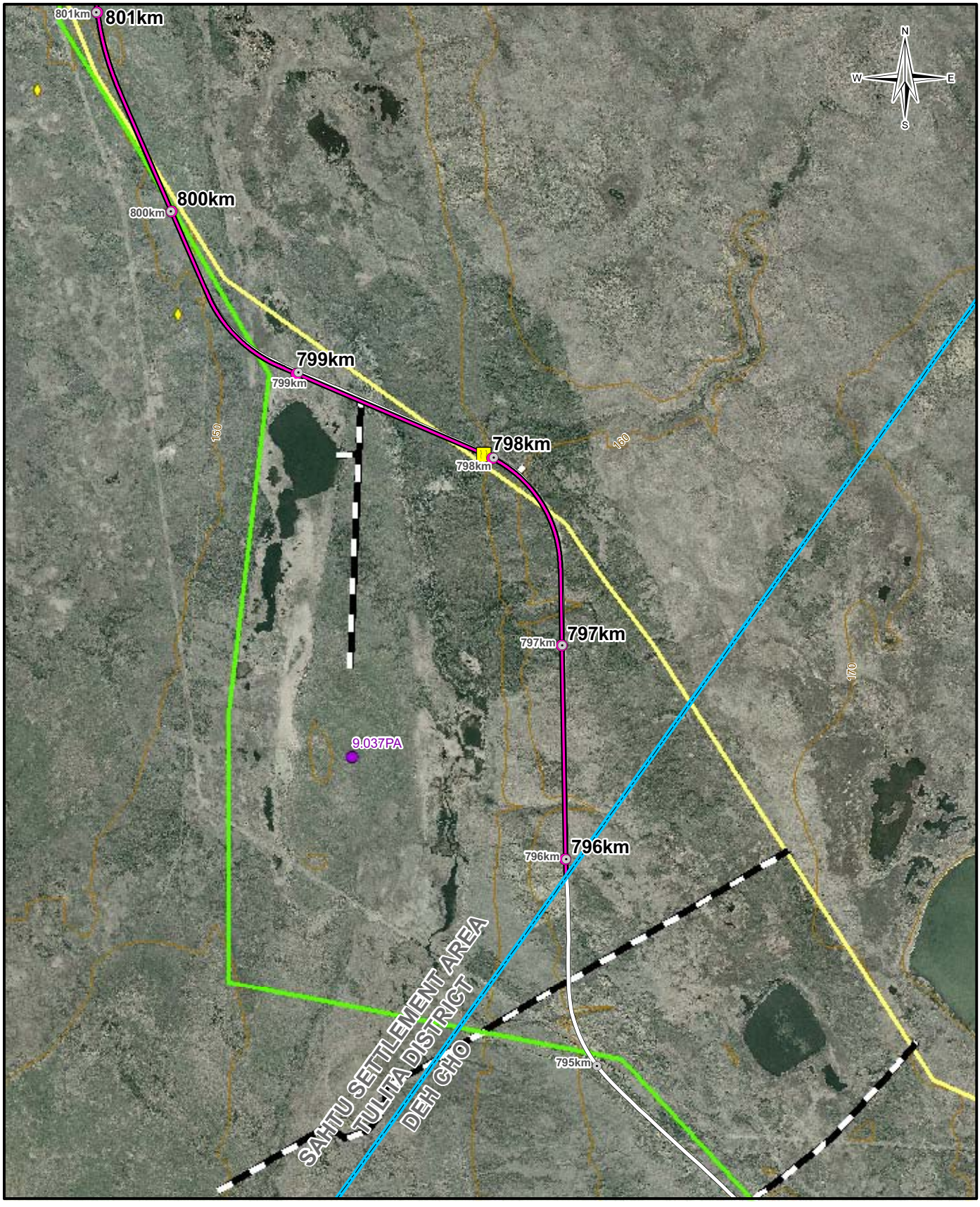
Map 53



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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

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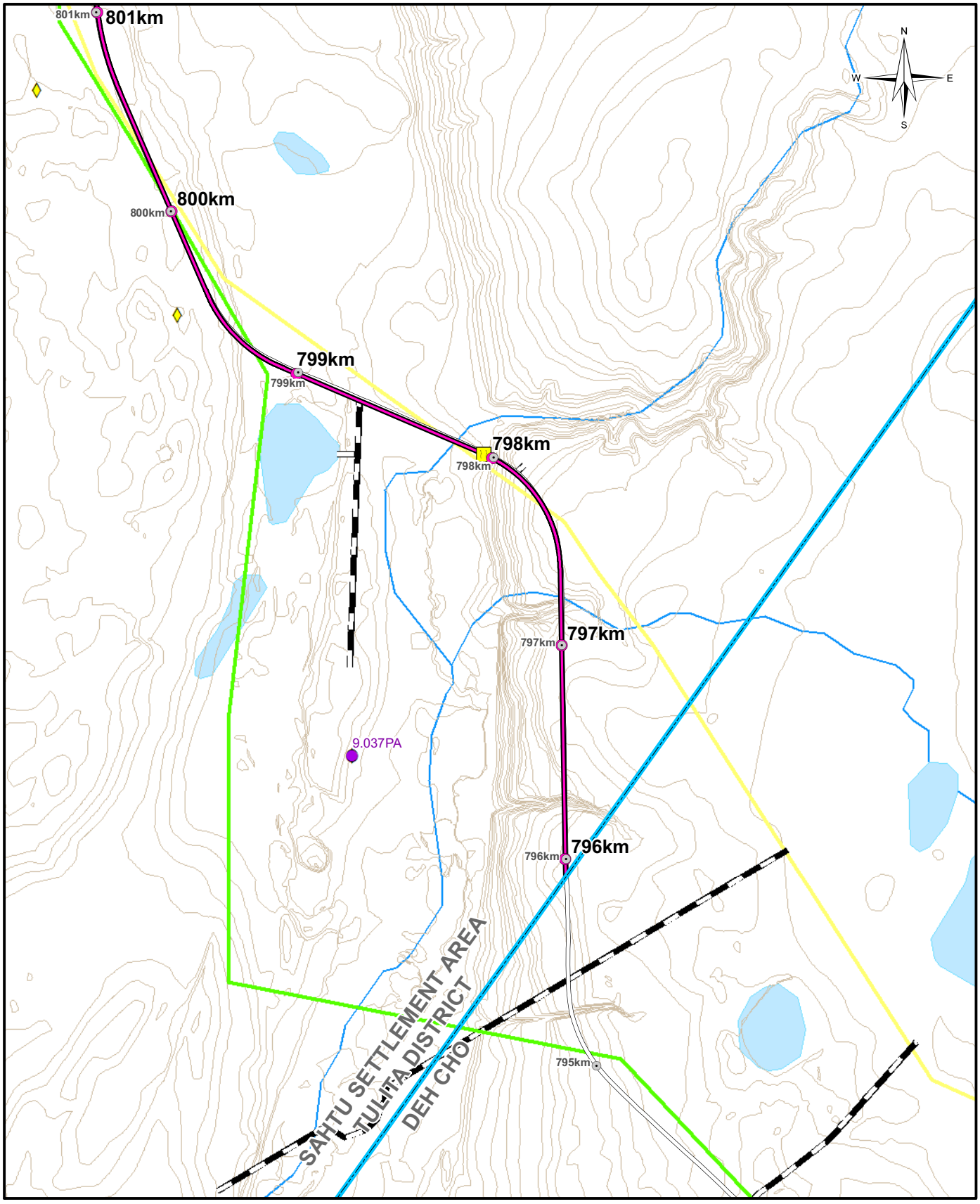
UTM Zone 8
NAD83

5658
NWT Ltd.

FILE NO. Y22101155_MapBook-Imagery-Oct2011.mxd
PROJECT NO. Y22101155 DATE October 14, 2011

Map 54



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MACKENZIE VALLEY HIGHWAY - TULITA DISTRICT

1:25,000 Map Book

Scale: 1:25,000 (0, 250, 500 Metres)

UTM Zone 8
NAD83

5658
NWT Ltd.

FILE NO. Y22101155_MapBook-NTS-Oct2011.mxd
PROJECT NO. Y22101155 DATE October 14, 2011

Map 54

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APPENDIX B

APPENDIX B BRIDGE CONCEPTS

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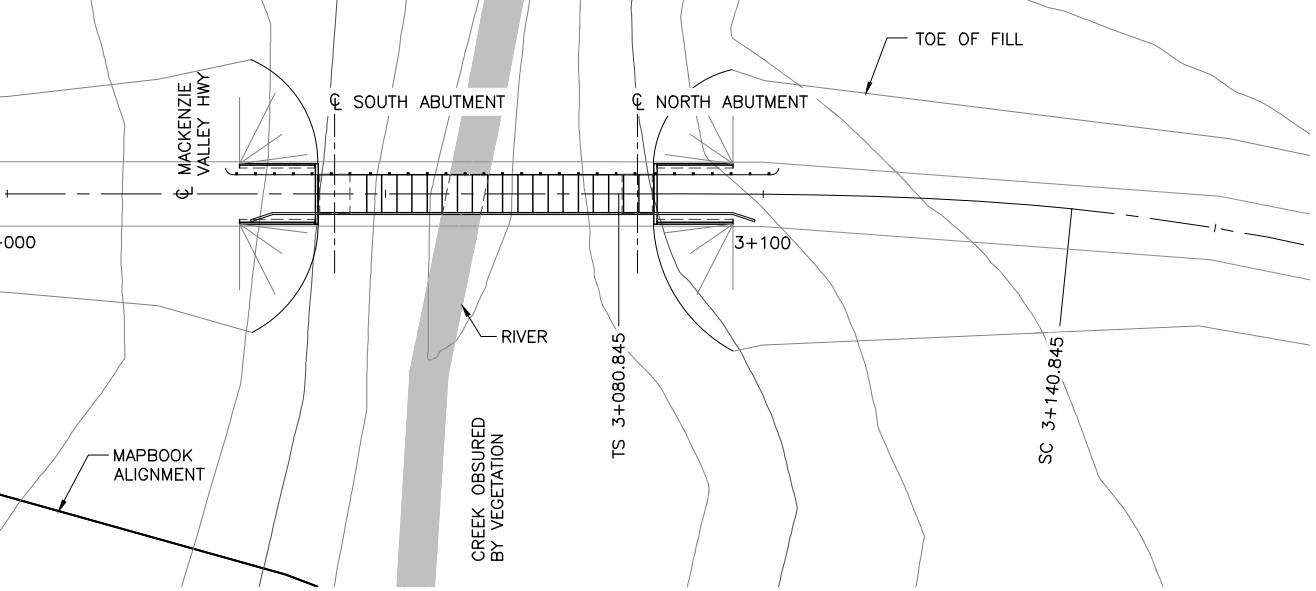
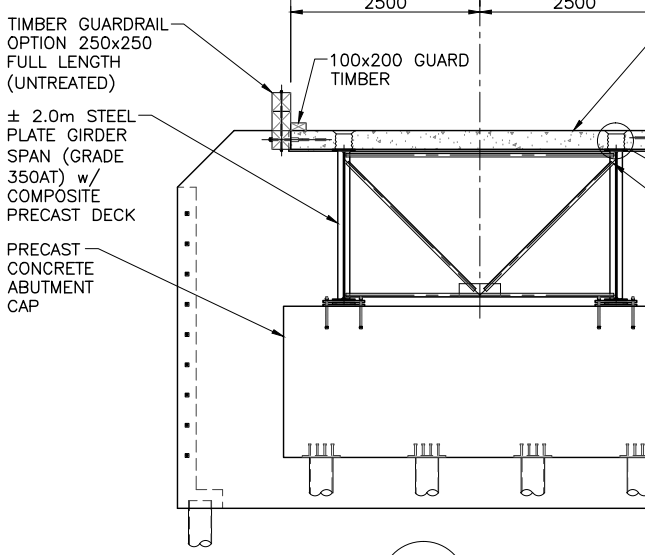


PLAN
SCALE: 1:500



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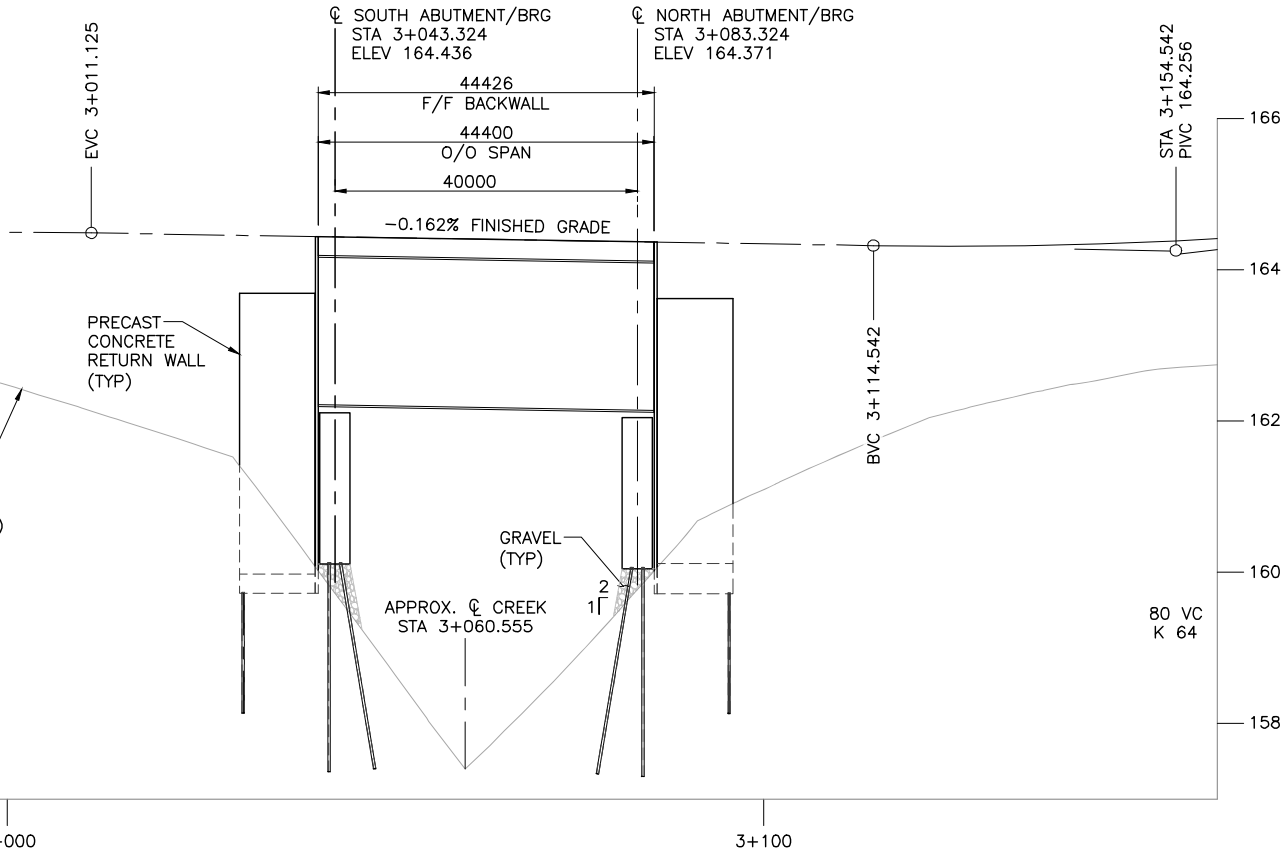
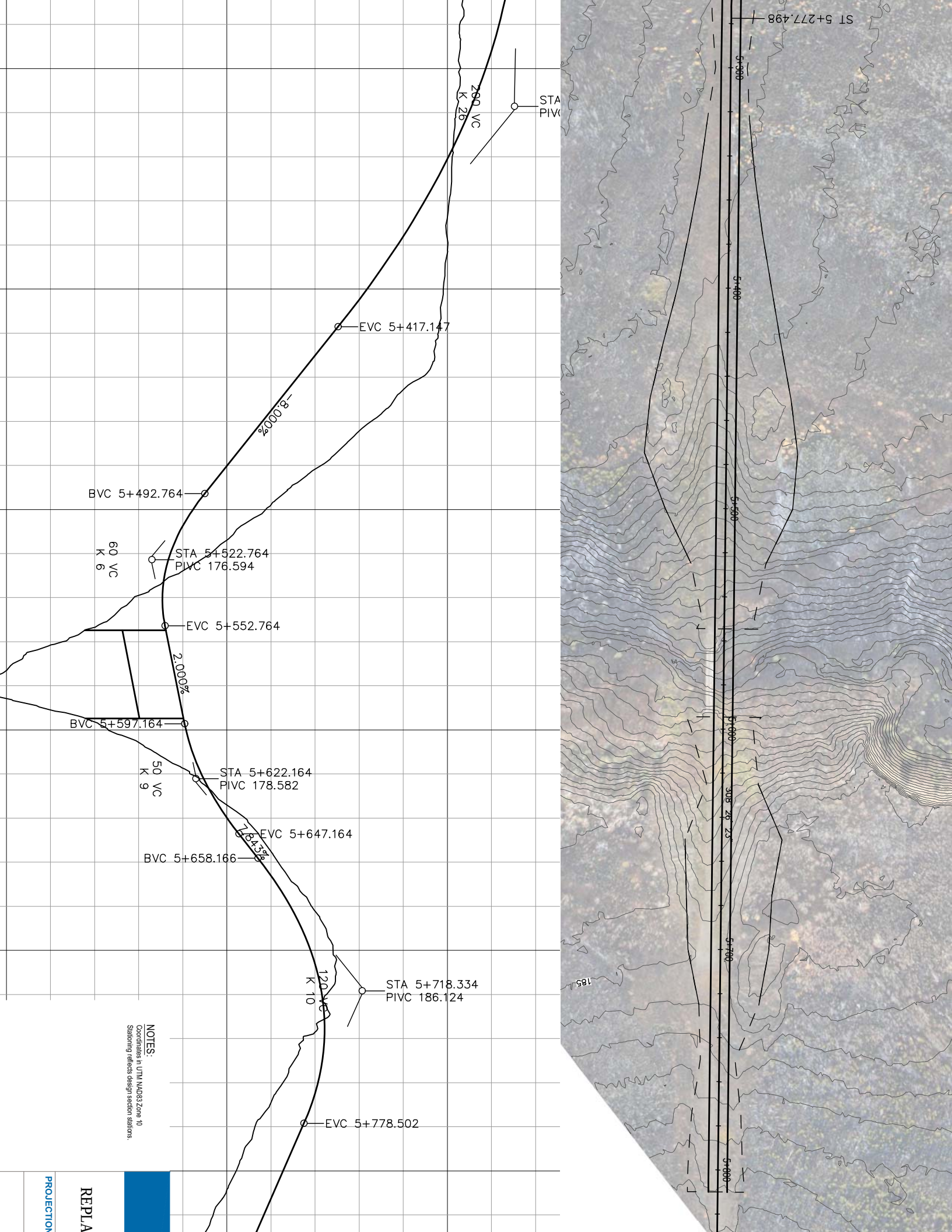


ELEVATION

PRELIM
– 40m SIN
– 4.4m FIL
– 4.35m FI
– 10m LON
– BRIDGE S
– ONE LANE

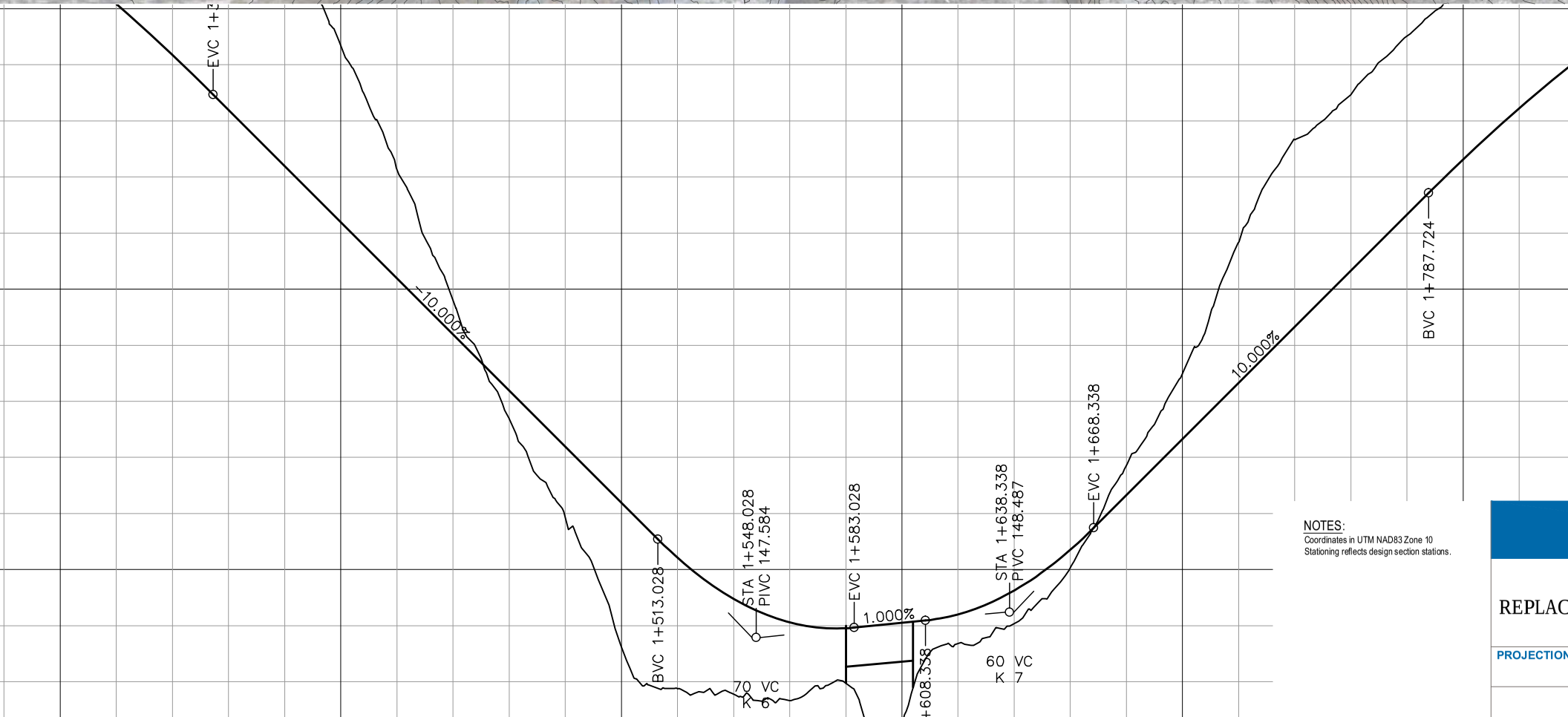
PROJECTION



NOTES:
Coordinates in UTM NAD83 Zone 10
Stationing reflects design section stations.

REPLA

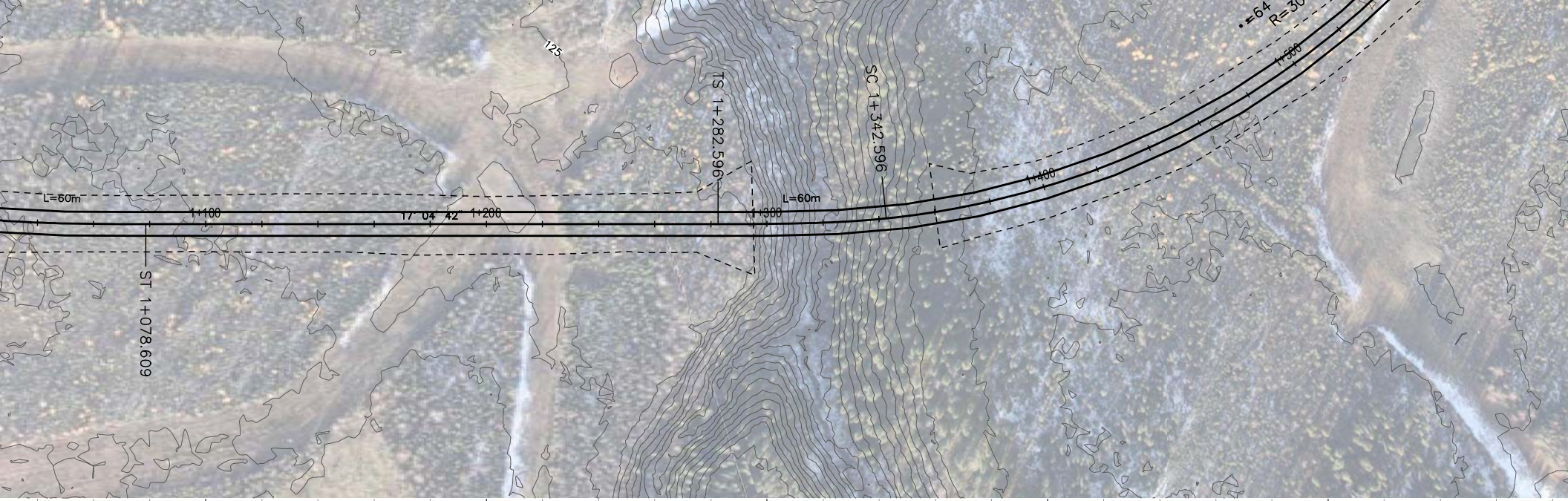
PROJECTION

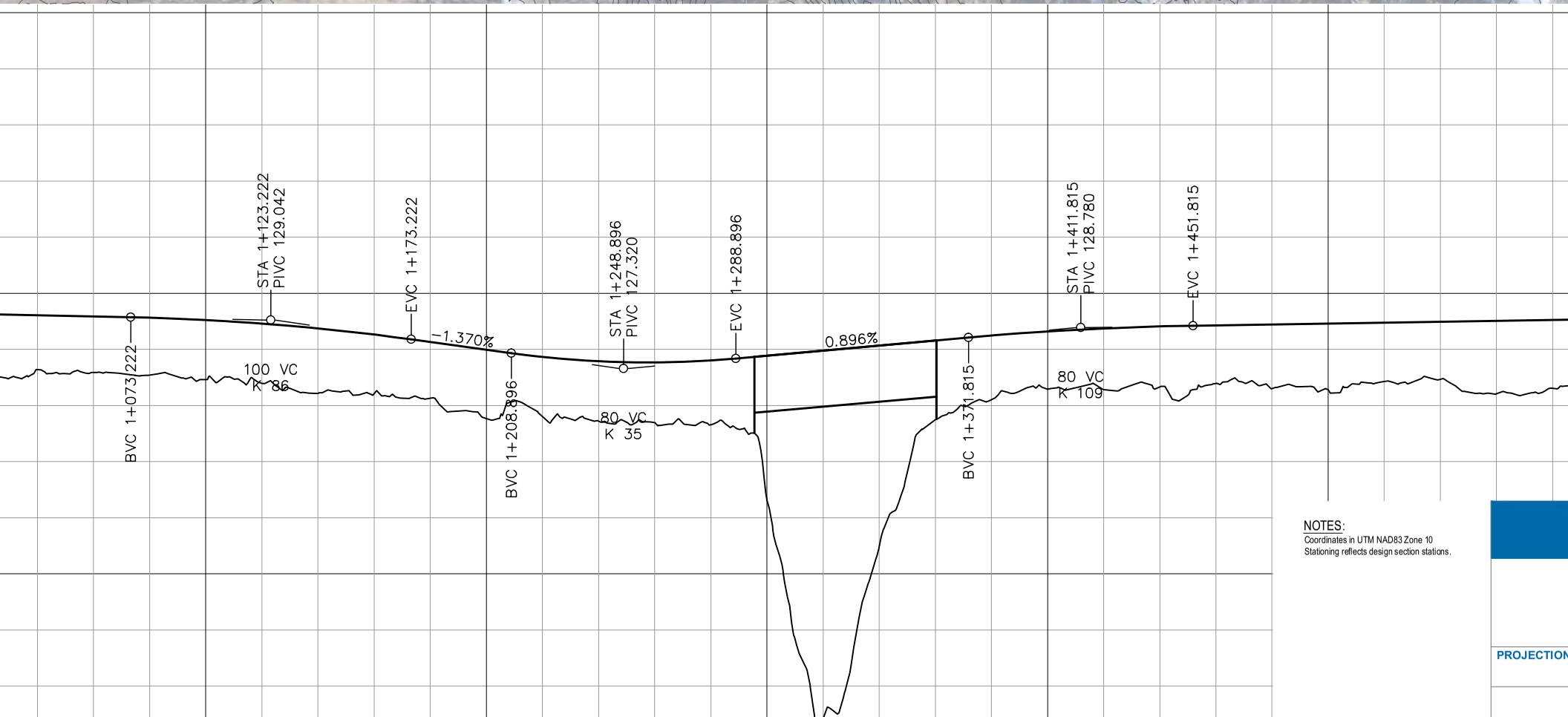


NOTES:
Coordinates in UTM NAD83 Zone 10
Stationing reflects design section stations.

REPLAC

PROJECTION





NOTES:
Coordinates in UTM NAD83 Zone 10
Stationing reflects design section stations.

PROJECTION

BVC 2+817.766

1.980%

EVC 2+752.723

STA 2+712.723
PIVC 114.304

80 VC
K 6.7

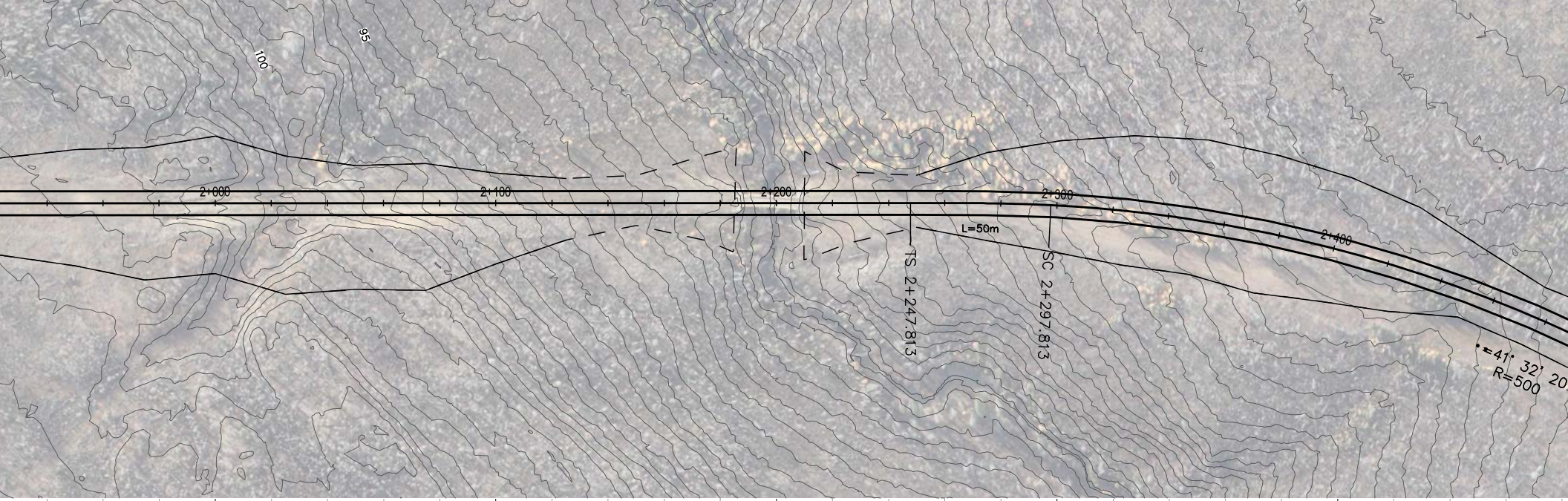
BVC 2+672.723

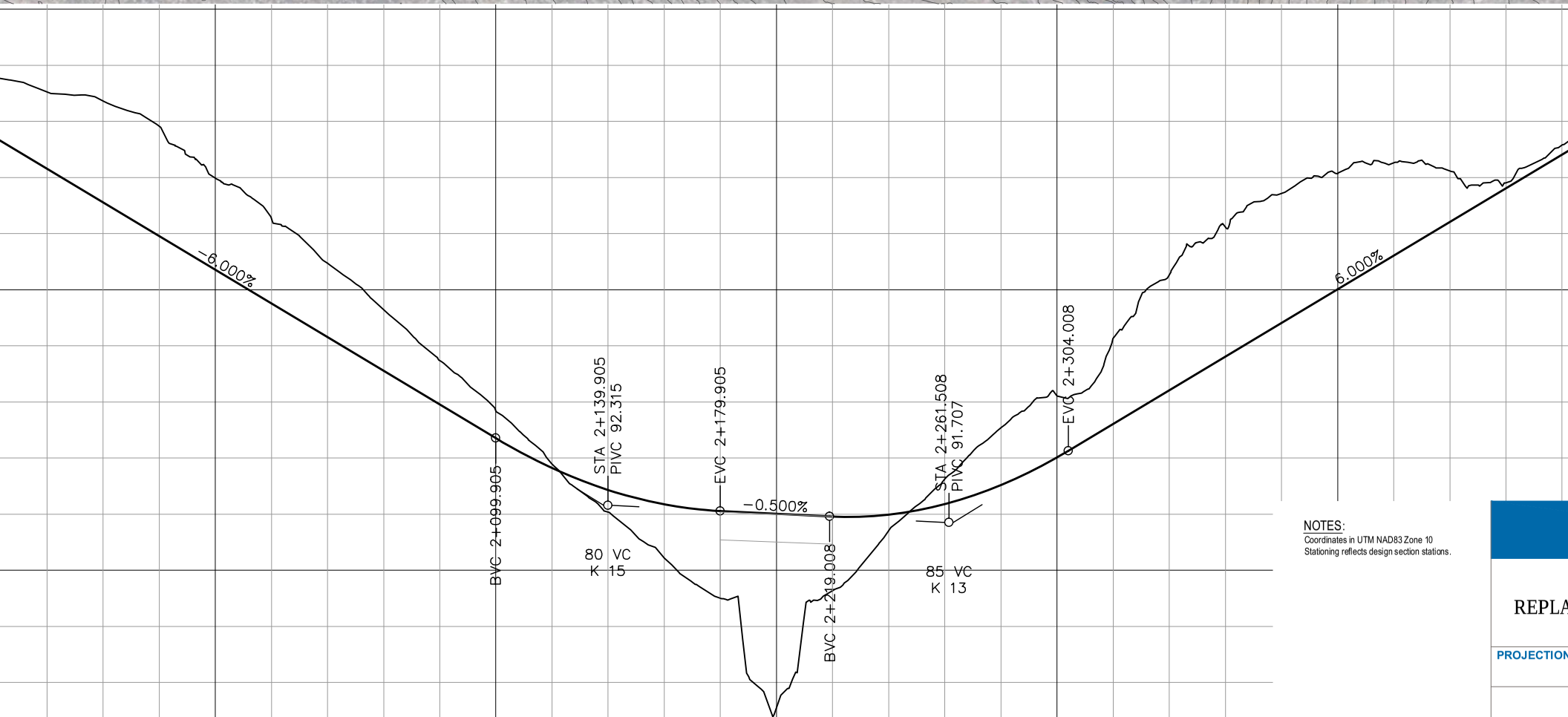
0.709%

EVC 2+346.013

NOTES:
Coordinates in UTM NAD83 Zone 10
Stationing reflects design section stations.

PROJECTION





NOTES:
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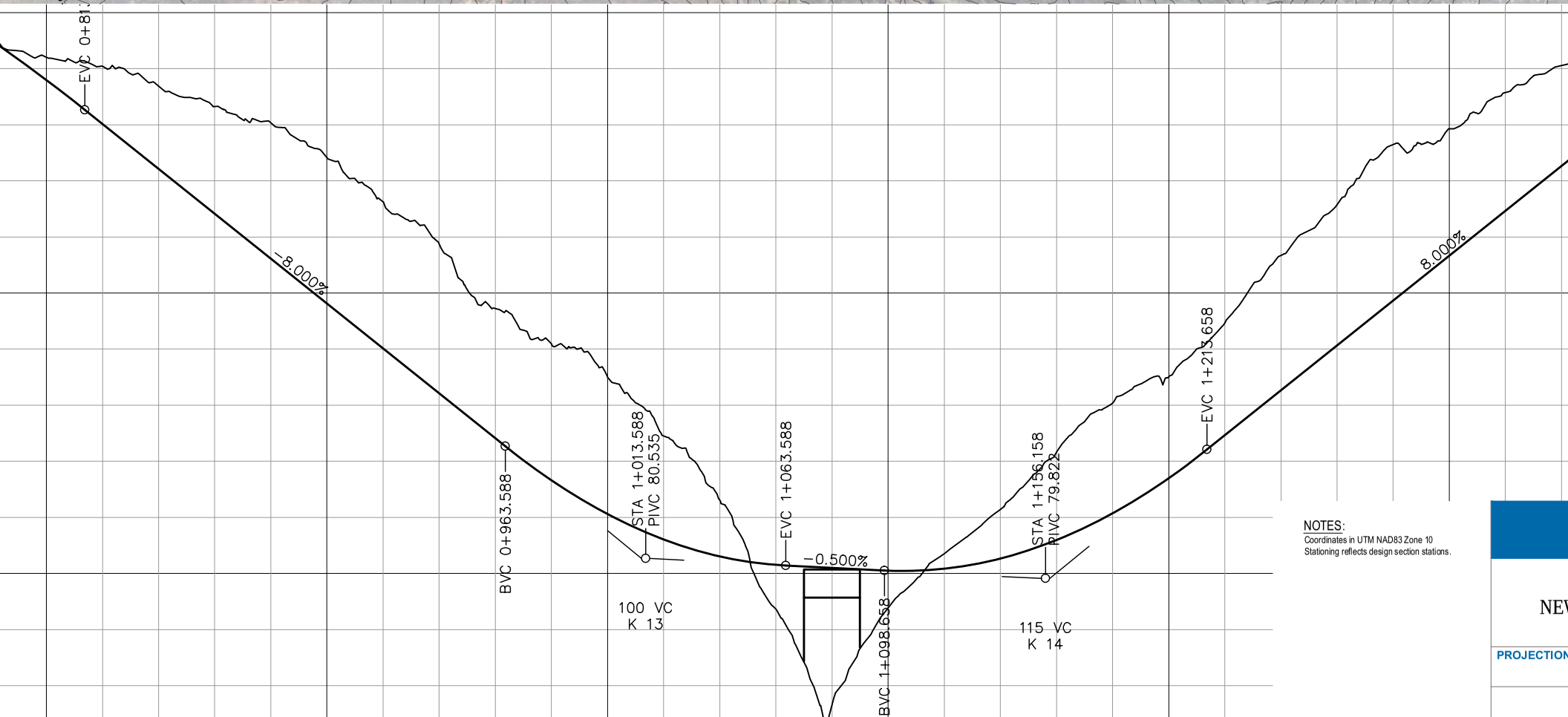
REPLA

PROJECTION



NOTES:
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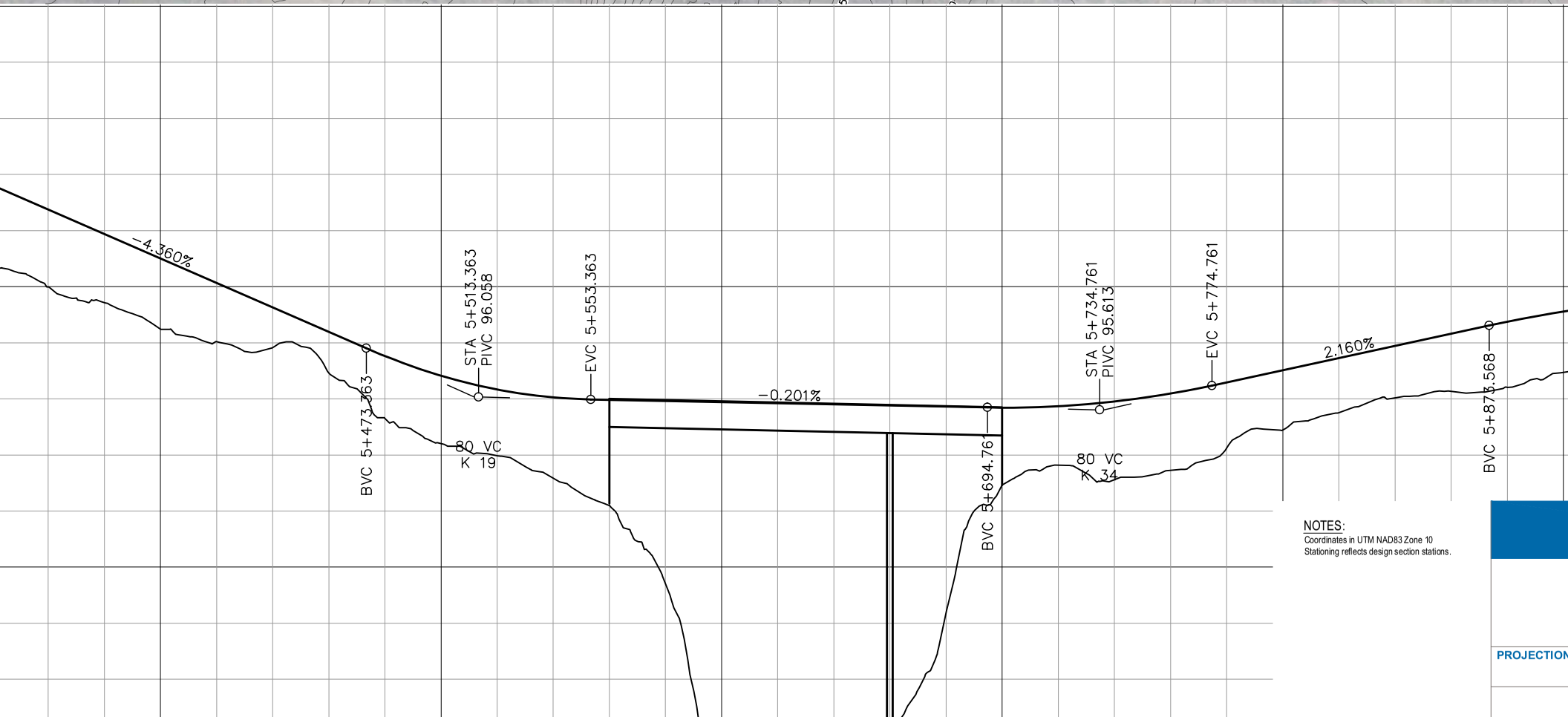
Stationing reflects design section stations.

NEW

PROJECTION



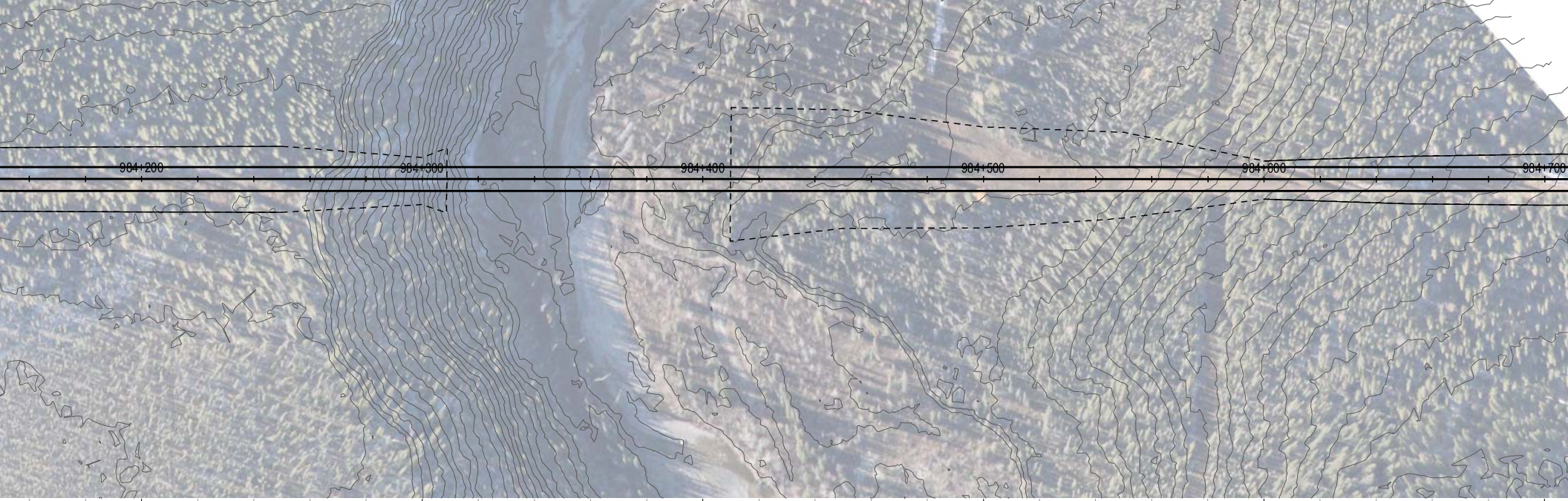
NOTES:
Coordinates in UTM NAD83 Zone 10
Stationing reflects design section stations.

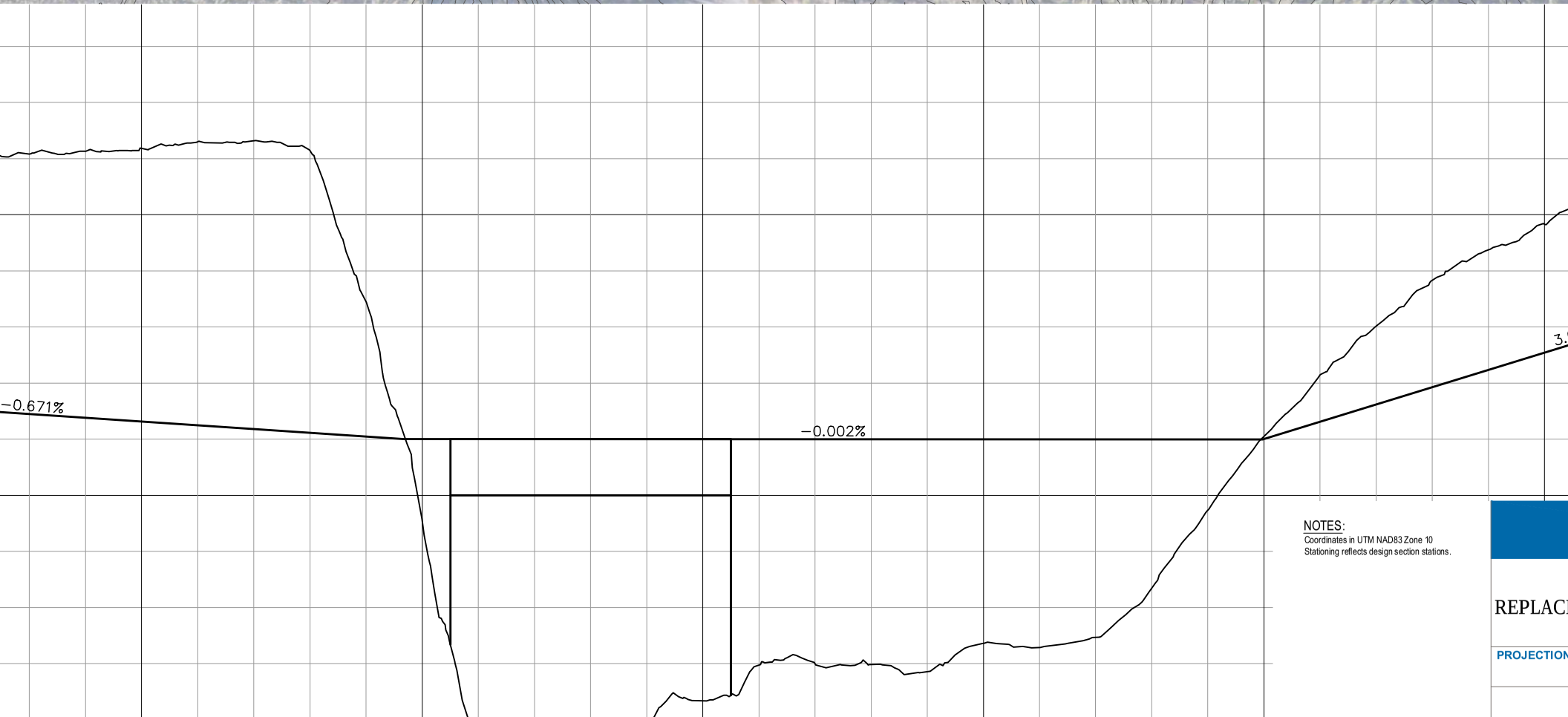
PROJECTION

M

Gre

PROJECTION

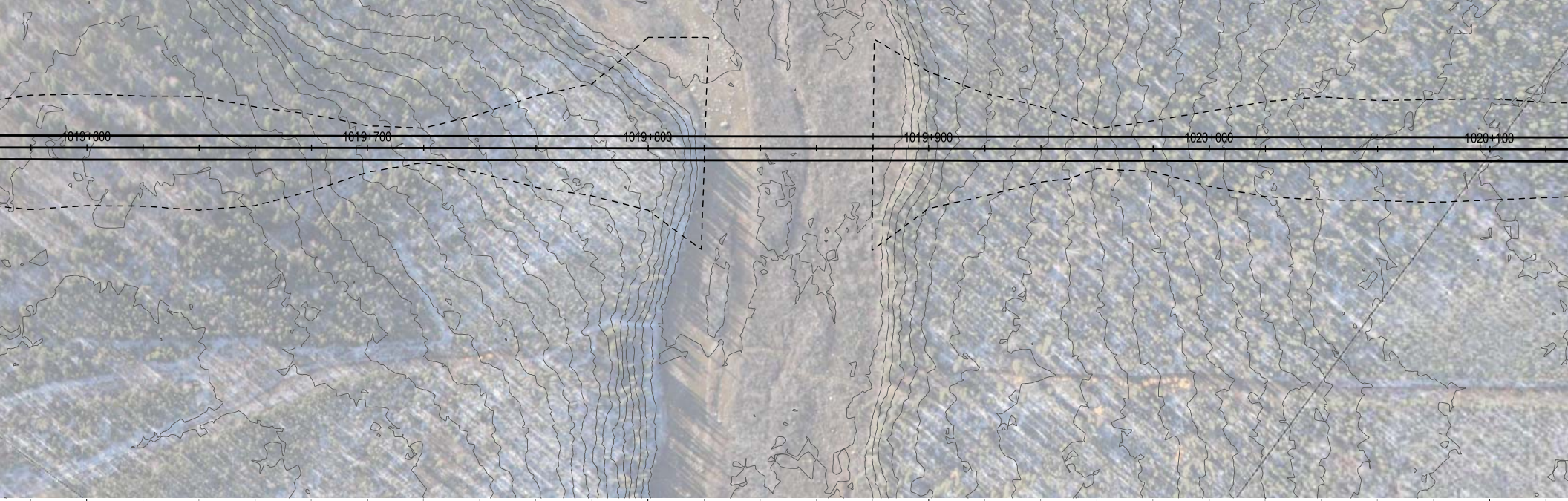




NOTES:
Coordinates in UTM NAD83 Zone 10
Stationing reflects design section stations.

REPLAC

PROJECTION



BVC 1019+651.188

80 VC
K 87

STA 1019+691.188
PIVC 94.864

EVC 1019+731.188

0.516%

BVC 1019+949.034

STA 1019+989.034
PIVC 96.402

80 VC
K 30

EVC 1020+029.034

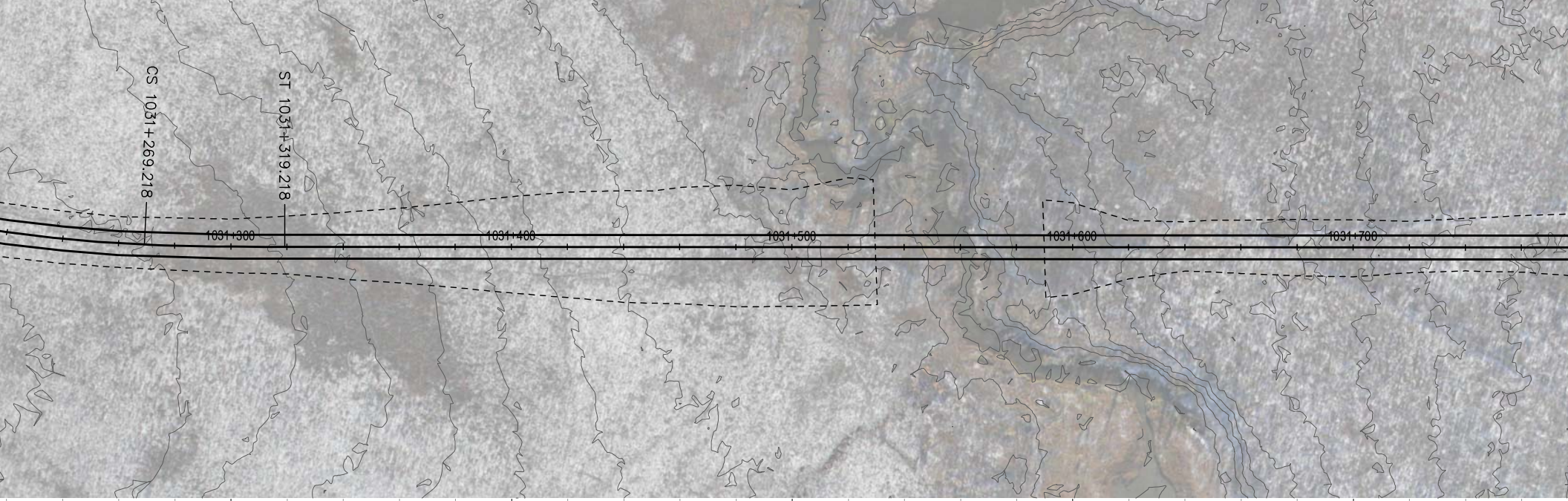
3.216%

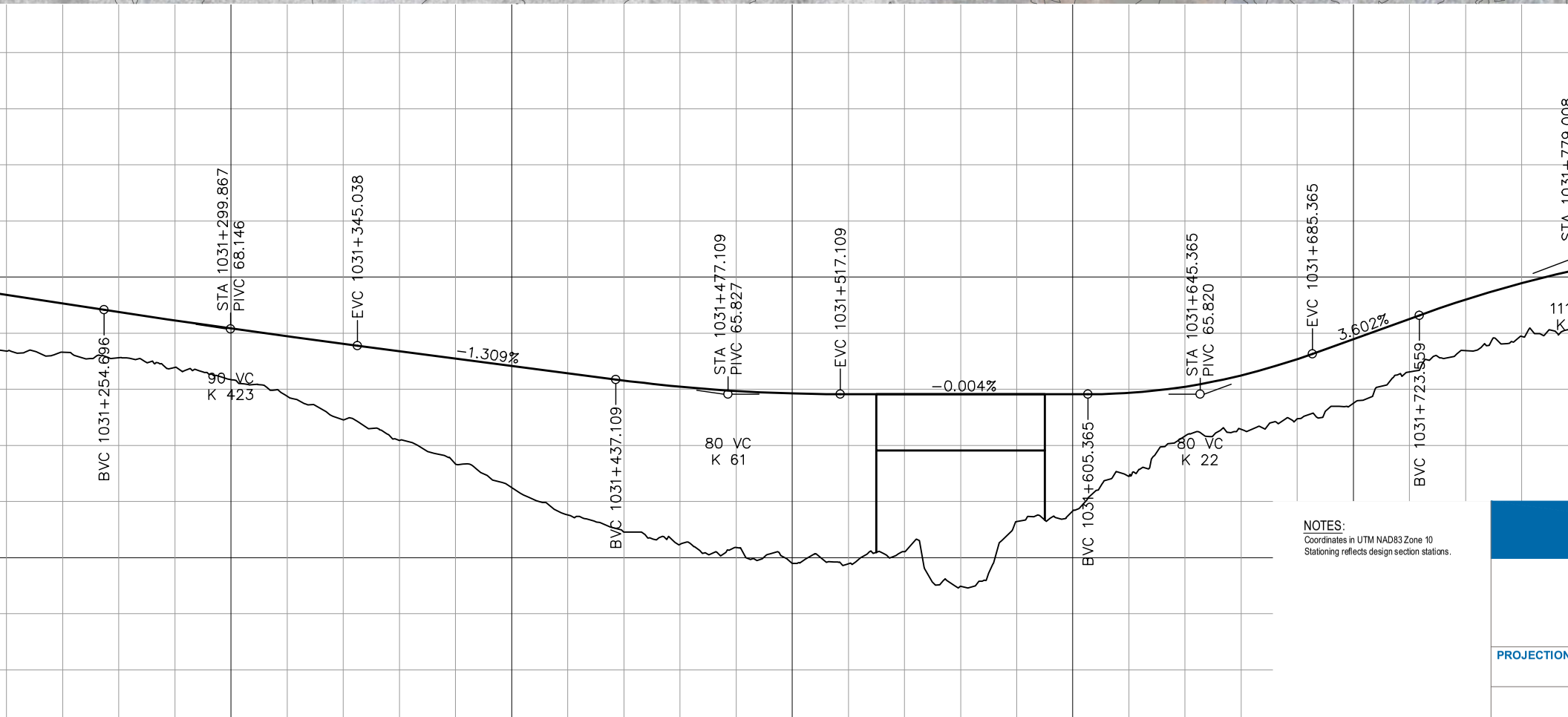
BVC 1020+086.125

NOTES:
Coordinates in UTM NAD83 Zone 10
Stationing reflects design section stations.

NEW E

PROJECTION





NOTES:
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PROJECTION

APPENDIX C

APPENDIX C CONSULTATION DOCUMENTS

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Announcing Upcoming Mackenzie Valley Highway
Tulita District Consultations

Project Progress Overview

– March 2011–

The Norman Wells Land Corporation, Tulita Land Corporation, Fort Norman Metis Land Corporation, Tulita Dene Band (collectively 5658 NWT Ltd.) and the Government of Northwest Territories Department of Transportation (DOT) have prepared this project 'backgrounder' for residents, organizations, and government agencies to announce the upcoming consultations on the Mackenzie Valley Highway within the Tulita District.

5658 NWT Ltd. and DOT have been working on your behalf to plan the construction of the proposed Mackenzie Valley Highway. The Highway will serve as the backbone for a single Transportation Corridor for transportation, utility, and communication infrastructure will reduce the overall environmental impact to the land while protecting wildlife habitat, traditional land use, and cultural values.

The consultant team, led by EBA a Tetra Tech Company has been conducting Project Description Report (PDR) consultations and gathering information since May 2010. Consultations sessions previously held in the communities (July 2010), included presentations on the highway construction process and discussions about its location and design.

Further consultation meetings are scheduled to discuss the proposed Mackenzie Valley Highway Project. Meeting schedules and locations are shown below. Notices will be posted in each community with the venue and time.

Norman Wells **Monday, March 28**	**Tulita** **Tuesday, March 29**

You are encouraged to come to the meetings to discuss the project with GTC representatives and the project team. The meetings will provide an opportunity to:

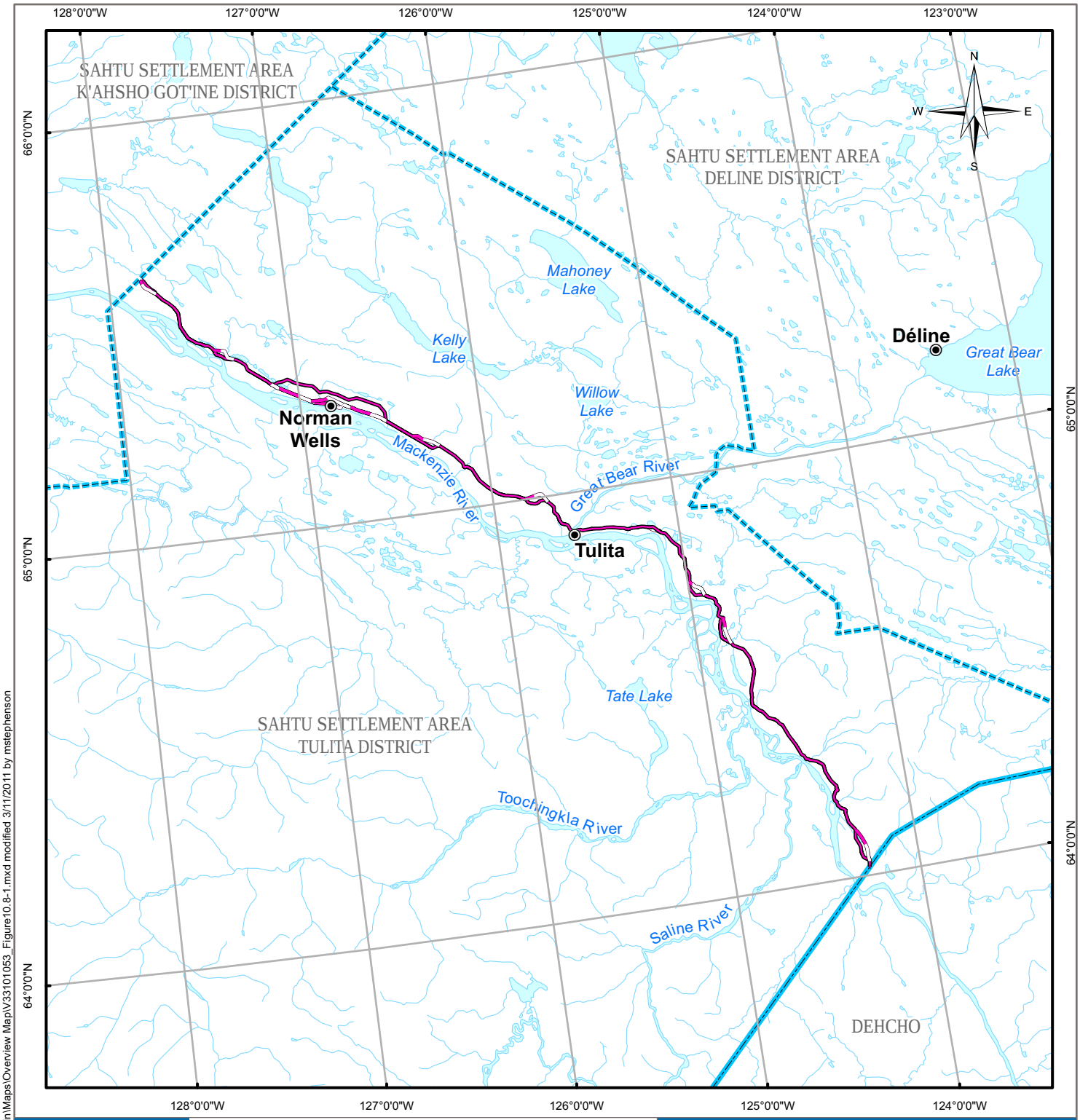
- **An overview presentation about the Mackenzie Valley Highway Project.**
- **A summary of comments heard at the first round of meetings.**
- **A timeline of project activities and further project details.**

More importantly, the project team needs the information you provide to help identify appropriate approaches for Highway stream crossings, potential material sources, potential sensitive areas, and other parts of the Highway that might require particular care and further investigation. There will be opportunities to voice your opinions and ask questions, and technical team members present to respond to your questions.

Do you have questions about the project or the upcoming consultations?
For more information about the project or to submit written questions or comments, please contact:

Robyn McGregor
EBA a Tetra Tech Company.
Phone: (403) 723-3269
Fax: (403) 203-3301
email: rmcgregor@eba.ca

Mariel Higuerey
EBA a Tetra Tech Company.
Phone: (403) 203-3305 ext 825
Fax: (403) 203-3301
email: mhiguerey@eba.ca



LEGEND

- Communities
- MVH Concept - EBA September 2010
- MVH Concept - EBA September 2010, Alternative
- Settlement Area Boundary
- Waterbody
- River

NOTES

Base data source: NTS 1:250,000
Alignment is considered preliminary and is subject to change

STATUS
ISSUED FOR REVIEW

MACKENZIE VALLEY HIGHWAY
TULITA SETTLEMENT AREA

Overview of Proposed Highway

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:1,450,000
20 10 0 20
Kilometres

FILE NO.
V33101053_Figure1.mxd

PROJECT NO.	DWN	CKD	APVD	REV
V33101053	BA	MS	RM	0

OFFICE	DATE
EBA-RIV	March 11, 2011

A TETRA TECH COMPANY

Figure 1

M:\TRANSPORTATION\NWT_Mackenzie_Highway\V33101053_Gwich'in\Maps\Overview Map\V33101053_Figure10.8-1.mxd modified 3/11/2011 by mstephenson

5658
NWT Ltd.

Announcing Upcoming Mackenzie Valley Highway Tulita District Consultations

Project Progress Overview

– October 2011–

The Norman Wells Land Corporation, Tulita Land Corporation, Fort Norman Metis Land Corporation, Tulita Dene Band (collectively 5658 NWT Ltd.) and the Government of Northwest Territories Department of Transportation (DOT) invite residents, organizations, and government agencies to the upcoming consultations on the Mackenzie Valley Highway within the Tulita District.

5658 NWT Ltd. and DOT have been working on your behalf to plan the construction of the proposed Mackenzie Valley Highway. The Highway will serve as the backbone for a single Transportation Corridor for transportation, utility, and communication infrastructure will reduce the overall environmental impact to the land while protecting wildlife habitat, traditional land use, and cultural values.

EBA, A Tetra Tech Company has prepared the preliminary design and Project Description Report (PDR) using information gathered through consultations and from other sources. This work started in the early part of 2010.

Consultations sessions previously held in the communities (July 2010 and March 2011), included presentations on the highway construction process and discussions about its location and design. The March sessions also included a discussion of how community input was being used in the project description.

Today the preliminary design and the Project Description Report are almost complete, have been reviewed by 5658 NWT Ltd. and are almost ready for submission to the Mackenzie Valley Environmental Impact Review Board.

Further consultation meetings are scheduled to discuss the proposed Mackenzie Valley Highway Project. Meeting schedules and locations are shown below. Notices will be posted in each community with the venue and time.

Norman Wells **Tuesday, October 4**	**Tulita** **Wednesday, October 5**

You are encouraged to come to the meetings to discuss the project with the project team. The meetings will provide an opportunity to:

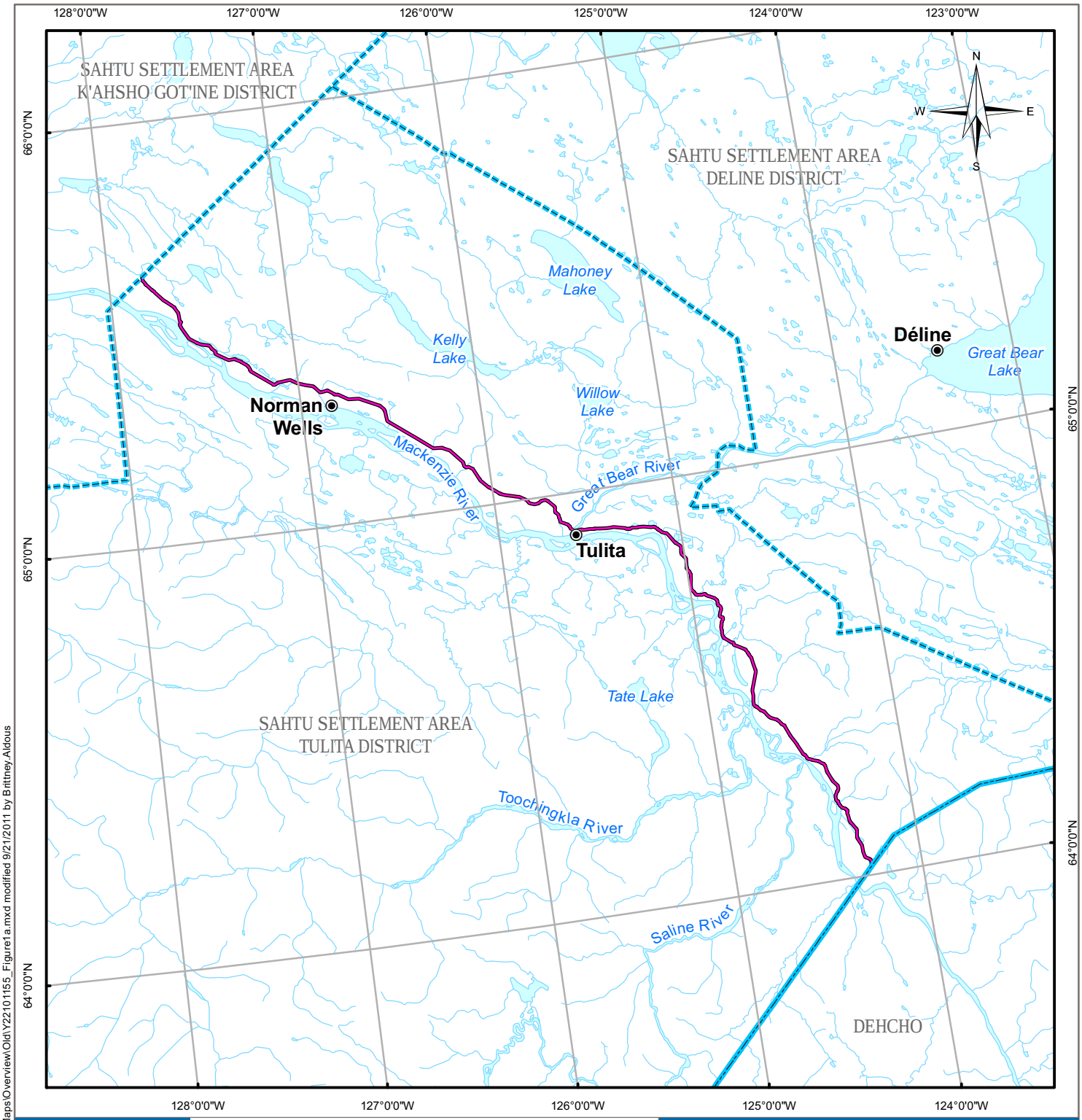
- View a presentation about the proposed Mackenzie Valley Highway Project
- See how the input and guidance received in the first and second rounds of consultation was incorporated in the Project Description Report.
- Listen to the explanation of the plan for next steps to move the project to regulatory review.
- Provide any remaining suggestions, and to ask any remaining questions. Technical team members will be available to respond to your inquiries.

Do you have questions about the project or the upcoming consultations?
For more information about the project or to submit written questions or comments, please contact:

Robyn McGregor
EBA, A Tetra Tech Company.
Phone: (403) 723-3269
Fax: (403) 203-3301
email: rmcgregor@eba.ca

Sunny Munroe
EBA, A Tetra Tech Company.
Phone: (867) 446-6057
Fax: (403) 203-3301
email: smunroe@eba.ca

Mariel Higuerey
EBA, A Tetra Tech Company.
Phone: (403) 203-3305 ext 825
Fax: (403) 203-3301
email: mhiguerey@eba.ca



LEGEND

- Communities
- MVH Concept - EBA June 2011
- Settlement Area Boundary
- Waterbody
- River

NOTES

Base data source: NTS 1:250,000
Alignment is considered preliminary and is subject to change

STATUS
ISSUED FOR USE

MACKENZIE VALLEY HIGHWAY
TULITA SETTLEMENT AREA

Overview of Proposed Highway

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:1,450,000
20 10 0 20
Kilometres

FILE NO. Y22101155_Figure1a.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y22101155	BA	MS	RM	0

OFFICE EBA-RIV
DATE September 21, 2011

A TETRA TECH COMPANY

Figure 1

M:\TRANSPORTATION\NWT_Mackenzie_Highway\Y22101155_TulitaMaps\Overview\Old\Y22101155_Figure1a.mxd modified 9/21/2011 by Brittney.Aldous

MACKENZIE VALLEY HIGHWAY
JULY 2010 COMMUNITY MEETINGS

The Norman Wells Land Corporation, Tulita Land Corporation, Fort Norman Metis Land Corporation, Tulita Dene Band (collectively 5658 NWT Ltd.) and the Government of Northwest Territories Department of Transportation invite residents, organizations, and agencies to participate in a community meeting to discuss the proposed Mackenzie Valley Highway.

The meeting will include:

- **A presentation about the Mackenzie Valley Highway Project, 2010**
- **Discussion of all-weather highway routing options**
- **Timeline of project activities, including the summer/fall 2010 field study**

Project representatives will be available to respond to questions and receive comments before, during, and after the presentation. There will be opportunities to talk in smaller groups and one-on-one.

Meeting Locations and Times:

Wednesday, July 28, 2010	**Norman Wells** – Canol Legion Hall
Thursday, July 29, 2010	**Tulita** – Tulita Arena Hall

Times: **5:30 p.m. Community Supper – Everyone is Welcome!**
6:30 p.m. Project Presentation and Discussion

Our project consultant, EBA Engineering Consultants Ltd., can provide you with more information. Please contact Sandra Lukas-Amulung at (403) 369-6048 (slukasamulung@eba.ca) or Robyn McGregor at (403) 723-3269 (rmcgregor@eba.ca).

MACKENZIE VALLEY HIGHWAY
MARCH 2011 COMMUNITY MEETINGS

The Norman Wells Land Corporation, Tulita Land Corporation, Fort Norman Metis Land Corporation, Tulita Dene Band (collectively 5658 NWT Ltd.) and the Government of Northwest Territories Department of Transportation invite residents, organizations, and agencies to participate in a community meeting to discuss the proposed Mackenzie Valley Highway.

The meeting will include:

- **An overview presentation about the Mackenzie Valley Highway Project.**
- **A summary of comments heard at the first round of meetings.**
- **A timeline of project activities and further project details.**

Project representatives will be available to respond to questions and receive comments before, during, and after the presentation. There will be opportunities to talk in smaller groups and one-on-one.

Meeting Locations and Times:

Monday, March 28, 2011	**Norman Wells** – Legion Hall
Tuesday, March 29, 2011	**Tulita** – Tulita Arena Hall

Times: **5:30 p.m. Community Supper – Everyone is Welcome!**
6:30 p.m. Project Presentation and Discussion

Our project consultant, EBA a Tetra Tech Company, can provide you with more information. Please contact Robyn McGregor at (403) 723-3269 (rmcgregor@eba.ca) or Mariel Higuerey at (403) 203-3305 ext. 825 (mhiguerey@eba.ca).

5658
NWT Ltd.

MACKENZIE VALLEY HIGHWAY
OCTOBER 2011 COMMUNITY MEETINGS

The Norman Wells Land Corporation, Tulita Land Corporation, Fort Norman Metis Land Corporation, Tulita Dene Band (collectively 5658 NWT Ltd.) and the Government of Northwest Territories Department of Transportation invite residents, organizations, and agencies to participate in a community meeting to discuss the proposed Mackenzie Valley Highway.

The meeting will include:

- A presentation of the Mackenzie Valley Highway draft Project Description Report.
- A review of the input and guidance received during previous consultations.
- A discussion on the next steps in the regulatory review process.

Project representatives will be available to respond to questions and receive comments before, during, and after the presentation. There will be opportunities to talk in smaller groups and one-on-one.

MEETING SCHEDULES AND LOCATIONS:

Tuesday, October 4th at 5:30 pm: **Norman Wells -** Legion Hall

Wednesday, October 5th at 5:30 pm: **Tulita –** Tulita Arena Hall

*** Participants are invited to attend supper at 5:30 pm, followed by the 6:30 pm presentation.**

Our project consultant, EBA, A Tetra Tech Company, can provide you with more information. Please contact Robyn McGregor at (403) 723-3269 (rmcgregor@eba.ca), Sunny Munroe at (867) 446-6057 (smunroe@eba.ca) or Mariel Higuerey at (403) 203-3305 ext. 825 (mhiguerey@eba.ca).

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The Norman Wells Land Corporation,
Tulita Land Corporation,
Fort Norman Mètis Land Corporation,
Tulita Dene Band (collectively 5658 NWT Ltd.) and
the Department of Transportation invite you to

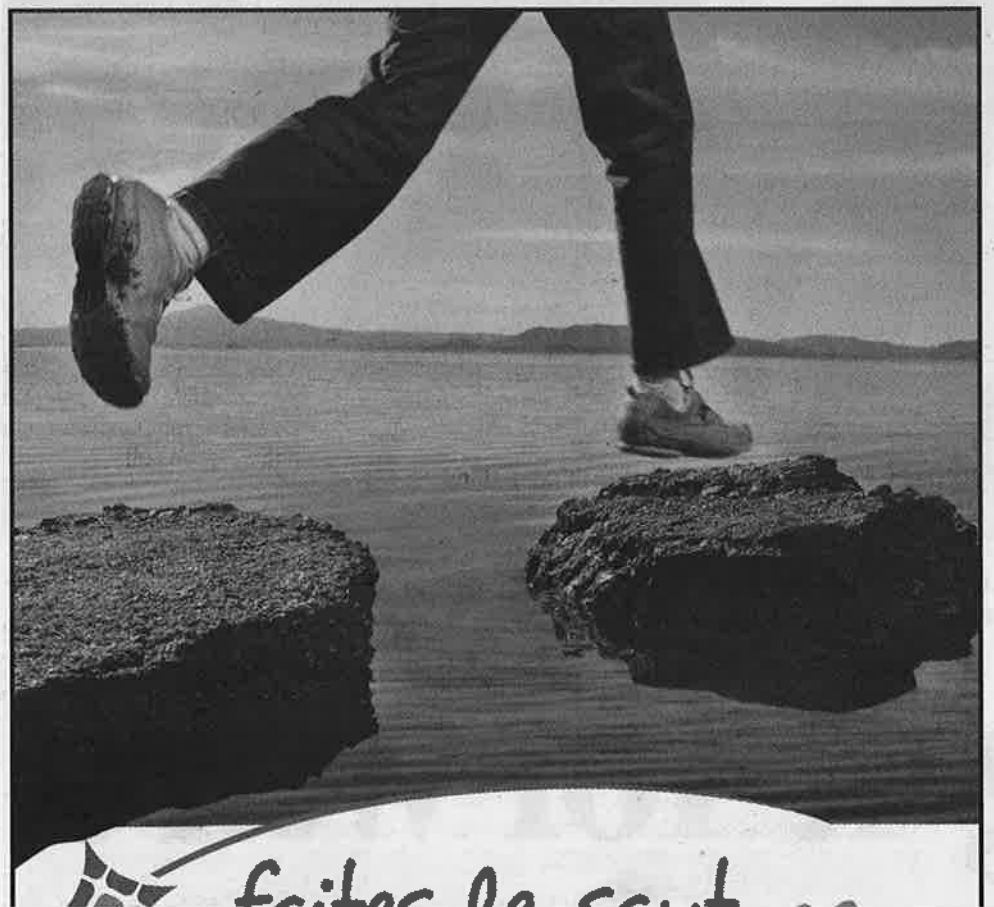
MACKENZIE VALLEY HIGHWAY COMMUNITY MEETINGS MARCH, 2011

Monday, March 28 – Norman Wells
Norman Wells Legion Hall

Tuesday, March 29 – Tulita
Tulita Arena Hall

***Supper is served at 5:30 pm, followed by presentations and discussions at 6:30 pm**

Everyone is welcome to attend!



Mission Staff

Western Canada Summer Games 2011

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October 2010 like
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***LEONA AGLUKKAQ:** Health minister announced delays changes to food subsidy.*

on the list until October 2012.

"We had a very aggressive timeline and that timeline is what we're extending and we think the program is sound but the implementation period was overly aggressive," Duncan said.

The extension will allow retailers two sealift cycles to order products which are cheaper to ship by sea than by air.

As per the original program changes, higher subsidy levels according

fell, executive vice-president of the North West Company which owns the Northern Stores.

He said he was pleased with the announcement.

"They've been hearing the same things we've been hearing," he said.

In October 2010, McMullen said 2,700 products – accounting for 80 per cent of sales at Northern Stores – was removed from the eligibility list, including things such as bacon and sour cream.

He said the company was given about a month and half to try and bring in the products at a lower cost. A freight rate increase at the same time did not help.

Now, the job for the long term is to plan ahead at getting as many of the eligible products shipped on the sealift as possible.

Duncan said because of the adjust-

to the maximum adv

fact FILE

SUBSIDY LIST

Items dropped from food mail last October that will be back on the subsidy list from April 1, 2011 to October 2012

- Cake and pastry flour
- Dry rice and pasta
- Cream, sour cream and cream cheese
- Ice cream, sherbet and frozen yogurt
- Processed cheese spreads
- Canned meat, fish, poultry,
- legumes, soups
- Hydrogenated ma
- Spreads and sauce
- Spices
- Jams, honey, syru
- Jelly powders, puc
- Condiments
- Coffee and tea
- Fruit drink crysta
- Personal hygiene including diapers
- Laundry detergen

Source: Department of Indian and Northern A

h-Shee eligible to run for grand c

Residency complaint dismissed by Tlicho chiefs

by Daniel T'seleie
orthern News Services
Tlicho

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this week after a
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uestioned whether
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r the required two
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o a press release
Government, "the
ed because many

people in Edzo and Yellowknife told Mr. Erasmus that they did not think Mr. Wah-Shee had lived in Edzo for the required second year period."

Wah-Shee said he has lived in Edzo (Behchoko) since February, 2009, and provided evidence – such as utility bills – to the returning officer as proof.

"I gave them just about 25 documents that clearly indicated that I had two-years residency," Wah-Shee said.

The complaint may have been, "a tactic to either delay (my campaign) or get me out of the race," said Wah-Shee. After learning of the complaint, Wah-Shee said his campaign had to be put on hold for eight days while awaiting the CEC's decision. As a result he had to delay two of his trips to outlying Tlicho communities.

The delay to his campaign may have given "some advantage" to the other candidates says Wah-Shee, but added "the candidates have every right to challenge the eligibility of their opponents."

James Wah-Shee

Despite the delays Wah-Shee said he will have time to visit each of the three outlying Tlicho communities (Wekweeti, Whati, and Gameti). He said the trips are important even though the majority of Tlicho citizens eligible to vote live in Behchoko. "When you're a candidate for Tlicho grand chief you have to cover all three of the outlying communities."

Edward Erasmus could not be reached for comment before deadline.

In order to be eligible to run for Tlicho grand chief, Tlicho citizens must live in a Tlicho community (or on Tlicho lands) for at least two years before the day of the election. This requirement is part of the Tlicho Constitution.

"Because (Tlicho grand chief) is the highest office in the Tlicho nation, there has to be some commitment (on the part of the candidate)," said John B. Zoe, senior adviser to the Tlicho Government.

Zoe said there have been cases in Canada where a community's elected chief chose not to reside in their com-

munity, and it's tho
residency requirem
to avoid.

When a complai
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"It's better to know up
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"You want to en
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Tlicho citizens v
polls on March 22 to
candidates for Tlicho
Edward Erasmus, Le
James Wah-Shee. C
Chief's Executive C
Jasper Lamouelle is
a candidate in the ele

The Norman Wells Land Corporation,
Tulita Land Corporation,
Fort Norman Mètis Land Corporation,
lita Dene Band (collectively 5658 NWT Ltd.) and
the Department of Transportation invite you to

ACKENZIE VALLEY HIGHWAY
COMMUNITY MEETINGS
MARCH, 2011

Monday, March 28 – Norman Wells
Norman Wells Legion Hall

Tuesday, March 29 – Tulita

sion Staff
anada Summer Games 2011

KAMLOOPS 2011
WESTERN CANADA SUMMER GAMES
THE GAMES BEGIN WITH YOU

SPORT NO

Mission Staff
2011 Western Canada Summer Ga
Kamloops, BC - August 5-14, 201

The Sport North Federation is now accepting applic
volunteer MISSION STAFF to attend the **2011 Weste**
Summer Games in Kamloops, BC from August 5-14,

Application forms and position descriptions are avai
the Sport North office and website: www.sportnorth.

For more information or to apply, contact:

5658
NWT Ltd.

**The Norman Wells Land Corporation,
Tulita Land Corporation,
Fort Norman Metis Land Corporation,
Tulita Dene Band (collectively 5658 NWT Ltd.) and
the Department of Transportation invite you to**

MACKENZIE VALLEY HIGHWAY COMMUNITY MEETINGS OCTOBER, 2011

Tuesday October 4th – Norman Wells
Norman Wells Legion Hall

Wednesday October 5th – Tulita
Tulita Arena Hall

***Supper is served at 5:30 pm, followed by presentations and discussions at 6:30 pm**

Everyone is welcome to attend!

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Northwest Territories

Mackenzie Valley Highway – Tulita District
Initial Consultations

Meeting Attendance Log

Date: July 29, 2010

Time: 5:30pm

Meeting: Tulita, NWT

Name	Organization / Company
Leon Andrew	
Wilfred Lennie	Land Corp, FNMLC
Sarah Lennie	
Lori Ann Lennie	FNMLC
Robert Lennie	
Danny Yakelga	Hamlet of Tulita.
Norman Andrew	
Frederick Andrew	R-R-C.
Ocelia Lafferty	FNMLC
Michele Krutko	FNMLC
Dyanne Doctor & Son	FNMLC.
Mary Jane Kuptana	Keele River Enterprises
Herb Sawyer	TNA – LHO
Joe Harris	Dene Nation
Helen Maccallum	

Mackenzie Valley Highway – Tulita District
Initial Consultations

Meeting Attendance Log

Date: July 29, 2010

Time: 5:30 pm

Meeting: Tulita, NWT

Name	Organization / Company
Maxine Jaremko	
Gabe H.	
EDWARD MACCALLUM	T.D.L.C
Douglas Yallee	Tulita Land Corp.
Rocky Norwegian	Ft. Norman Metis Lands.
Terry Kunkel	Keele River Ent.
CHRIS HOPKINS	SAHTU RENEWABLE RESOURCE Board
22	

Mackenzie Valley Highway – Tulita District
Initial Consultations

Meeting Attendance Log

Date: July 28, 2010
Time: 5:30 pm
Meeting: Norman Wells, NWT

Name	Organization / Company
Margaret McDonald	NWC
Ine Spilchak	"
Ted McDonald	"
Sherry Hodgson	Hodgson Contracting
Lisa McDonald	NWC
Irvin McDonald	NWAC
Norm Hodgson	KLWCC
Duane Norwegian	
Steve Desclenes	INAC
Stephanie Desclenes	NWT Res.
Ruby L McDonald	General Public
Dan McNeely	" "
Ron Pizzolo	
Wendy C. Johnson	Mayor Norman Wells
Ethel Blondin Andrew	Pres. 5658 / NWAC

15

Mackenzie Valley Highway – Tulita District
Initial Consultations

Meeting Attendance Log

Date: July 28, 2010

Time: 5:30pm

Meeting: Norman Wells, NWT

Name	Organization / Company
Heidi Hodgson-Deschene	IOL & NWLC B.O.D.
Laurel McDonald	NWLC / community member
Roger Odjard	NWLC
Norm McDonald	N.C.I.
19	

Mackenzie Valley Highway – Tulita District
March 2011 Consultations

Meeting Attendance Log

Date: MARCH 28TH, 2011

Time: 5:30 PM

Meeting: NORMAN WELLS - LEGION

Name	Organization / Company
[illegible]	Denendeh Gateway
MARK Gylander	Public
Amanda Campbell	Public
Shelley Empey	Public
Chris Yachimec	Public
Trevor Yachimec	Public
Marydan McDonald	Public
Kathleen McDonald	NWCYRP
SAM KIVI.	Self.
JOHN KIVI	NWTHC/self.
M Lafleur	Public
Andrea Hrynkiw	Sahtu Renewable Resources Board.
Margaret McDonald	Chair, Mgmt Com
Donna Schaefer Taylor	Public
Dale Kochan	Public
Daryl McDonald	
Lottie McDonald	Public
David + Glenda James	Public/GNWT

Mackenzie Valley Highway – Tulita District
March 2011 Consultations

Meeting Attendance Log

Date: MARCH 28TH, 2011

Time: 5:30 PM

Meeting: NORMAN WELLS

Name	Organization / Company
TOM LAKUSTA	HAY RIVER.
NINA LARSSON	ENERGY NORTH.
HEIDI HODGSON-DESCHENE	NORMAN WELLS Land Corp.
Deni Gaccione	Town of Norman Wells.
HARVEY PIERROT	PUBLIC
HEATHER SAYINE-CRAWFORD	Public
Jenny Pierrot	N. Wells Land Corp.
Dolly Pierrot	Public
Harold Harris	Public
Anne Yakeleya-Fauvel	Public
Norm Hodgson	RRC
LEON ANDREW	Public.
Brian Lickoch.	"
Ethel Blondin-Andrew	5658 Pres / SSI Chair
Chris N. Buist	N Wells Chamber of Commerce
Ida Lennie	Public
Delbert Manuel	"
Ann Marie Tait	Public

Mackenzie Valley Highway – Tulita District
March 2011 Consultations

Meeting Attendance Log

Date: MARCH 28TH, 2011

Time: 5:30

Meeting: NORMAN WELLS – LEGION

Name	Organization / Company
Ruby L. McDonald	Norman Wells Land Corporation
Blaine McDonald	Norman Wells L Corp
SHOLA ABIONA	NORTHWESTEL INC.
ROBYN MCGREGOR	EBA
NEIL MACLEOD	EBA
Jim Stevens	DOT
Mariel Higuercy	EBA

Mackenzie Valley Highway – Tulita District
March 2011 Consultations

Meeting Attendance Log

Date: MARCH 29TH, 2011

Time: 5:30 PM

Meeting: TULITA - ARENA

Name	Organization / Company
CHRIS HOPKINS	SRRB.
David Manache	T.R.R.C
Sasha Doctor	TYCS
Leon Andrew	Public
Margaret McDonald	NWLC
Frank Andrew	Tulita Dene Band
Donna Schaer	
Ruth Doctor	Public
Raeleen Naksana	
Caroline Widow	
Cook Matthews	TDB
Shelly Widow	Youth of TNFC
Sneak	TDB
[illegible]	Tulita Hydro Comp.
Joe Bernard	
Boniface Ayah	
Gordon Yakeleya	T.L.C.
Norma Camsell	T.D.B

Mackenzie Valley Highway – Tulita District
March 2011 Consultations

Meeting Attendance Log

Date: MARCH 29TH, 2011

Time: 5:30 PM

Meeting: TULITA - ARENA

Name	Organization / Company
Maurice Mendo	
EDDY MCPHERSON	F N M.
X DANNY YALLEGA	F N M
WILFRED LENNIE	FMLC
Ethel Blondin-Andrew	Pres 5658 / 55E CH
Jared K...	Public
Albert B...	
Tom T...	Public
Helen Maccauley	
Lori Ann Lennie	Focal.
Stacey Nadazo	
Debbie Yallee	
William Horassi	
Jonas Peter	
BOB McPHERSON	M.Y.R Constr LTD
Charlie M...	Public
[illegible]	5658
Cindy Desjarlais	
ROCKY NORWEGIAN JR	

Mackenzie Valley Highway – Tulita District
March 2011 Consultations

Meeting Attendance Log

Date: MARCH 29TH, 2011

Time: 5:30 PM

Meeting: TULITA - ARENA

Name	Organization / Company
Douglas Yallee	
Roderick Yallee	STM Services LTD
Sulli Bayell	STM Service LTD
Richard Andrew	
ROBYN MCGREGOR	EBA
NEIL MACLEOD	EBA
JIM STEVENS	DOT
MARIEL HIGUEREY	EBA

Mackenzie Valley Highway – Tulita District
Stakeholder Consultations
Meeting Attendance Log

Date: AUGUST 15, 2011

Time: 6:00 PM

Meeting: NORMAN WELLS LAND CORP – NORMAN WELLS, NT

Name	Organization / Company
Ruby L. McDonald	Norman Wells Land Corporation
Blaine McDonald	Norman Wells Land corp.
Margaret McDonald	NWLC.
Cece McCauley	Pres – N.W.L.C
Ed. L Kodaloon	S. " " " "
Donna Schaar/Taylor	NWLC
Jade Kochon	NWLC
	N.W.L.C.
	"
Jaa McDonald	
Ethel Blondin-Andrew	NWLC
Les McDonald	NWLC
Paul Tan	NWLC
Laurel McDonald	NWLC / RRC
Paul Watson	NWLC / RRC

Mackenzie Valley Highway – Tulita District
Stakeholder Consultations
Meeting Attendance Log

Date: AUGUST 16, 2011

Time: 10:00 am

Meeting: Hamlet of Tulita - Tulita NT
Tulita Dene Band

Name	Organization / Company
Rocky Norwegian	Public
GARY VARELAY/A	R.R.C. Boy
Urban Antoine	Public
Mildred [illegible]	Public
Russell Schmidlo	Tulita
Gerard Yakeleya?	
James McPherson	
Cecil MacCauley	
Kyanna Lennie	Tulita
Gordon Yakeleya	
Brian Menacho	Tulita.
[illegible]	Tulita Band Council
ARSENE MACNEILL	TULITA BAND REP
Jones Peters	
Frank Yalle	
DYANNE DOCTOR	Tulita, NT
Fred Andrew Jr.	Tulita R-R-C.

Mackenzie Valley Highway – Tulita District
Stakeholder Consultations
Meeting Attendance Log

Date: AUGUST 16, 2011

Time: 2:00 pm

Meeting: Tulita RRC - Tulita, NT
Fort Norman Metis Land Corp - Tulita, NT

Name	Organization / Company
David Menache	T.R.R.C.
Jimmy Mendo	Public
Ed. McPherson	F.N.M.

Mackenzie Valley Highway – Tulita District
Stakeholder Consultations
Meeting Attendance Log

Date: AUGUST 16, 2011

Time: 3:00 pm

Meeting: Tulita Land Corp - Tulita, NT

Name	Organization / Company
JASON MERCREDI	TULITA LAND CORP.
GORDON YAKELEYA	
[illegible]	
Jimmy Mendo	TLC

Mackenzie Valley Highway – Tulita District
October 2011 Consultations
Meeting Attendance Log

Date: OCTOBER 4, 2011
Time: 5:30PM
Meeting: NORMAN WELLS

	Name	Organization / Company
1	Nicole Horassi	student
2	BRITTANY LEBLUE	NWLC – student.
3	Eddy Hodgson	NWLC
4.	Mitzi Hodgson	~~NWLC~~
5	Fr. Oleafor Michael	
6	Ruby L McDonald	Norman Wells Land Corporation
7	Cory McCauley	Pres. N.W.L.C. Corp
8	Travis Kellon	
9	Ethel Blondin-Andrew	Phrm. 581/5658 Pres.
10	Maria Cristina Lagare	public
11.	Julie L. Bearis	
12	Margaret McDonald	NWLC
13	Darren Whiteman	Student
14	Qualin Lennie	Student
15	Delany Harley	Student
16	Sakina Louison	Student

Mackenzie Valley Highway – Tulita District
October 2011 Consultations
Meeting Attendance Log

Date: OCTOBER 4, 2011

Time: 5:30 pm

Meeting: NORMAN WELLS

	Name	Organization / Company
17	Donna Schaer	NWLC Member
18	TOLYION "	"
19	Dale Kochon	"
20	Chris Burst	NW Chamber of Commerce.
21	Delbert Manuel	Imperial Oil
22	Sonya Wall	
23		
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32		

Mackenzie Valley Highway – Tulita District
October 2011 Consultations
Meeting Attendance Log

Date: OCTOBER 5, 2011

Time: 5:30 PM

Meeting: Tulita

	Name	Organization / Company
1	Frank Andrew	Tulita Dene Band
2	Jim Bavard	Tulita
3	Boniface Ayah	Tulita
4	Cecile Enyah	Tulita
5	Kristen Andrew	Tulita
6	Rosalie Andrew	Tulita
7	David Menacho	Tulita
8	Frank B. Isherwood	Tulita
9	Joe Mackay	
10	Elder David Yallee	Tulita DAVID YALLEE
11	Jay Ayah	M.J Industries
12	Bryson Doctor	M.J Industries
13	Dylan Paul	M.J Industries
14	Helen Maccauley	Tulita
15	Ann Etchinelle	Tulita
16	David Etchinelle	

Mackenzie Valley Highway – Tulita District
October 2011 Consultations
Meeting Attendance Log

Date: OCTOBER 5, 2011

Time: 5:30 PM

Meeting: Tulita

	Name	Organization / Company
17.	Robert Lennie	Tulita
18	Richard MacCarthy	Tulita
19	EDWARD MACCAULEY	TULITA LAND CORP.
20	NORMAN ITNDREW	TULITA
21	Lillian Dotto	Tulita
22	Hope Menacho	Tulita
23	Shauna Etchinelle	tulita
24	Kristianna Andrew	Tulita
25.	Keesha Antoine	Tulita
26	Matthew yakeleya	M.J industries
27	Peter van YAKELEYA	M.J industries
28	JOSEPH AYAH	TULITA
29	Bernetta Hrassi	Tulita
30	Jane Hrassi	Tulita
31	RODERIK YALLEE	Tulita
32	Lyle Etchinelle	Tulita

Mackenzie Valley Highway – Tulita District
October 2011 Consultations
Meeting Attendance Log

Date: OCTOBER 5, 2011

Time: 5:30 PM

Meeting: TULITA

	Name	Organization / Company
33	JACK HORASSI	TULITA
34.	Rocky Norwegian	Ft Norman Metis Lands.
35	Ethel Blondin-Andrew	5658 Pres / SSI CHR.
36	MARGARET McDONALD	5658 Chair, Mgmt Committee
37	BéAnna Lynne	Community member Tulita
38	Shirley Harewood	" / Tulita Librarian
39	EMMA LENNIE	FNMLC.
40	WILFRED LENNIE	FNMLC.
41		MLA Assistant
42	EDWARD ANDREW	
43		
44		
45		

Mackenzie Valley Highway
Tulita District,
Sahtu Settlement Area

Community & Regulatory Consultations
July 2010

Meeting Overview

- **Opening Prayer**
- **Introductions**
- **July 2010 Consultations – Purpose and Approach**
- **Our Starting Point**
  - **History of the Highway**
  - **Proposal to Move Forward in 2010**
  - **Tulita District - GNWT: Making Decisions Together**
- **Questions, Comments & Suggestions**
- **Discussion Around Maps**

The Tulita District

5658 NWT Ltd.

- Tulita Land Corp
- Fort Norman Metis Land Corp
- Norman Wells Land Corp
- Tulita Dene Band

Mackenzie Valley Highway Team

5658 NWT Ltd. (Tulita District)

EBA Engineering Consultants Ltd.

Consultation, Engineering, Environmental, Regulatory & Project Description Report

Hwy Steering Committee

- Tulita Land Corp
- Fort Norman Metis Land Corp
- Norman Wells Land Corp
- Tulita Dene Band
- GNWT Dept. of Transportation

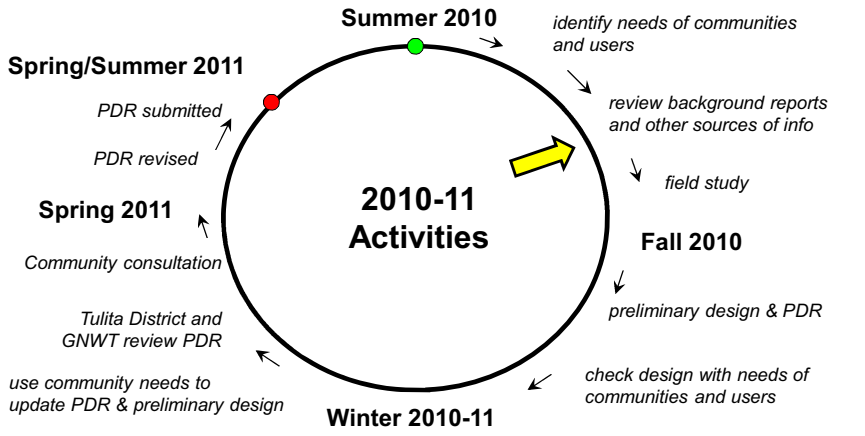
Partnership Approach

- **The Highway is a partnership between the Tulita District and GNWT, Department of Transportation (DOT)**
- **The Tulita District makes up 275km of the >800km Mackenzie Valley Highway corridor**
- **The vision for the future is a *Transportation Corridor* that minimizes the environmental footprint in the Tulita District**

Project Approach: Planning to Construction

2010	2011	2011 and Beyond
PDR Preparation	Environmental Screening in the Sahtu Settlement Area	From PDR to Construction: • Environmental Screening (and other applicable regulatory processes) • Obtain Funding • Complete Detailed Design • On-going Community Consultations • Construction

Making Decisions Together



Purpose of Initial Consultations

"What do we need to understand about the land and the people who live here to make wise decisions about the construction of the Mackenzie Valley Highway?

Where should it be built and what it should look like?"

Planning

- **History:**

  The Highway and Associated Development Planning (1970s to present)

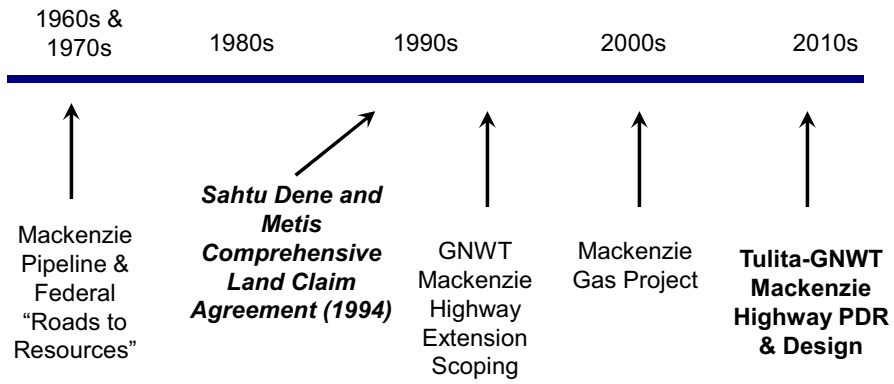
- **Where are we going?**
  The Proposal to Move Forward in 2010

- **Tulita District-GNWT: Making Decisions Together**
  Identifying what is most important as we plan the Mackenzie Valley Highway

History:
Looking Back to Help Plan The Way Forward

- **Tulita District Land and Culture**
- **Mackenzie Valley Highway (1970s, 1990s)**
  - **1970s – Public Works Canada (PWC) Studies**
  - **Mid-1990s – Highway Constructed to Wrigley**
  - **1999 – GNWT Mackenzie Valley Highway Extension Scoping Study**
- **Mackenzie Gas Project (2000s)**
- **Public Winter Road & Existing Bridges**
- **Sahtu Highway Conference (August 2009)**

Recent Development Planning



Community Consultation

- The Highway 'Scoping' study identified that communities wanted to be consulted:
  - **Before approval**
  - **Before construction**
  - **Throughout the Highway's lifespan**
- Discussing with leaders, elders and communities at the beginning.
- As a first step in a long journey, we are meeting with:
  - Norman Wells, July 28, 2010
  - Tulita, July 29, 2010
- Future meetings with public and smaller groups

The Next Steps

2010	Spring / Summer 2011	2011 and Beyond
PDR Preparation	Environmental Screening in Sahtu	From PDR to Construction: • Environmental Screening (and other applicable regulatory processes) • Obtain Funding • Complete Detailed Design • On-going Community Consultations • Construction

Possible Discussion Points

- Hunting, trapping, fishing
- Wildlife and habitat
- Stream crossings
- Erosion, slumping
- Permafrost
- Material sources
- Cumulative effects
- Traditional use
- Camps & cabins
- Traplines
- Social and cultural adaptation
- Heritage and archaeological sites
- Tourism
- Safety
- Training & employment
- Others?

Mackenzie Valley Highway
Tulita District,
Sahtu Settlement Area

Community Consultations
March 2011

Meeting Overview

- **Opening Prayer**
- **Supper and Slideshow**
- **Introductions**
- **Presentation on project progress**
- **Discussion Around the Maps**

Partnership Approach

- **The Highway is a partnership between the 5658 NWT Ltd. and GNWT, Department of Transportation (DOT)**
- **The Tulita District makes up 275km of the >800km Mackenzie Valley Highway corridor**
- **The vision for the future is a *Transportation Corridor* that minimizes the environmental footprint in the Tulita District**

The Tulita District

5658 NWT Ltd.

- Tulita Land Corp
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- Norman Wells Land Corp
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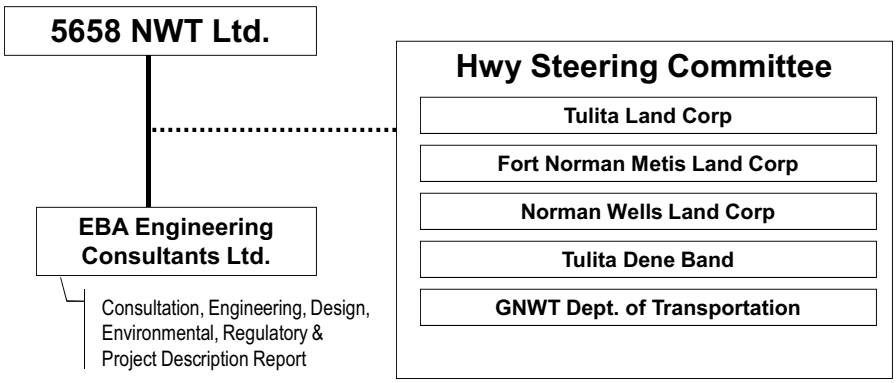
Mackenzie Valley Highway Team



Purpose of Initial Consultations July 2010

"What do we need to understand about the land and the people who live here to make wise decisions about the construction of the Mackenzie Valley Highway?

Where should it be built and what it should look like?"

Purpose of Today's Meeting

Show Progress

Answer any questions

Get some additional input from you

Purpose of the Project Description Report

Tells the story and answers the questions of:

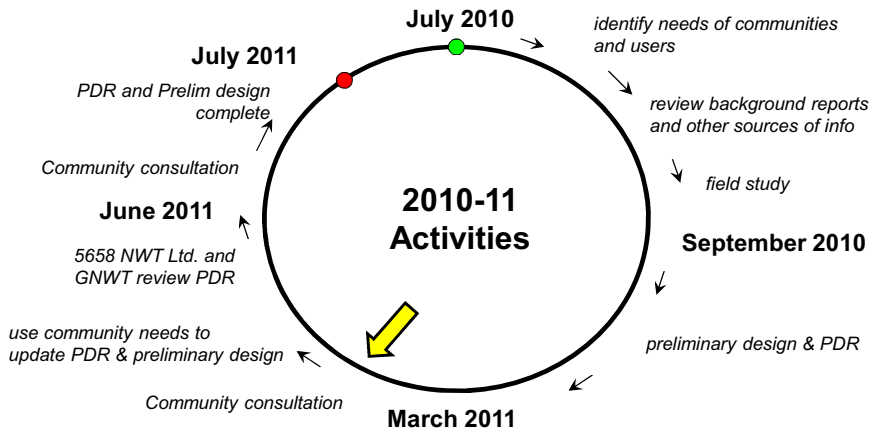
- What will the Highway look like?
- Where will it be built?
- How will it be built?
- What will be the benefit of the Highway?
- What is the impact of the Highway on the environment?
- What will be included in the design and construction to minimize impact on the environment?

What will the Project Description Report be used for?

The PDR will be used by 5658 NWT Ltd. and DOT to:

- Secure approval from the regulators; and
- Secure funding to build the Highway.

Progress to date

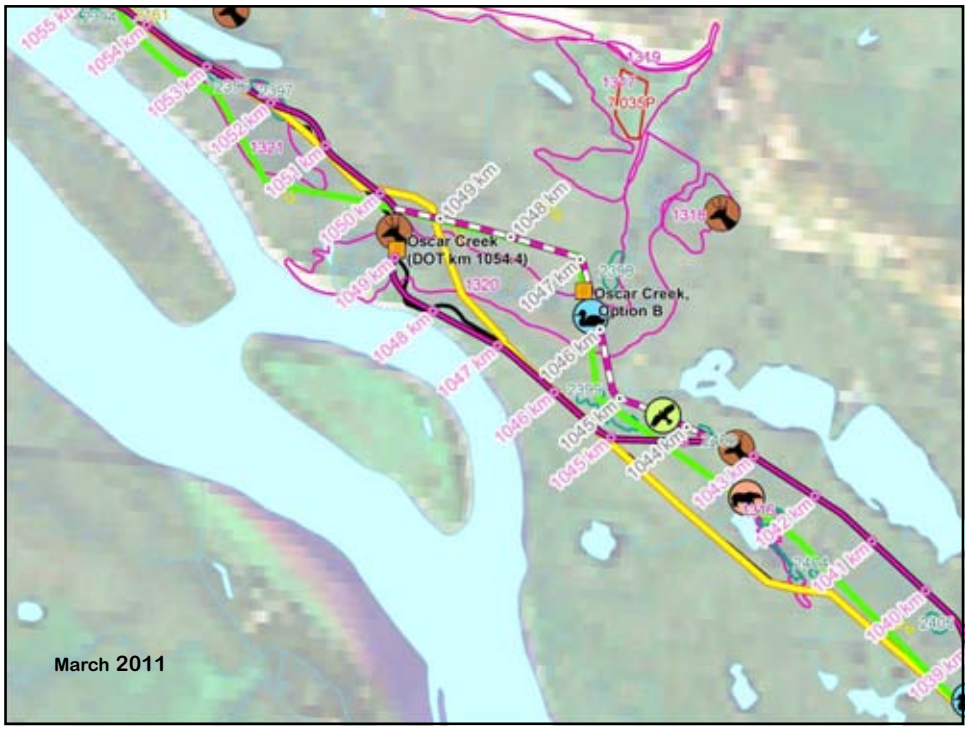


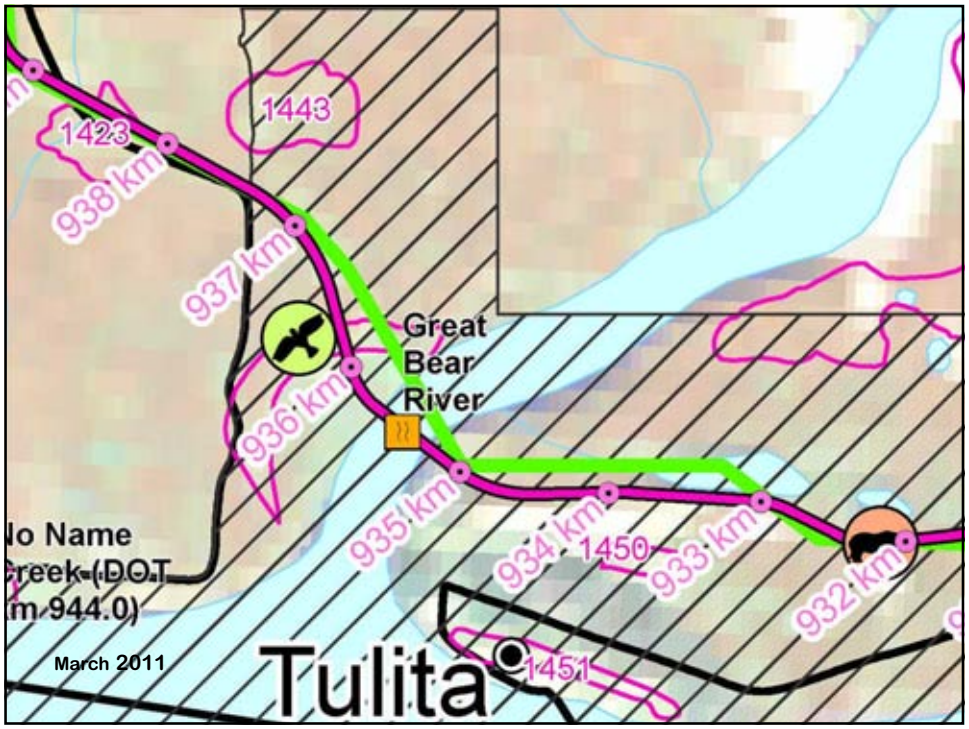
Your questions and comments from July 2010

- It is important to look at options and alternatives for the alignment.
- What is the consultation beyond these meetings?
- What work will be done by local contractors and services?
- How wide is the Transportation Corridor?
- What is the suitable route for the Highway?
- Where are the borrow sources?
- How will dust be controlled?

Your questions and comments from July 2010

- Where will new bridges be needed?
- Where will the Great Bear River Bridge be located?
- Where will Oscar Creek Bridge be located?


Oscar Creek
(DOT km 1054.4)
Oscar Creek,
Option B
March 2011


1443
1423
938 km
937 km
Great
Bear
River
936 km
935 km
934 km
1450
933 km
932 km
No Name
Creek (DOT
km 944.0)
March 2011
Tulita
1451

Your questions and comments from July 2010

- When will construction start?
- How long will the construction take?
- How much will it cost?

Next Steps

- April/May - Complete the Preliminary Design and Project Description Report (with review by committees)
- June - Return to present it to you
- July - Revise with any additional input
- Fall - Combine with Prelim Design and Project Description for Other Segments of the Highway
- Jan 2012 - Submit to the Mackenzie Valley Land and Water Board

Questions and Discussion Around the Maps

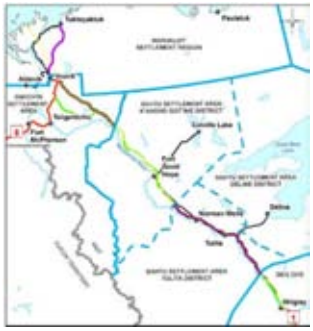
March 2011

Mackenzie Valley Highway
Tulita District

WHAT DO YOU KNOW ABOUT THE HIGHWAY?

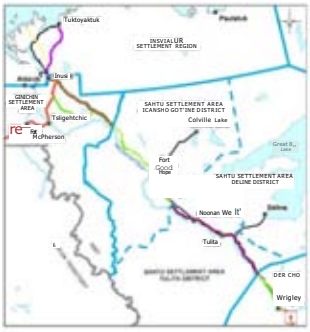
School Presentation
October 2011

WHERE ARE WE IN RELATION TO THE HIGHWAY?



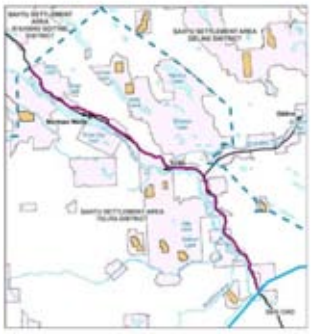
October 2011 Mackenzie Valley Highway

Tulita District



School Presentation
October 2011

WHAT QUESTIONS DO YOU HAVE ABOUT THE HIGHWAY?



HISTORY/BACKGROUND

- Highway has been in consideration since the 1960's
- 1970's alignment is referenced in the Land Claim Agreement (Schedule 17)
- Schedule 17 allows for revisiting of the alignment and designated land parcels
- Scoping studies continued into 1990s and 2000s

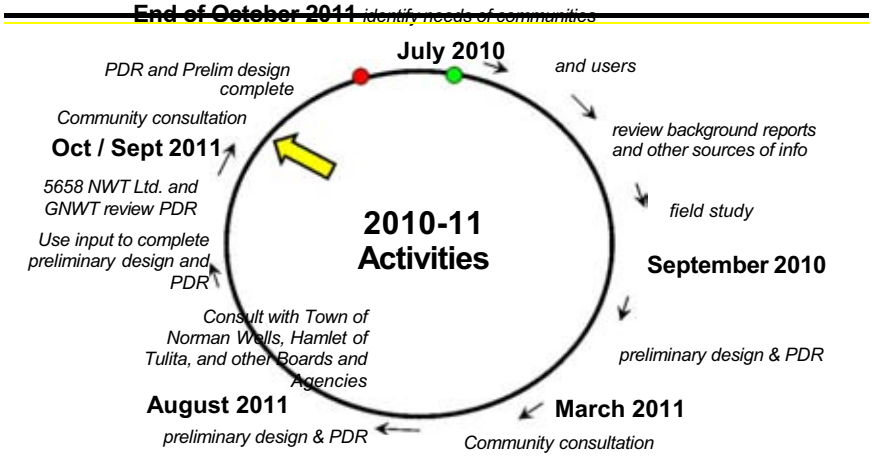
ABOUT THE HIGHWAY

- Within a Transportation Corridor with other developments such as the fibre optic cable and pipeline
- 285 km, two lane gravel highway (8.5 m wide)
- 80 km/h posted speed limit
- Uses existing Winter Road Bridges with some exceptions
- Winter construction with some activities in the summer
- 3 to 4 years of construction & costing $599 million

PARTNERSHIP APPROACH

- The Highway is a partnership between the 5658 NWT Ltd. and GNWT, Department of Transportation (DOT)
- The Tulita District makes up 285km of the >800km Mackenzie Valley Highway corridor
- The vision for the future is a *Transportation Corridor* that minimizes the environmental footprint in the Tulita District

HOW IT WORKS!



October 2011 Mackenzie Valley Highway

Tulita District

WHAT DO YOU THINK?...

October 2011 Mackenzie Valley Highway

Tulita District

SOME OF WHAT WE HAVE HEARD...

"Benefits of the road are opportunities for business, education and training."

"The Highway will be important for the younger generation."

"Need to ensure that all community issues are considered."

"Traditional knowledge and use of the land will be important considerations."

"Some of the bridges along the winter road are not in the right place."

SOME OF WHAT WE HAVE HEARD...

"The highway will help in the pipeline construction."

"The highway will bring opportunities for increased tourism in the area and help improve the local economy."

"You will need to consider climate change and changes in permafrost when you construct the highway."

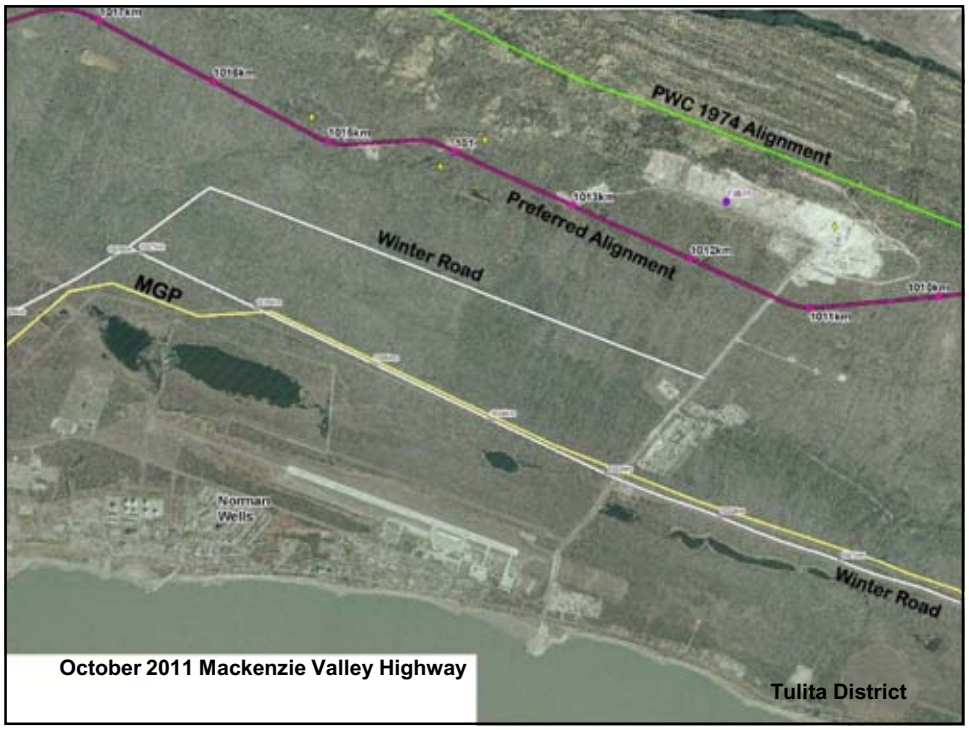
"You will need to consider sensitive areas, locations of cabins and other items when deciding where to put the highway."

IF YOU HAD $599 MILLION...

What would you consider important when designing and building the Highway??

In the vicinity of Norman Wells...

- Four Options Considered:
  - Through Town
  - Along the Winter Road
  - Straight Along the foot of the north hills
  - Following the topography along the foot of the north hills



In the vicinity of Tulita...

- Three Options Considered:

  PWC 1974 Alignment
  Alternate Alignment for Great Bear River Bridge (2006 PDR)
  Preferred Alignment (June 2011)

PWC 1974 Alignment
Preferred Alignment
Winter Road
Tulita
October 2011 Mackenzie Valley Highway
Tulita District

QUESTIONS ???

Mackenzie Valley Highway
Tulita District,
Sahtu Settlement Area

Presentation of the Project Description
October 2011

History/Background

- Highway has been in consideration since the 1960's
- 1970's alignment is referenced in the Land Claim Agreement (Schedule 17)
- Schedule 17 allows for revisiting of the alignment and designated land parcels
- Scoping studies continued into 1990s and 2000s

Partnership Approach

- The work on the description of the Highway is a partnership between the 5658 NWT Ltd. and GNWT, Department of Transportation (DOT)
- The vision for the future is a *Transportation Corridor* that minimizes the environmental footprint in the Tulita District
- The Tulita District is one of four sections of the Highway from Wrigley to Inuvik
- EBA works for 5658 to deliver the preliminary design and Project Description Report

The PDR describes the Highway and answers questions of:

- What will the Highway look like?
- Where will the Highway be built?
- How will the Highway be built?
- How was traditional knowledge used to describe where and how to build the Highway?
- How long will it take to build the Highway and how much will it cost?
- What will be the benefit of the Highway?

The PDR describes the Highway and answers questions of:

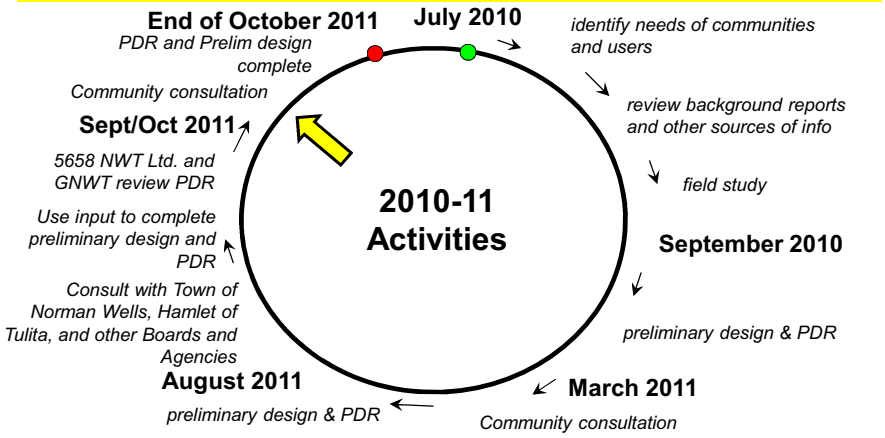
- What is the impact of the Highway on the environment?
- What is included in the design and construction to minimize impact on the environment?
- What are the next stages of work (one-on-one interviews, survey, geotechnical investigation, refining the location, detailed design, etc.)?

What will the Project Description Report be used for?

The PDR will be used by 5658 NWT Ltd. and DOT to:

- Secure approval from the regulators;
- Secure funding to build the Highway; and
- Be the guideline for the next stages (one-on-one interviews, survey, geotechnical investigation, refining the location, detailed design, etc.)

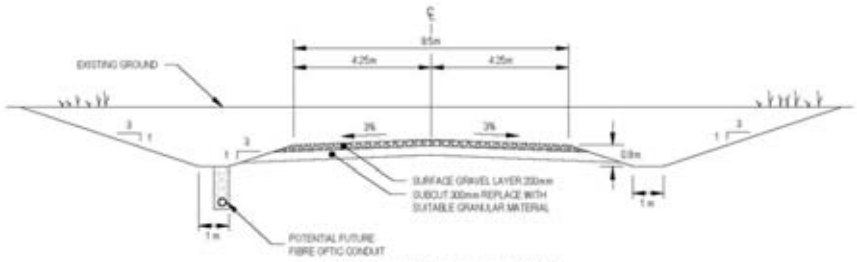
Progress to date



What will the Highway look Like?

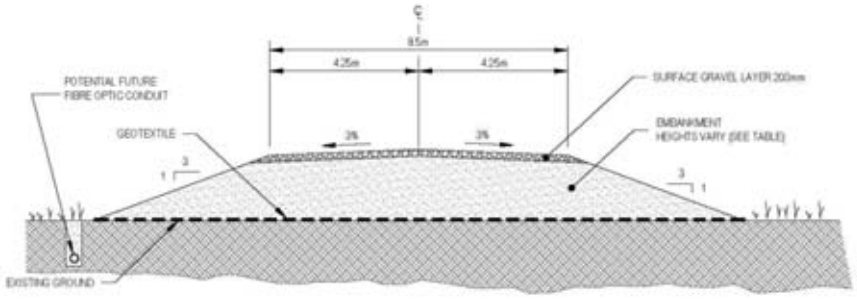
- 285 km, two lane gravel highway (8.5 m wide)
- 80 km/h posted speed limit
- Single lane bridges (except at Great Bear River)

What will the Highway look Like?



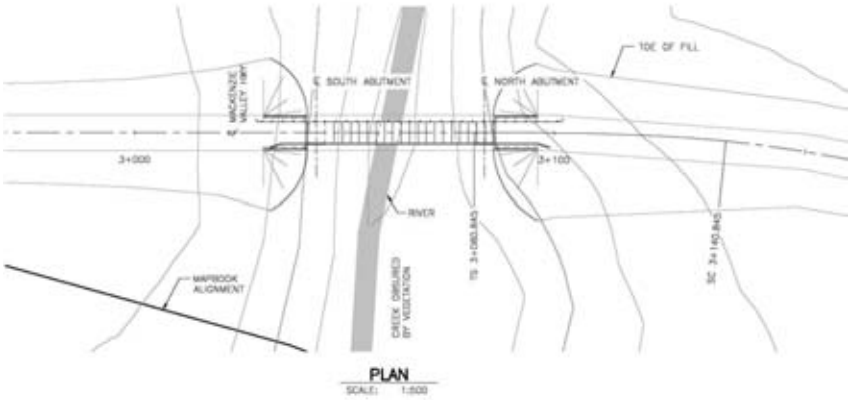
TYPICAL HIGHWAY CROSS SECTION
EARTH CUT SECTION

What will the Highway look Like?



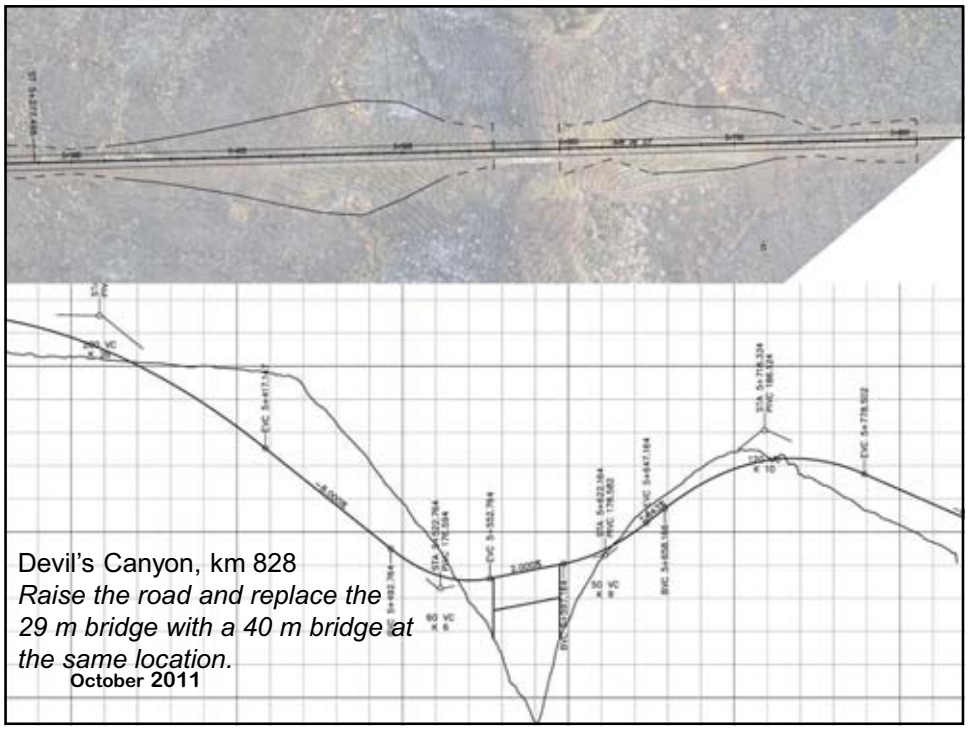
TYPICAL HIGHWAY CROSS SECTION
FILL SECTION

What will the Highway look Like?



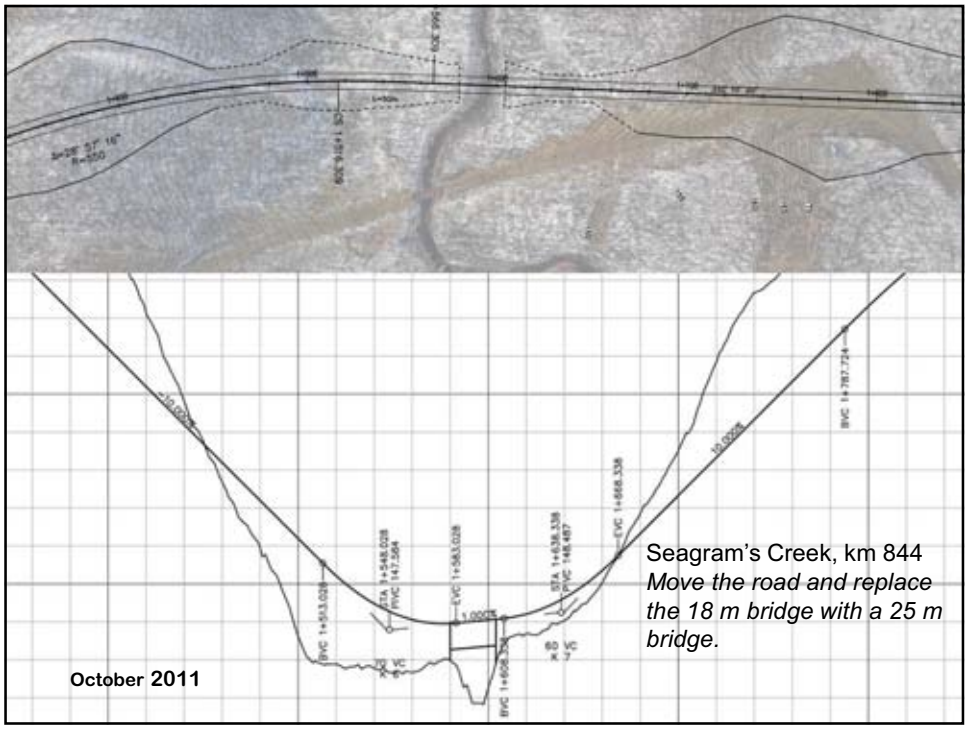
Where will the Highway be built?

- Concept of a Transportation Corridor with other developments such as the fibre optic cable and pipeline
- 285 km within the Tulita District
- 149 km along the existing winter road
- 138 km along new alignment
- Uses existing Winter Road Bridges with some exceptions



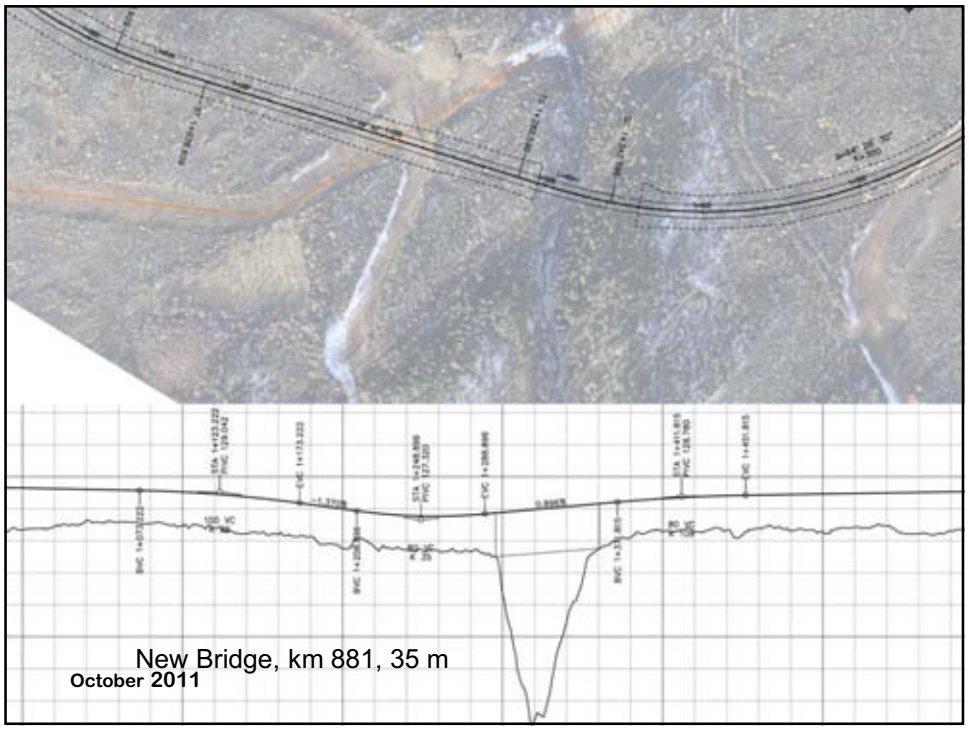
Devil's Canyon, km 828
Raise the road and replace the 29 m bridge with a 40 m bridge at the same location.

October 2011



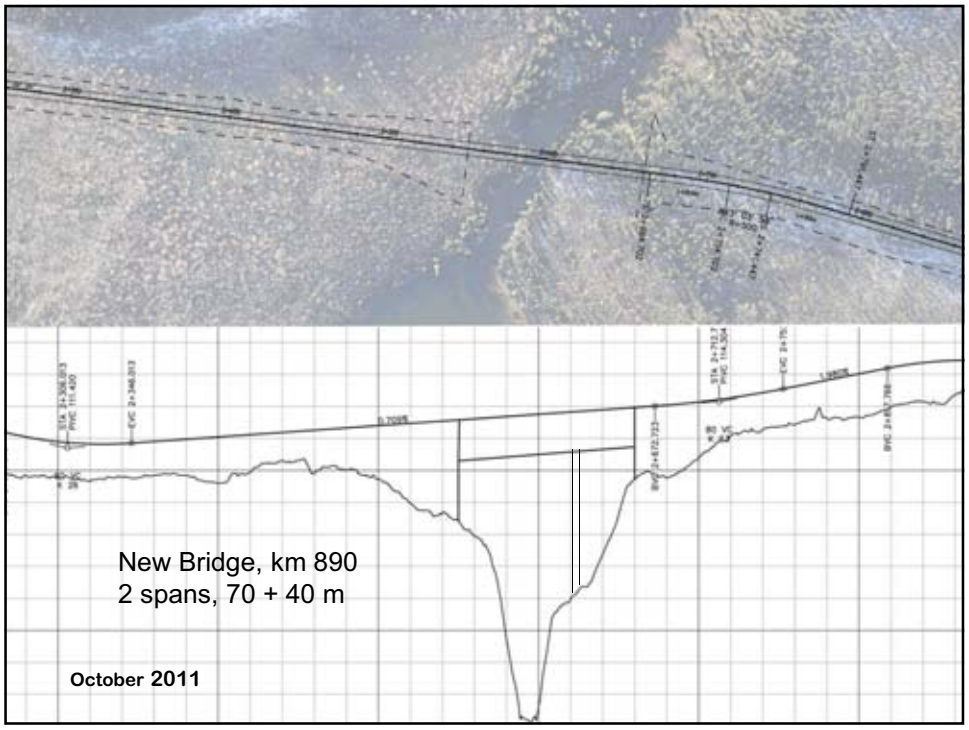
Seagram's Creek, km 844
Move the road and replace the 18 m bridge with a 25 m bridge.

October 2011



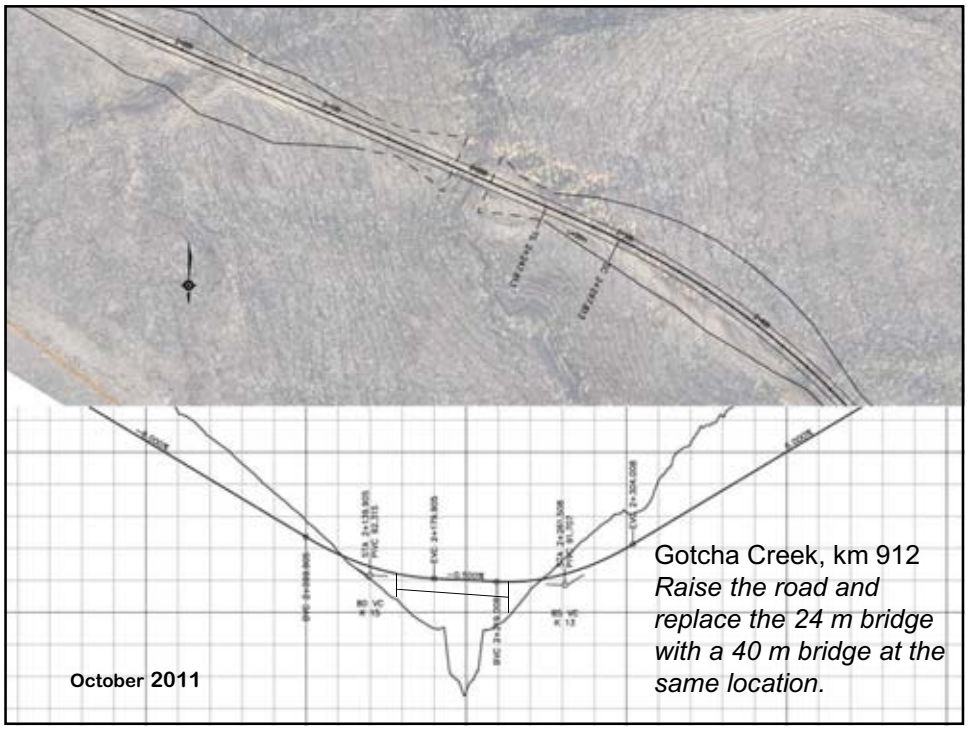
New Bridge, km 881, 35 m

October 2011



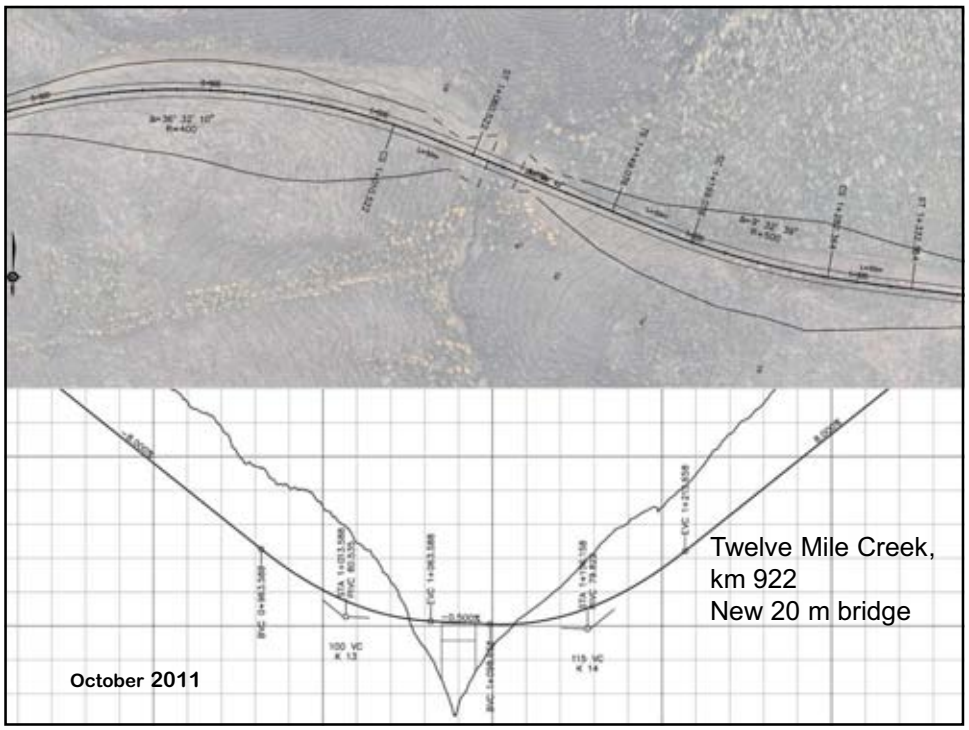
New Bridge, km 890
2 spans, 70 + 40 m

October 2011



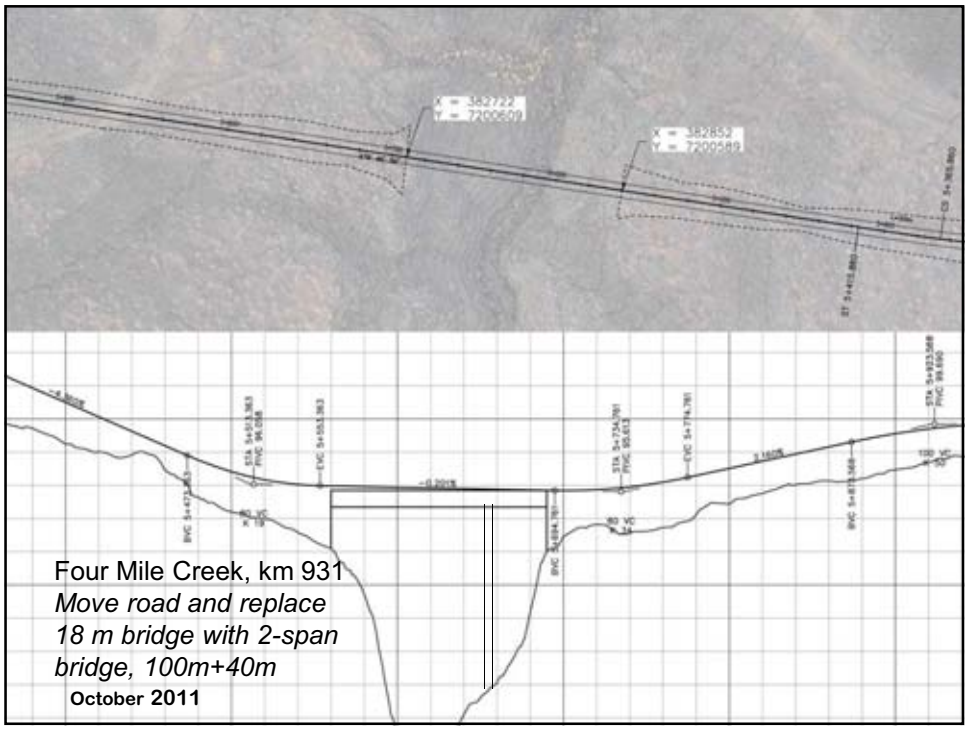
Gotcha Creek, km 912
Raise the road and replace the 24 m bridge with a 40 m bridge at the same location.

October 2011

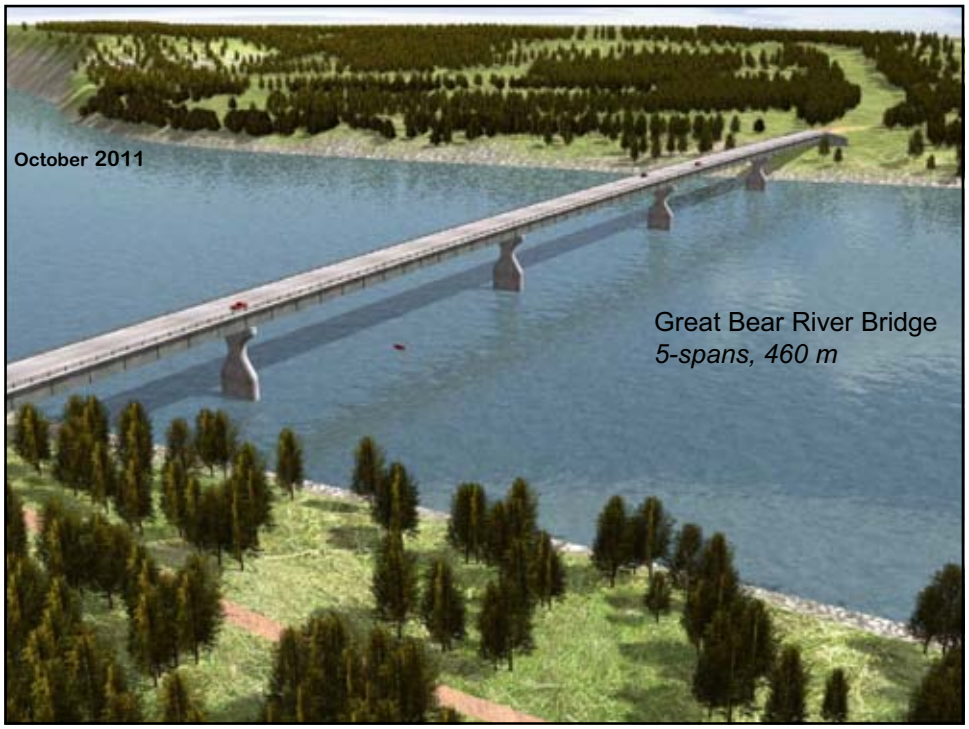


Twelve Mile Creek, km 922
New 20 m bridge

October 2011

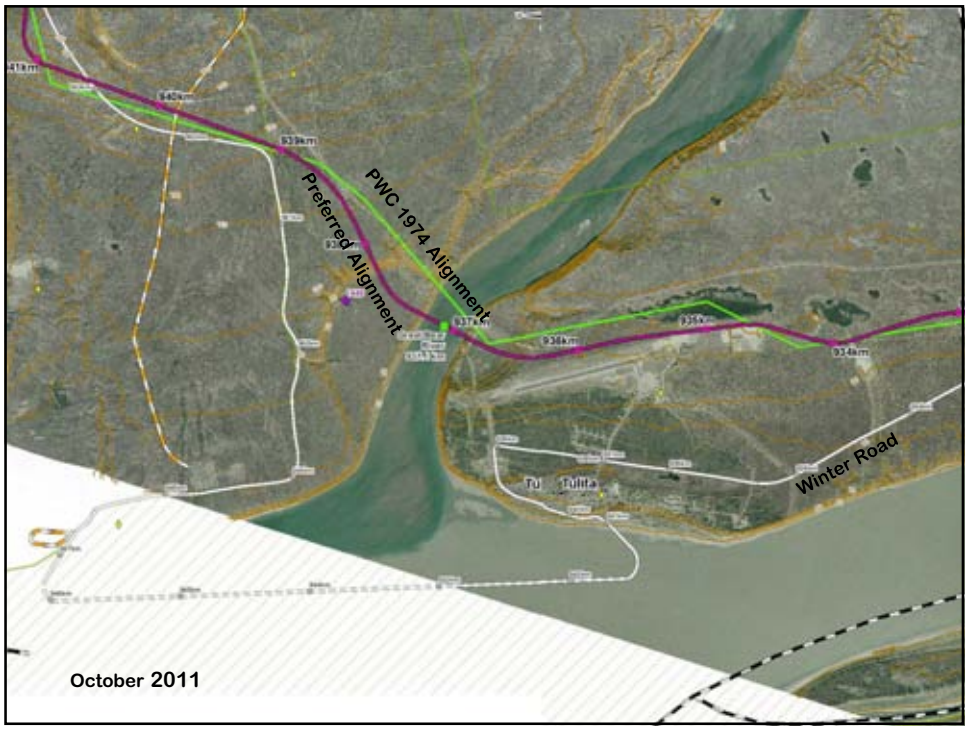


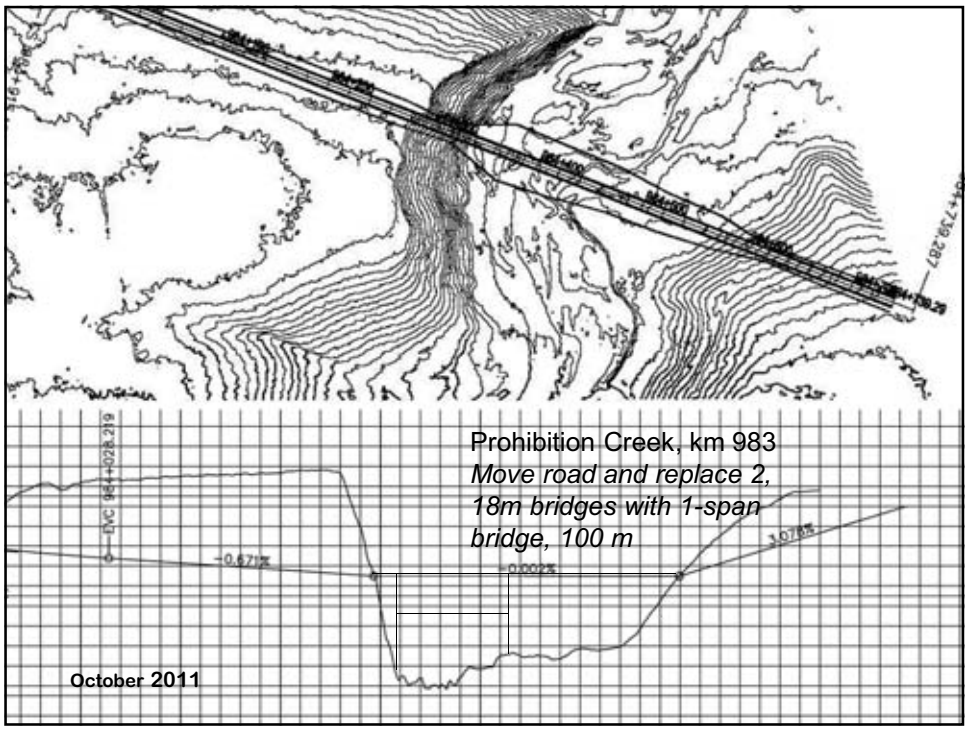
Four Mile Creek, km 931
Move road and replace 18 m bridge with 2-span bridge, 100m+40m
October 2011

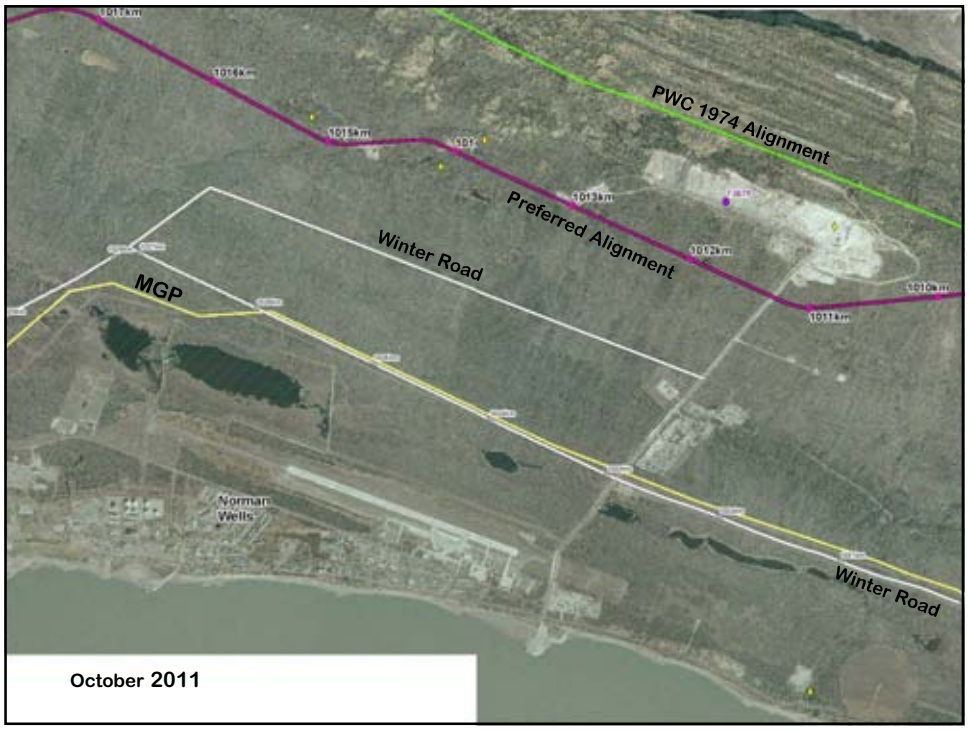


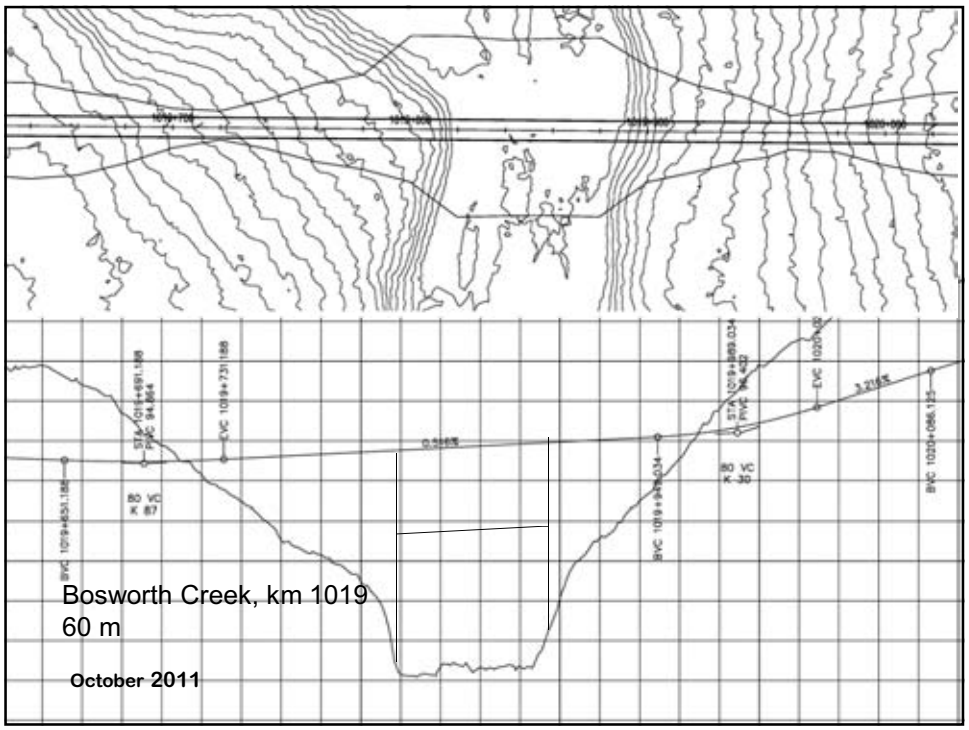
October 2011

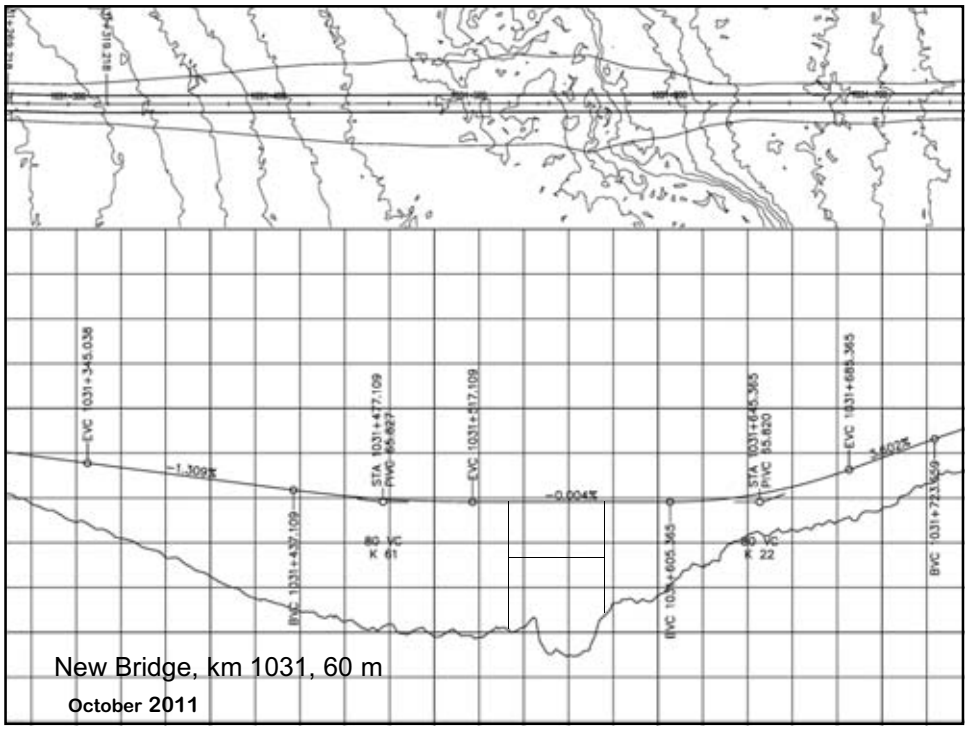
Great Bear River Bridge
5-spans, 460 m


PWC 1974 Alignment
Preferred Alignment
Winter Road
Tuhta
October 2011


Prohibition Creek, km 983
Move road and replace 2, 18m bridges with 1-span bridge, 100 m
October 2011


PWC 1974 Alignment
Preferred Alignment
Winter Road
MGP
Norman Wells
Winter Road
October 2011


Bosworth Creek, km 1019
60 m
October 2011



How will the Highway be built?

- Through appropriate partnerships
- Opportunities for training segments (i.e., a 20 km segment near Tulita designated for training)
- Multiple camps and deployment points building in both directions.
- Material production at selected sources in late fall, early winter.
- Mostly winter construction using the winter road for access.
- Some activities such as grading and placing of surfacing material to be conducted in the summer.

October 2011

Mackenzie Valley Highway
Tulita District

How was Traditional Knowledge used to define where and how to build the Highway?

- Started by talking to you
- You pointed us to the available publications
- Returned in March 2011 with preliminary ideas of where the Highway would go and you helped us by identifying cabins, area of use, sensitive and traditional use areas on the maps and guiding us to further information
- With your help, we've used all of this information/discussion to select the preliminary line on the map for the Highway.
- Now, in the Stage 2 activities (ongoing consultations, one-on-one interviews, elders flyover, door-to-door surveys), together we'll look closer, using traditional knowledge to refine the design for the Highway and the plan for construction.

How was Traditional Knowledge used to define where and how to build the Highway?

Started by talking to you

You pointed us to the available publications

- Sahtu Land Use Plan third draft, issued by the SLUPB in August 2010,
- Rakekee Gok'e Godi: Places We Take Care Of (SHPSJWG 2000),
- Spirit of the Mountains: Shuhtagot'ine Nene and Naats'ihch'oh Traditional Knowledge Study (SENES 2009), and
- Traditional Knowledge Study Report: Great Bear River Bridge (EBA 2006).

Returned in March 2011 with preliminary ideas of where the Highway would go and you helped us by identifying cabins, area of use, sensitive and traditional use areas on the maps and guiding us to further information:

- Department of Environment and Natural Resources – Values at Risk
- Sahtu Renewable Resource Board – Harvesting Areas
- Sahtu Land Use Planning Board – Traditional Trails

How long will it take to build the Highway and how much will it cost?

- Start of construction will depend on approvals and funding
- Approvals could take two or more years
- If funding is available, construction could be completed in 3 to 4 years
- Estimated cost for construction of the Highway in the Tulita District is $599 Million
- Includes $60 Million to construct the Great Bear River Bridge

What will be the benefit of the Highway?

"Benefits of the road are opportunities for business, education and training."

"The Highway will be important for the younger generation."

"The highway will help in the pipeline construction."

"The highway will bring opportunities for increased tourism in the area and help improve the local economy."

What will be the impact of the Highway on the environment?

- There will be a footprint.
- There will be increased traffic.
- Availability of access communities and the land will be increased.

What is included in the design and the construction to minimize the impact on the environment?

There will be a footprint.

- Utilize the existing winter road
- Open few material sources at key locations
- Avoid cuts
- Requirements for monitoring and management during construction

What is included in the design and the construction to minimize the impact on the environment?

- Availability of access to the communities and the land will be increased:
  - Increase monitoring and enforcement of permission to access the land as per the Land Claim Agreement and Regulations
  - Joint Transportation Corridor Management Group
  - Monitoring during operation

What is included in the design and the construction to minimize the impact on the environment?

- There will be increased traffic.
  - Use appropriate design standards for safe travel
  - Dust free surfacing near sensitive areas
  - Increased maintenance and traffic enforcement
  - Joint Transportation Corridor Management Group
  - Monitoring during operation

Next Steps for the PDR work

October - Revise preliminary design and Project Description Report with any additional input, complete and 5658 will submit to DOT.

Early Winter - Combine with Prelim Design and Project Description for Other Segments of the Highway

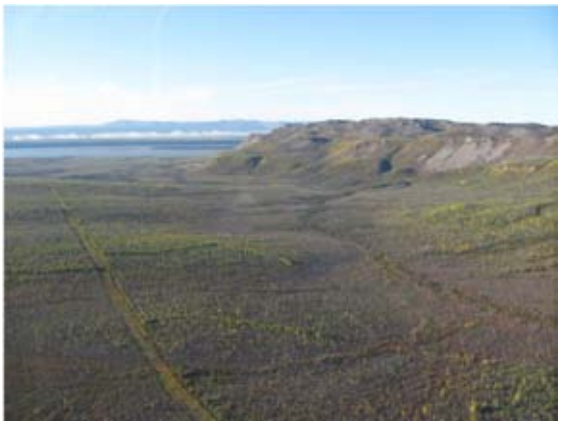
Jan 2012 - Submit to the Mackenzie Valley Land and Water Board

What are the next stages of work?

Stage 2 Activities (Start in Nov 2011 when funding available):

- On-Going Consultations to refine the design:
  - Community Meetings, Door-to-Door Surveys, Elders Flyover, One-on-One Interviews
- Geotechnical Investigation:
  - Along preferred alignment, in material sources and at new bridge sites.
- Fisheries, Hydrology, Hydraulics Investigation:
  - At new bridge sites
- Vegetation, Rare Plants, Wildlife, Archaeology Investigation:
  - In locations along the alignment and in material sources that have not yet been covered by DOT and MGP

Questions and Discussion



October 2011

Mackenzie Valley Highway
Tulita District

APPENDIX D

APPENDIX D CONSULTATION SUMMARY TABLES

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Comments and Questions from Tulita - Mackenzie Valley Highway, Tulita District

Theme	Question/Comment	Consultation Session				Consideration of Comments
		Tulita Community July 29, 2010	Tulita Community March 29, 2011	Chief Albert School October 5, 2011	Tulita Community October 5, 2011	
MVH (practical considerations)	Is it misleading to say that the route has not been selected when there is existing bridge infrastructure?	1				The bridges will likely be used, but the road needs to "connect the dots" between bridges. We are responsible for asking the community questions about the routes, as we need to defend the final route presented. If there is a better location for a bridge, we will put that into the report. The Project Team wants to ensure that the routes minimize impacts, especially near towns. In Norman Wells, there is a highway bypass.
	The Town of Tulita has been lobbying for the Great Bear Bridge and has been told by the Minister of Transportation that the location of the bridge is open for consultation. They were hoping that the location of the bridge would be part of this discussion?	1				The Minister's commitment will be observed. There was a lot of consultation conducted to determine the bridge location. The consultation process and how the bridge location was determined will be reviewed and will be discussed further as part of this process.
	The community needs gravel sources for the bridge.	1				There are approvals in place for the bridge already; everyone's interested in the bridge.
	There were two sites identified for the bridge.	1				The consultation, engineering factors, and decision will be reviewed and new input will be considered.
	When will the project start? What will be required for this portion of the project? Who will be hired and trained?	1				The Project Description Report will occur in 2010-2011. The contract is expected to conclude by Summer 2011. There is an upcoming 6 day field program that will require 2 local field assistants. These assistants need to have an FAC permit for firearms and be able to work with engineers and scientists. The Project Team is requesting input from the community as to who these 2 people should be. Additional work includes catering and providing language interpretation for future meetings (2 more meetings; 3 total). EBA is conducting field studies and writing the Project Description Report. When the project is in the regulatory process, there will eventually be more work related to detailed design, borrow sources, drilling, etc. At this stage, there will be more opportunities for hiring locals. The Project Team needs input as to the community's preferred service providers.
	Will there be work this winter?	1				No, there will be a 6 day field program this August/ September. Future work will be in winter, particularly related to borrow source investigations. Currently, there is only funding available to prepare this Project Description Report. There is no funding for work beyond that.
	What is happening to the Oscar Creek Bridge?	1	1			The Highway in that portion will be moved because the land in the new location is better, Oscar Bridge could be moved to the new location if length is appropriate.
	Prefer the road bypass the town, but connect to the town	1				Comment noted
	What does the yellow line in the maps represent?		1			The pipeline location.
	Why will the PDR be submitted to the Mackenzie Land and Water Board and not the Sahtu Land and Water Board?		1			Because of the trans-boundary nature of the application, it will be taken to the Mackenzie Land and Water Board and they will engage with the other boards.
	So the completed PDR will be submitted to the Mackenzie Land and Water Board, but what about the water crossing permits?		1			Permits related to water crossings and gravel sources will be taken to the local boards and regulators. Is the end product that will be taken to Mackenzie Land and Water Board.
	The close location of Great Bear Bridge to town has come up several times with Elders, it is a concern.		1			Comment noted
	Map #2 has two very different routes in Norman Wells.		1			The two routes are looking at the options to go around and through Norman Wells. This was a preference question we asked last night at community meeting.
	What technical safety issues are promoted in the design stage?		1			Building an all weather Highway that can support travel at 80 Km/h and has enough width to accommodate two way traffic plus shoulders. Minimize collisions still requires people's good judgment. (speed, gas, watch for wildlife and other people just to name a few).
	The Department of Transportation has been widening portions of the existing winter road; will that be the chosen alignment?		1			We are widening to improve the driving conditions in the winter road but that doesn't mean it will be the selected alignment.
	Are borrow sites and granular material needed in the Tulita section?		1			The answer to that question will be provided when we return in July.

Comments and Questions from Tulita - Mackenzie Valley Highway, Tulita District

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		Tulita Community July 29, 2010	Tulita Community March 29, 2011	Chief Albert School October 5, 2011	Tulita Community October 5, 2011	
MVH (practical considerations)	Has an alternative route along the skirt of the mountain been considered?		1			Please show us in the map and we will include it in our studies.
	The 1974 alignment is part of the Higher North and Resources study/project?		1			Yes, and much of that information we are using as background in our studies.
	Is the PDR a realignment of the winter road?		1			It is a PDR for a new alignment that in some portions follows the winter road.
	Are there following steps established, or funding available for next parts/steps?		1			The funding request will be given to the new government elected in October.
	What is the time frame to construct the highway once it has been approved?		1			Application filing is estimated for January 2012, it will take approximately 2 years for the review to be completed plus on extra year of design.
	Is there an expiry date on the info provided? Expiry of permit?		1			It has 3 year period life
	How long will it take to build the highway?			1		2 years of design and approval. 3 and a half to 4 years to build. Depending on availability of funding.
	How will highway be connected over lakes and rivers?			1		Around lakes and above rivers with bridges. No construction over or through lakes.
	When will you start highway?			1		You will start it. Construction will start when approvals are completed.
	Will bridges go straight across or be supported in the water.			1		Bear River Bridge for example will have 5 spans supported in water. Other bridges will have two spans, but the pier will be out of the water.
	What about ice?			1	1	Bridges will be designed to handle ice. Bridges will be high enough and with enough space between spans to allow for ice movement.
	Are Deline and Colville Lake in the highway alignment?			1		No
	Will there be a consideration for two lane bridges a part from Bear River?				1	No, single lane bridges will serve the projected traffic volumes in the long term.
	Can you explain how you are going to achieve the highway construction over wet terrain? Will you just pile gravel on top of itself more and more?				1	Wet terrain and ice-rich terrain has been avoided in the preliminary design.
	What about the other areas of the highway? Where are they with their portions of the PDR?				1	Gwich'in done in June; K'ahsho Got'ine and Deh Cho are soon to be completed.
	If bridge is near water intake wouldn't that be worse with backups that we can already observe during summer time? 5-7 years ago whole pipe was down the Mackenzie backing up water. Backups might affect drinking water. This concern needs to be reflected in the PDR.				1	This bridge was approved once. It will not impact flow of water, or impede ice. PDR can still move forward and we can work to address these concerns.
	Is the Project Team considering land tenure and land rights?	1				We recognize the different land types but want to work on the best route first and then work on land tenure processes. The same method is being used in the Inuvialuit and Gwichin areas. We need input from Sahtu to understand the process, but the land tenure acquisition portion of the work is outside of EBA's scope of work for this project.
	The community is concerned about youth committing suicide from the proposed Great Bear Bridge. In some places, bars and rails are being added to bridges to prevent suicide.	1				Comment noted
	People depend on fish lakes, historical sites, etc. Need to start the project with collecting traditional knowledge from Elders.	1				We do listen and try to balance traditional knowledge and input from the community with other factors, such as economics. For example, residents of Inuvik and Tuktoyaktuk wanted the proposed highway located 30-40 km from Husky Lakes, but later agreed to a distance of 10 km when they considered all of the factors.
	A comment we had in July 2010 session was looking at the sacred areas around Peel River.		1			We are still conducting studies and the intention is to keep the Highway away from those areas.
	There is a cabin close to the road around Jasper Lake, does Highway accommodate this?		1			We met with NWT Environment and Natural Resources today and we are getting information about the values at risk to include in our studies and avoid when designing Highway.
	There are related safety issues and social impacts to the Highway people don't like, but at the same time there are roles the community must play in order to improve it. What about a corridor management group? People getting together to review the statistics, see the impacts and how to prevent them. It would be something new, different and constructive.		1			Beyond safely travelling the community must contribute in minimizing the social and economical impacts. The management group can be implemented once the Highway is in operation.

Comments and Questions from Tulita - Mackenzie Valley Highway, Tulita District

Theme	Question/Comment	Consultation Session				Consideration of Comments
		Tulita Community July 29, 2010	Tulita Community March 29, 2011	Chief Albert School October 5, 2011	Tulita Community October 5, 2011	
Society	Before a lot of people were against the Highway, now is different people want it even though they are aware it will bring social implications. It is necessary to talk to the youth and for them to listen to the elders about the consequences of drinking and driving. We are now heading into the Highway, there is no turning back, and people need to express how much they want this going forward or not. Later the pipeline will come in and Tulita will change some more. Changes are coming. It is important to listen to the elders on where they want the bridges, they know how the decisions will affect us in the future. It is important to speak up at this time if you want to see the Highway or not.		1			Comment noted
	Why didn't you prepare a Traditional Knowledge (TK) study with the community?		1			We are not doing a new TK study. We will gather the information collected by the Sahtu Land Use Planning Board for the pipeline and join it information from the archeological studies.
	The Sahtu Renewable Resource Board has a lot of TK information. Why wasn't it used?		1			We weren't aware of this information. Now we will be sure to incorporate it.
	It breaks my heart to see the TK component has been overlooked, as I am aware a lot of people would have like to contribute to it.		1			In the steps we are taking, we are looking for points of contact that can provide this information. Please let us know if there are any other sources we should be incorporating.
	From the regulatory point of view, what will they deem as an appropriate TK study?		1			It is sufficient with demonstrating we have considered and use available TK information without having to conduct a new one.
	The TK studies belong to the people so you need to ask them for permission to use that information. It does not belong to the Sahtu Land and Water Board.		1			Comment noted
	Where are we headed? Do consultation/survey with the community about TK study. We want what we told the Minister, to have community input before supporting the Highway.		1			This is not a government PDR but a 5658-people PDR. We are here because it is still a work in progress. We will need to measure approval before going ahead. Without the support of the community it will not be funded. Come to the maps as it was intended from the beginning and show us where we should move the Highway to, based on your land/TK knowledge.
	People should use this opportunity to say what their concerns are and what is on their mind, putting differences aside. Highway will ultimately be a benefit for the people. Since 74 we knew there would be a Highway from Wrigley with good and bad implications. We need to explain to youth why it is beneficial. When we have discussion we identify mistakes, from there we make corrections and we can teach our children so they don't fall on those mistakes again. Our challenge is to teach young people to correct our ways. Highway is to proceed and present opportunities. Our way of life (aboriginal) is slower and new the new comers are faster, but we need to do things together for future generations.		1			Comment noted
	Way back when, elders talked about the proposed Highway crossing being located bellow Bear River. They chose this location for safety reasons, it is dangerous for youth crossing in bicycles. The crossing proposed now is to close. If the Highway is to go ahead all communities should be informed and come to meetings to have input.		1		1	We are here to listen and will come back to get information on how you want Highway to be built.
	Don't go to Sahtu Land Use and Planning Board for TK, you need peoples consent. You need to do new one not use what other companies have done.		1			We will discuss new scope with 5658.
	Make sure TK process is done properly from the first time.		1			Comment noted

Comments and Questions from Tulita - Mackenzie Valley Highway, Tulita District

Theme	Question/Comment	Consultation Session				Consideration of Comments
		Tulita Community July 29, 2010	Tulita Community March 29, 2011	Chief Albert School October 5, 2011	Tulita Community October 5, 2011	
Society	Highway will affect the land and the culture. People don't know how close it will be to cabins.			1		We have talked to people with cabins to get their input in the locations near the highway.
	Highway will mean open access year round. Drugs and alcohol from south.			1		That may very well happen. People will have to make wise choices.
	Highway will be beneficial as winter road is bumpy and hard to drive on. It will allow travel between communities. Food in grocery stores will probably be cheaper.			1		Comment noted
	What happens to people who trap?			1		Highway crosses trap lines, but so does winter road. We would talk to people who trap to get their advice.
	Will it still be possible to go up Bear River in a boat?			1		Yes
	About TK, for the Sahtu in the north is considered very important not like in the south. We are concerned about bear habitat, beavers and berries among others. A preferred road alignment has been chosen at this time but would like to know how wildlife will be considered during construction. Will there be monitors so bears and wildlife are not pushed out of the way?				1	The preliminary design will be refined based on more information that is gathered during the detailed design stage. During construction monitors will do two things: monitor construction and contractors and advise on new information (i.e., bear dens, etc.) that arise during construction.
	Concerned with historic sites in gravel sources. Our kids need to understand their importance. Is there a mechanism through which we can get this information to them? Kids need to get knowledge and training.				1	The potential material sources have been chosen because there isn't any known historical sites in the vicinity. In the detailed design stage before construction, archaeological investigations in these sources and also one-on-one interviews will be undertaken to collect info about those gravel sources. A suggestion to get the younger people knowledge and training in the historical resources is to hire them as part of the team that conductgs the one-on-one interviews, or as support for the archaeological investigations.
	Have there been studies elsewhere in Canada to assess the impact on isolated communities?				1	The best example is the Dempster Highway. We have looked at that example and used available lessons learned in the preliminary design for the Highway.
	This is now a plan that can be followed. People need to understand what we are doing here. Elder's flyover may show new things, for example Bear River Bridge, they said youth could get hurt. Will this information be a consideration to move highway?				1	Comment noted and yes the new information will be considered in the detailed design prior to construction.
Economy	Which of the Tulita options is more economic?			1		Winter road as there would be no changes, however pink align (preferred alignment) is better in comparison to the green (1974 alignment)
Environment	The definition provided for cumulative effects was from an industrial point of view; in Tulita, people look at cumulative effects from an environmental point of view, amongst others.	1				Comment noted
	There is a general concern regarding people from the south accessing the Sahtu region, particularly for wildlife harvesting.	1				We need to meet with the agencies in the area to discuss this further as this is the first public meeting.
	Will the highway be located by fish lakes?	1				In areas near lakes, some segments of the road will not receive certain treatments due to certain risks to fish, water quality, etc. Calcium can get into lakes if it is used nearby.
	Calcium also attracts wildlife.	1				Dust control needs to be used sparingly and needs to be well thought out. There is a balance between the benefits, concerns and risks. The Project Team is trying to reduce the risks. As such, we need to identify fish lakes. The Project Team will look into other dust control measures.
	There have been many climate change studies conducted. The field work should occur in the fall to avoid the seasonal fog.	1				Yes, the field crews are trying to schedule their reconnaissance for August/ September to avoid the fog tat typically occurs in late September.
	Concerned about Highway around Tulita. Collisions, animals, children on highway, pollution, dust.		1			Comment noted
	What are the plans to mitigate dust?	1	1			The Department of Transportation uses chloride and magnesium in especially critical areas, but we are looking at other options to address same critical points.
	What will be the impact on the land?			1		Design considers wildlife, lakes, rivers, TK among others

Comments and Questions from Tulita - Mackenzie Valley Highway, Tulita District

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		Tulita Community July 29, 2010	Tulita Community March 29, 2011	Chief Albert School October 5, 2011	Tulita Community October 5, 2011	
Environment	What about oil spills?			1		Oil spills are a possibility and will be stored away from stream with tanks and any spills must be cleaned up right away.
	How will the Hwy affect the water source?			1	2	The water source for the community of Tulita is the Great Bear River. The Highway and the bridge are designed to avoid impact to the water intake.
	I understand the talk about animals and habitat but my concern is where are the potential gravel sites?				1	On the posted maps you will see the potential gravel sources identified. More investigation will be done in the detailed design to make sure these are good and will not harm the environment.
	In the 70's a blue book was developed with all the gravel sources identified in it. This was used when the negotiations for the Land Claim Agreement took place. Will you use this information and go back to the specific sources for detail discussion?				1	The information was used in the preliminary design and PDR. More investigation on the material sources will be done in the detailed design prior to construction.
	When negotiating the land claim the blue book was used. Have you interviewed the people that took place in that negotiation and know about the gravel sources?				1	No, not yet but is a good idea
	Where is the highway in relation to Bear Rock? We should consider not touching any gravel sources in it.				1	We are aware of gravel sources around Bear Rock but these will not be used.
Consultation	It's all "us", not "you" and "us". The community and 5658 decide.	1				Everything that is prepared by EBA is reviewed by the Steering Committee and the Management Committee. The Steering Committee reviews the work first, and then provides comments for the Management Committee for their review and decision. EBA takes direction from the Management Committee.
	The decisions of the community show up in the report.	1				Comment noted
	The Land Claim Agreement, Schedule B has a designated route for the road. To move the route, this will need to be negotiated with the land corporation and may take years and legal work to be completed if the road is located on settlement lands.	1				Comment noted
	Should have more residents at this meeting because it is very important. When will there be more meetings?	1				There will be more meetings in late fall, after the field reconnaissance and consultation/ meetings. There will be more advertising prior to the next meeting.
	Keep in mind through the process to consult more with the community when addressing bridge location, especially with Great Bear Bridge.		1			Comment noted
	Will there be further consultation with the Tulita Dene Band?		1			We will be contacting the agencies shortly to see if separate meetings are wanted.
	Do a house to house survey to provide more understanding.		1			Comment noted
	Have more information shared/ available at schools		1			Comment noted
	Have the Chief put it on radio with interpret on Slavey so more people Know about it and that way it can also bring better turn-out at the meetings.		1			Comment noted

Comments and Questions from Tulita - Mackenzie Valley Highway, Tulita District

Theme	Question/Comment	Consultation Session				Consideration of Comments
		Tulita Community July 29, 2010	Tulita Community March 29, 2011	Chief Albert School October 5, 2011	Tulita Community October 5, 2011	
Other	The Tulita District is not in this partnership (as per the presentation). It's best to call it "Tulita District Area" or "5658 NWT Ltd." to be accurate.	1				Comment noted
	Who is submitting the Project Description Report to the government (i.e., 5658 NWT Ltd. or EBA)?	1				EBA will prepare the report in the voice of 5658; 5658 and the GNWT Department of Transportation will submit the report together.
	There was a MVH initiative in the 60s. MLAs talk about going to Ottawa and pushing the project forward. MLAs will get together and will discuss goals for 17 legislation assembly strategy to continue work in the next 4 years. They will communicate to people in Ottawa how this piece of infrastructure is important to the people in the north.				1	Comment noted

Comments and Questions from Norman Wells - Mackenzie Valley Highway, Tulita District

Theme	Question/Comment	Consultation Session				Consideration of Comments
		Norman Wells Community July 28, 2010	Norman Wells Community March 28, 2011	Mackenzie Mountain School October 4, 2011	Norman Wells Community October 4, 2011	
MVH (practical considerations)	How wide is the proposed corridor?	1				The lines shown on the maps are not scale. The width of the corridor along the Mackenzie Valley will not be consistent due to bridges, etc.
	Are the corridor sizes based on a first come, first serve scenario?	1				The Project Team is building on available MGP information and is not working to recreate data. Other public information is available from the Geologic Survey of Canada. Imperial Oil has offered digital mapping files to the Department of Transportation. The Project Team will use shared information and public information.
	The worst place to navigate along the road is a slide area by the water; it was recommended that the route go along the ridge and that the Project Team use traditional knowledge.	1				Comment noted
	It's been said that for every dollar spent on the road, that the pipeline company will save a dollar. Have the pipeline companies been asked to contribute financially to this project?	1				Yes. This matter has been raised by the Prime Minister, Town Councils, Department of Transportation, etc. Until Imperial Oil receives approvals and licences for the MGP, they do not want to commit to additional development projects. It is understood that the proposed highway reduces risks, costs, etc. for pipeline companies; however, Imperial Oil has stated that their plans to construct the pipeline are not dependent on whether the highway is constructed or not.
	This is a 50-50 proposition with CAN-NOR and Government of the Northwest Territories.	1				Comment noted
	Some of the permanent bridges were supposed to lengthen the winter road, but did not plan appropriately for freshet and as a result, some bridges are surrounded by water during freshet. New bridges may be needed.	1				Comment noted
	Some routes can be used for the highway and some cannot, depends on freshet, etc.	1				Comment noted
	The highway should be located outside the town. One resident suggested that the route cannot be located outside of town due to Jackfish Lake, and that the two existing routes through town should be identified so that more discussion can be had.	1				Comment noted
	The Town needs to know where there are good gravel sources. The Town would also like to know if there is information that they can provide to other organizations regarding the road.	1				Comment noted
	The Winter Road is currently located on high ground and is a good starting point for a proposed route.	1				Comment noted
	Regarding gravel – the Project Team should review the MGP gravel sources and identify how much MGP needs.	1				Comment noted
	The winter road location is good for the all weather road	1				Comment noted
	Which are the new bridges?		1			Section 6 of this PDR
	What is the criteria used to determine the proposed/alternate routes?		1			Width, length, quality of material, proximity to sources, environmental considerations, drivability and safety, route furthest away from traditional use/archeological areas. These are just a few items within the list. Also do we want to bring traffic through town as an economic development opportunity, or have the Highway go on the other side of the airport to allow for the expansion of community development and redirect heavy traffic away from town?

Comments and Questions from Norman Wells - Mackenzie Valley Highway, Tulita District

Theme	Question/Comment	Consultation Session				Consideration of Comments
		Norman Wells Community July 28, 2010	Norman Wells Community March 28, 2011	Mackenzie Mountain School October 4, 2011	Norman Wells Community October 4, 2011	
MVH (practical considerations)	What does "best topography" mean?		1			In the Tulita District, best topography refers to flat areas, avoiding muskeg; avoid areas highly affected by permafrost. They are the most stable areas, with crossings at stream crossings 90 degrees, I locations where banks are not to steep.
	Are you aware of Dr. Ford's study that recommends making this a UNESCO heritage site? It focuses on the sink holes and rock formations?		1			EBA asked for material information to research
	Where will construction start? From the middle going both ways or from one of the extremes?		1		1	Construction will be staged from multiple locations including Norman Wells and Tulita because access is provided through the Winter Road.
	What are you going to do so Liard Highway problems don't happen here?		1			Much like the Alaska Highway, Liard Highway was built fast and without sustainable practices in mind; its main purpose was to provide access to resource areas. That is not the philosophy under which Highways are built today. The idea today is having capital up-front to reduce maintenance costs, manage climate changes and make it sustainable.
	Wouldn't recycled rubber cut down on dust?		1			We are evaluating different products for surface treatment with focus on areas where dust control is imperative.
	After Steep Creek, coming in from Wrigley, it is very slanted and often gets overflowed. In winter time it becomes ice all the way uphill making it a safety hazard.		1			Comment noted
	What about river crossings like Bear River?			1		Bear River will get a bridge. Use winter road bridges and build some new ones
	When will construction begin?			1		Earliest construction 2013-2014 depending on funding and approvals (Section 7 of this PDR)
	Will construction take place in winter?			1		Yes
	How will you deal with the dips where permafrost melts?			1		First, design embankment to avoid permafrost melt and second, repair dips through maintenance.
	If construction takes 3 to 4 years how will we use the winter road?			1		Temporary detours will be implemented. Can't close the winter road.
	From Wrigley to Norman Wells traffic has to deal with ruts at the end of season. Wouldn't highway traffic on Wrigley make it worse?			1		Yes it will, the challenge is to maintain the road
	Is the maintenance included in the cost?			1		Maintenance not included with the exception of the winter road maintenance during construction.
	Is the pipeline the reason why the highway is being built?			1		Highway may benefit the construction of the pipeline but is not the reason for building it.
	So in 2013-2014 construction will start?			1		Yes, if all funding and permits are in place, construction will start winter 2013 or 2014
	Does the $599 million budget include construction and materials only or will it also pay for workers?			1		Includes labour
	Can the cost be overrun?			1		This is only an estimate. Detail engineering and design work is needed to fine tune the costs.
	Road is over 800 km, will all of it be graveled? That is a lot of gravel.			1		The Highway will be constructed with available material.
	Is this entire project funded by government?			1		Yes
	How many bridge areas will require cut?				1	Included in the preliminary design
	When do the permits expire after submission to the MLWB?				1	Regarding permits, approval from Minister will not expire; Water licences and Land Permits will depend, these can vary from 3 to 5 up to 10 years and some have renewal options.
	Will the Transportation Corridor Management Group be developed prior or during construction? How will pay for this?				1	The idea of a Transportation Corridor Management Group could start now, but will need to be funded from a variety of sources, government and private sector.

Comments and Questions from Norman Wells - Mackenzie Valley Highway, Tulita District

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		Norman Wells Community July 28, 2010	Norman Wells Community March 28, 2011	Mackenzie Mountain School October 4, 2011	Norman Wells Community October 4, 2011	
Society	People need training. During construction of the highway, the contracts should specify that there by apprenticeships and training for residents.	1				Comment noted
	concern that the highway will create big change, and not sure if it will be positive or negative change for the community	1				Comment noted
	concern that the highway will change the way of life (e.g., currently a quiet way of life)	1				Comment noted
	Access to northern culture means we could take on more southern values from contact because of open access.			1		Joint management group with representatives from local groups work to preserve culture
	We need other things like alternative energy sources. Highway is not the priority.			1		Comment noted
Economy	Benefits from the Highway include: - access to outside world without paying $1,700 - 1,800 for flights - reduced freight costs - open area up for touris - reduce costs of flights (example provided based on Mayor's experiences in Labrador with a remote community before/after road construction) - feeling of freedom (psychological benefits) - change in attitude for people from a remote community - smaller companies can afford o come out and explore in the region - more investment into smaller companies - additional income to residents from businesses	1				Comment noted
	Concern of decreased wages due to decreased cost of living	1				Comment noted
	Will there be winter field work? Jobs?		1			If funding is available geotech, surveys, environmental studies could be start during 2011-2012 winter
	What does it mean, if funding is available for winter field work?		1			Department of Transportation is looking for funding to support Stage 2 activities (i.e., winter field work).
	Lot of money will go into this project. Is it actually worth it?			1		The PDR attempts to demonstrate this.
	Will there be local hire?			1		Yes this is expected
	What about local business like airlines? Wouldn't be an impact to them?			1		May be a negative impact but could also be an increase in air travel from the south as a result of increased economic development in the area.
	When highway becomes functional, the tax benefits will go down.				1	Comment noted
	Most people don't have credit cards to get food in Town. Food crisis is getting worse.				1	Comment noted
	Motion needs to be passed (by the land claimant groups and band council to support the PDR). Perhaps go to the MLWB to see if each region's support is enough to have the overall support.				1	Comment noted

Comments and Questions from Norman Wells - Mackenzie Valley Highway, Tulita District

Theme	Question/Comment	Consultation Session				Consideration of Comments
		Norman Wells Community July 28, 2010	Norman Wells Community March 28, 2011	Mackenzie Mountain School October 4, 2011	Norman Wells Community October 4, 2011	
Environment	Will the proponent be applying for a land use permit in 2011?	1				The proponent is currently identifying the expectations and will talk to AANDC further.
	There is time pressure to conduct the field studies before the snow falls, and the field crews need input as to where to direct their reconnaissance efforts.	1				Comment noted
	not too many wildlife around the winter road, but some beaver dams and caribou	1				Comment noted
	concern regarding increased access to the area for exploration	1				Comment noted
	concern with people shooting wildlife from the road	1				Comment noted
	concern with the road corridors and potential effect on wildlife	1				Comment noted
	the winter road provides easy access for hunting (which is good and bad)	1				Comment noted
	hunting can be managed if there are monitors and enforcement (e.g., steep fines implemented immediately)	1				Comment noted
	concern regarding garbage and litter along the proposed highway	1				Comment noted
	Will there be a prequalification included in the next steps?		1			Next stages will be delivered through same model with 5658 as today.
	When piling material how will damage to areas around Highway and cabins be avoided?		1			Preliminary design avoids such areas.
	How will monitor camps function to make sure construction is being done properly? Will it be some kind of enforcement to avoid companies' damage to the environment? What will happen when all the work is done?		1			All Sahtu licences have conditions already with periodic check-ups. Extra efforts in monitoring has been recommended.
	Concerns about minimal damage to the environment and the job being done properly.		1			Extra efforts in monitoring has been recommended.
	If detour are being created while highway is constructed won't that create more disturbances?			1		Temporary detours will be constructed to minimize impact.
	Winter road already affects the environment. This will be more.			1		Comment noted
	Are all this costs, efforts and effects on environment worth it?			1		The PDR attempts to demonstrate the value.
	What about dust control?			1		Right now magnesium or calcium chloride are being used. Other products are considered in the PDR
	We should think about environment before we make it worse than it is. I would rather live without a highway. I don't see we are missing out on anything.			1		Comment noted
	Will the submission be elevated to an Environmental Assessment?				1	Possibly
	When the cut brush across the road occurs, how wide will these be? Will these be done with big machinery?				1	Currently winter road has a cleared right-of-way of 100 ft.- 30 metres. The Highway will have a cleared right-of-way of 200 ft. – 60 metres. A suggestion is to start with selective harvesting and then machine cut the remaining.
	Clay is good on road to avoid dust as it sheds water and holds together.				1	Comment noted

Comments and Questions from Norman Wells - Mackenzie Valley Highway, Tulita District

Theme	Question/Comment	Consultation Session				Consideration of Comments
		Norman Wells Community July 28, 2010	Norman Wells Community March 28, 2011	Mackenzie Mountain School October 4, 2011	Norman Wells Community October 4, 2011	
Consultation	The definition and the requirements for consultation are identified in the Sahtu Land Agreement. The presentation should identify the location in the agreement and explain to people what their rights are. As well, the Project Team needs to meet with people with specific land tenures along the proposed route options.	1				One-on-One interviews will be conducted as part of the detailed design stages prior to construction, to refine the alignment.
	The Tulita District (name applied to the four organizations under 5658 NWT Ltd.) has hired EBA to do this project, so consultation should be directed from the Committee.	1				Comment noted
	The Steering Committee and their legal counsel should inform the Project Team of the legal consultation provisions.	1				Comment noted
	The Town Council support the meeting and the highway, but would like to be kept informed of upcoming meetings.	1				Meeting specifically held with Town Council on August 2, 2011
	When will the proposed routes be on the map for the community to review?	1				We have three routes on the maps that were brought today (Winter Road, MGP, 1977 Route) that we would like initial input on.
	The Town Council would like to provide input, but they need more notice and they want the community's input.	1				The Project Team are happy to accept route options and look forward to Council and community involvement.
	What is the timeline? Will it be submitted in July?		1			Submission of the overall Highway to MVLWB in January 2012
	Has this approach been used before to build Highways?		1			New to the NWT
	I'm happy to see EBA working with Land Claim groups in Tulita.		1			Comment noted
	W. McDonald lives close to Oscar Bridge, as a resident what does he need to do to have input?		1			EBA asked for contact information
Other	Is EBA writing the whole report?	1				Yes with input from 5658 committee representatives.
	The community of Tulita may have a potential issue with the subconsultants selected as they have agreements with other firms and may want other firms to have a portion of the work.	1				The Project Team will be meeting with the Community of Tulita tomorrow (July 29, 2010). The current subcontractor contracts are relatively small. The Project Team has requested input from Tulita previously on this matter and will continue to discuss this with Tulita, particularly as they are part of the Management Committee.
	Why did you come here to tells us all this and talk about the highway?			1		You will be the future users of the highway. We need to hear from people living here, get the information that will help us develop
	What is the most efficient way to get road built?			1		Go to school become engineer designers or environmental scientist, the highway will need lots of things as construction will start in various areas at once.
	Will there be spin off projects as result of highway?			1		Pipeline, resource exploration but also the increase in local businesses.
	The Mackenzie Aboriginal Corporation presented pipeline and highway projects together, this loaded the motion and gave a negative aspect to it. When joint motion was put forward it was defeated.				1	Comment noted

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FORT NORMAN METIS LAND CORPORATION & TULITA RENEWABLE RESOURCE COUNCIL

- A short presentation was made by EBA to the Fort Norman Metis Land Corporation (FNMLC) and the Tulita Renewable Resource Council (TRRC) on August 16, 2011 at 2 pm. In attendance were Eddie McPherson, Jr., President of the FNMLC and David Menacho, President of the TRRC.
- Four alignment options in the vicinity of Norman Wells, three alignment options in the vicinity of Tulita and two options for Oscar Creek were discussed.
- The FNMLC and TRRC representatives indicated an overall support for the Highway. They also indicated the importance of traditional knowledge, the importance to continue the community consultation and participation as it was everyone's project and money and they need to be vigilant.
- Availability of funding for the next steps (Stage 2 activities), highway construction, and training was discussed.
- Copies of the map showing the preferred alignment option dated August 2011 and detailing land tenure, and surface and subsurface rights were provided to the FNMLC and the TRRC.

HAMLET OF TULITA & TULITA DENE BAND

- A short presentation was made by EBA to the Hamlet of Tulita and the Tulita Dene Band on August 16, 2011 at 11 am. In attendance were Chief Frank Andrew (Tulita Dene Band), Gary Yakeleya (Hamlet), Rocky Norwegian, Cecile McCauley, Gordon Yakeleya, Dyanne Doctor and various members of the public.
- Four alignment options in the vicinity of Norman Wells, three alignment options in the vicinity of the Tulita and two options for Oscar Creek were discussed.
- Attendees identified that the alignment along the existing winter road, specifically around Bear Rock, was a problem area and needed to be reviewed with care.
- During the meeting there was an overall support for the Highway and the benefits it would bring to the community. Attendees also indicated their satisfaction with the consultation process over the course of project development.
- Main points discussed during the meeting were:
    - The importance of a highway construction training program prior to the start of construction starting that could also secure funding.
    - Schedule 17 of the Sahtu Dene and Metis Comprehensive Land Claim Agreement references the Public Works 1970s alignment and that the alignment can be refined through further engineering studies. The interpretation of this as it relates to any potential amendment to the Land Claim Agreement needs to be correct.
    - The necessity to fortify and build strong bridges for the Mackenzie Valley Highway. For the future presentation to the community, slides showing the different bridges within the Tulita District should be included so community members can look at them and advise what works best.
    - The preliminary design should use traditional knowledge regarding land use, rare and medicinal plants along the alignment. Constant monitoring during construction will be required.
    - Availability of funding for the next steps (Stage 2 activities), highway construction, and training.
- The following questions will be forwarded to Jim Stevens, Department of Transportation:
    - Why is the design and construction of bridges for Prohibition and Four Mile Creeks going ahead of PDR completion?
    - What other work is being done for future all-weather highway while the PDR work is underway?
    - Is there capital work (design and construction) planned for other bridges (Twelve Mile Creek?) while the PDR work and regulatory approvals are underway?

- Copies of the map showing the preferred alignment option dated August 2011 were provided to the Hamlet and Tulita Dene Band.

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NWT Ltd.

NORMAN WELLS LAND CORPORATION AND NORMAN WELLS RENEWABLE RESOURCE COUNCIL

- A short presentation was made by EBA to the Norman Wells Land Corporation (NWLC) and the Norman Wells Renewable Resource Council on August 15, 2011 at 6 pm. In attendance were Cece McCauley, President of the NWLC, Laurel McDonald from the NWRRC, and 13 other NWLC and NWRRC members.
- Four alignment options in the vicinity of Norman Wells, three alignment options in the vicinity of the Tulita and two options for Oscar Creek were discussed.
- Attendees indicated that the alignment option near the quarry (material source) is preferred as it is located on good ground and promotes future development. The attendees commented on the options for the Highway in the vicinity of Tulita and indicated that the location of the alignment closer to the community would provide better opportunities to develop businesses.
- During the meeting most attendees supported the Highway and the related economic and tourism benefits it would bring to the community.
- Items discussed during the meeting were:
    - The creation of a multi-organization Transportation Corridor Management Committee to coordinate the operation of the Highway, development of economic opportunities, access to the land and efforts to mitigate any negative social impacts.
    - The preference to harvest timber as a Sahtu business opportunity instead of wasting it or just clearing areas by pushing the construction equipment.
    - The necessity to reclaim and recover the pits used for highway construction.
    - The potential impacts of ice backups during break-up season against bridge structures.
    - The government responsibility to assist the communities and provide health and social services where they are currently not available.
    - Availability of funding for the next steps (Stage 2 activities), highway construction, and training.
    - The creation of a mitigation fund to build capacity in the region in which industry can take part and which would allow the community to contribute and take ownership of the Highway construction.
- Outstanding questions raised during the meeting that will be answered in the PDR and at the next meeting:
    - What is the time period after approval is granted during which the construction must start? Is there a limit or is it indefinite?
- Copies of the map showing the preferred alignment option dated August 2011 and detailing land tenure, and surface and subsurface rights were provided to the NWLC and NWRRC.

TOWN OF NORMAN WELLS

- A short presentation was made by EBA to the Town of Norman Wells on August 2, 2011 at 7 pm. In attendance were Mayor Dudley Johnson, four Councilors and Ian Fremantle, Town Manager.
- Four alignment options in the vicinity of the Town of Norman Wells were discussed.
- The Council identified that the alignment along the existing winter road was not preferable since the Imperial Oil Bridge is not of sufficient strength to carry highway loads.
- The Town Council indicated an overall support for the Highway, a preference for the alignment that is on high ground near the Town's material source, and support for continuing discussions with DOT relative to use of material from the source to support construction. The Town Council also indicated that short duration operational closures for the future Highway will need to be considered as blasting does occur in the material source.
- The Town Council pointed out that there will be a need to manage all developments that required use of the material source both for the construction material and as a location to set up temporary camp facilities.
- Copies of maps showing the development of the overall alignment dated March 2011 and showing the alignment options in the vicinity of Norman Wells dated August 2, 2011 were provided to the Town Council.

TULITA LAND CORPORATION

- A short presentation was made by EBA to the Tulita Land Corporation (TLC) on August 16, 2011 at 3 pm. In attendance were Arsene Menacho, Gordon Yakeleya (President), Maurice Mendo and Jimmy Mendo.
- Four alignment options in the vicinity of Norman Wells, three alignment options in the vicinity of Tulita and two options for Oscar Creek were discussed.
- Attendees indicated that the Tulita MVH concept for June 2011 would be tightly limited by the airstrip on the south side and the lake on the north side and recommended that this be reviewed again in the detailed design stage.
- The TLC members indicated an overall support for the Highway. They also mentioned their preference to deliver highway project as a P3 (public-private partnership) project.
- Discussion items during the meeting were:
    - The highway impacts on moose and caribou population need to be considered;
    - The preference for delivery of the construction is for the land corporations to choose a partner with suitable construction resources and expertise and be able to control the benefits of work to local.
    - Availability of funding for the next steps (Stage 2 activities), highway construction, and training.
    - The necessity to enforce wildlife monitoring.
- Copies of the map dated August 2011 showing the preferred alignment option was provided to the TLC, and a copy was left for the TDLC.

APPENDIX E

APPENDIX E WILDLIFE SPECIES OCCURRING OR POTENTIALLY OCCURRING WITHIN THE STUDY AREA

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Appendix E - Wildlife Species Occurring or Potentially Occurring Within the Study Area

Common Name	Scientific Name	Conservation Status		
		NWT	SARA	COSEWIC
Birds				
Greater White-fronted Goose	*Anser albifrons*	Secure	-	Not Assessed
Snow Goose	*Chen caerulescens*	Secure	-	Not Assessed
Canada Goose	*Branta canadensis*	Secure	-	Not Assessed
Tundra Swan	*Cygnus columbianus*	Secure	-	Not Assessed
American Wigeon	*Anas americana*	Secure	-	Not Assessed
Mallard	*Anas platyrhynchos*	Secure	-	Not Assessed
Northern Shoveler	*Anas clypeata*	Secure	-	Not Assessed
Northern Pintail	*Anas acuta*	Sensitive	-	Not Assessed
Green-winged Teal	*Anas crecca*	Secure	-	Not Assessed
Canvasback	*Aythya valisineria*	Secure	-	Not Assessed
Ring-necked Duck	*Aythya collaris*	Secure	-	Not Assessed
Greater Scaup	*Aythya marila*	Secure	-	Not Assessed
Lesser Scaup	*Aythya affinis*	Sensitive	-	Not Assessed
Surf Scoter	*Melanitta perspicillata*	Sensitive	-	Not Assessed
White-winged Scoter	*Melanitta fusca*	Sensitive	-	Not Assessed
Long-tailed Duck	*Clangula hyemalis*	Sensitive	-	Not Assessed
Common Goldeneye	*Bucephala clangula*	Secure	-	Not Assessed
Red-breasted Merganser	*Mergus serrator*	Secure	-	Not Assessed
Spruce Grouse	*Falcipennis canadensis*	Secure	-	Not Assessed
Willow Ptarmigan	*Lagopus lagopus*	Secure	-	Not Assessed
Rock Ptarmigan	*Lagopus muta*	Secure	-	Not Assessed
Sharp-tailed Grouse	*Tympanuchus phasianellus*	Secure	-	Not Assessed
Red-throated Loon	*Gavia stellata*	Secure	-	Not Assessed
Pacific Loon	*Gavia pacifica*	Secure	-	Not Assessed
Common Loon	*Gavia immer*	Secure	-	Not At Risk
Horned Grebe	*Podiceps auritus*	Secure	No Status	Special Concern
Red-necked Grebe	*Podiceps grisegena*	Secure	-	Not At Risk
Osprey	*Pandion haliaetus*	Secure	-	Not Assessed
Bald Eagle	*Haliaeetus leucocephalus*	Secure	-	Not At Risk
Northern Harrier	*Circus cyaneus*	Secure	-	Not At Risk
Sharp-shinned Hawk	*Accipiter striatus*	Secure	-	Not At Risk
Northern Goshawk	*Accipiter gentilis*	Secure	-	Not At Risk
Red-tailed Hawk	*Buteo jamaicensis*	Secure	-	Not At Risk
Rough-legged Hawk	*Buteo lagopus*	Secure	-	Not At Risk
Golden Eagle	*Aquila chrysaetos*	Secure	-	Not At Risk
Merlin	*Falco columbarius*	Secure	-	Not At Risk
Gyrfalcon	*Falco rusticolus*	Secure	-	Not At Risk

Appendix E - Wildlife Species Occurring or Potentially Occurring Within the Study Area

Common Name	Scientific Name	Conservation Status		
		NWT	SARA	COSEWIC
Peregrine Falcon	*Falco peregrinus anatum/tundrius*	Sensitive	No Status	Special Concern
Sandhill Crane	*Grus canadensis*	Secure	-	Not Assessed
Black-bellied Plover	*Pluvialis squatarola*	Sensitive	-	Not Assessed
American Golden-Plover	*Pluvialis dominica*	Sensitive	-	Not Assessed
Semipalmated Plover	*Charadrius semipalmatus*	Secure	-	Not Assessed
Lesser Yellowlegs	*Tringa flavipes*	Sensitive	-	Not Assessed
Solitary Sandpiper	*Tringa solitaria*	Undetermined	-	Not Assessed
Spotted Sandpiper	*Actitis macularius*	Secure	-	Not Assessed
Whimbrel	*Numenius phaeopus*	Sensitive	-	Not Assessed
Hudsonian Godwit	*Limosa haemastica*	Sensitive	-	Not Assessed
Semipalmated Sandpiper	*Calidris pusilla*	Sensitive	-	Not Assessed
Least Sandpiper	*Calidris minutilla*	Sensitive	-	Not Assessed
Baird's Sandpiper	*Calidris bairdii*	Secure	-	Not Assessed
Pectoral Sandpiper	*Calidris melanotos*	Secure	-	Not Assessed
Dunlin	*Calidris alpina*	Sensitive	-	Not Assessed
Stilt Sandpiper	*Calidris himantopus*	Undetermined	-	Not Assessed
Long-billed Dowitcher	*Limnodromus scolopaceus*	Sensitive	-	Not Assessed
Wilson's Snipe	*Gallinago delicata*	Undetermined	-	Not Assessed
Red-necked Phalarope	*Phalaropus lobatus*	Sensitive	-	Not Assessed
Bonaparte's Gull	*Larus philadelphia*	Secure	-	Not Assessed
Mew Gull	*Larus canus*	Secure	-	Not Assessed
Herring Gull	*Larus argentatus*	Secure	-	Not Assessed
Glaucous Gull	*Larus hyperboreus*	Secure	-	Not Assessed
Arctic Tern	*Sterna paradisaea*	Secure	-	Not Assessed
Great Horned Owl	*Bubo virginianus*	Secure	-	Not Assessed
Snowy Owl	*Bubo scandiacus*	Secure	-	Not At Risk
Northern Hawk Owl	*Surnia ulula*	Secure	-	Not At Risk
Great Grey Owl	*Strix nebulosa*	Secure	-	Not At Risk
Short-eared Owl	*Asio flammeus*	Sensitive	Special Concern (Schedule 3)	Special Concern
Belted Kingfisher	*Ceryle alcyon*	Secure	-	Not Assessed
Yellow-bellied Sapsucker	*Sphyrapicus varius*	Secure	-	Not Assessed
American Three-toed Woodpecker	*Picoides dorsalis*	Secure	-	Not Assessed
Northern Flicker	*Colaptes auratus*	Secure	-	Not Assessed
Alder Flycatcher	*Empidonax alnorum*	Secure	-	Not Assessed
Say's Phoebe	*Sayornis saya*	Undetermined	-	Not Assessed
Northern Shrike	*Lanius excubitor*	Secure	-	Not Assessed

Appendix E - Wildlife Species Occurring or Potentially Occurring Within the Study Area

Common Name	Scientific Name	Conservation Status		
		NWT	SARA	COSEWIC
Gray Jay	*Perisoreus canadensis*	Secure	-	Not Assessed
Common Raven	*Corvus corax*	Secure	-	Not Assessed
Horned Lark	*Eremophila alpestris*	Secure	-	Not Assessed
Tree Swallow	*Tachycineta bicolor*	Secure	-	Not Assessed
Bank Swallow	*Riparia riparia*	Secure	-	Not Assessed
Cliff Swallow	*Petrochelidon (Hirundo) phyrrhonota*	Secure	-	Not Assessed
Barn Swallow	*Hirundo rustica*	Sensitive	-	Not Assessed
Boreal Chickadee	*Poecile hudsonica*	Sensitive	-	Not Assessed
Ruby-crowned Kinglet	*Regulus calendula*	Secure	-	Not Assessed
Townsend's Solitaire	*Myadestes townsendi*	Secure	-	Not Assessed
Gray-cheeked Thrush	*Catharus minimus*	Secure	-	Not Assessed
Swainson's Thrush	*Catharus ustulatus*	Secure	-	Not Assessed
American Robin	*Turdus migratorius*	Secure	-	Not Assessed
Varied Thrush	*Ixoreus naevius*	Undetermined	-	Not Assessed
American Pipit	*Anthus rubescens*	Sensitive	-	Not Assessed
Bohemian Waxwing	*Bombycilla garrulus*	Secure	-	Not Assessed
Tennessee Warbler	*Vermivora peregrina*	Secure	-	Not Assessed
Orange-crowned Warbler	*Vermivora celata*	Secure	-	Not Assessed
Yellow Warbler	*Dendroica petechia*	Secure	-	Not Assessed
Magnolia Warbler	*Dendroica magnolia*	Secure	-	Not Assessed
Yellow-rumped Warbler	*Dendroica coronata*	Secure	-	Not Assessed
Palm Warbler	*Dendroica palmarum*	Secure	-	Not Assessed
Blackpoll Warbler	*Dendroica striata*	Sensitive	-	Not Assessed
Northern Waterthrush	*Seiurus noveboracensis*	Secure	-	Not Assessed
Common Yellowthroat	*Geothlypis trichas*	Secure	-	Not Assessed
Wilson's Warbler	*Wilsonia pusilla*	Secure	-	Not Assessed
American Tree Sparrow	*Spizella arborea*	Sensitive	-	Not Assessed
Chipping Sparrow	*Spizella passerina*	Secure	-	Not Assessed
Savannah Sparrow	*Passerculus sandwichensis*	Secure	-	Not Assessed
Fox Sparrow	*Passerella ilia*	Secure	-	Not Assessed
Song Sparrow	*Melospiza melodia*	Undetermined	-	Not Assessed
Lincoln's Sparrow	*Melospiza lincolnii*	Secure	-	Not Assessed
White-throated Sparrow	*Zonotrichia albicollis*	Sensitive	-	Not Assessed
Harris's Sparrow	*Zonotrichia querula*	Sensitive	-	Not Assessed
White-crowned Sparrow	*Zonotrichia leucophrys*	Secure	-	Not Assessed
Dark-eyed Junco	*Junco hyemalis*	Secure	-	Not Assessed
Red-winged Blackbird	*Agelaius phoeniceus*	Secure	-	Not Assessed

Appendix E - Wildlife Species Occurring or Potentially Occurring Within the Study Area

Common Name	Scientific Name	Conservation Status		
		NWT	SARA	COSEWIC
Lapland Longspur	*Calcarius lapponicus*	Secure	-	Not Assessed
Smith's Longspur	*Calcarius pictus*	Undetermined	-	Not Assessed
Snow Bunting	*Plectrophenax nivalis*	Secure	-	Not Assessed
Rusty Blackbird	*Euphagus carolinus*	May Be At Risk	Special Concern (Schedule 1)	Special Concern
Pine Grosbeak	*Pinicola enucleator*	Secure	-	Not Assessed
White-winged Crossbill	*Loxia leucoptera*	Secure	-	Not Assessed
Common Redpoll	*Carduelis flammea*	Secure	-	Not Assessed
Hoary Redpoll	*Carduelis hornemanni*	Undetermined	-	Not Assessed
Amphibians				
Boreal Chorus Frog	*Pseudacris maculate*	Secure	-	Not Assessed
Wood Frog	*Lithobates sylvatica*	Secure	-	Not Assessed
Mammals				
Arctic Shrew	*Sorex arcticus*	Secure	-	Not Assessed
Cinereus Shrew	*Sorex cinereus*	Secure	-	Not Assessed
Snowshoe Hare	*Lepus americanus*	Secure	-	Not Assessed
Arctic Ground Squirrel	*Spermophilus parryii*	Secure	-	Not Assessed
Red Squirrel	*Tamiasciurus hudsonicus*	Secure	-	Not Assessed
Beaver	*Castor canadensis*	Secure	-	Not Assessed
North American Deer Mouse	*Peromyscus maniculatus*	Secure	-	Not Assessed
Neoarctic Brown Lemming	*Lemmus trimucronatus*	Secure	-	Not Assessed
Northern Bog Lemming	*Synaptomys borealis*	Secure	-	Not Assessed
Meadow Vole	*Microtus pennsylvanicus*	Secure	-	Not Assessed
Northern Red-backed Vole	*Myodes rutilus*	Secure	-	Not Assessed
Root (Tundra) Vole	*Microtus oeconomus*	Secure	-	Not Assessed
Taiga Vole	*Microtus xanthognathus*	Secure	-	Not Assessed
Common Muskrat	*Ondatra zibethicus*	Secure	-	Not Assessed
North American Porcupine	*Erethizon dorsata*	Secure	-	Not Assessed
Coyote	*Canis latrans*	Secure	-	Not Assessed
Gray Wolf	*Canis lupus*	Secure	-	Not At Risk
Arctic Fox	*Vulpes lagopus*	Secure	-	Not Assessed
Red Fox	*Vulpes vulpes*	Secure	-	Not Assessed
American Black Bear	*Ursus americanus*	Secure	-	Not At Risk
Grizzly Bear	*Ursus arctos*	Sensitive	Not Assessed	Special Concern
American Marten	*Martes americana*	Secure	-	Not Assessed
American Mink	*Neovison vison*	Secure	-	Not Assessed
Ermine	*Mustela erminea*	Secure	-	Not Assessed
Least Weasel	*Mustela nivalis*	Secure	-	Not Assessed

Appendix E - Wildlife Species Occurring or Potentially Occurring Within the Study Area

Common Name	Scientific Name	Conservation Status		
		NWT	SARA	COSEWIC
North American River Otter	*Lontra canadensis*	Secure	-	Not Assessed
Wolverine	*Gulo gulo*	Sensitive	No Status	Special Concern
Canada Lynx	*Lynx canadensis*	Secure	-	Not At Risk
Barren-ground Caribou	*Rangifer tarandus groenlandicus*	Sensitive	-	Not Assessed
Woodland Caribou (Boreal)	*Rangifer tarandus caribou*	Sensitive	Threatened (Schedule 1)	Threatened
Moose	*Alces americanus*	Secure	-	Not Assessed

* References: Cornell Lab of Ornithology and the American Ornithologists' Union 2010; COSEWIC 2010; [1]ENR 2010; Government of Canada 2010; Sibley 2003; Banfield 1977; ENR 2005, National Geographic 2006, Wilson and Ruff)

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APPENDIX F

APPENDIX F FISH HABITAT RECONNAISSANCE WAYPOINT SUMMARY

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Potential Fish Habitat (PFH) Stream Classifications[1]	Site ID (Waypoint)	km Post	Date of Aerial Survey (dd/mm/yyyy)	UTM (NAD83)	Suggested Crossing Structure[2]	Comments (observations at time of survey)
1	88		8/9/2010	9 W 598244 7245877	B	Bosworth Creek Option B: Anecdotal reports of grayling in the creek and lake trout at the confluence with the Mackenzie River.
1	110		8/9/2010	9 W 587530 7248934	B	Drainage between two lakes
1	145		8/9/2010	9 W 572193 7258537	B	Unfinished Oscar Creek Bridge. Probable migration, rearing and spawning habitats present.
1	153		8/9/2010	9 W 563986 7267203	B	Ouflow of large lake into creek; wetted width >10 m.
1	180		8/9/2010	9 W 626464 7228215	B	Prohibition Creek new crossing option A; Good habitat conditions at proposed crossing site.
1	336		10/9/2010	10 W 406854 7178332	B	Creek drains series of small lakes; beaver dam and debris obstructions downstream may affect fish passage.
1	379		10/9/2010	10 W 377412 7201254	B	Great Bear River. Width approximately 400-500 m; very good habitat for sportfish and baitfish.
2	73		10/9/2010	10 W 392020 7198797	B	Locally named Twelve Mile Creek. Upstream lakes suitable for pike and whitefish. Width variable 1-3 m; some woody debris obstructions.
2	None		10/9/2010	10 W 411798 7171042	B	Large drainage channel from lake. Prelim design reroute of road to avoid windy curved winter road alignment. Requires further investigation at detailed design stage.
2	100		8/9/2010	9 W 595048 7247716	C	Small undisturbed creek ~1 m wide; migration, spawning, and rearing potential if flow is sufficient.
2	102		8/9/2010	9 W 592072 7248904	C	Small undisturbed creek ~1 m wide; migration, spawning, and rearing potential if flow is sufficient.
2	104		8/9/2010	9 W 590700 7249449	C	Small undisturbed creek ~1-2 m wide; migration, spawning, and rearing potential if flow is sufficient.
2	108		8/9/2010	9 W 589085 7249107	C	Small undisturbed creek ~1-2 m wide; migration, spawning, and rearing potential if flow is sufficient.
2	109		8/9/2010	9 W 588162 7249047	C	Small undisturbed creek ~ 1 m wide; migration, spawning, and rearing potential if flow is sufficient.
2	217		9/9/2010	10 W 437813 7101870	C	Pool in area of the proposed crossing; baitfish rearing and migration habitat; sportfish migration habitat.
2	221		9/9/2010	10 W 435639 7108217	C	Wide flooded area through disturbed winter road crossing; beaver activity upstream near lake outflow; fish migration area.
2	224		9/9/2010	10 W 434299 7115389	C	Creek widens into pool at proposed crossing site; affected by winter road route; flooded trees present; baitfish rearing and migration; sportfish migration habitat.
2	297		9/9/2010	10 W 410947 7168766	C	Small, partially confined creek at existing disturbed winter road crossing; wetted width 0.5 m; seasonal fish migration habitat only.
2	306		9/9/2010	10 W 412162 7167518	C	Creek is a channel between lakes; channel and riparian vegetation affected by winter road route; wide unconfined wetted area.
2	318		10/9/2010	10 W 411435 7174830	C	Creek drainage from series of lakes; beaver pond formed at point of proposed crossing-potential migration obstruction; channel and riparian area affected by winter road.
2	325		10/9/2010	10 W 408491 7178378	B or C	Crossing is at creek near lake outflow; riparian area disturbed by existing winter road; creek narrows at existing crossing; good habitat conditions.
2	329		10/9/2010	10 W 407681 7179921	C	Creek drainage between lakes; crossing at narrow section (1-2 m wide); habitat for sport and bait fish. Riparian area disturbed by existing winter road.
2	331		10/9/2010	10 W 407102 7180445	C	Creek drainage between lakes; riparian area disturbed by existing winter road; crossing area partly obstructed; width 0.5-2 m. Habitat for sport and bait fish.
2	366		10/9/2010	10 W 394969 7198798	B or C	Creek is dispersed at existing disturbed winter road location; migration possible; channel connects lakes.
2	373		10/9/2010	10 W 382776 7200651	B	Four Mile Creek; new bridge proposed just south of existing bridge; existing bridge crossing riparian area disturbed by winter road; creek ~ 3m wide.
3	128		8/9/2010	9 W 584611 7250128	C	Dispersed creek flow in unconfined channel (wetland area); riparian area disturbed by existing winter road; drains small lakes; poor habitat.
3	129		8/9/2010	9 W 583812 7250539	C	Unconfined channel (wetland) through disturbed winter road area; poor habitat.
3	131		8/9/2010	9 W 582790 7251290	C	Unconfined channel draining small lake; flows through disturbed winter road; poor habitat.
3	139		8/9/2010	9 W 579722 7254467	C	Unconfined channel flowing from lake; poor habitat; little flow at time of survey.
3	140		8/9/2010	9 W 579335 7254832	C	Unconfined channel through vegetation; poor habitat; little flow at time of survey; flows from lake 600 m to North
3	141		8/9/2010	9 W 578715 7255332	C	Unconfined channel through grass vegetation; poor habitat; little flow at time of survey; flows from lake 600 m to North
3	178		8/9/2010	9 W 623577 7230276	C	Proposed crossing at area distrurbed by existing winter road crossing; ~2-3 m wide; option A (south of crossing at #187 (option B)); considerable woody debris in riparian area.
3	187		8/9/2010	9 W 623983 7230954	C	Proposed crossing in undisturbed area; creek is confined and 3-4 m wide at crossing; habitat potential for sport and bait fish.
3	191		8/9/2010	9 W 629551 7227955	C	Very small, undisturbed shallow creek flows from small lake.
3	238		9/9/2010	10 W 432940 7121733	C	Crossing site is disturbed due to existing winter road; creek is partly confined at crossing area due to bank damage from road; creek drains small lake.
3	243		9/9/2010	10 W 431935 7123962	C	Confined channel with good substrate habitat but shallow flow and cobble step pools; channel 2 m wide.
3	249		9/9/2010	10 W 431072 7126467	C	Outflow creek from small lake; dispersed flow through wetland area and through disturbed existing winter road route; baitfish habitat possible.
3	264		9/9/2010	10 W 424671 7135082	C	Creek dry at time of survey; riparian area disturbed by existing winter road; channel <2 m wide.
3	278		9/9/2010	10 W 415870 7151094	C	Crossing is in an unconfined wetland area with dispersed flow; multiple culverts may be necessary; existing winter road has disturbed riparian vegetation in this area.
3	293		9/9/2010	10 W 412724 7164552	C	Crossing is at unconfined channel (wetland area); winter road crosses at this location causing disturbance of vegetation.
3	295		9/9/2010	10 W 410998 7166150	C	Dispersed creek flow in unconfined channel (~11 m wide); upstream lakes with possible pike habitat.
3	296		9/9/2010	10 W 410938 7167644	C	Dispersed creek flow in unconfined channel (~5 m wide); upstream lake with possible pike habitat.
3	298		9/9/2010	10 W 411245 7169818	C	Unconfined channel through seasonal drainage area affected by existing winter road. Poor habitat conditions.
3	300		9/9/2010	10 W 411627 7170638	C	Confined dry channel at time of survey; approximately 2 m wide; stream drains small lakes; poor habitat conditions.
3	301		9/9/2010	10 W 411952 7170879	C	Confined dry channel at time of survey; approximately 3 m wide; stream drains small lakes and wetlands; poor habitat conditions.
3	303		9/9/2010	10 W 411981 7171329	C	Confined, very small, nearly dry channel at time of survey; ~20 cm wetted width, 2 m channel width; drains small lakes.
3	363		10/9/2010	10 W 397368 7198303	C	Unconfined channel at crossing due to flow through winter road ruts; wetted area at crossing ~ 3-8 m wide; drains small lakes; poor habitat conditions.

Notes:

[1] Classifications: 1=Primary fish habitat importance, bridge required; 2=secondary fish habitat importance, bridge or culvert requirement based on site specific conditions; 3=Tertiary fish habitat importance (Imperial Oil Limited et al. 2004)

[2] B=Bridge; C=Culvert; Recommendations based solely on fish/fish habitat considerations.

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APPENDIX G

APPENDIX G AERIAL AND GROUND FISH HABITAT RECONNAISSANCE FORMS

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Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 073 **Date (mm/dd/yy):** 10/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 10 W Easting 392020 Northing 7198797

Channel Width: ☐ <1m ☑ 1-3m ☐ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☑
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__20_%
Forbs	☑	_30_%
Shrubs	☑	_15_%
Conifer	☑	__20_%
Deciduous	☑	__15_%

Substrate:

Silt	☐	_____%
Sand	☑	_90_%
Gravel	☑	_10_%
Cobble	☐	___%
Boulder	☐	___%
Bedrock	☐	_____%

Obstructions Visible: yes ☑ no ☐ Type small woody debris Location sections along stream

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☐	_____%
Run	☑	_____%
Pool	☐	_____%
Rapids	☐	_____%

Photos:

Photo #	Description
P9100075-6	**crossing winter road, facing south (Mackenzie river in foreground)**
P9100077-8	**winter road crossing, detail (board used as crossing)**
P9100079	**winter road a few meters west of crossing, damaged culvert laying on ground**
P9100080	**crossing winter road, facing north**
P9100081	**crossing winter road, facing north west**
P9100082-3	**crossing winter road, facing west (damaged culvert in distance)**
P9100084	**creek channel detail, woody debris**
P9100085	**creek crossing detail**

Comments:

Unnamed stream, locally called Twelve Mile Creek.
Lakes upstream suitable habitat for northern pike and whitefish.

Crossing approximately 1 meter wide and 0.2 meters deep.
Crossing may require a small bridge or large culvert.
Water brown in color. Small woody debris moderate.

baitfish migrate, spawn and reside (rear) potential
sportfish migrate, spawn and reside (rear) potential.

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 088 **Date (mm/dd/yy):** 8/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☑ Yes ☐ No **Site No.:** RPR 301

UTM: 9 W Easting 598244 Northing 7245877

Channel Width: ☐ <1m ☐ 1-3m ☐ 3-10m ☑ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☑
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	_10_%
Forbs	☐	__%
Shrubs	☑	__20_%
Conifer	☑	__60_%
Deciduous	☑	__10_%

Substrate:

Silt	☐	_____%
Sand	☐	__%
Gravel	☐	_____%
Cobble	☑	_45_%
Boulder	☑	_45_%
Bedrock	☑	__10_%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☑

Channel Islands Present: yes ☑ no ☐

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☑	__18__%
Run	☑	__70_%
Pool	☑	__2__%
Rapids	☑	__10_%

Photos:

Photo #	Description
P9080001-2	**stream bed**
P9080003,09,10	**woody debree**
P9080004	**upstream (north)**
P9080005-6	**stream bed**
P9080007, 11	**upstream (north)**
P9080008, 12	**downstream (south)**

Comments:

New Crossing for Bosworth Creek along road alignment option B

Anecdotal reports of graylings in the creek and lake trout caught at mouth of outflow into Mackenzie River.

Creek drains into Mackenzie River 4.5 km south.

Small and woody debree trace-moderate.

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 100 **Date (mm/dd/yy):** 8/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 9 W Easting 595048 Northing 7247716

Channel Width: ☐ <1m ☑ 1-3m ☐ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☑
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__30_%
Forbs	☐	__%
Shrubs	☑	_45_%
Conifer	☑	__5_%
Deciduous	☑	__20_%

Substrate:

Silt	☐	_____%
Sand	☐	__%
Gravel	☐	_____%
Cobble	☑	_30_%
Boulder	☑	_70_%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☐	_____%
Run	☑	_____%
Pool	☐	_____%
Rapids	☐	_____%

Photos:

Photo #	Description
P9080018-19	**downstream facing south**
P9080020, 28	**channel detail**
P9080022-26	**channel downstream facing south**
P9080027, 29	**channel upstream facing north**
P9080030	**channel upstream**

Comments:

Crossing approximately 1 meter wide and 0.1 meter deep.
Crossing may require a culvert.
Water is clear.

baitfish migration, and spawn potential
sportfish migration potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 102 **Date (mm/dd/yy):** 8/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 9 W Easting 592072 Northing 7248904

Channel Width: ☐ <1m ☑ 1-3m ☐ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☐
- 26-50 ☑
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__5_%
Forbs	☐	__%
Shrubs	☑	_45_%
Conifer	☑	__30_%
Deciduous	☑	__20_%

Substrate:

Silt	☐	_____%
Sand	☐	__%
Gravel	☑	__100_%
Cobble	☐	__%
Boulder	☐	__%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☐	_____%
Run	☑	_____%
Pool	☐	_____%
Rapids	☐	_____%

Photos:

Photo #	Description
P9080031	**out of focus**
P9080032	**channel south**
P9080033, 37	**proposed crossing detail**
P9080034-5	**channel downstream south**
P9080036	**channel upstream north**

Comments:

This small creek drains into a lake (approx 2km downstream, south)

Crossing approximately 1 meter wide and 0.3 meter deep.
Crossing may require a culvert.
Water is clear.

baitfish migration, and spawning potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 104 **Date (mm/dd/yy):** 8/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 9 W Easting 590700 Northing 7249449

Channel Width: ☐ <1m ☑ 1-3m ☐ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☐
- 26-50 ☐
- 51-75 ☑
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__5_%
Forbs	☐	__%
Shrubs	☑	_45_%
Conifer	☑	__30_%
Deciduous	☑	__20_%

Substrate:

Silt	☐	_____%
Sand	☐	__%
Gravel	☐	___%
Cobble	☑	_100_%
Boulder	☐	__%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☐	_____%
Run	☑	_____%
Pool	☐	_____%
Rapids	☐	_____%

Photos:

Photo #	Description
P9080038-40	**channel upstream (north)**
P9080041	**proposed water crossing**
P9080042-3	**channel downstream (south)**

Comments:

This small creek drains into a lake (approx 2km downstream, south)

Crossing approximately 1 meter wide and 0.2 meter deep.
Crossing may require a culvert.
Water is clear with brown tinge.
Small woody debris (trace)

baitfish migration, and spawning potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 108 **Date (mm/dd/yy):** 8/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 9 W Easting 589085 Northing 7249107

Channel Width: ☐ <1m ☑ 1-3m ☐ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☐
- 26-50 ☑
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__5_%
Forbs	☑	10_%
Shrubs	☑	_55_%
Conifer	☑	__15_%
Deciduous	☑	_15_%

Substrate:

Silt	☐	_____%
Sand	☐	__%
Gravel	☐	___%
Cobble	☑	_50_%
Boulder	☑	50_%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☐	_____%
Run	☑	_____%
Pool	☐	_____%
Rapids	☐	_____%

Photos:

Photo #	Description
P9080044	**proposed water crossing, south**
P9080045	**proposed water crossing**
P9080046-8	**channel downstream (south)**

Comments:

This small creek drains into a lake (approx 900 meters downstream, south)

Crossing approximately 1 meter wide and 0.2 meter deep.
Crossing may require a culvert.
Water is clear.

baitfish migration, and spawning potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 109 **Date (mm/dd/yy):** 8/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 9 W Easting 588162 Northing 7249047

Channel Width: ☐ <1m ☑ 1-3m ☐ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☐
- 26-50 ☑
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__5_%
Forbs	☑	10_%
Shrubs	☑	_55_%
Conifer	☑	__15_%
Deciduous	☑	_15_%

Substrate:

Silt	☐	_____%
Sand	☐	__%
Gravel	☐	___%
Cobble	☑	_50_%
Boulder	☑	50_%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☐	_____%
Run	☑	_____%
Pool	☐	_____%
Rapids	☐	_____%

Photos:

Photo #	Description
P9080049	**cover**
P9080050	**proposed water crossing**

Comments:

This small creek is the drainage between two small lakes (2km apart)

Crossing approximately 1 meter wide and 0.2 meter deep.
Crossing may require a culvert.
Water is clear.

baitfish migration, and spawning potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 110 **Date (mm/dd/yy):** 8/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 9 W Easting 587530 Northing 7248934

Channel Width: ☐ <1m ☐ 1-3m ☑ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☑
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__70_%
Forbs	☑	5_%
Shrubs	☑	_15_%
Conifer	☑	__5_%
Deciduous	☑	_5_%

Substrate:

Silt	☐	_____%
Sand	☑	100__%
Gravel	☐	___%
Cobble	☐	__%
Boulder	☐	_%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☑

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:
- Riffle ☐ _____%
- Run ☐ _____%
- Pool ☐ _____%
- Rapids ☐ _____%

Photos:

Photo #	Description
P9080051	**proposed water crossing, facing north west, outflow of lake**
P9080052-3	**proposed water crossing detail**
P9080054-5	**proposed water crossing, facing west, outflow of lake**
P9080056	**lake (upstream)**
P9080057	**proposed water crossing location, facing south west**

Comments:

This small creek is the drainage between two small lakes (2km apart)

Crossing approximately 6 meter wide and 0.6 meter deep.
Crossing may require a small bridge.
Water is clear.

baitfish migrate, and spawn potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 128 **Date (mm/dd/yy):** 8/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 9 W Easting 584611 Northing 7250128

Channel Width: ☐ <1m ☐ 1-3m ☑ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☑
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__50_%
Forbs	☐	_%
Shrubs	☐	__%
Conifer	☑	__50_%
Deciduous	☐	__%

Substrate:

Silt	☐	_____%
Sand	☑	100__%
Gravel	☐	___%
Cobble	☐	__%
Boulder	☐	_%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☐
- Partially confined ☐
- Unconfined ☑

Habitat Type:

Riffle	☐	_____%
Run	☐	_____%
Pool	☐	_____%
Rapids	☐	_____%

Photos:

Photo #	Description
P9080075	**water crossing, facing north west, drainage between series of lakes**
P9080076	**proposed water crossing detail**
P9080077	**proposed water crossing, facing south**
P9080078	**proposed water crossing, facing upstream NE**
P9080079	**proposed water crossing location, facing south west**
P9080080-1	**substrate**

Comments:

This is the drainage between a series of seasonal wetlands and small lakes.
Although fairly dry now, this wetland area could flood in the spring and provide fish migratory access and breeding habitat.

Crossing approximately 6 meter wide and 0.3 meter deep.
Crossing may require a large culvert.
Water is brown.

baitfish migration, and spawning potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 129 **Date (mm/dd/yy):** 8/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

P9080082

UTM: 9 W Easting 583812 Northing 7250539

Channel Width: ☐ <1m ☐ 1-3m ☑ 3-10m ☐ >10 m

Stream Discharge Stage:
Low (0-30% bankfull) ☑
Moderate (30-90% bankfull) ☐
High (>90% bankfull) ☐

Crown Closure (%):
0 ☐
1-25 ☑
26-50 ☐
51-75 ☐
75-100 ☐

Type of Riparian Vegetation:

None	☐	____%
Grass	☑	__50_%
Forbs	☐	_%_
Shrubs	☐	__%__
Conifer	☑	__50_%
Deciduous	☐	__%__

Substrate:

Silt	☐	____%
Sand	☑	100__%
Gravel	☐	___%
Cobble	☐	__%
Boulder	☐	_%
Bedrock	☐	____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous ☐ Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
Confined ☐
Partially confined ☑
Unconfined ☐

Habitat Type:
Riffle ☐ ____%
Run ☐ ____%
Pool ☐ ____%
Rapids ☐ ____%

Photos:

Photo #	Description
P9080082	**NE**
P9080083	**N**
P9080084	**W**
P9080085	**NE, detail of channel connection with lake in distance**
P9080086	**SW, detail channel connection with Mackenzie river in distance**
P9080087	

Comments:

This is the drainage between a series of seasonal wetlands and small lakes.
Although fairly dry now, this wetland area could flood in the spring and provide migratory habitat.
This channel may be a means to access large lake 1km north of crossing.
Crossing approximately 6 meter wide and 0.3 meter deep.
Crossing may require a large culvert.
Water is brown.

baitfish migration, and spawning potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 131 **Date (mm/dd/yy):** 8/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 9 W Easting 582790 Northing 7251290

Channel Width: ☐ <1m ☐ 1-3m ☑ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☑
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__40_%
Forbs	☐	_%
Shrubs	☑	_10_%
Conifer	☑	__50_%
Deciduous	☐	__%

Substrate:

Silt	☐	_____%
Sand	☑	100__%
Gravel	☐	___%
Cobble	☐	__%
Boulder	☐	_%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☐
- Partially confined ☑
- Unconfined ☐

Habitat Type:
- Riffle ☐ _____%
- Run ☐ _____%
- Pool ☐ _____%
- Rapids ☐ _____%

Photos:

Photo #	Description
P9080090	**N**
P9080091	**E**
P9080092	**S, channel connects to nearby lake**

Comments:

This is the drainage between a series of seasonal wetlands and small lakes.
Although fairly dry now, this wetland area could flood in the spring and provide migratory habitat.
This channel may be a means to access large lake 1km north of crossing.
Crossing approximately 6 meter wide and 0.3 meter deep.
Crossing may require a large culvert.
Water is brown.
baitfish migration, and spawning potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 139 **Date (mm/dd/yy):** 8/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 9 W Easting 579722 Northing 7254467

Channel Width: ☐ <1m ☐ 1-3m ☑ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☑
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__40_%
Forbs	☐	_%
Shrubs	☑	_10_%
Conifer	☑	__50_%
Deciduous	☐	__%

Substrate:

Silt	☐	_____%
Sand	☑	100__%
Gravel	☐	___%
Cobble	☐	__%
Boulder	☐	_%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☐
- Partially confined ☑
- Unconfined ☐

Habitat Type:

Riffle	☐	_____%
Run	☐	_____%
Pool	☐	_____%
Rapids	☐	_____%

Photos:

Photo #	Description
P9080093	**proposed crossing, channel detail**
P9080094	**North, channel connects to large lake**
P9080095	**S, channel connects to nearby lake**

Comments:

This is the drainage between a series of lakes.
Although fairly dry now, this wetland area could flood in the spring and provide migratory habitat.
This channel may be a means to access large lake 1km north of crossing.
Crossing approximately 6 meter wide.
Crossing may require a large culvert.
instream vegetation grass
baitfish migration, and spawning potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 140 **Date (mm/dd/yy):** 8/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 9 W Easting 579335 Northing 7254832

Channel Width: ☐ <1m ☐ 1-3m ☑ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☑
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__40_%
Forbs	☐	_%
Shrubs	☑	_10_%
Conifer	☑	__50_%
Deciduous	☐	__%

Substrate:

Silt	☐	_____%
Sand	☑	100__%
Gravel	☐	___%
Cobble	☐	__%
Boulder	☐	_%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☐
- Partially confined ☑
- Unconfined ☐

Habitat Type:

Riffle ☐	_____%
Run ☐	_____%
Pool ☐	_____%
Rapids ☐	_____%

Photos:

Photo #	Description
P9080096	**channel facing south**
P9080097	**North, channel connects to large lake**
P9080098	**proposed crossing, channel detail**

Comments:

This is the drainage between a series of wetlands and lakes.
Although fairly dry now, this wetland area could flood in the spring and provide migratory habitat.
This channel may be a means to access large lake 600 meters north of crossing.
Crossing approximately 6 meter wide.
Crossing may require a large culvert.
instream vegetation grass

baitfish migration, and spawning potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 141 **Date (mm/dd/yy):** 8/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 9 W Easting 578715 Northing 7255332

Channel Width: ☐ <1m ☐ 1-3m ☑ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☑
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__40_%
Forbs	☐	_%
Shrubs	☑	_10_%
Conifer	☑	__50_%
Deciduous	☐	__%

Substrate:

Silt	☐	_____%
Sand	☑	100__%
Gravel	☐	___%
Cobble	☐	__%
Boulder	☐	_%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☐
- Partially confined ☑
- Unconfined ☐

Habitat Type:
- Riffle ☐ _____%
- Run ☐ _____%
- Pool ☐ _____%
- Rapids ☐ _____%

Photos:

Photo #	Description

Comments:

This is the drainage between a series of wetlands and lakes.
Although fairly dry now, this wetland area could flood in the spring and provide migratory habitat.
This channel may be a means to access large lake 600 meters north of crossing.
Crossing approximately 6 meters wide.
Crossing may require a large culvert.
instream vegetation grass

baitfish migration, and spawning potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 145 **Date (mm/dd/yy):** 8/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☑ Yes ☐ No **Site No.:** RPR 292

UTM: 9 W Easting 572193 Northing 7258537

Channel Width: ☐ <1m ☐ 1-3m ☐ 3-10m ☑ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☑
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☐	_10_%
Forbs	☐	__%
Shrubs	☐	__20_%
Conifer	☐	__60_%
Deciduous	☐	__10_%

Substrate:

Silt	☐	_____%
Sand	☐	__%
Gravel	☐	_____%
Cobble	☐	_45_%
Boulder	☐	_45_%
Bedrock	☐	__10_%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☑

Channel Islands Present: yes ☑ no ☐

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☑	__18__%
Run	☑	__70_%
Pool	☑	__2__%
Rapids	☑	__10_%

Photos:

Photo #	Description
P9080099	**Oscar Creek unfinished bridge, facing north**
P9080100	**Oscar Creek unfinished bridge, facing west (NW)**
P9080101	**Oscar Creek unfinished bridge, facing west**
P9080102, 105	**Oscar Creek unfinished bridge, facing south**
P9080103	**bridge foundation**
P9080104	**channel detail, west bend, woody debris**
P9080106	**channel overview, west bend, facing west**
P9080107-8	**bridge overview, facing south**

Comments:

Oscar Creek Bridge Unfinished
Winter road and bridge at awkward alignment.
Bridge never finished, stopped during construction. Cannot be used in winter or summer.
Winter road passes along side bridge.
Edward (monitor): water levels of Oscar Creek rise higher than bridge, and in fact go over bridge in the spring.
Perhaps unsuitable location for a bridge.
Suitable habitat for arctic grayling, northern pike, round whitefish, sculpin etc
baitfish migrate, reside and spawn potential
sportfish migrate, reside and spawn potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 146 **Date (mm/dd/yy):** 8/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 9 W Easting 575571 Northing 7256930

Channel Width: ☐ <1m ☑ 1-3m ☐ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☑
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	_80_%
Forbs	☐	__%
Shrubs	☑	_10_%
Conifer	☑	__10_%
Deciduous	☐	___%

Substrate:

Silt	☐	_____%
Sand	☑	_100_%
Gravel	☐	_____%
Cobble	☐	__%
Boulder	☐	__%
Bedrock	☐	___%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☑

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☐	____%
Run	☐	___%
Pool	☐	____%
Rapids	☐	___%

Photos:

Photo #	Description
P9080110, 115	**proposed crossing, facing west, cutline of proposed route running west (NW).**
P9080111	**proposed crossing, facing east (NE)**
P9080112	**proposed crossing, facing east (NE), channel connects to lake upstream**
P9080113	**proposed crossing, downstream channel, west**
P9080114, 116	**channel detail**
P9080117	**channel downstream, west**
P9080118	**overview of channel, connection to lake(s), facing east**

Comments:

Proposed water crossing, outflow of nearby lake.
lake with suitable habitat for northern pike and whitefish.
Crossing is approximately 3 meters wide and 1 meter deep.
Crossing may require a bridge.
instream vegetation grass
small woody debris (moderate)
baitfish migrate, reside and spawn potential
sportfish migrate, reside and spawn potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 147 **Date (mm/dd/yy):** 8/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☑ Yes ☐ No **Site No.:** RPR 292

UTM: 9 W Easting 575027 Northing 7257882

Channel Width: ☐ <1m ☐ 1-3m ☐ 3-10m ☑ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☑
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	_30_%
Forbs	☑	_10_%
Shrubs	☑	__20_%
Conifer	☑	__40_%
Deciduous	☐	___%

Substrate:

Silt	☐	_____%
Sand	☐	__%
Gravel	☑	__80_%
Cobble	☑	_20_%
Boulder	☐	__%
Bedrock	☐	___%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☑

Channel Islands Present: yes ☑ no ☐

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☑	__2_%
Run	☑	_98_%
Pool	☐	____%
Rapids	☐	___%

Photos:

Photo #	Description
P9080119-121	**Oscar Creek proposed crossing of alternative route. Downstream west.**
P9080122-3	**Oscar Creek bottom substrate.**
P9080124	**channel NE**
P9080125	**Oscar Creek, proposed crossing (facing north)**
P9080126	**bridge foundation**
P9080124	**channel detail, west bend, woody debris**
P9080125	**channel overview, west bend, facing west**
P9080126	**bridge overview, facing south**

Comments:

Oscar Creek proposed alternative route (upstream north of unfinished bridge)

Proposed water crossing will require a bridge. This location for water crossing would be better than existing location of unfinished bridge.

Suitable habitat for cisco (least, arctic and common), arctic grayling, arctic lamrey, broad whitefish, burbot, inconnu, northern pike, whitefish (lake, round), walleye, sucker (longnose, white) and cyprinid forage or bait fish: longnose dace, chub (fltahead, lake), ninespine stickleback, spotail shiner, trout-perch baitfish migrate, reside and spawn potential, sportfish migrate, reside and spawn potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 148 **Date (mm/dd/yy):** 8/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 9 W Easting 572464 Northing 7259215

Channel Width: ☐ <1m ☐ 1-3m ☑ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☐
- 26-50 ☐
- 51-75 ☑
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	_5_%
Forbs	☑	_5_%
Shrubs	☑	_25_%
Conifer	☑	__60_%
Deciduous	☑	__5_%

Substrate:

Silt	☐	_____%
Sand	☐	__%
Gravel	☐	_____%
Cobble	☑	_40_%
Boulder	☑	_60_%
Bedrock	☐	___%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☑

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☑	_10_%
Run	☑	_70_%
Pool	☑	_20_%
Rapids	☐	___%

Photos:

Photo #	Description
P9080126	**proposed crossing, creek facing south**
P9080127	**proposed crossing, creek facing south**
P9080128	**proposed crossing, creek detail**

Comments:

Unnamed creek, watershed drainage between lake in northwest to Oscar Creek in south.

Crossing is approximately 3-5 meters wide and 0.3-1 meter deep in sections.
Crossing may require a bridge.

small woody debris (trace)
Suitable habitat for arctic grayling, sculpin

baitfish migrate, reside and spawn potential
sportfish migrate, reside and spawn potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 153 **Date (mm/dd/yy):** 8/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 9 W Easting 563986 Northing 7267203

Channel Width: ☐ <1m ☐ 1-3m ☐ 3-10m ☑ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☐
- 26-50 ☐
- 51-75 ☑
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	_10_%
Forbs	☐	__%
Shrubs	☑	_25_%
Conifer	☑	__60_%
Deciduous	☑	__5_%

Substrate:

Silt	☐	_____%
Sand	☑	_100_%
Gravel	☐	_____%
Cobble	☐	__%
Boulder	☐	__%
Bedrock	☐	___%

Obstructions Visible: yes ☑ no ☐ Type fill Location at winter road crossing

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:
- Riffle ☐ __%
- Run ☑ __%
- Pool ☐ __%
- Rapids ☐ ___%

Photos:

Photo #	Description
P9080135	**crossing at winter road, facing west**
P9080136	**crossing at winter road, facing east (outflow of lake)**
P9080137-8	**proposed crossing, creek detail (fill may have been added to winter road crossing)**

Comments:

Crossing is the outflow of a quite substantial size lake (2-3 km long), drainage downstream (S) to the Mackenzie River (2.5 km).
Crossing is approximately 15 meters wide and 0.3-0.7 meter deep in sections.
Crossing may require a bridge.
water is brown in color.
small woody debris (moderate)
beaver lodge on lake
Lake suitable habitat for northern pike, whitefish, arctic grayling, sculpin
baitfish migrate, reside and spawn potential
sportfish migrate, reside and spawn potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 178 **Date (mm/dd/yy):** 8/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 9 W Easting 623577 Northing 7230276

Channel Width: ☐ <1m ☑ 1-3m ☐ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☐
- 26-50 ☐
- 51-75 ☑
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	_10_%
Forbs	☐	__%
Shrubs	☑	_25_%
Conifer	☑	__60_%
Deciduous	☑	__5_%

Substrate:

Silt	☐	_____%
Sand	☐	__%
Gravel	☑	_50__%
Cobble	☑	_50 %
Boulder	☐	__%
Bedrock	☐	___%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:
- Riffle ☐ __%
- Run ☑ __%
- Pool ☐ __%
- Rapids ☐ ___%

Photos:

Photo #	Description
P9080167, 169	**crossing at winter road, facing south**
P9080168	**crossing at winter road, detail**
P9080170	**creek detail (centre of winter road)**
P9080171	**creek detail (off centre of winter road)**

Comments:

Small drainage from mountains to a small series of lakes (south).

Crossing is approximately 1 meter wide and 0.1meter deep.
Crossing may require a culvert.

water is clear.
small woody debris (moderate)

baitfish migration, and spawning potential
sportfish migration, and spawning potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 180 **Date (mm/dd/yy):** 8/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☑ Yes ☐ No **Site No.:** RPR 313

UTM: 9 W Easting 626464 Northing 7228215

Channel Width: ☐ <1m ☐ 1-3m ☐ 3-10m ☑ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☑
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	_10_%
Forbs	☐	__%
Shrubs	☑	__20_%
Conifer	☑	__70_%
Deciduous	☐	___%

Substrate:

Silt	☐	_____%
Sand	☑	_20_%
Gravel	☑	_15_%
Cobble	☑	_60_%
Boulder	☑	_5_%
Bedrock	☐	___%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☑

Channel Islands Present: yes ☑ no ☐

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☑	__2_%
Run	☑	_98_%
Pool	☐	____%
Rapids	☐	___%

Photos:

Photo #	Description
P9080176	**Prohibition Creek proposed crossing of alternative route, channel detail.**
P9080177	**Prohibition Creek proposed crossing, upstream north.**
P9080178	**Alternative crossing, overview, facing south east, in line with cutline.**
P9080179	**Prohibition Creek proposed crossing, upstream north.**
P9080180	**Prohibition Creek proposed crossing, downstream south.**
P9080181	**channel detail, bed material, bars**
P9090007	**Prohibition Creek silhouette taken from Mackenzie River (facing north)**

Comments:

Prohibition Creek proposed alternative route (option A)
Clear water with moderate flow.
Proposed water crossing will require a bridge.
Bed approximately 20 meters wide, current water conditions approx 0.2 m depth.
Suitable habitat for arctic grayling, northern pike, whitefish (broad, round and mountain species), cisco, longnose sucker,
bull trout, burbot, trout-perch, lake chub, spottail shiner, sculpin (spoonhead and slimy).

baitfish migrate, reside and spawn potential
sportfish migrate, reside and spawn potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 182 **Date (mm/dd/yy):** 8/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☑ Yes ☐ No **Site No.:** RPR 313

UTM: 9 W Easting 626803 Northing 7229866

Channel Width: ☐ <1m ☐ 1-3m ☐ 3-10m ☑ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☑
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	_10_%
Forbs	☐	__%
Shrubs	☑	__20_%
Conifer	☑	__60_%
Deciduous	☑	_10_%

Substrate:

Silt	☐	_____%
Sand	☐	__%
Gravel	☑	_10_%
Cobble	☑	_90_%
Boulder	☐	__%
Bedrock	☐	___%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☑

Channel Islands Present: yes ☑ no ☐

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☑	__2_%
Run	☑	_98_%
Pool	☐	____%
Rapids	☐	___%

Photos:

Photo #	Description
P9080182	**Prohibition Creek proposed crossing of alternative route B, facing upstream north.**
P9080183	**Prohibition Creek proposed crossing, channel detail.**
P9080184	**Alternative crossing, overview, facing south east, in line with cutline.**
P9080185	**channel detail, bed material, bars**
P9080186	**Prohibition Creek proposed crossing, facing east**
P9080187-8	**Prohibition Creek proposed crossing, facing west**
P9090007	**Prohibition Creek siluette taken from Mackezie River (facing north)**

Comments:

Prohibition Creek proposed alternative route (option B)
Clear water with moderate flow.
Proposed water crossing will require a bridge.
Bed approximately 20 meters wide, current water conditions approx 0.2 m depth.
Suitable habitat for arctic grayling, northern pike, whitefish (broad, round and mountain species), cisco, longnose sucker,
bull trout, burbot, trout-perch, lake chub, spottail shiner, sculpin (spoonhead and slimy).

baitfish migrate, reside and spawn potential
sportfish migrate, reside and spawn potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 187 **Date (mm/dd/yy):** 8/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 9 W Easting 623983 Northing 7230954

Channel Width: ☐ <1m ☐ 1-3m ☑ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☐
- 26-50 ☐
- 51-75 ☐
- 75-100 ☑

Type of Riparian Vegetation:

None	☐	_____%
Grass	☐	__%
Forbs	☐	__%
Shrubs	☑	_10_%
Conifer	☑	__45_%
Deciduous	☑	__45_%

Substrate:

Silt	☐	_____%
Sand	☐	__%
Gravel	☐	___%
Cobble	☑	_50 %
Boulder	☑	_50_%
Bedrock	☐	___%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☐	__%
Run	☑	__%
Pool	☐	__%
Rapids	☐	___%

Photos:

Photo #	Description
P9080189	**creek upstream north**
P9080190	**creek downstream south**
P9080191	**creek detail**

Comments:

Small flows south to a series of lakes.

Crossing is approximately 3-4 meters wide and 0.6 -0.8 meters deep.
Crossing may require a culvert.

water is brown in color.
small woody debris (moderate)

baitfish migration, and spawning potential
sportfish migration, and spawning potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 191 **Date (mm/dd/yy):** 8/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 9 W Easting 629551 Northing 7227955

Channel Width: ☐ <1m ☑ 1-3m ☐ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☐
- 26-50 ☐
- 51-75 ☐
- 75-100 ☑

Type of Riparian Vegetation:

None	☐	_____%
Grass	☐	__%
Forbs	☐	__%
Shrubs	☑	_20_%
Conifer	☑	__75_%
Deciduous	☑	__5_%

Substrate:

Silt	☐	_____%
Sand	☐	__%
Gravel	☐	___%
Cobble	☑	_30 %
Boulder	☑	_70_%
Bedrock	☐	___%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☑

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☐	__%
Run	☑	__%
Pool	☐	__%
Rapids	☐	___%

Photos:

Photo #	Description
P9080192	**creek downstream south**
P9080193	**creek downstream south**

Comments:

This very small creek flows from a lake in the north to the Mackenzie (south).

Crossing is approximately 1 meter wide and bed appears to have water 0.0-0.2 m depth in locations.
Crossing may require a culvert.

small woody debris (moderate)

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 217 **Date (mm/dd/yy):** 9/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 10 W Easting 437813 Northing 7101870

Channel Width: ☐ <1m ☐ 1-3m ☐ 3-10m ☑ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☐
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☑

Crown Closure (%):
- 0 ☐
- 1-25 ☐
- 26-50 ☐
- 51-75 ☑
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	____%
Grass	☑	10%
Forbs	☐	____%
Shrubs	☑	5%
Conifer	☑	40%
Deciduous	☑	45%

Substrate:

Silt	☐	____%
Sand	☑	100%
Gravel	☐	____%
Cobble	☐	____%
Boulder	☐	____%
Bedrock	☐	____%

Obstructions Visible: yes ☐ no ☑ Type ____ Location ____

Channel Pattern: Straight ☐ Sinuous ☑ Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☐	____%
Run	☑	____%
Pool	☑	____%
Rapids	☐	____%

Photos:

Photo #	Description
P9090059	**crossing on winter road, facing north (NW)**
P9090060	**crossing winter road (west)**
P9090061	**crossing winter road (east)**
P9090062	**western drainage, towards the Mckenzie river (in distance)**

Comments:

Crossing is approximately 15 meters wide and may require a small bridge/large culvert.
deep pool at winter road crossing
instream vegetation includes live trees
beaver activity observed in western reaches
water dark brown color
small woody debris in channel 15%
this primary channel (with affiliates) drains west directly into Mackenzie (approx 8km south of crossing)
baitfish reside and migrate potential
sportfish migrate potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 221 **Date (mm/dd/yy):** 9/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 10 W Easting 435639 Northing 7108217

Channel Width: ☐ <1m ☐ 1-3m ☑ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☑
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__40___%
Forbs	☐	_____%
Shrubs	☑	__25___%
Conifer	☑	__10___%
Deciduous	☑	__25___%

Substrate:

Silt	☐	_____%
Sand	☑	_100___%
Gravel	☐	_____%
Cobble	☐	_____%
Boulder	☐	_____%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous ☐ Meandering ☑

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☐
- Partially confined ☑
- Unconfined ☐

Habitat Type:

Riffle	☐	_____%
Run	☑	_____%
Pool	☑	_____%
Rapids	☐	_____%

Photos:

Photo #	Description
P9090065	**crossing on winter road, facing north (NW)**
P9090066	**crossing winter road (west)**
P9090067	**crossing winter road (west)**
P9090068	**east upstream section lake, beaver activity observed**

Comments:

Crossing is approximately 8 meters wide and may require a big culvert or two culverts. Banks lay flat with winter road.
Flooded area. Channel drains west and empties into the McKenize River (approx 8km away).
Instream vegetation includes live trees
Beaver activity observed in eastern origins at lake.
Lake at upper confluences of stream, is suitable whitefish and northern pike habitat.
Water dark brown color
baitfish reside, migrate and spawn potential
sportfish migrate and spawn potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 224 **Date (mm/dd/yy):** 9/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 10 W Easting 434299 Northing 7115389

Channel Width: ☐ <1m ☐ 1-3m ☐ 3-10m ☑ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☐
- Moderate (30-90% bankfull) ☑
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☐
- 26-50 ☐
- 51-75 ☑
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__40___%
Forbs	☐	_____%
Shrubs	☑	__25___%
Conifer	☑	__10___%
Deciduous	☑	__25___%

Substrate:

Silt	☐	_____%
Sand	☑	_100___%
Gravel	☐	_____%
Cobble	☐	_____%
Boulder	☐	_____%
Bedrock	☐	_____%

Obstructions Visible: yes ☑ no ☐ Type small woody debris, beaver dam Location west side of winter road crossing.

Channel Pattern: Straight ☐ Sinuous ☑ Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☐	_____%
Run	☑	_____%
Pool	☑	_____%
Rapids	☐	_____%

Photos:

Photo #	Description
P9090073	**crossing on winter road, facing north**
P9090074	**crossing winter road (west)**
P9090075	**crossing winter road (west)**
P9090076	**crossing winter road (west)**
P9090077	**crossing winter road (west)**
P9090078	**upstream of crossing (east)**

Comments:

Crossing is approximately 8-15 meters wide and may require a small bridge/large culvert.
Beaver activity observed. Small woody debris disrupting flow, causing pooling. Log jams and sediment wedges.
Instream vegetation includes live trees
Water dark brown color
South bank vertical, north bank sloping.
baitfish reside and migrate potential
sportfish migrate potential
Channel drains west and empties into the McKenize River (approx 2km away).

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 238 **Date (mm/dd/yy):** 9/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 10 W Easting 432940 Northing 7121733

Channel Width: ☐ <1m ☐ 1-3m ☐ 3-10m ☑ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☑
- 1-25 ☐
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__10___%
Forbs	☐	_____%
Shrubs	☑	__10___%
Conifer	☑	__90___%
Deciduous	☐	_____%

Substrate:

Silt	☐	_____%
Sand	☑	_100___%
Gravel	☐	_____%
Cobble	☐	_____%
Boulder	☐	_____%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous ☑ Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☐
- Partially confined ☑
- Unconfined ☐

Habitat Type:

Riffle	☐	_____%
Run	☐	_____%
Pool	☑	_____%
Rapids	☐	_____%

Photos:

Photo #	Description
P9090095	**crossing on winter road, facing east (NE)**
P9090096	**crossing winter road (west)**
P9090097	**crossing winter road (east)**
P9090098	**crossing winter road (east)**
P9090099	**crossing winter road (south)**

Comments:

Crossing is approximately 100 meters wide and may require several culverts.
Crossing at flooded wet area, water in patches.
Instream vegetation includes grass.
Water dark brown color
Banks vertical in eastern reaches and sloping in western reaches.
baitfish reside and migration potential
Channel drains west and empties into the McKenize River (approx 2km away). Eastern origins of channel supplied by small lake.

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 243 **Date (mm/dd/yy):** 9/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 10 W Easting 431935 Northing 7123962

Channel Width: ☐ <1m ☑ 1-3m ☐ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☐
- 26-50 ☐
- 51-75 ☑
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__2_%
Forbs	☐	_____%
Shrubs	☑	__8__%
Conifer	☑	__80_%
Deciduous	☑	__10__%

Substrate:

Silt	☐	_____%
Sand	☐	_____%
Gravel	☐	_____%
Cobble	☑	__100_%
Boulder	☐	_____%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous ☑ Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☐	_____%
Run	☑	_____%
Pool	☐	_____%
Rapids	☐	_____%

Photos:

Photo #	Description
P9090100	**crossing on winter road, facing south (SE)**
P9090101	**crossing winter road (east)**
P9090102	**crossing winter road (west)**
P9090103	**crossing winter road bed material**

Comments:

Crossing is approximately 2 meters wide (current water depth of 0.1 m) and may require a culvert.
Stream flowing south (slowly) to the Mackenzie River (approximately 2 km away)
Bed cobble with rock piles (step-pool breaks). Small woody debris trace.
Water clear.
Banks steep to sloping in upper and lower reaches. Grade <3%

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 249 **Date (mm/dd/yy):** 9/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 10 W Easting 431072 Northing 7126467

Channel Width: ☐ <1m ☐ 1-3m ☑ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☑
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__40_%
Forbs	☐	_____%
Shrubs	☑	__40_%
Conifer	☑	__5_%
Deciduous	☑	__15__%

Substrate:

Silt	☐	_____%
Sand	☑	_100_%
Gravel	☐	_____%
Cobble	☐	___%
Boulder	☐	_____%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous ☑ Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☐
- Partially confined ☑
- Unconfined ☐

Habitat Type:
- Riffle ☐ _____%
- Run ☐ _____%
- Pool ☐ _____%
- Rapids ☐ _____%

Photos:

Photo #	Description
P9090104	**crossing on winter road**
P9090105	**crossing winter road (east), beaver lodge on lake**

Comments:

Crossing is approximately 10 meters wide (current water depth of 0.1 m) and may require culvert(s).
No current observed flow. Area flooded. Mackenzie River is approximately 2 km to west.
Instream vegetation include grasses and standing timber (and or living trees).
Water brown in color. No woody debris.
Water crossing is drainage of small lake. Beaver lodge on lake.
baitfish reside and migrate potential
sportfish (northern pike) spawn potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 264 **Date (mm/dd/yy):** 9/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☑ Yes ☐ No **Site No.:** RPR 355

UTM: 10 W Easting 424671 Northing 7135082

Channel Width: ☐ <1m ☑ 1-3m ☐ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☑
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__10_%
Forbs	☐	_____%
Shrubs	☑	__60_%
Conifer	☑	__15_%
Deciduous	☑	__15__%

Substrate:

Silt	☐	_____%
Sand	☐	__%
Gravel	☐	_____%
Cobble	☑	_20_%
Boulder	☑	_80_%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☐	_____%
Run	☑	_____%
Pool	☐	_____%
Rapids	☐	_____%

Photos:

Photo #	Description
IMGP019	**crossing winter road (north)**
IMGP020	**crossing winter road (east)**
IMGP021	**bed material**
IMGP022	**crossing winter road, upstream western section**
IMGP023	**crossing winter road, upstream western section**

Comments:

Channel bed is approximately 2 meters wide and dry (trace of water). Crossing may require culvert.
Channel connects to Mackenzie River approximately 2.5 km south.
Moderate small woody debris; would not hamper or obstruct flow.

Sportfish migration and spawning potential in spring if the existing high gradient to Mackenzie river had been lower.

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 278 **Date (mm/dd/yy):** 9/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 10 W Easting 415870 Northing 7151094

Channel Width: ☐ <1m ☐ 1-3m ☐ 3-10m ☑ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☑
- 1-25 ☐
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__50_%
Forbs	☑	_10_%
Shrubs	☑	__30_%
Conifer	☑	__10_%
Deciduous	☐	_____%

Substrate:

Silt	☐	_____%
Sand	☑	_100___%
Gravel	☐	_____%
Cobble	☐	_____%
Boulder	☐	_____%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☑ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☐
- Partially confined ☐
- Unconfined ☑

Habitat Type:

Riffle	☐	_____%
Run	☐	_____%
Pool	☐	_____%
Rapids	☐	_____%

Photos:

Photo #	Description
IMGP031	**crossing on winter road, facing north**
IMGP032	**crossing on winter road, facing west**
IMGP033	**crossing on winter road, facing west. Large lake in distance.**

Comments:

Crossing is approximately 100 meters wide and may require several culverts.
Crossing at flooded wet area.
Instream vegetation includes grass.
no discernable banks
Channel drains west into a large lake (approx 1 km away).
Drainage network directly connected to this channel empties into the Mackenzie River (approx 2km away).
baitfish spawning potential in spring

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 293 **Date (mm/dd/yy):** 9/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 10 W Easting 412724 Northing 7164552

Channel Width: ☐ <1m ☐ 1-3m ☐ 3-10m ☑ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☑
- 1-25 ☐
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__40_%
Forbs	☐	__%
Shrubs	☑	__30_%
Conifer	☑	__30_%
Deciduous	☐	_____%

Substrate:

Silt	☐	_____%
Sand	☑	_100___%
Gravel	☐	_____%
Cobble	☐	_____%
Boulder	☐	_____%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☑

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☐
- Partially confined ☐
- Unconfined ☑

Habitat Type:
- Riffle ☐ _____%
- Run ☐ _____%
- Pool ☐ _____%
- Rapids ☐ _____%

Photos:

Photo #	Description
IMGP044	**crossing on winter road, facing west**
IMGP045	**channel bottom substrate**
IMGP046	**crossing on winter road, facing north**

Comments:

Crossing is approximately 12 meters wide (current wet section 2 meters wide).
Crossing at flooded wet area. This wet area may require several culverts.
Instream vegetation includes grass. Small woody debris abundant on bottom of channel.
no discernable banks
possibly caused by backflooding of Big Smith Creek.

baitfish reside, migration and spawning potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 295 **Date (mm/dd/yy):** 9/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 10 W Easting 410998 Northing 7166150

Channel Width: ☐ <1m ☐ 1-3m ☐ 3-10m ☑ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☑
- 1-25 ☐
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__40_%
Forbs	☐	__%
Shrubs	☑	__30_%
Conifer	☑	__30_%
Deciduous	☐	_____%

Substrate:

Silt	☐	_____%
Sand	☑	_100___%
Gravel	☐	_____%
Cobble	☐	_____%
Boulder	☐	_____%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☑

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☐
- Partially confined ☐
- Unconfined ☑

Habitat Type:
- Riffle ☐ _____%
- Run ☐ _____%
- Pool ☐ _____%
- Rapids ☐ _____%

Photos:

Photo #	Description
IMGP047	**crossing on winter road, facing south**
IMGP048	**crossing on winter road, facing east. Lakes which supply the channel.**
IMGP049	**crossing on winter road, facing east. Lakes which supply the channel.**
IMGP050	**crossing on winter road, facing east. Lakes which supply the channel.**
IMGP051	**crossing on winter road, facing north. Mackenzie river in top left hand corner of picture.**
IMGP052	**crossing on winter road, facing west. Mackenzie river in close proximity to crossing.**

Comments:

Winter road skirts the edges of the existing lakes.
Crossing at flooded wet area. This wet area may require several culverts.
Instream vegetation includes grass and standing dead timber. Small woody debris trace.
no discernable banks
Crossing is approximately 11 meters wide (current wet section 1 meter wide).
Crossing at lower confluence of a series of interconnected lakes with suitable habitat for N pike and whitefish.
baitfish reside, migration and spawning potential
sportfish spawn potential.

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 296 **Date (mm/dd/yy):** 9/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 10 W Easting 410938 Northing 7167644

Channel Width: ☐ <1m ☐ 1-3m ☐ 3-10m ☑ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☑
- 1-25 ☐
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__40_%
Forbs	☐	__%
Shrubs	☑	__30_%
Conifer	☑	__30_%
Deciduous	☐	_____%

Substrate:

Silt	☐	_____%
Sand	☑	_100___%
Gravel	☐	_____%
Cobble	☐	_____%
Boulder	☐	_____%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☑

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☐
- Partially confined ☐
- Unconfined ☑

Habitat Type:
- Riffle ☐ _____%
- Run ☐ _____%
- Pool ☐ _____%
- Rapids ☐ _____%

Photos:

Photo #	Description
IMGP053	**crossing on winter road, facing south**
IMGP054	**crossing on winter road, facing east.**
IMGP055	**crossing on winter road, facing north. Lakes which supply the crossing area.**

Comments:

Winter road skirts the edges of the existing lakes.
Crossing between 2 waterbodies. This wet area may require several culverts.
Instream vegetation includes live spruce trees. Area of low topo between two lakes.
Mackenzie river 800m away, seperated by high grade (cliff).
Crossing is approximately 50 meters wide (current wet section 5 meter wide).
Nearby lake with suitable habitat for N pike and baitfish.
baitfish reside, migration and spawning potential
sportfish reside and spawn potential.

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 297 **Date (mm/dd/yy):** 9/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 10 W Easting 410947 Northing 7168766

Channel Width: ☐ <1m ☐ 1-3m ☑ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☑
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__20_%
Forbs	☐	__%
Shrubs	☑	__40_%
Conifer	☑	__40_%
Deciduous	☐	_____%

Substrate:

Silt	☐	_____%
Sand	☑	_100___%
Gravel	☐	_____%
Cobble	☐	_____%
Boulder	☐	_____%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☐
- Partially confined ☑
- Unconfined ☐

Habitat Type:

Riffle	☐	_____%
Run	☐	_____%
Pool	☐	_____%
Rapids	☐	_____%

Photos:

Photo #	Description
IMGP056	**crossing on winter road, facing south**
IMGP057	**crossing on winter road, facing south**
IMGP058	**crossing on winter road, facing east**
IMGP059	**crossing on winter road, facing north**
IMGP060	**detail of crossing at winter road**
IMGP061	**detail of crossing at winter road**

Comments:

Winter road skirts the edges of the outflow of a series of small lakes.
Crossing in a wet area may require several culverts.
Instream vegetation includes grass and live spruce trees.
Channel is quite dry (approximately 10 meters wide).
Stream's current wetted width is 0.5 meter wide crossing the winter road and 1m wide on other downstream sections.

baitfish reside, migration and spawning potential
sportfish spawning potential.

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 298 **Date (mm/dd/yy):** 9/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 10 W Easting 411245 Northing 7169818

Channel Width: ☐ <1m ☐ 1-3m ☑ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☑
- 1-25 ☐
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__40_%
Forbs	☐	__%
Shrubs	☑	__30_%
Conifer	☑	__30_%
Deciduous	☐	_____%

Substrate:

Silt	☐	_____%
Sand	☑	_100___%
Gravel	☐	_____%
Cobble	☐	_____%
Boulder	☐	_____%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☑

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☐
- Partially confined ☐
- Unconfined ☑

Habitat Type:
- Riffle ☐ _____%
- Run ☐ _____%
- Pool ☐ _____%
- Rapids ☐ _____%

Photos:

Photo #	Description
IMGP062	**crossing on winter road, facing east**
IMGP063	**crossing on winter road, facing west (NW)**
IMGP064	**crossing on winter road, facing west**
IMGP065	**crossing on winter road, facing south west**
IMGP066	**crossing on winter road, facing south**

Comments:

Winter road cuts through the drainage between a series of small lakes.
Crossing in a wet area may require several culverts.
Instream vegetation includes grass and shrubs.
Channel is quite dry (approximately 20 meters wide in sections).
Stream's current wetted width is 0.5 meter wide crossing the winter road .

baitfish reside, migration and spawning potential
sportfish migration potential.

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 300 **Date (mm/dd/yy):** 9/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 10 W Easting 411627 Northing 7170638

Channel Width: ☐ <1m ☑ 1-3m ☐ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☐
- 26-50 ☐
- 51-75 ☑
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☐	___%
Forbs	☐	__%
Shrubs	☑	__5_%
Conifer	☑	__90_%
Deciduous	☑	__5__%

Substrate:

Silt	☐	_____%
Sand	☐	___%
Gravel	☐	_____%
Cobble	☑	__50_%
Boulder	☑	__50_%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☐	_____%
Run	☑	_____%
Pool	☐	_____%
Rapids	☐	_____%

Photos:

Photo #	Description
IMGP067	**crossing on winter road, facing south (SE)**
IMGP068	**crossing on winter road, facing east (SE)**
IMGP069	**channel detail**

Comments:

This crossing is the drainage from a series of small lakes. Mackenzie River 2km downstream (east).
Crossing may require a culvert.

Channel is quite dry (approximately 2 meters wide). Wetted width 0.5 meters wide.

baitfish migration and spawning potential
sportfish migration potential (perhaps out of lake system)

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 301 **Date (mm/dd/yy):** 9/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 10 W Easting 411952 Northing 7170879

Channel Width: ☐ <1m ☑ 1-3m ☐ 3-10m ☐ >10 m

Stream Discharge Stage:
- ☑ Low (0-30% bankfull)
- ☐ Moderate (30-90% bankfull)
- ☐ High (>90% bankfull)

Crown Closure (%):
- ☐ 0
- ☐ 1-25
- ☐ 26-50
- ☑ 51-75
- ☐ 75-100

Type of Riparian Vegetation:

None	☐	_____%
Grass	☐	___%
Forbs	☐	__%
Shrubs	☑	__5_%
Conifer	☑	__90_%
Deciduous	☑	__5__%

Substrate:

Silt	☐	_____%
Sand	☐	___%
Gravel	☐	_____%
Cobble	☑	__30_%
Boulder	☑	__70_%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☑ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- ☑ Confined
- ☐ Partially confined
- ☐ Unconfined

Habitat Type:

Riffle	☐	_____%
Run	☑	_____%
Pool	☐	_____%
Rapids	☐	_____%

Photos:

Photo #	Description
IMGP070	**crossing on winter road, facing east**
IMGP071	**crossing on winter road, facing east**

Comments:

This crossing is the drainage from a series of small lakes. Mackenzie River 2km downstream (east).
Crossing may require a culvert.

Channel is quite dry (approximately 3 meters wide). Wetted width 0.5 meters wide.

baitfish migration and spawning potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 303 **Date (mm/dd/yy):** 9/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 10 W Easting 411981 Northing 7171329

Channel Width: ☐ <1m ☑ 1-3m ☐ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☐
- 26-50 ☐
- 51-75 ☐
- 75-100 ☑

Type of Riparian Vegetation:

None	☐	_____%
Grass	☐	___%
Forbs	☐	__%
Shrubs	☑	__5_%
Conifer	☑	__90_%
Deciduous	☑	__5__%

Substrate:

Silt	☐	_____%
Sand	☐	___%
Gravel	☐	_____%
Cobble	☑	__50_%
Boulder	☑	__50_%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☐	_____%
Run	☑	_____%
Pool	☐	_____%
Rapids	☐	_____%

Photos:

Photo #	Description
IMGP072	**crossing on winter road, facing north**
IMGP073	**crossing on winter road, detail**

Comments:

This crossing is the drainage from a series of small lakes. Mackenzie River 2km downstream (east).
Crossing may require a culvert.

Channel is quite dry (approximately 2 meters wide). Wetted width 0.2 meters wide.
Instream vegetation includes grass and willows.

baitfish migration and spawning potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 306 **Date (mm/dd/yy):** 9/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 10 W Easting 412162 Northing 7167518

Channel Width: ☐ <1m ☐ 1-3m ☐ 3-10m ☑ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☑
- 1-25 ☐
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	___%
Forbs	☐	__%
Shrubs	☑	__5_%
Conifer	☑	__60_%
Deciduous	☑	__35_%

Substrate:

Silt	☐	_____%
Sand	☑	_100_%
Gravel	☐	_____%
Cobble	☐	___%
Boulder	☐	___%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☐
- Partially confined ☐
- Unconfined ☑

Habitat Type:

Riffle	☐	_____%
Run	☑	_____%
Pool	☐	_____%
Rapids	☐	_____%

Photos:

Photo #	Description
IMGP074	**crossing on winter road, facing lake to the west**
IMGP075	**crossing on winter road, detail of materials just west of crossing**
IMGP076	**crossing on winter road, facing lake to the west**
IMGP077	**crossing on winter road, facing south**
IMGP078	**crossing on winter road, facing lake to the east**
IMGP079	**crossing on winter road, north**
IMGP080	**crossing on winter road, facing south**

Comments:

This crossing is located at the connection between two lakes.
This crossing is part of a series of small lakes which drain into the Mackenzie River 2 km downstream (east).
Crossing may require several culverts.
Channel is quite dry (approximately 100 meters wide). Wetted width 3 meters wide.
Instream vegetation includes grass and few willow.
water brown in color

baitfish migration and spawning potential
sportfish reside, migration and spawning potential.

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 318 **Date (mm/dd/yy):** 10/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 10 W Easting 411435 Northing 7174830

Channel Width: ☐ <1m ☐ 1-3m ☐ 3-10m ☑ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☐
- Moderate (30-90% bankfull) ☑
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☑
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__5_%
Forbs	☐	__%
Shrubs	☑	__15_%
Conifer	☑	__35_%
Deciduous	☑	__45_%

Substrate:

Silt	☐	_____%
Sand	☐	_100_%
Gravel	☐	_____%
Cobble	☐	___%
Boulder	☐	___%
Bedrock	☐	_____%

Obstructions Visible: yes ☑ no ☐ Type Beaver dam Location downstream (approx 2 meters)

Channel Pattern: Straight ☑ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☐	_____%
Run	☐	_____%
Pool	☑	_____%
Rapids	☐	_____%

Photos:

Photo #	Description
P9100002	**crossing winter road, facing south**
P9100003	**crossing winter road, facing west (Mckenzie river in background)**
P9100004	**beaver dam (just west of winter road crossing)**
P9100005	**Lake and crossing created by beaver activity (facing east)**

Comments:

This crossing is the drainage from a series of small lakes. Mackenzie River 700 meters downstream (west).
Winter road crossing ponded by flooding from beaver dam.

Crossing approximately 15 meters wide and 3 meters deep.
Crossing may require bridge or altered alignment around pond.
Water brown in color.

baitfish reside and spawn potential
sportfish reside, and spawn potential.

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 325 **Date (mm/dd/yy):** 10/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 10 W Easting 408491 Northing 7178378

Channel Width: ☐ <1m ☐ 1-3m ☐ 3-10m ☑ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☐
- Moderate (30-90% bankfull) ☑
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☑
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__5_%
Forbs	☐	__%
Shrubs	☐	___%
Conifer	☑	__70_%
Deciduous	☑	__15_%

Substrate:

Silt	☐	_____%
Sand	☑	_100_%
Gravel	☐	_____%
Cobble	☐	___%
Boulder	☐	___%
Bedrock	☐	_____%

Obstructions Visible: yes ☑ no ☐ Type sedimentation or fill Location outflow at road crossing

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:
- Riffle ☐ _____%
- Run ☐ _____%
- Pool ☑ _____%
- Rapids ☐ _____%

Photos:

Photo #	Description
P9100007	**crossing winter road, facing west**
P9100008	**crossing winter road, facing east (wateshed consisting of lakes)**
P9100009	**crossing winter road, facing west (drainage into lake downstream)**

Comments:

This crossing is the drainage between a series of small lakes. Mackenzie River 2 km downstream (south).
This crossing exhibiting some sloping, narrowing at the outflow into a narrow channel (with instream vegetation consisting of live conifers).

Crossing approximately 15 meters wide and 3 meters deep.
Crossing may require a small bridge or large culvert.
Water brown in color.

baitfish reside and spawn potential
sportfish reside, and spawn potential.

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 329 **Date (mm/dd/yy):** 10/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☑ Yes ☐ No **Site No.:** RPR 342

UTM: 10 W Easting 407681 Northing 7179921

Channel Width: ☐ <1m ☑ 1-3m ☐ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☑
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__15_%
Forbs	☐	__%
Shrubs	☑	_25_%
Conifer	☑	__30_%
Deciduous	☑	__30_%

Substrate:

Silt	☐	_____%
Sand	☑	_100_%
Gravel	☐	_____%
Cobble	☐	___%
Boulder	☐	___%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☐	_____%
Run	☑	_____%
Pool	☐	_____%
Rapids	☐	_____%

Photos:

Photo #	Description
P9100018	**crossing winter road, facing north**
P9100019	**crossing winter road, facing west**
P9100020	**crossing winter road, facing west (drainage into lake downstream near Rosie's Cabin)**
P9100021	**crossing winter road, facing south**
P9100022, 23	**crossing winter road, facing east**
P9100024	**upstream section of stream (west)**
P9100025	**crossing winter road, facing north**

Comments:

This crossing is the drainage between a series of small lakes. Mackenzie River 3.5 km downstream (south west).

Crossing approximately 1-2 meters wide in sections and 0.5 meters deep.
Crossing may require a culvert.
Water brown in color.
Some small woody debris (moderate).
Potential fish species: northern pike, lake whitefish, white sucker, lake chub
baitfish migrate, reside and spawn potential
sportfish migrate, reside, and spawn potential.

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 331 **Date (mm/dd/yy):** 10/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 10 W Easting 407102 Northing 7180445

Channel Width: ☐ <1m ☑ 1-3m ☐ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☐
- 26-50 ☐
- 51-75 ☑
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__15_%
Forbs	☐	__%
Shrubs	☑	_25_%
Conifer	☑	__50_%
Deciduous	☑	__10_%

Substrate:

Silt	☐	_____%
Sand	☑	_100_%
Gravel	☐	_____%
Cobble	☐	___%
Boulder	☐	___%
Bedrock	☐	_____%

Obstructions Visible: yes ☑ no ☐ Type road fill Location at crossing

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:
- Riffle ☐ _____%
- Run ☑ _____%
- Pool ☐ _____%
- Rapids ☐ _____%

Photos:

Photo #	Description
P9100026	**crossing winter road, facing south west (beaver lodge on lake)**
P9100027	**crossing winter road, facing east**
P9100028	**crossing winter road, facing east, channel source a small lake in distance**
P9100029	**crossing winter road, facing north**
P9100030	**channel overview (facing east)**
P9100031	**channel overview (facing east)**

Comments:

This crossing is the drainage between a series of small lakes. Mackenzie River 4 km downstream (south west).
Crossing approximately 0.5-2 meters wide and 0.3 meters deep in sections .
Crossing may require a culvert.
Water brown in color.
Some small woody debris (moderate).
baitfish migrate, reside and spawn potential
sportfish migrate, reside, and spawn potential.

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 336 **Date (mm/dd/yy):** 10/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 10 W Easting 406854 Northing 7178332

Channel Width: ☐ <1m ☐ 1-3m ☐ 3-10m ☑ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☐
- Moderate (30-90% bankfull) ☑
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☑
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__5_%
Forbs	☐	__%
Shrubs	☑	_5_%
Conifer	☑	__85_%
Deciduous	☑	__5_%

Substrate:

Silt	☐	_____%
Sand	☑	_100_%
Gravel	☐	_____%
Cobble	☐	___%
Boulder	☐	___%
Bedrock	☐	_____%

Obstructions Visible: yes ☑ no ☐ Type beaver dam and small log jams Location downstream

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☐	_____%
Run	☑	_____%
Pool	☐	_____%
Rapids	☐	_____%

Photos:

Photo #	Description
P9100032-4	**proposed crossing, facing north**
P9100035-7	**proposed crossing , facing south west**
P9100038	**proposed crossing**
P9100039	**proposed crossing, facing north east**
P9100040-2	**channel downstream (south)**
P9100043	**proposed crossing detail, beaver dam in channel**

Comments:

This crossing is the drainage from a series of small lakes. Mackenzie River 2 km downstream (south west).

Crossing approximately 20 meters wide and 2 meters deep.
Crossing may require a bridge.
Water brown in color.
Large woody debris (trace) and small woody debris (moderate).

baitfish migrate, reside and spawn potential
sportfish migrate, reside, and spawn potential.

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 363 **Date (mm/dd/yy):** 10/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 10 W Easting 397368 Northing 7198303

Channel Width: ☐ <1m ☐ 1-3m ☑ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☑
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__5_%
Forbs	☐	__%
Shrubs	☑	_5_%
Conifer	☑	__75_%
Deciduous	☑	__15_%

Substrate:

Silt	☐	_____%
Sand	☑	_100_%
Gravel	☐	_____%
Cobble	☐	___%
Boulder	☐	___%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☐
- Partially confined ☐
- Unconfined ☑

Habitat Type:
- Riffle ☐ _____%
- Run ☐ _____%
- Pool ☐ _____%
- Rapids ☐ _____%

Photos:

Photo #	Description
P9100057	**crossing winter road, facing north (drainage from lake)**
P9100058	**crossing winter road, facing north west**
P9100059	**crossing winter road, facing west**
P9100060	**crossing winter road, drainage dissapears into conifers on south side of road**

Comments:

This crossing is the drainage from a series of small lakes. Mackenzie River 1.5 km downstream (south).
Drainage disapears into some conifers.

Crossing approximately 3- 8 meters wide and 0.2 meters deep.
Crossing may require a culvert.
Water brown in color.

baitfish migrate, and spawn potential

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 366 **Date (mm/dd/yy):** 10/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 10 W Easting 394969 Northing 7198798

Channel Width: ☐ <1m ☐ 1-3m ☐ 3-10m ☑ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☑
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__10_%
Forbs	☐	__%
Shrubs	☑	_15_%
Conifer	☑	__70_%
Deciduous	☑	__5_%

Substrate:

Silt	☐	_____%
Sand	☑	_100_%
Gravel	☐	_____%
Cobble	☐	___%
Boulder	☐	___%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☐
- Partially confined ☑
- Unconfined ☐

Habitat Type:
- Riffle ☐ _____%
- Run ☐ _____%
- Pool ☐ _____%
- Rapids ☐ _____%

Photos:

Photo #	Description
P9100061-2	**crossing winter road, facing west**
P9100063	**crossing winter road, facing south, downstream drainage into small lake**
P9100064	**crossing winter road, facing south, downstream drainage into small lake (Mackenzie river in distance)**
P9100065	**crossing winter road, facing south east**
P9100066	**crossing winter road, facing east**
P9100067-8	**lake outflow north of crossing**
P9100070-4	**drainage south into a lake**

Comments:

This crossing is the drainage between two small lakes.
Lakes suitable habitat for northern pike and whitefish.
Crossing approximately 8-15 meters wide and 0.2 meters deep.
Crossing may require a small bridge or large culvert.
Water brown in color.
Large woody debris (moderate)
baitfish migrate, and spawn potential
sportfish migrate, reside, and spawn potential.

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 373 **Date (mm/dd/yy):** 10/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☑ Yes ☐ No **Site No.:** RPR 332

UTM: 10 W Easting 382776 Northing 7200651

Channel Width: ☐ <1m ☑ 1-3m ☐ 3-10m ☐ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☑
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__20_%
Forbs	☑	_30_%
Shrubs	☑	_15_%
Conifer	☑	__20_%
Deciduous	☑	__15_%

Substrate:

Silt	☐	_____%
Sand	☑	_90_%
Gravel	☑	_10_%
Cobble	☐	___%
Boulder	☐	___%
Bedrock	☐	_____%

Obstructions Visible: yes ☑ no ☐ Type small woody debris Location sections along stream

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☐	_____%
Run	☑	_____%
Pool	☐	_____%
Rapids	☐	_____%

Photos:

Photo #	Description
P9100086-9	**old existing bridge crossing**
P9100090-2	**proposed water crossing, facing south (Mackenzie river in distance)**
P9100093	**proposed water crossing, facing east, along proposed alignment**
P9100094-5	**proposed water crossing, facing north, existing bridge in foreground**
P9100096-99	**existing bridge detail**
P9100100	**four mile creek detail downstream (south)**
P9100101	**four mile creek detail upstream (north)**
P9100102-04	**existing creek crossing detail of banks**

Comments:

Unnamed stream, locally called Nine (EIS) or Four (Edward) Mile Creek.
Lakes upstream suitable habitat for northern pike and whitefish.
Crossing approximately 3 meters wide and 0.5 meters deep.
Crossing may require a small bridge.
Water clear and running. Small woody debris moderate.
DFO 1998 found at confluence: arctic grayling (juvenile), burbot, northern pike, emarald shiner, spottail shiner and lake chub.
Rearing habitat (all above species and bull trout and whitefish potentially).
baitfish migrate, spawn and reside (rear) potential
sportfish migrate, spawn and reside (rear) potential.

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 379 **Date (mm/dd/yy):** 10/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☑ Yes ☐ No **Site No.:** RPR 330

UTM: 10 W Easting 377412 Northing 7201254

Channel Width: ☐ <1m ☐ 1-3m ☐ 3-10m ☑ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☐
- Moderate (30-90% bankfull) ☑
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☑
- 1-25 ☐
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	__20_%
Forbs	☐	__%
Shrubs	☑	_35_%
Conifer	☑	__45_%
Deciduous	☐	___%

Substrate:

Silt	☐	_____%
Sand	☐	__%
Gravel	☐	_10_%
Cobble	☑	__40_%
Boulder	☑	_40_%
Bedrock	☐	_____%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous [Meandering ☐

Channel Islands Present: yes ☐ no ☑

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☐	_____%
Run	☑	_____%
Pool	☐	_____%
Rapids	☐	_____%

Photos:

Photo #	Description
P9100105	**proposed crossing facing east**
P9100106	**proposed crossing facing upstream north**
P9100107	**proposed crossing facing west**
P9100108	**east bank**
P9100109-10	**proposed crossing facing east along alignment**
P9090023-4	**proposed crossing facing upstream north**

Comments:

The Great Bear River
Crossing approximately 500 meters wide and 2-3 meters deep.
Crossing may require a very large bridge or ferry.
Water clear and running with eddies.
Suitable habitat for sportfish: cisco (arctic, least), whitefish (lake, round), inconnu, arctic grayling, trout (lake, bull), northern pike, walleye,
burbot, goldeye, arctic lamprey and longnose sucker.
Suitable habitat for baitfish: chub (lake and flathead), shiner (emerald and spottail), longnose dace, ninespine stickleback,
trout-perch, slimy sculpin.
baitfish migrate, spawn and reside (rear, overwinter, adult) potential
sportfish migrate, spawn and reside (rear, overwinter, adult) potential.

Aerial and Ground Fish Habitat Reconnaissance Form - Qualitative Assessment

Site ID: 127 Bosworth Creek at Norman Wells **Date (mm/dd/yy):** 8/9/2010

Crossing site in MacKenzie Gas Pipeline EIS? ☐ Yes ☑ No **Site No.:**

UTM: 9 W Easting 599052 Northing 7242388

Channel Width: ☐ <1m ☐ 1-3m ☐ 3-10m ☑ >10 m

Stream Discharge Stage:
- Low (0-30% bankfull) ☑
- Moderate (30-90% bankfull) ☐
- High (>90% bankfull) ☐

Crown Closure (%):
- 0 ☐
- 1-25 ☑
- 26-50 ☐
- 51-75 ☐
- 75-100 ☐

Type of Riparian Vegetation:

None	☐	_____%
Grass	☑	_10_%
Forbs	☐	__%
Shrubs	☑	__20_%
Conifer	☑	__60_%
Deciduous	☑	__10_%

Substrate:

Silt	☐	_____%
Sand	☐	__%
Gravel	☐	_____%
Cobble	☑	_45_%
Boulder	☑	_45_%
Bedrock	☑	__10_%

Obstructions Visible: yes ☐ no ☑ Type _____ Location _____

Channel Pattern: Straight ☐ Sinuous ☐ Meandering ☑

Channel Islands Present: yes ☑ no ☐

Channel Confinement:
- Confined ☑
- Partially confined ☐
- Unconfined ☐

Habitat Type:

Riffle	☑	__18__%
Run	☑	__70_%
Pool	☑	__2__%
Rapids	☑	__10_%

Photos:

Photo #	Description
P9080072-3	**DOT Bridge at Bosworth Creek, Norman Wells**
P9080074	**winter road alignment (west)**

Comments:

Existing DOT Bridge
Edward (Environmental Monitor) graylings in creek and lake trout caught at mouth of outflow into Mackenzie River.

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APPENDIX H

APPENDIX H COMMUNITY DATA

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Norman Wells - Statistical Profile

POPULATION

	Norman Wells	Northwest Territories
Population (2010)		
Total	816	43,759
Males	425	22,627
Females	391	21,132
0 - 4 Years	53	3,432
5 - 9 Years	53	3,147
10 - 14 Years	43	2,952
15 - 24 Years	127	7,313
25 - 44 Years	285	13,731
45 - 59 Years	185	9,082
60 Yrs. & Older	70	4,102
Aboriginal	315	22,123
Non-Aboriginal	501	21,636
Population Dependency Ratio (2010)		
< 15 Yrs.	0.25	0.32
60 Yrs. & Older	0.12	0.14
Historical Population		
1996	840	41,741
1997	808	41,625
1998	826	40,802
1999	747	40,638
2000	755	40,480
2001	766	40,844
2002	747	41,665
2003	795	42,561
2004	836	43,301
2005	823	43,399
2006	805	43,198
2007	846	43,545
2008	840	43,699
2009	816	43,673
2010	816	43,759
Ave. Annual Growth Rate (96-10)		
Total Population	-0.2	0.3
< 15 Yrs.	-3.3	-1.5
60 Yrs. & Older	11.1	4.3
Population Projections		
2015	829	45,281
2020	839	46,616
2025	858	47,626

HEALTH & VITAL STATS

	Norman Wells	Northwest Territories
% of Population that Smoke		
2009	40.5	35.2

	Norman Wells	Northwest Territories
Number of Births		
1998	10	678
1999	10	659
2000	15	673
2001	12	613
2002	7	635
2003	17	701
2004	15	698
2005	14	712
2006	12	687
2007	15	725
Teen Births		
1998	-	82
1999	-	83
2000	2	84
2001	1	70
2002	-	72
2003	2	72
2004	-	86
2005	-	68
2006	1	73
2007	2	65
Number of Deaths		
1998	-	146
1999	4	162
2000	2	156
2001	2	163
2002	1	169
2003	2	202
2004	2	153
2005	-	148
2006	4	182
2007	-	174
Injury Deaths (inc. suicides)		
1998	-	24
1999	1	36
2000	1	31
2001	-	31
2002	-	24
2003	1	36
2004	-	23
2005	-	21
2006	1	36
2007	-	32
Suicides		
1998	-	7
1999	1	15
2000	-	7
2001	-	8
2002	-	8
2003	-	10
2004	-	11
2005	-	4
2006	-	5
2007	-	9

HOUSEHOLDS & FAMILIES

	Norman Wells	Northwest Territories
% of Households with 6 or More People		
1981	7.4	13.9
1986	4.4	11.5
1991	2.2	9.8
1996	5.4	8.6
2001	3.7	7.2
2004	2.3	7.0
2006	3.3	6.2
2009	4.2	6.7
Family Structure (2006)		
Total Family Structure	190	10,875
Husband-Wife	100	5,555
Common-law	60	2,990
Lone Parent	35	2,330
% Lone-Parent Families	18.4	21.4
Tenure (2009)		
Total	307	14,522
Owned	117	7,623
Rented	190	6,899
% Owned	38.1	52.5
% of Households in Core Need		
1996	16.0	19.7
2000	8.0	20.3
2004	8.5	16.3
2009	7.5	19.0

CRIME

	Norman Wells	Northwest Territories
Violent Crimes		
2000	21	2,708
2001	30	2,767
2002	30	3,179
2003	36	3,698
2004	51	3,857
2005	44	3,711
2006	67	3,527
2007	43	4,025
2008	41	3,839
2009	28	3,730
Property Crimes		
2000	62	5,535
2001	87	5,417
2002	65	6,397
2003	76	8,179
2004	95	9,018
2005	56	8,357
2006	75	8,292
2007	117	8,807
2008	76	8,881
2009	60	8,568
Other Criminal Code		
2000	11	3,325
2001	29	4,350
2002	27	3,934
2003	35	4,068
2004	38	5,233
2005	27	6,475
2006	56	5,695
2007	75	5,942
2008	49	6,377
2009	34	5,981
Federal Statutes		
2000	9	415
2001	12	432
2002	18	655
2003	8	595
2004	21	632
2005	11	742
2006	9	534
2007	10	665
2008	22	815
2009	19	827
Traffic		
2000	3	328
2001	5	459
2002	11	568
2003	7	642
2004	13	768
2005	12	884
2006	11	829
2007	17	813
2008	10	1,051
2009	6	810
Violent Crime Rate (per 1,000 persons)		
2000	27.8	66.9
2001	39.2	67.7
2002	40.2	76.3
2003	45.3	86.9
2004	61.0	89.1
2005	53.5	85.5
2006	83.2	81.6
2007	50.8	92.4
2008	49.3	87.8
2009	35.0	85.9
Property Crime Rate (per 1,000 persons)		
2000	82.1	136.7
2001	113.6	132.6
2002	87.0	153.5
2003	95.6	192.2
2004	113.6	208.3
2005	68.0	192.6
2006	93.2	192.0
2007	138.1	202.3
2008	91.3	203.1
2009	75.0	197.2

INCOME ASSISTANCE

	Norman Wells	Northwest Territories
Beneficiaries (monthly average)		
2001	10	2,425
2002	9	2,200
2003	8	2,142
2004	5	2,058
2005	9	1,911
2006	13	1,912
2007	8	2,024
2008	11	2,067
2009	20	2,402
2010	13	2,313
Cases (monthly average)		
2001	3	1,202
2002	3	1,118
2003	3	1,111
2004	3	1,110
2005	3	1,051
2006	5	1,060
2007	4	1,121
2008	5	1,172
2009	10	1,415
2010	8	1,429
Payments ($000)		
2001	25	8,840
2002	21	8,701
2003	19	8,946
2004	18	9,270
2005	23	8,610
2006	29	8,534
2007	30	9,783
2008	43	12,048
2009	111	14,563
2010	76	15,074

TRADITIONAL ACTIVITIES (2008)

	Norman Wells	Northwest Territories
Hunted & Fished (%)	42.5	39.4
Trapped (%)	2.5	6.2
Produced Arts & Crafts (%)	5.1	8.7
Households Consuming Country Food (Half or More) (%)	29.3	28.1

ABORIGINAL LANGUAGES

	Norman Wells	Northwest Territories
% Aboriginals that Speak an Aboriginal Language		
1984	65.9	59.1
1989	51.5	55.6
1994	36.4	50.1
1999	28.7	45.1
2004	26.9	44.0
2009	29.6	38.0

EDUCATION

	Norman Wells	Northwest Territories
% with High School Diploma or More		
1986	62.8	51.6
1989	77.2	59.8
1991	78.7	59.9
1994	83.1	63.2
1996	84.1	63.5
1999	82.2	66.1
2001	85.6	64.8
2004	85.0	67.5
2006	79.1	67.0
2009	81.5	69.3
Employment Rates (2009)		
Less than High School Diploma	39.5	35.4
High School Diploma or Greater	89.2	81.2

LABOUR FORCE

	Norman Wells	Northwest Territories
Participation Rate		
1986	85.1	74.5
1989	83.4	74.9
1991	86.7	78.2
1994	85.6	77.2
1996	90.2	77.2
1999	90.5	78.3
2001	88.7	77.1
2004	88.8	75.6
2006	87.0	76.5
2009	84.7	75.1
Unemployment Rate		
1986	5.4	11.2
1989	6.7	13.2
1991	5.1	11.3
1994	9.0	14.8
1996	6.9	11.7
1999	7.0	13.7
2001	7.0	9.5
2004	2.7	10.4
2006	7.0	10.4
2009	5.3	10.3
Employment Rate		
1986	80.5	66.2
1989	77.7	65.0
1991	81.1	69.3
1994	78.0	65.7
1996	84.8	68.2
1999	84.2	67.5
2001	82.5	69.8
2004	86.4	67.8
2006	81.7	68.6
2009	80.3	67.3

	Norman Wells	Northwest Territories
Selected Employment Rates (2009)		
Males	85.9	68.1
Females	72.8	66.4
Aboriginal	65.2	49.8
Non-Aboriginal	89.6	83.1
15-24	58.9	42.0
25-34	84.4	75.5
35-44	89.6	81.9
45-54	96.4	84.3
55-64	87.8	74.6
65 & Over	-	17.1
Labour Force Activity (2009)		
Population 15 & Over	649	33,730
Employed	521	22,702
Unemployed	29	2,616
Not in the Labour Force	99	8,412
Potential Available Labour Supply (2009)		
Number of Unemployed	38	4,847
% Do Rotational	55.3	57.1
% Male	55.3	59.1
% Aboriginal	68.4	77.2
% Less than High School Diploma	60.5	55.9
Labour Force Profile (2006)		
% Gov't, Health, Social Serv, Educ	26.0	37.3
% Goods Producing	32.0	17.2
% Other Industries	43.0	43.9
Annual Work Pattern (2008)		
% Worked	88.3	79.0
% Worked More than 26 weeks	85.3	77.5

PERSONAL INCOME

Total Income ($000)		
1999	23,243	886,962
2000	23,074	921,079
2001	24,577	1,058,019
2002	25,706	1,148,300
2003	27,794	1,199,686
2004	31,330	1,246,589
2005	32,074	1,297,842
2006	36,809	1,384,602
2007	39,040	1,469,865
2008	39,820	1,542,755
% Change in Total Inc. (1999-2008)	71.3	73.9

	Norman Wells	Northwest Territories
Average Personal Income ($)		
1999	47,435	35,650
2000	50,161	36,220
2001	52,291	39,186
2002	54,694	42,047
2003	54,498	42,572
2004	60,250	44,080
2005	62,890	46,170
2006	66,925	48,396
2007	72,296	51,072
2008	75,132	52,943
Employment Income ($000)		
1999	21,817	772,452
2000	21,768	805,159
2001	23,102	935,854
2002	24,259	1,016,653
2003	26,108	1,058,922
2004	29,461	1,101,853
2005	30,118	1,145,168
2006	34,550	1,208,376
2007	36,605	1,294,015
2008	36,815	1,356,780
% Change in Emp. Inc. (1999-2008)	68.7	75.6
Average Employment Income ($)		
1999	47,428	35,450
2000	50,623	36,187
2001	51,338	38,497
2002	55,134	41,428
2003	53,282	41,904
2004	60,124	43,969
2005	62,746	45,843
2006	66,442	47,856
2007	71,775	50,627
2008	72,186	52,650
Percent Taxfilers Less than $15,000		
1999	26.5	32.8
2000	21.7	32.0
2001	21.3	28.8
2002	21.3	27.6
2003	19.6	28.0
2004	15.4	27.3
2005	15.7	26.0
2006	18.2	24.9
2007	16.7	23.3
2008	15.1	23.7
Percent Taxfilers More than $50,000		
1999	42.9	28.1
2000	43.5	28.2
2001	44.7	31.4
2002	46.8	34.4
2003	47.1	35.1
2004	48.1	36.5
2005	51.0	38.3
2006	50.9	39.9
2007	53.7	42.7
2008	56.6	43.7

FAMILY INCOME

	Norman Wells	Northwest Territories
Average Family Income		
1999	93,747	70,463
2000	94,994	71,864
2001	97,953	80,225
2002	104,895	87,143
2003	108,163	88,244
2004	118,814	91,362
2005	129,760	96,171
2006	138,495	101,622
2007	155,579	107,252
2008	149,650	111,796
Percent Families Less than $30,000		
1999	21.1	26.3
2000	16.7	26.2
2001	15.8	20.8
2002	15.8	19.4
2003	10.5	20.3
2004	14.3	20.2
2005	10.0	19.0
2006	9.5	18.0
2007	10.5	16.6
2008	10.0	17.0
Percent Families More than $75,000		
1999	63.2	40.6
2000	61.1	41.6
2001	57.9	47.4
2002	57.9	50.4
2003	63.2	50.7
2004	61.9	52.7
2005	70.0	55.3
2006	66.7	57.1
2007	68.4	59.5
2008	70.0	60.8

PRICES

	Norman Wells	Northwest Territories
2009 Living Cost Diff. (Edm = 100)	152.5	..
2010 Food Price Index (YK = 100)	179.6	..

ENVIRONMENT

	Norman Wells	Northwest Territories
Average Temperature (°C)		
January 2003	-26.4	..
January 2004	-28.4	..
January 2005	-24.1	..
January 2006	-28.8	..
January 2007	-23.2	..
July 2003	18.3	..
July 2004	17.0	..
July 2005	14.8	..
July 2006	17.0	..
July 2007	18.3	..

COMMUNITY LIVING

	Norman Wells	Northwest Territories
% Who Volunteered in 2008	38.4	37.7
% of Homes with Internet Access in 2008	80.1	73.5

SYMBOLS

- zero or too small to be expressed
.. not available
x data suppressed

SOURCES & NOTES

Population

Population and Historical Population: NWT Bureau of Statistics, GNWT. Estimates are calculated by allocating the demographic components of growth, down to a community level. Sex, age and ethnicity estimates developed by NWT Bureau of Statistics.

Population Dependency Ratio: NWT Bureau of Statistics, GNWT. Ratios for < 15 years refer to the number of people less than 15 years of age divided by the number of people between the ages of 15 and 59. Ratios for 60 years and older refer to the number of people 60 years of age or older divided by the number of people between the ages of 15 and 59.

Average Annual Growth Rate: NWT Bureau of Statistics, GNWT. Average annual growth rate (AAGR) is calculated as:

$$AAGR = \left(\sqrt[14]{\frac{Pop_{2010}}{Pop_{1996}}} - 1 \right) * 100$$

Population Projections: NWT Bureau of Statistics, GNWT. Population projections incorporate assumptions regarding fertility, mortality & migration patterns. These assumptions are reflective of historical patterns, as well as recent trends observed for the Northwest Territories.

Health & Vital Stats

% of Population that Smoke: NWT Bureau of Statistics, GNWT. Refers to the percent of people 15 years of age or older that smoke.

Number of Births: Health Statistics Division, Statistics Canada.

Teen Births: Health Statistics Division, Statistics Canada. Refers to births to women aged 19 or less.

Number of Deaths: Health Statistics Division, Statistics Canada.

Cause of Deaths: Health Statistics Division, Statistics Canada. Injury deaths are deaths due to accidents, homicide and suicides.

Household & Families

Percent of Households with 6 or More People: Census, Statistics Canada (1981, 1986, 1991, 1996, 2001 & 2006); NWT Bureau of Statistics, GNWT (2004 & 2009). A household refers to an occupied private dwelling.

Family Structure: Census, Statistics Canada. Refers to the classification of census families into husband-wife couples, common-law couples, and lone parent families.

Tenure: NWT Bureau of Statistics, GNWT. Refers to whether some member of the household owns or rents the dwelling.

Percent of Households in Core Need: NWT Bureau of Statistics, GNWT. 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.

Crime

Incidents in a particular detachment may include incidents from surrounding communities.

Violent Crimes: Canadian Center for Justice Statistics, Statistics Canada. Refers to incidences of homicides, attempted murder, assaults (including sexual assaults), abduction and robbery.

Property Crimes: Canadian Center for Justice Statistics, Statistics Canada. Includes but is not limited to incidences of breaking & entering, theft, position of stolen goods and fraud.

Other Criminal Code: Canadian Center for Justice Statistics, Statistics Canada. Includes but is not limited to incidences of offensive weapons, bail violation, disturbing the peace and mischief (property damage).

Federal Statutes: Canadian Center for Justice Statistics, Statistics Canada. Includes but is not limited to incidences of possession and trafficking of drugs.

Traffic: Canadian Center for Justice Statistics, Statistics Canada. Includes but is not limited to incidences of dangerous operation of motor vehicle and impaired operation of motor vehicle.

Violent Crime Rates (per 1,000 persons): NWT Bureau of Statistics, GNWT. Rates are determined using population estimates developed by the NWT Bureau of Statistics.

Property Crime Rates (per 1,000 persons): NWT Bureau of Statistics, GNWT. Rates are determined using population estimates developed by the NWT Bureau of Statistics.

Income Assistance

Note: Due to program changes in 2007, data prior to this year is not directly comparable.

Beneficiaries (monthly average): Department of Education Culture & Employment, GNWT. Refers to the monthly average number of recipients of income assistance and their dependents, if any, over the year.

Cases (monthly average): Department of Education Culture & Employment, GNWT. Refers to the monthly average number of people requesting and receiving social assistance over the year.

Payments ($000): Department of Education Culture & Employment, GNWT. Refers to the total amount of payments over the year. Payments are recorded for the month for which assistance was received.

Traditional Activities

Hunted & Fished (%): NWT Bureau of Statistics, GNWT. Refers to the percent of people 15 years of age or older that hunted or fished during the year.

Trapped (%): NWT Bureau of Statistics, GNWT. Refers to the percent of people 15 years of age or older that trapped during the year.

Produced Arts & Craft (%)s: NWT Bureau of Statistics, GNWT. Refers to the percent of people 15 years of age or older that made arts and crafts during the year.

Households Consuming Country Food: NWT Bureau of Statistics, GNWT. Refers to the percent of households reporting that half, most or all (50% or more) of the meat or fish consumed is harvesting in the NWT.

Aboriginal Languages

Percent of Aboriginal that Speak an Aboriginal Language: NWT Bureau of Statistics, GNWT. Refers to the percent of aboriginal people 15 years of age or older that can speak an aboriginal language well enough to carry on a conversation. Aboriginal languages include Inuktitut, Inuvialuktun, Inuinnaqtun, Dogrib, Cree, Chipewyan, North Slavey, South Slavey, and Gwich'n.

Education

Percent with High School Diploma or More: Census, Statistics Canada (1986, 1991, 1996, 2001 & 2006); NWT Bureau of Statistics, GNWT (1989, 1994, 1999, 2004 & 2009). Refers to the percent of population 15 years of age or older that have a high school diploma.

2009 Employment Rates: NWT Bureau of Statistics, GNWT. Refers to the employment rate for two groups of people: those who do not have a high school certificate, and those with at least a high school certificate. Employment rate refers to the percentage of persons 15 years of age and over who are working at a job.

Labour Force

Census, Statistics Canada (1986, 1991, 1996, 2001 & 2006); NWT Bureau of Statistics, GNWT (1989, 1994, 1999, 2004 & 2009).

Participation Rate: The percentage of persons 15 years of age and over who are in the labour force. See below for definition of labour force.

Unemployment Rate: The percentage of the labour force that was unemployed during the week prior to the survey. See below for definition of labour force.

Employment Rate: The percentage of persons 15 years of age and over who were employed during the week prior to the survey.

Employed: Refers to persons who during the week prior to the survey: (i) did any work at all, excluding housework, maintenance around the home and volunteer work; or (ii) were absent from their job or business because of vacation, illness, on strike or locked out, etc.

Unemployed: Refers to persons who during the week prior to the survey: (i) were without work, had actively looked for work in the previous four weeks and were available for work; or (ii) had been on temporary lay-off and expected to return to their job; or (iii) had definite arrangements to start a new job within the next four weeks.

Labour Force: Refers to persons who were either employed or unemployed during the week prior to the survey.

Not in the Labour Force: Refers to persons who do not participate in the labour force, they are neither employed or unemployed.

Potential Available Labour Supply: Refers to those persons who are unemployed. They can be classified into various categories, including, those who want to do rotational work, gender, ethnicity, or level of schooling.

Annual Work Pattern: Work pattern measures the amount of work over a given year. Worked in 2008 refers to the percent of people 15 years of age or older who worked in 2008, while worked more than 26 weeks refers to the percent of workers who worked more than 26 weeks in the year. The weeks need not be consecutive.

Personal Income

Small Area and Administrative Data Division, Statistics Canada. Data is based upon filed tax returns.

Total Income ($000): Refers to total money income received from all sources.

Average Personal Income ($): Refers to the average money income received from all sources.

Employment Income ($000): Refers to total income received by persons 15 years of age and over for any employment.

Average Employment Income ($): Refers to average income received by persons 15 years of age and over for any employment.

Percent Tax-filers Less Than $15,000: Refers to the percent of tax-filers who report they are making less than $15,000.

Percent Tax-filers More Than $50,000: Refers to the percent of tax-filers who report they are making more than $50,000.

Family Income

Small Area and Administrative Data Division, Statistics Canada. Data is based upon filed tax returns. Refers to the total income of a family; it is the sum of the total incomes of all members of that family.

Average Family Income ($): Refers to the average money income received from all sources for the family as a whole.

Percent Families Less Than $30,000: Refers to the percent of families who report they are making less than $30,000.

Percent Families More Than $75,000: Refers to the percent of families who report they are making more than $75,000.

Environment

Average Temperature (°C): Environment Canada. Calculated as the mean daily temperatures, averaged over the reference month. The mean daily temperature is the average between the daily maximum and minimum.

Community Living

% Who Volunteered in 2008: NWT Bureau of Statistics. Refers to the population 15 years of age and over who volunteered during the year.

% of Homes with Internet Access in 2008: NWT Bureau of Statistics.

Prices

Living Cost Differentials: Price Division, Statistics Canada.

Food Price Index: NWT Bureau of Statistics, GNWT.

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Tulita - Statistical Profile

POPULATION

	Tulita	Northwest Territories
Population (2010)		
Total	564	43,759
Males	285	22,627
Females	279	21,132
0 - 4 Years	45	3,432
5 - 9 Years	46	3,147
10 - 14 Years	53	2,952
15 - 24 Years	142	7,313
25 - 44 Years	115	13,731
45 - 59 Years	102	9,082
60 Yrs. & Older	61	4,102
Aboriginal	507	22,123
Non-Aboriginal	57	21,636
Population Dependency Ratio (2010)		
< 15 Yrs.	0.40	0.32
60 Yrs. & Older	0.17	0.14
Historical Population		
1996	468	41,741
1997	477	41,625
1998	473	40,802
1999	490	40,638
2000	493	40,480
2001	501	40,844
2002	506	41,665
2003	508	42,561
2004	504	43,301
2005	525	43,399
2006	523	43,198
2007	533	43,545
2008	548	43,699
2009	564	43,673
2010	564	43,759
Ave. Annual Growth Rate (96-10)		
Total Population	1.3	0.3
< 15 Yrs.	-1.4	-1.5
60 Yrs. & Older	6.6	4.3
Population Projections		
2015	587	45,281
2020	603	46,616
2025	623	47,626

HEALTH & VITAL STATS

	Tulita	Northwest Territories
% of Population that Smoke		
2009	47.6	35.2

	Tulita	Northwest Territories
Number of Births		
1998	11	678
1999	12	659
2000	2	673
2001	3	613
2002	7	635
2003	8	701
2004	7	698
2005	13	712
2006	5	687
2007	7	725
Teen Births		
1998	2	82
1999	4	83
2000	1	84
2001	1	70
2002	1	72
2003	-	72
2004	2	86
2005	1	68
2006	-	73
2007	1	65
Number of Deaths		
1998	3	146
1999	1	162
2000	1	156
2001	5	163
2002	-	169
2003	3	202
2004	2	153
2005	2	148
2006	3	182
2007	3	174
Injury Deaths (inc. suicides)		
1998	-	24
1999	-	36
2000	-	31
2001	2	31
2002	-	24
2003	-	36
2004	-	23
2005	-	21
2006	3	36
2007	-	32
Suicides		
1998	-	7
1999	-	15
2000	-	7
2001	-	8
2002	-	8
2003	-	10
2004	-	11
2005	-	4
2006	-	5
2007	-	9

HOUSEHOLDS & FAMILIES

	Tulita	Northwest Territories
% of Households with 6 or More People		
1981	23.1	13.9
1986	37.5	11.5
1991	18.2	9.8
1996	19.2	8.6
2001	19.2	7.2
2004	13.6	7.0
2006	13.8	6.2
2009	11.4	6.7
Family Structure (2006)		
Total Family Structure	125	10,875
Husband-Wife	45	5,555
Common-law	40	2,990
Lone Parent	40	2,330
% Lone-Parent Families	32.0	21.4
Tenure (2009)		
Total	158	14,522
Owned	65	7,623
Rented	93	6,899
% Owned	41.1	52.5
% of Households in Core Need		
1996	36.4	19.7
2000	43.2	20.3
2004	35.7	16.3
2009	37.3	19.0

CRIME

	Tulita	Northwest Territories
Violent Crimes		
2000	44	2,708
2001	44	2,767
2002	22	3,179
2003	41	3,698
2004	48	3,857
2005	46	3,711
2006	37	3,527
2007	51	4,025
2008	62	3,839
2009	73	3,730
Property Crimes		
2000	97	5,535
2001	128	5,417
2002	102	6,397
2003	94	8,179
2004	138	9,018
2005	112	8,357
2006	167	8,292
2007	120	8,807
2008	166	8,881
2009	166	8,568
Other Criminal Code		
2000	26	3,325
2001	47	4,350
2002	29	3,934
2003	18	4,068
2004	37	5,233
2005	33	6,475
2006	49	5,695
2007	69	5,942
2008	47	6,377
2009	77	5,981
Federal Statutes		
2000	2	415
2001	4	432
2002	4	655
2003	2	595
2004	5	632
2005	5	742
2006	16	534
2007	6	665
2008	15	815
2009	16	827
Traffic		
2000	2	328
2001	6	459
2002	2	568
2003	6	642
2004	9	768
2005	3	884
2006	7	829
2007	5	813
2008	19	1,051
2009	11	810
Violent Crime Rate (per 1,000 persons)		
2000	89.2	66.9
2001	87.8	67.7
2002	43.5	76.3
2003	80.7	86.9
2004	95.2	89.1
2005	87.6	85.5
2006	70.7	81.6
2007	95.1	92.4
2008	112.7	87.8
2009	129.0	85.9
Property Crime Rate (per 1,000 persons)		
2000	196.8	136.7
2001	255.5	132.6
2002	201.6	153.5
2003	185.0	192.2
2004	273.8	208.3
2005	213.3	192.6
2006	319.3	192.0
2007	223.9	202.3
2008	301.8	203.1
2009	293.3	197.2

INCOME ASSISTANCE

	Tulita	Northwest Territories
Beneficiaries (monthly average)		
2001	33	2,425
2002	20	2,200
2003	14	2,142
2004	11	2,058
2005	10	1,911
2006	27	1,912
2007	37	2,024
2008	51	2,067
2009	74	2,402
2010	54	2,313
Cases (monthly average)		
2001	15	1,202
2002	10	1,118
2003	8	1,111
2004	6	1,110
2005	6	1,051
2006	12	1,060
2007	21	1,121
2008	26	1,172
2009	39	1,415
2010	30	1,429
Payments ($000)		
2001	93	8,840
2002	59	8,701
2003	43	8,946
2004	34	9,270
2005	32	8,610
2006	75	8,534
2007	141	9,783
2008	223	12,048
2009	350	14,563
2010	286	15,074

TRADITIONAL ACTIVITIES (2008)

	Tulita	Northwest Territories
Hunted & Fished (%)	41.7	39.4
Trapped (%)	12.0	6.2
Produced Arts & Crafts (%)	13.7	8.7
Households Consuming Country Food (Half or More) (%)	78.5	28.1

ABORIGINAL LANGUAGES

	Tulita	Northwest Territories
% Aboriginals that Speak an Aboriginal Language		
1984	84.8	59.1
1989	82.0	55.6
1994	61.3	50.1
1999	62.9	45.1
2004	47.3	44.0
2009	46.9	38.0

EDUCATION

	Tulita	Northwest Territories
% with High School Diploma or More		
1986	21.3	51.6
1989	38.6	59.8
1991	38.0	59.9
1994	34.3	63.2
1996	43.9	63.5
1999	40.1	66.1
2001	37.9	64.8
2004	39.3	67.5
2006	37.7	67.0
2009	46.6	69.3
Employment Rates (2009)		
Less than High School Diploma	26.6	35.4
High School Diploma or Greater	57.6	81.2

LABOUR FORCE

	Tulita	Northwest Territories
Participation Rate		
1986	52.2	74.5
1989	58.7	74.9
1991	62.0	78.2
1994	68.0	77.2
1996	68.4	77.2
1999	77.9	78.3
2001	62.1	77.1
2004	64.6	75.6
2006	59.4	76.5
2009	52.9	75.1
Unemployment Rate		
1986	12.5	11.2
1989	14.1	13.2
1991	22.6	11.3
1994	39.8	14.8
1996	23.1	11.7
1999	24.7	13.7
2001	13.9	9.5
2004	13.8	10.4
2006	17.1	10.4
2009	21.2	10.3
Employment Rate		
1986	45.7	66.2
1989	50.4	65.0
1991	46.0	69.3
1994	40.9	65.7
1996	54.4	68.2
1999	58.6	67.5
2001	51.7	69.8
2004	55.7	67.8
2006	49.3	68.6
2009	41.7	67.3

	Tulita	Northwest Territories
Selected Employment Rates (2009)		
Males	40.0	68.1
Females	43.4	66.4
Aboriginal	36.0	49.8
Non-Aboriginal	80.8	83.1
15-24	12.9	42.0
25-34	53.8	75.5
35-44	63.6	81.9
45-54	71.2	84.3
55-64	61.2	74.6
65 & Over	2.8	17.1
Labour Force Activity (2009)		
Population 15 & Over	410	33,730
Employed	171	22,702
Unemployed	46	2,616
Not in the Labour Force	193	8,412
Potential Available Labour Supply (2009)		
Number of Unemployed	89	4,847
% Do Rotational	75.3	57.1
% Male	61.8	59.1
% Aboriginal	95.5	77.2
% Less than High School Diploma	50.6	55.9
Labour Force Profile (2006)		
% Gov't, Health, Social Serv, Educ	39.0	37.3
% Goods Producing	12.2	17.2
% Other Industries	43.9	43.9
Annual Work Pattern (2008)		
% Worked	63.4	79.0
% Worked More than 26 weeks	54.6	77.5

PERSONAL INCOME

	Tulita	Northwest Territories
Total Income ($000)		
1999	5,394	886,962
2000	5,825	921,079
2001	6,013	1,058,019
2002	6,522	1,148,300
2003	7,151	1,199,686
2004	7,706	1,246,589
2005	9,047	1,297,842
2006	9,583	1,384,602
2007	8,995	1,469,865
2008	9,830	1,542,755
% Change in Total Inc. (1999-2008)	82.2	73.9

	Tulita	Northwest Territories
Average Personal Income ($)		
1999	24,518	35,650
2000	24,271	36,220
2001	25,054	39,186
2002	26,088	42,047
2003	27,504	42,572
2004	29,638	44,080
2005	31,197	46,170
2006	33,045	48,396
2007	32,125	51,072
2008	32,767	52,943
Employment Income ($000)		
1999	4,316	772,452
2000	4,751	805,159
2001	4,859	935,854
2002	5,313	1,016,653
2003	5,842	1,058,922
2004	6,346	1,101,853
2005	7,557	1,145,168
2006	7,950	1,208,376
2007	7,565	1,294,015
2008	8,400	1,356,780
% Change in Emp. Inc. (1999-2008)	94.6	75.6
Average Employment Income ($)		
1999	22,716	35,450
2000	22,624	36,187
2001	22,086	38,497
2002	24,150	41,428
2003	25,400	41,904
2004	26,442	43,969
2005	27,989	45,843
2006	31,800	47,856
2007	29,096	50,627
2008	31,111	52,650
Percent Taxfilers Less than $15,000		
1999	40.9	32.8
2000	45.8	32.0
2001	45.8	28.8
2002	48.0	27.6
2003	42.3	28.0
2004	34.6	27.3
2005	34.5	26.0
2006	34.5	24.9
2007	35.7	23.3
2008	40.0	23.7
Percent Taxfilers More than $50,000		
1999	13.6	28.1
2000	12.5	28.2
2001	16.7	31.4
2002	16.0	34.4
2003	19.2	35.1
2004	23.1	36.5
2005	20.7	38.3
2006	24.1	39.9
2007	21.4	42.7
2008	23.3	43.7

FAMILY INCOME

	Tulita	Northwest Territories
Average Family Income		
1999	40,950	70,463
2000	46,550	71,864
2001	49,780	80,225
2002	50,036	87,143
2003	50,927	88,244
2004	54,708	91,362
2005	64,358	96,171
2006	66,750	101,622
2007	61,042	107,252
2008	69,292	111,796
Percent Families Less than $30,000		
1999	60.0	26.3
2000	30.0	26.2
2001	50.0	20.8
2002	36.4	19.4
2003	36.4	20.3
2004	33.3	20.2
2005	25.0	19.0
2006	25.0	18.0
2007	33.3	16.6
2008	33.3	17.0
Percent Families More than $75,000		
1999	-	40.6
2000	20.0	41.6
2001	20.0	47.4
2002	18.2	50.4
2003	18.2	50.7
2004	25.0	52.7
2005	33.3	55.3
2006	33.3	57.1
2007	25.0	59.5
2008	33.3	60.8

PRICES

	Tulita	Northwest Territories
2009 Living Cost Diff. (Edm = 100)	162.5	..
2010 Food Price Index (YK = 100)	178.0	..

ENVIRONMENT

Average Temperature (°C)		
January 2003	-27.7	..
January 2004	-25.7	..
January 2005	-24.3	..
January 2006	-27.9	..
January 2007	-24.1	..
July 2003	18.5	..
July 2004	17.6	..
July 2005	14.8	..
July 2006	16.1	..
July 2007	19.4	..

COMMUNITY LIVING

% Who Volunteered in 2008	28.3	37.7
% of Homes with Internet Access in 2008	46.2	73.5

SYMBOLS

- zero or too small to be expressed
.. not available
x data suppressed

SOURCES & NOTES

Population

Population and Historical Population: NWT Bureau of Statistics, GNWT. Estimates are calculated by allocating the demographic components of growth, down to a community level. Sex, age and ethnicity estimates developed by NWT Bureau of Statistics.

Population Dependency Ratio: NWT Bureau of Statistics, GNWT. Ratios for < 15 years refer to the number of people less than 15 years of age divided by the number of people between the ages of 15 and 59. Ratios for 60 years and older refer to the number of people 60 years of age or older divided by the number of people between the ages of 15 and 59.

Average Annual Growth Rate: NWT Bureau of Statistics, GNWT. Average annual growth rate (AAGR) is calculated as:

$$AAGR = \left(\sqrt[14]{\frac{Pop_{2010}}{Pop_{1996}}} - 1 \right) * 100$$

Population Projections: NWT Bureau of Statistics, GNWT. Population projections incorporate assumptions regarding fertility, mortality & migration patterns. These assumptions are reflective of historical patterns, as well as recent trends observed for the Northwest Territories.

Health & Vital Stats

% of Population that Smoke: NWT Bureau of Statistics, GNWT. Refers to the percent of people 15 years of age or older that smoke.

Number of Births: Health Statistics Division, Statistics Canada.

Teen Births: Health Statistics Division, Statistics Canada. Refers to births to women aged 19 or less.

Number of Deaths: Health Statistics Division, Statistics Canada.

Cause of Deaths: Health Statistics Division, Statistics Canada. Injury deaths are deaths due to accidents, homicide and suicides.

Household & Families

Percent of Households with 6 or More People: Census, Statistics Canada (1981, 1986, 1991, 1996, 2001 & 2006); NWT Bureau of Statistics, GNWT (2004 & 2009). A household refers to an occupied private dwelling.

Family Structure: Census, Statistics Canada. Refers to the classification of census families into husband-wife couples, common-law couples, and lone parent families.

Tenure: NWT Bureau of Statistics, GNWT. Refers to whether some member of the household owns or rents the dwelling.

Percent of Households in Core Need: NWT Bureau of Statistics, GNWT. 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.

Crime

Incidents in a particular detachment may include incidents from surrounding communities.

Violent Crimes: Canadian Center for Justice Statistics, Statistics Canada. Refers to incidences of homicides, attempted murder, assaults (including sexual assaults), abduction and robbery.

Property Crimes: Canadian Center for Justice Statistics, Statistics Canada. Includes but is not limited to incidences of breaking & entering, theft, position of stolen goods and fraud.

Other Criminal Code: Canadian Center for Justice Statistics, Statistics Canada. Includes but is not limited to incidences of offensive weapons, bail violation, disturbing the peace and mischief (property damage).

Federal Statutes: Canadian Center for Justice Statistics, Statistics Canada. Includes but is not limited to incidences of possession and trafficking of drugs.

Traffic: Canadian Center for Justice Statistics, Statistics Canada. Includes but is not limited to incidences of dangerous operation of motor vehicle and impaired operation of motor vehicle.

Violent Crime Rates (per 1,000 persons): NWT Bureau of Statistics, GNWT. Rates are determined using population estimates developed by the NWT Bureau of Statistics.

Property Crime Rates (per 1,000 persons): NWT Bureau of Statistics, GNWT. Rates are determined using population estimates developed by the NWT Bureau of Statistics.

Income Assistance

Note: Due to program changes in 2007, data prior to this year is not directly comparable.

Beneficiaries (monthly average): Department of Education Culture & Employment, GNWT. Refers to the monthly average number of recipients of income assistance and their dependents, if any, over the year.

Cases (monthly average): Department of Education Culture & Employment, GNWT. Refers to the monthly average number of people requesting and receiving social assistance over the year.

Payments ($000): Department of Education Culture & Employment, GNWT. Refers to the total amount of payments over the year. Payments are recorded for the month for which assistance was received.

Traditional Activities

Hunted & Fished (%): NWT Bureau of Statistics, GNWT. Refers to the percent of people 15 years of age or older that hunted or fished during the year.

Trapped (%): NWT Bureau of Statistics, GNWT. Refers to the percent of people 15 years of age or older that trapped during the year.

Produced Arts & Craft (%)s: NWT Bureau of Statistics, GNWT. Refers to the percent of people 15 years of age or older that made arts and crafts during the year.

Households Consuming Country Food: NWT Bureau of Statistics, GNWT. Refers to the percent of households reporting that half, most or all (50% or more) of the meat or fish consumed is harvesting in the NWT.

Aboriginal Languages

Percent of Aboriginal that Speak an Aboriginal Language: NWT Bureau of Statistics, GNWT. Refers to the percent of aboriginal people 15 years of age or older that can speak an aboriginal language well enough to carry on a conversation. Aboriginal languages include Inuktitut, Inuvialuktun, Inuinnaqtun, Dogrib, Cree, Chipewyan, North Slavey, South Slavey, and Gwich'n.

Education

Percent with High School Diploma or More: Census, Statistics Canada (1986, 1991, 1996, 2001 & 2006); NWT Bureau of Statistics, GNWT (1989, 1994, 1999, 2004 & 2009). Refers to the percent of population 15 years of age or older that have a high school diploma.

2009 Employment Rates: NWT Bureau of Statistics, GNWT. Refers to the employment rate for two groups of people: those who do not have a high school certificate, and those with at least a high school certificate. Employment rate refers to the percentage of persons 15 years of age and over who are working at a job.

Labour Force

Census, Statistics Canada (1986, 1991, 1996, 2001 & 2006); NWT Bureau of Statistics, GNWT (1989, 1994, 1999, 2004 & 2009).

Participation Rate: The percentage of persons 15 years of age and over who are in the labour force. See below for definition of labour force.

Unemployment Rate: The percentage of the labour force that was unemployed during the week prior to the survey. See below for definition of labour force.

Employment Rate: The percentage of persons 15 years of age and over who were employed during the week prior to the survey.

Employed: Refers to persons who during the week prior to the survey: (i) did any work at all, excluding housework, maintenance around the home and volunteer work; or (ii) were absent from their job or business because of vacation, illness, on strike or locked out, etc.

Unemployed: Refers to persons who during the week prior to the survey: (i) were without work, had actively looked for work in the previous four weeks and were available for work; or (ii) had been on temporary lay-off and expected to return to their job; or (iii) had definite arrangements to start a new job within the next four weeks.

Labour Force: Refers to persons who were either employed or unemployed during the week prior to the survey.

Not in the Labour Force: Refers to persons who do not participate in the labour force, they are neither employed or unemployed.

Potential Available Labour Supply: Refers to those persons who are unemployed. They can be classified into various categories, including, those who want to do rotational work, gender, ethnicity, or level of schooling.

Annual Work Pattern: Work pattern measures the amount of work over a given year. Worked in 2008 refers to the percent of people 15 years of age or older who worked in 2008, while worked more than 26 weeks refers to the percent of workers who worked more than 26 weeks in the year. The weeks need not be consecutive.

Personal Income

Small Area and Administrative Data Division, Statistics Canada. Data is based upon filed tax returns.

Total Income ($000): Refers to total money income received from all sources.

Average Personal Income ($): Refers to the average money income received from all sources.

Employment Income ($000): Refers to total income received by persons 15 years of age and over for any employment.

Average Employment Income ($): Refers to average income received by persons 15 years of age and over for any employment.

Percent Tax-filers Less Than $15,000: Refers to the percent of tax-filers who report they are making less than $15,000.

Percent Tax-filers More Than $50,000: Refers to the percent of tax-filers who report they are making more than $50,000.

Family Income

Small Area and Administrative Data Division, Statistics Canada. Data is based upon filed tax returns. Refers to the total income of a family; it is the sum of the total incomes of all members of that family.

Average Family Income ($): Refers to the average money income received from all sources for the family as a whole.

Percent Families Less Than $30,000: Refers to the percent of families who report they are making less than $30,000.

Percent Families More Than $75,000: Refers to the percent of families who report they are making more than $75,000.

Environment

Average Temperature (°C): Environment Canada. Calculated as the mean daily temperatures, averaged over the reference month. The mean daily temperature is the average between the daily maximum and minimum.

Community Living

% Who Volunteered in 2008: NWT Bureau of Statistics. Refers to the population 15 years of age and over who volunteered during the year.

% of Homes with Internet Access in 2008: NWT Bureau of Statistics.

Prices

Living Cost Differentials: Price Division, Statistics Canada.

Food Price Index: NWT Bureau of Statistics, GNWT.

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APPENDIX I

APPENDIX I FUEL SPILL CONTINGENCY PLAN EXAMPLE

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EXAMPLE OF FUEL SPILL CONTINGENCY PLAN
MACKENZIE VALLEY HIGHWAY
SAHTU SETTLEMENT AREA, NORTHWEST TERRITORIES

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1.0 INTRODUCTION AND PROJECT DETAILS

_____(the Contractor) has prepared this spill contingency plan for construction activities being undertaken at camps and sites along the Mackenzie Valley Highway alignment within the Sahtu Settlement Area (SSA), Northwest Territories (the Highway). The plan looks to address the appropriate response capabilities and measures that will be in place to effectively respond to potential spills in the Sahtu Settlement Area.

1.1 COMPANY NAME, LOCATION AND MAILING ADDRESS

Company name, mailing address, phone, fax, E-mail information will be provided by the Contractor prior to the commencement of any activities, as well as provide a main contact person to whom address all inquiries.

1.2 EFFECTIVE DATE OF SPILL CONTINGENCY PLAN

To be completed by the Contractor.

1.3 LAST REVISIONS TO SPILL CONTINGENCY PLAN

Date and sections updates to be indicted by the Contractor when any changes take place to the present document.

1.4 DISTRIBUTION LIST

The distribution list of the plan and its most recent revisions will be determined by the Contractor. It will include the following: Environmental Health and Safety Manager, Project Engineer, Camp Manager, Contractor, Indian and Northern Affairs Canada, Environmental Protection - Environment Canada, Area Manager - Fisheries and Oceans Canada, Environmental Protection Division - Government of the NWT, Land and Water Board, Sahtu Organizations.

1.5 PURPOSE AND SCOPE

The purpose of this plan is to outline the Contractor response actions in the case of spills, including a worst case scenario, in the Sahtu Settlement Area while doing work activities related to the Highway. The plan identifies: key response personnel, roles and responsibilities and equipment and resources for spill response to ensure quick access to all the information when required.

The management plan also details spill response procedures with the goal of minimizing potential health and safety hazards, environmental damage, and clean-up efforts.

1.6 COMPANY ENVIRONMENTAL POLICY

This portion will be completed by the Contractor to include their health and safety policy. It will include the protection of employees, public and environment; legislation compliance; government and public proactive cooperation; mitigation and information/communication goal statements.

The plan will be presented to all working onsite staff during their orientation sessions. All employees and subcontractors will be made aware of the locations of the plan on camps and sites in the SSA. As well, training sessions will be scheduled to ensure employees have an understanding of the steps to be undertaken in the event of a spill. Spill kits storage and contents, spill technologies and responsive methods update information will be communicated to all working personnel.

1.7 PROJECT DESCRIPTION

The purpose of this project is to construct 284 km of all-weather, graveled highway, including an allowance for future installation of fibre optic cable within the highway right-of-way, through the Tulita District of the Sahtu Settlement Area in the Northwest Territories. This part of the proposed Mackenzie Valley Highway extension from Wrigley north to Inuvik would cover the section within the Tulita District of the Sahtu Settlement Area (SSA). When completed, this section of the Highway would be operated and maintained as part of the NWT public highway system.

The construction and operation of the Highway will involve:

- Selecting preferred locations for the Highway alignment, stream crossings, borrow sources, and future installation of a communications fibre optic cable within the Highway right-of-way.
- Developing supporting construction and maintenance infrastructure, including, borrow sources (long-term and temporary), temporary winter access roads, camps, and fuel, equipment and materials staging and storage locations.
- Connecting existing and proposed highways including the Dempster Highway east/southeast of Inuvik and the Mackenzie Valley Highway within the Gwich'in Settlement Area, the K'ahsho Got'ine District of the Sahtu Settlement Area and the Deh Cho.
- De-commissioning and restoring temporary borrow sources and access roads.

1.8 SITE DESCRIPTION

Camp site details including geographic location and adjacent communities will be included in this section; this will help identify potential areas affected by potential spills.

Map or maps to be included illustrating the Contractors camp site and equipment location.

1.9 LIST OF HAZARDOUS MATERIALS ON-SITE

List of hazardous materials on-site, the type of storage container, the average and maximum quantities stored and their location to be detailed by the Contractor.

1.10 EXISTING PREVENTATIVE MEASURES

Due to the nature of the materials to be stored on site and the remote location of some camp sites adequate training to all staff and subcontractors is essential.

The estimated fuel requirements for construction of the Highway are in the order of 40M to 49M litres. Fuel storage requirements will be defined for individual sites at the time of preparation of this plan.

Fuel will be delivered in the winter from regional storage hubs to fuel tanks situated along the Highway in the staging and storage areas, in the borrow sources, and in the camps.

The camp manager or a designated fuel monitor shall conducts daily visual inspections to check for leaks, damage to fuel storage containers, stained or discolored soils around storage areas and adjacent motorized equipment. Spill kits shall be located wherever fuel is stored or used, and a checklist for the inspections will be kept as records in the Contractor's files.

1.11 ADDITIONAL COPIES

Several copies of the plan shall be kept on-site at all times near fuel storage areas. Additional copies distribution will be determined prior to construction activities commencing with additional copies made available by contacting the Contractor directly.

1.12 MEDIA AND PUBLIC INQUIRIES

All inquiries are to be directed to the manager or the Contractor's headquarters office for appropriate channeling. If a reporter or member of the public arrives at the site unexpectedly, the camp manager will make every effort possible to contact the manager or Contractor's headquarter to discuss the situation.

Any news or updates of potential interest to the media or general public, will be noted to the manager so that the Contractor is prepared to deal with inquiries at any time.

If a spill occurred a NWT Spill Report needs to be filled out (see Appendix A). This information is available for the public to view upon request by contacting the NWT Spill Line or by viewing the GNWT Hazardous Materials Spills Database online at http://www.e-engine.ca/eps_spillreport/.

2.0 RESPONSE ORGANIZATION

A flow chart depicting the response organization and applicable alternates, as well as the chain of command for responding to a spill or release shall be detailed by the Contractor prior to commencing any activities. This chart summarizes the duties of various response personnel, contact information (including 24-hour phone numbers) and the location of communications equipment on site. INAC's flow chart of response organization is provided below as an example.

Figure 1: Flow chart of response organization

3.0 ACTION PLAN

Potential spill sizes and sources, as wells as potential environmental impacts of spill (including worst case scenario) are dependent on the hazardous material on site used by the Contractor. Details shall be provided prior to any activity commencing.

3.1 PROCEDURES

There are three (3) activities that must be taken when a spill occurs. First, there must be a Response, followed by Containment, followed by Recovery. A spill may be as easy to deal with as noticing a valve leaking, putting down some absorbent material and disposing of the used material in a responsible fashion.

This is a very simple scenario but there has been a response, an effort to contain and recovery of the spill. There are intermediary steps within each of the activities and they are identified below. The sequence of the steps is extremely important and will be followed.

However, each potential spill will have its own unique characteristics and the sequence may need to be altered to suit the circumstances. Common sense should prevail.

3.1.1 Procedures for initial actions

3.1.1.1 Step 1 – Identify the Source of the Spill

- Locate the source of the spill.
- Contact the camp manager by radio and notify that you have a spill.
- Assess the immediate hazards of the spill.
- If it is safe and within your capability to do so, shut off the source of the spill.

3.1.1.2 Step 2 – Secure the Area

- Assess spill area and eliminate all sources of ignition.
- Keep the public away from the spill.
- Determine the direction of the spill, how quickly it is migrating and what is causing it to migrate (wind, gravity).
- Determine if human life is in danger and alert the RCMP, the Health Centre, the Volunteer Fire Department and the local Renewable Resource Officer.

3.1.1.3 Step 3 – Initiate the Containment of the Spill

- Deploy the on-site spill containment equipment as required.
- Notify the camp manager of the spill and request assistance if required.
- Erect barriers to minimize the migrating of the spill.
- Notify the Contractor if heavy equipment is required.
- If the spill cannot be contained with the resources available then contact the NWT 24-Hour Spill Line at (867) 920-8130 and request assistance.

3.1.2 Spill Reporting Procedures

3.1.2.1 Step 4 – Reporting the Spill

- When the source of the spill has been shut down and it is reasonably contained, it must be reported to the NWT Spill Line.
- NWT Spill Report forms are included Appendix B.
- Fill out the NWT Spill Report as completely as possible and fax it immediately to (867) 873-6924 or email it to spills@gov.nt.ca. If a fax machine or computer is not available then you must still complete the

NWT Spill Report and telephone the NWT Spill Line at (867) 920-8130 to report the spill.

- You will be required to report to the NWT Spill Line until the spill has been recovered. Depending on the severity of the spill this may take days, weeks or even months.

3.1.3 Procedures for Transferring, Storing, and Managing Spill-related Wastes

Used sorbent materials are to be placed in plastic bags for disposal. Following clean up, any tools or equipment used shall be properly washed and decontaminated, or replaced. Spilled petroleum products and materials used for containment will be placed into empty waste oil containers and sealed for proper disposal at an approved disposal facility.

3.1.4 Procedures for Restoring Affected Areas

Once a spill of reportable size has been contained, the Contractor will consult with INAC or lead agency Inspector assigned to determine the level of cleanup required. The Inspector may require a site specific study to ensure appropriate clean up levels are met. Criteria that may be considered include natural biodegradation of oil, replacement of soil and revegetation.

4.0 RESOURCE INVENTORY

4.1 ON-SITE RESOURCES

Spill kits, booms, sorbent materials, earth moving equipment will be detailed by the Contractor prior to the start of any on site activities.

4.2 OFF-SITE RESOURCES

Contacts listed below will vary on the estimated time needed to reach the site. This list shall be reviewed and updated by the Contractor prior to the start of any on site activities.

- NWT 24-Hour spill line - (867) 920-8130
- Indian and Northern Affairs Canada Inspector (Inuvik) - (867) 777-8901
- Environment Canada (Emergency) Yellowknife - (867) 669-4725
- GNWT Environmental Protection Division - (867) 873-7654
- GNWT Environmental Health Office - (867) 669-8979
- Town of Norman Wells – (867) 587-3700
- Hamlet of Tulita – (867) 588-4471
- RCMP (Norman Wells) - (867) 587-1111
- Norman Wells Medical Services - (867) 586-3675
- Norman Wells Fire Department – (867) 587-2222

5.0 TRAINING PROGRAM

The success of any spill response depends on adequately trained personnel. The level of training has to be tailored to the functions to be performed and the skill levels of the individual.

Exercises are equally important to the success of any spill recovery. The purpose of the Exercises is to reinforce training through hands-on deployment and response to a spill with the available equipment and identify areas for additional training. Exercises may consist of a tabletop exercise or an operational one.

The tabletop version would involve writing up a spill scenario and going through the Spill Contingency Plan to determine its effectiveness. The operational Exercise would involve the actual deployment and testing of the response equipment under a hypothetical spill scenario. It is recommended that a tabletop Exercise be conducted annually. Operational Exercises will be conducted every three years in conjunction with Government agencies.

5.1 OUTLINE OF TRAINING PROGRAM

Greater and broader training amongst all levels of onsite personnel will help produce a higher quality of work and will result in greater opportunities for the Contractor to gain new work and new clients.

The Contractor shall provide and/or support both formal and informal training, on-the-job and classroom training, safety-specific and skill-specific training. Training and skills-assessment shall begin on hiring. New employees will receive basic orientation on safety standards and procedures which are standard procedures for company operations.

Basic Safety Program training, WHMIS, First Aid and Transportation of Dangerous Goods programs will be carried out periodically in house as required. As well, programs in Safety Program Supervision, Hazard Identification and Control and Incident Investigation will be provided to supervisory personnel at minimum, in order that such information and developed procedures can be passed down to all personnel through safety meetings.

Programs such as Light Duty Vehicle Operator, Heavy Equipment Training, Class 3 and Class 1 Driving Courses and Contaminated Soils Courses will be offered as operations require. Many subjects related to new tasks and procedures, or to address newly identified hazards, will be addressed at safety meetings and daily tailgate meetings.

5.2 TRAINING SCHEDULE AND RECORD KEEPING

Employee files will contain records and copies of all training certificates and licenses, both those issued by the Contractor for in-house training, and also licensing and certification provided by government agencies, training institutions and regulators.

1. Employee files will contain personal information including:
2. Driver License Information (including copy of driver's licence)
3. List of Personal Training Certificates (copies of those certificates)

4. Personal Medical History (this may remain sealed in an envelope and returned at end of employment term)
5. Contractor's Base Rules & Policies – Sign off
6. Contractor's Vehicle Policy – Sign off
7. Drug & Alcohol – Sign off
8. Health & Safety and Environmental Management Hand book – Sign off
9. Safety Orientation Acknowledgement Form

A record of On the Job Training shall be signed by a supervisor and the worker to acknowledge task competency and is to be maintained on file within the company.

APPENDIX A

Material Safety Data Sheets (MSDS) for hazardous materials stored on site

The MSDS shall be provided by the Contractor based on the products used for their operations.

APPENDIX B

NWT Spill Report Form (most recent approved version)

http://www.enr.gov.nt.ca/_live/documents/content/NT-NU_Interactive_Spill_Form.pdf

APPENDIX C

Immediately Reportable Spill Quantities

TDG Class	Substance for NWT 24 Hour Spill Line	Immediately Reportable Quantities
1 2.3 2.4 6.2 7 None	Explosives Compressed gas (toxic) Compressed gas (corrosive) Infectious substances Radioactive Unknown substance	Any amount
2.1 2.2	Compressed gas (flammable) Compressed gas (non-corrosive, non-flammable)	Any amount of gas from containers with a capacity greater than 100 L
3.1 3.2 3.3	Flammable liquids	> 100 L
4.1 4.2 4.3	Flammable solids Spontaneously combustible solids Water reactant	> 25 kg
5.1 9.1	Oxidizing substances Miscellaneous products or substances excluding PCB mixtures	> 50 L or 50 kg
5.2 9.2	Organic peroxides Environmentally hazardous	> 1 L or 1 kg
6.1 8 9.3	Poisonous substances Corrosive substances Dangerous wastes	> 5 L or 5 kg
9.1	PCB mixtures of 5 or more ppm	> 0.5 L or 0.5 kg
None	Other contaminants (e.g. crude oil, drilling fluid, produced water, waste or spent chemicals, used or waste oil, vehicle fluids, waste water, etc.)	> 100 L or 100 kg
None	Sour natural gas (i.e. contains H2S) Sweet natural gas	Uncontrolled release or sustained flow of 10 minutes or more