Mackenzie Valley Highway

Environmental Scoping Document

January 2013

Department of Transportation,
Government of the NWT
Yellowknife, Northwest Territories

Project Number: 123510598

Northwest Territories Transportation

Table of Contents

List of Tables

List of Figures

1 INTRODUCTION

The Department of Transportation and its partners are proposing to extend the Mackenzie Valley Highway (MVH) from Wrigley to the Dempster Highway. An application for a Class A Land Use Permit for initial project activity in the Gwich'in Settlement Area has been submitted to the Mackenzie Valley Land and Water Board (MVLWB). In expectation of a referral of the application for environmental assessment, this Environmental Scoping Document is intended to assist with the scoping of an environmental assessment or environmental impact review of the project.

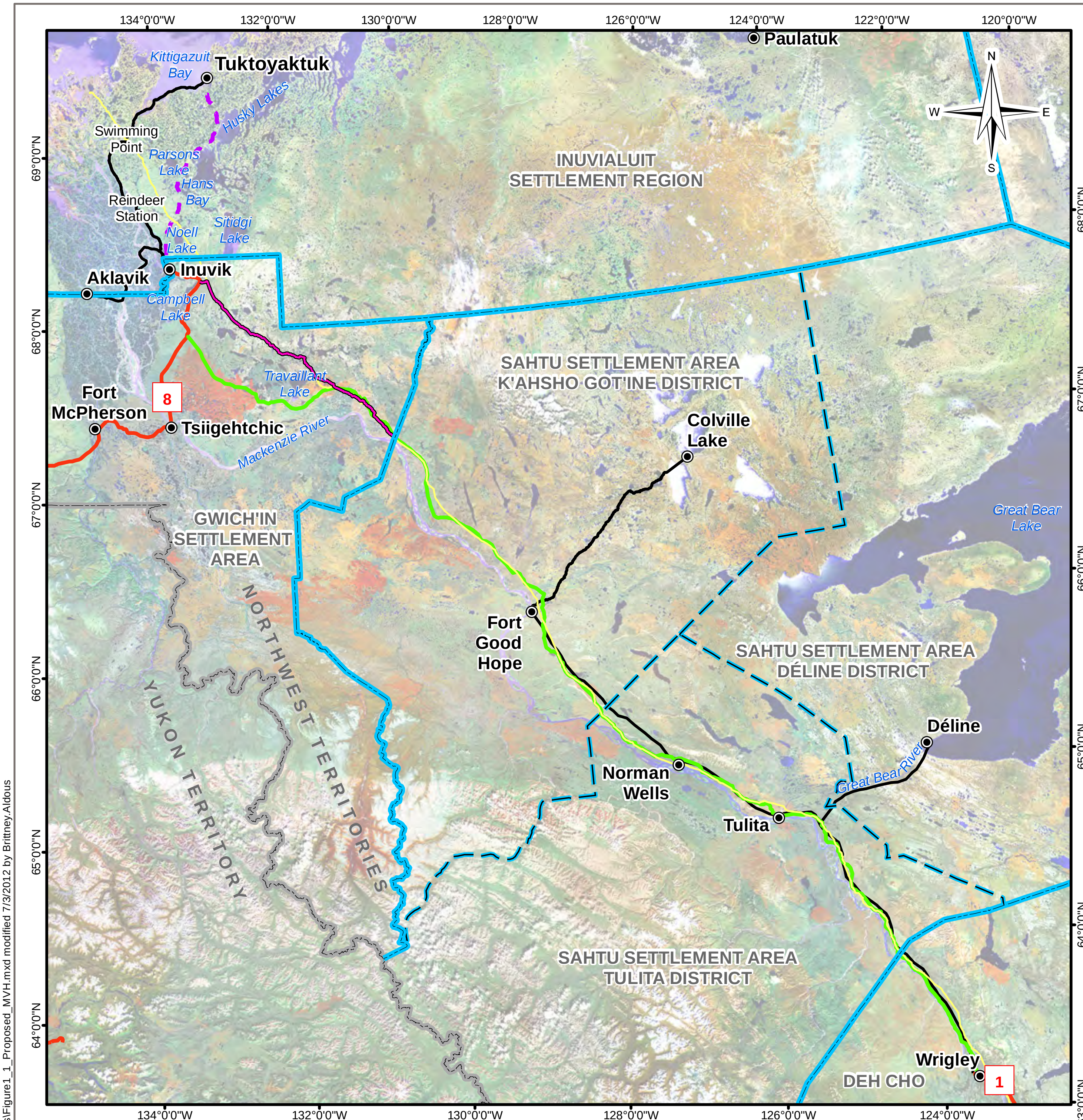
1.1 Project Overview

The Mackenzie Highway (Hwy 1) currently extends from the Northwest Territories/Alberta border to the community of Wrigley in the central Mackenzie Valley. The MVH project (Project) proposes to extend the existing highway from Wrigley, to the Dempster Highway near Inuvik, connecting the communities of Tulita, Norman Wells and Fort Good Hope with the Northwest Territories all-weather highway system. The development includes the following components:

- Initial extension of the current winter road from Fort Good Hope north to the Dempster Highway;
- Construction of an 818 km all-season gravel highway from Wrigley to the Dempster Highway;
- Construction of watercourse crossing structures;
- Construction and operation of temporary and permanent borrow pits and quarries;
- Construction and operation of permanent highway maintenance areas;
- Construction and operation of temporary support infrastructure and workspaces including, camps, laydown and staging areas, bulk fuel storage areas and airstrips; and
- Reclamation of temporary facilities and workspaces.

The Project will pass through the Dehcho Region, the Tulita and K'ahsho Got'ine Districts of the Sahtu Settlement Area (SSA) and the Gwich'in Settlement Area (GSA) of the Northwest Territories (NWT). Figure 1-1 illustrates the route of the proposed MVH. Table 1-1 illustrates the length of the proposed Project in each of these regions.

The MVH will be operated and maintained as part of the NWT Public Highway System.



LEGEND

- Communities
- PWC 1974 Highway Concept Route
- Mackenzie Gas Project Corridor
- MVH Concept - December 2010
- Dempster Highway (NWT HWY 8)
- Public Winter Road
- Proposed Inuvik to Tuktoyaktuk Highway (2009)
- Settlement Area Boundary
- District Boundary
- Territorial Boundary

NOTES
Base data source:
J.D. Mollard and Associates Limited. (February 2008).
Location of the Proposed Mackenzie Highway Extension.
NTS 1:250,000

STATUS
ISSUED FOR USE

MACKENZIE VALLEY HIGHWAY

Proposed Mackenzie Valley Highway Alignment

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:3,600,000
50 25 0 50
Kilometres

FILE NO.
Figure1_1_Proposed_MVH.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y22101294	BA	MS	RM	0

OFFICE	DATE
EBA-RIV	July 2012

Northwest Territories
Nehtruh - EBA

Figure 1-1

M:\TRANSPORTATION\NWT_Mackenzie_Highway\Y22101294_MVH\Maps\Figure1_1_Proposed_MVH.mxd modified 7/3/2012 by Brittney.Aldous

Table 1-1 Mackenzie Valley Highway Route Segment Lengths

Region	MVH KM Post	Length (km)
Dehcho	690 to 796	106
Tulita District	796 to 1081	285
K’ahsho Got’ine District	1081 to 1328	247
Gwich’in Settlement Area	1328 to 1508	180
Total		**818**

1.2 Project Approvals

The proposed Project will be constructed on Crown lands, Commissioner’s Lands and Private lands as identified in the Gwich’in Comprehensive Land Claim Agreement and Sahtu Dene and Métis Comprehensive Land Claim Agreement. Table 1-2 illustrates the anticipated rights and approvals required during the pre-development phase. Table 1-3 indicates rights and approvals anticipated to be required during construction and operation.

Table 1-2 Approvals Required for Pre-Development Activities - Mackenzie Valley Highway

Project Activities	Approval or Authorization Required	Agency
Pre- Development		
Environmental Baseline Studies Programs	Research Licence	Aurora Research Institute
Wildlife Baseline Studies	Wildlife Research Permit	GNWT Department of Environment and Natural Resources
Fisheries Baseline Studies	Fisheries Research Licence	Fisheries and Oceans Canada
Archaeological Field Investigations	Archaeology Research Permit	GNWT Prince of Wales Northern Heritage Centre
Geotechnical Investigations	Land Use Permit Water Licence Fisheries Approval(s)	Land and Water Boards Fisheries and Oceans Canada

Table 1-3 Approvals Required for Construction and Operation Activities - Mackenzie Valley Highway

Project Activities	Approval or Authorization Required	Agency
Construction		
Rights to Access land	Gwich'in Land Use Plan Amendment Access Agreements	Gwich'in Land Use Planning Board Gwich'in Tribal Council Yamoria District Land Corp. Tulita District Land Corp.
Barge Landing facilities	Navigable Waters Approval(s) Water Licence(s)	Transport Canada Land and Water Boards
Camps, airstrips and staging areas	Land Use Permit(s) Water Licence(s) Navigable Waters Approval	Land and Water Boards Land and Water Boards Transport Canada
Right-of-way clearing/winter road construction	Timber Permit Land Use Permit(s)	Environment and Natural Resources Land and Water Boards
Borrow sources development	Quarry Permit(s) Land Use Permit(s) Water Licence(s) Explosives Storage Permit Explosives Use Permit	AANDC/GTC/Land Corporations/MACA Land and Water Boards Natural Resources Canada Natural Resources Canada
Watercourse crossing construction	HADD Authorization(s) Water Licence(s) Land Use Permit(s)	Fisheries and Oceans Land and Water Boards
Embankment construction	Land Use Permit(s) Water Licence(s)	Land and Water Boards
Operations		
Long-term occupation (Right-of-Way)	Reserve, Lease or Licence of Occupation Lease or Land Transfer	AANDC District Land Corporations/GTC
Road Maintenance	Land Use Permit(s)	Land and Water Boards
Quarrying	Quarry Permit(s) and/or Quarry Lease(s)	Aboriginal Affairs and Northern Development Canada/District Land Corporations/GTC

1.3 Purpose of the Environmental Scoping Document

The Environmental Scoping Document is intended to provide information about the Project, which is the full development associated with the current application for the Class A Land Use Permit for (Right of Way clearing) in the GSA. The DOT acknowledges that it is possible that activities associated with the Project might cause significant adverse impacts on the environment, or could potentially be a cause for public concern. As such, DOT anticipates that the Project will be referred to the MVEIRB for environmental assessment (EA) or environmental impact review (EIR). This Environmental Scoping Document is not only intended to provide the information to support the Preliminary Screening of the current application, but more importantly to provide project information to assist the MVEIRB in developing the scope of an anticipated EA or EIR. The Environmental Scoping Document:

- Describes the purpose for, and history of the Project;
- Describes the spatial and temporal scope of project activities;
- Describes the Project's components;
- Summarizes public involvement in Project planning and presents a summary of public concerns about the Project;
- Identifies environmental components (VC)s in the Project area; and
- Summarizes concerns (issues) an EA or EIR would potentially focus on.

The information in this Environmental Scoping Document is drawn largely from four Project Description Reports (PDRs) prepared in partnership with regional land claim organizations in each of the four Regions and Districts crossed by the Project:

- Project Description Report for the Construction of the Mackenzie Valley Highway Gwich'in Settlement Area, NT (Gwich'in Tribal Council and Govt. Northwest Territories, 2011)
- Project Description Report for Construction of the Mackenzie Valley Highway K'ahsho Got'ine District, Sahtu Settlement Area (K'asho Development Foundation and Govt. Northwest Territories, 2012)
- Project Description Report for Construction of the Mackenzie Valley Highway Tulita District, Sahtu Settlement Area (5658 NWT Ltd., and Govt. Northwest Territories, 2011)
- Mackenzie Valley Highway Extension Pehdzeh Ki Ndeh – Dehcho Region: Project Description Report (Pehdzeh Ki First Nation and Govt. Northwest Territories, 2011)

Additional information has been obtained through discussions with officials from regulatory agencies in 2012 and ongoing project planning.

The Environmental Scoping Document presents preliminary information about the Project and its potential effects on the environment, based on studies completed to date. The DOT recognizes that additional environmental studies, negotiations, planning and design are required in order to complete an Environmental Impact Statement for the Project. This additional work is ongoing, and will benefit from timely guidance received by the MVEIRB regarding the scope and factors to be addressed during an environmental assessment.

2 PROJECT BACKGROUND

An all-weather highway up the Mackenzie Valley to the Arctic Coast has been a long-term Canadian priority (since Diefenbaker's Roads to Resources Program in the 1950's). This highway is identified as a GNWT priority in various highway strategy documents and funding proposals including the 2005 *Connecting Canada, Coast to Coast to Coast*.

The recent completion of regional PDRs for various sections of the highway will help the GNWT engage the federal government in discussions on how to fund and construct the highway and to support future environmental assessment and regulatory activities.

The ongoing realization of the vision of a MVH has been supported by the federal government through the Canadian Northern Development Agency (CanNor)'s contribution to the development of the regional PDRs.

2.1 Purpose of the MVH Project

Construction of the highway from Wrigley to Inuvik is consistent with the GNWT's vision and is intended to provide the following specific benefits:

- provide a year round transportation link connecting the Mackenzie Delta and the Mackenzie Valley with the rest of the Northwest Territories and southern Canada;
- support resource exploration, development, and production to stimulate the regional economy;
- decrease the cost of living for residents by increasing access to goods and services;
- increase access to health care, educational resources, and employment opportunities;
- mitigate effects of climate change on current winter road system;
- enable opportunities for communities and families to interact and share social and cultural connections and participate in recreational and sporting activities;
- create tourism and hospitality opportunities;
- reduce the cost of delivering government services; and
- deliver government's commitment to economic development in the Northwest Territories.

2.2 Previous Studies

The concept of building an all-weather highway through the Mackenzie Valley to connect southern Canada with northern communities originated in the 1960s, although it was not until 1972 that the federal government announced that the Mackenzie Highway would be extended from Fort Simpson to the Dempster Highway. Construction of the highway started in Fort Simpson but was halted in 1977, approximately 18 km south of Wrigley after 210 km were completed.

The Government of the Northwest Territories (GNWT) developed its Highway Strategy in 1989 after authority for the NWT highway system was devolved from the federal government. By 1994, the remaining 18km of the highway to Wrigley was completed. Preliminary engineering, environmental and financial studies to support planning for construction of the remainder of the MVH to Inuvik were completed in 1999. The northern portion of the highway, connecting Tuktoyaktuk to Inuvik, is currently undergoing environmental assessment by the Environmental Impact Review Board.

In 2010, the Department of Transportation (DOT) of the GNWT signed Memorandums of Understanding (MOUs) with the Gwich'in Tribal Council (GTC), the Tulita District Investment Corporation Ltd., K'ahsho Got'ine Development Foundation, and the Pehdzeh Ki First Nation to complete Project Description Reports (PDRs) to support further planning for the development of the Project in their respective territories. The PDRs were completed in 2011 and 2012 providing preliminary design and environmental planning information for each territory. Contacts for the groups involved are provided below.

Gwich'in Tribal Council

Mr. Fred Koe
Chief Operating Officer
PO Box 1509
Inuvik, NT X0E 0T0
T. 867-777-7900
F. 867-777-7919

K'ahsho Development Foundation

Edwin Erutse
PO Box 18
Fort Good Hope, Northwest Territories,
X0E 0H0
T: 780-927-2424
F: 780-926-4061

Tulita District Investment Corporation Ltd.

Ethel Blondin-Andrew
Box 480
Norman Wells, Northwest Territories
X0E 0V0
T. 867-587-4433
F. 867-587-2049

Pehdzeh Ki First Nation

Chief Tim Lennie
PO Box 56
Wrigley, Northwest Territories
X0E 1E0
T: 867-581-3321
F: 867-581-3229

2.3 Proponent

The Government of the Northwest Territories will act as the proponent, coordinating the involvement of other potential partners in the development of the Project. Contact information for the Government of the Northwest Territories is provided below.

Mr. Jim Stevens
Director Mackenzie Valley Highway
Department of Transportation
Highways Building, 2nd Floor
4510- 50th Avenue
P.O. Box 1320
Yellowknife, NT X1A 2L9
T. 867.920.5247
F. 867,920.2565

3 DEVELOPMENT SCOPE

The proposed Project includes the construction, operation and reclamation of an all-weather highway between the community of Wrigley and the Dempster Highway, south of Inuvik. The development includes the following components:

- Initial extension of the current winter road from Fort Good Hope north to the Dempster Highway;
- Construction of 818 km all-season gravel highway from Wrigley to the Dempster Highway;
- Construction of watercourse crossing structures;
- Construction and operation of temporary and permanent borrow sources;
- Construction and operation of permanent highway maintenance areas;
- Construction and operation of temporary support infrastructure and workspaces including, camps; laydown and staging areas, bulk fuel storage areas and airstrips;
- Ongoing highway operations and maintenance; and
- Reclamation of facilities not required for ongoing operations.

The highway is expected to operate for an indeterminate period.

During preparation of the regional PDRs, installation of a fibre optic cable in the highway Right of Way was initially included as a project component. As project development has evolved, the fibre optic cable has been removed and while reference to its inclusion still remains in the PDRs, it is no longer a component of the development of the MVH.

3.1 Development Location

The proposed Project is located in the Mackenzie Valley region of the Northwest Territories, between KM 248 of the Dempster Highway in the north and the terminus of the all-weather highway at Wrigley in the south (Figure 1-1). The coordinates of the segments of the Project in each of the settlement regions are presented in Table 3-1.

Table 3-1 Development Location

Project Feature	KM	Latitude (N)	Longitude (W)
Junction with Dempster Highway (north end)	1508	68°16'45"	133°14'47"
Boundary of the GSA/Sahtu Settlement Area	1328	67°19'41"	130°23'48"
Boundary of the K'ahsho Got'ine and Tulita Districts of the Sahtu Settlement Area	1081	65°38'19"	127°48'19"
Boundary of Tulita District and Dehcho Region	796	64°01'08"	123°28'44"
Wrigley (south end)	690	63°13'58"	124°16'26"

3.2 Preferred Alignment and Alternatives

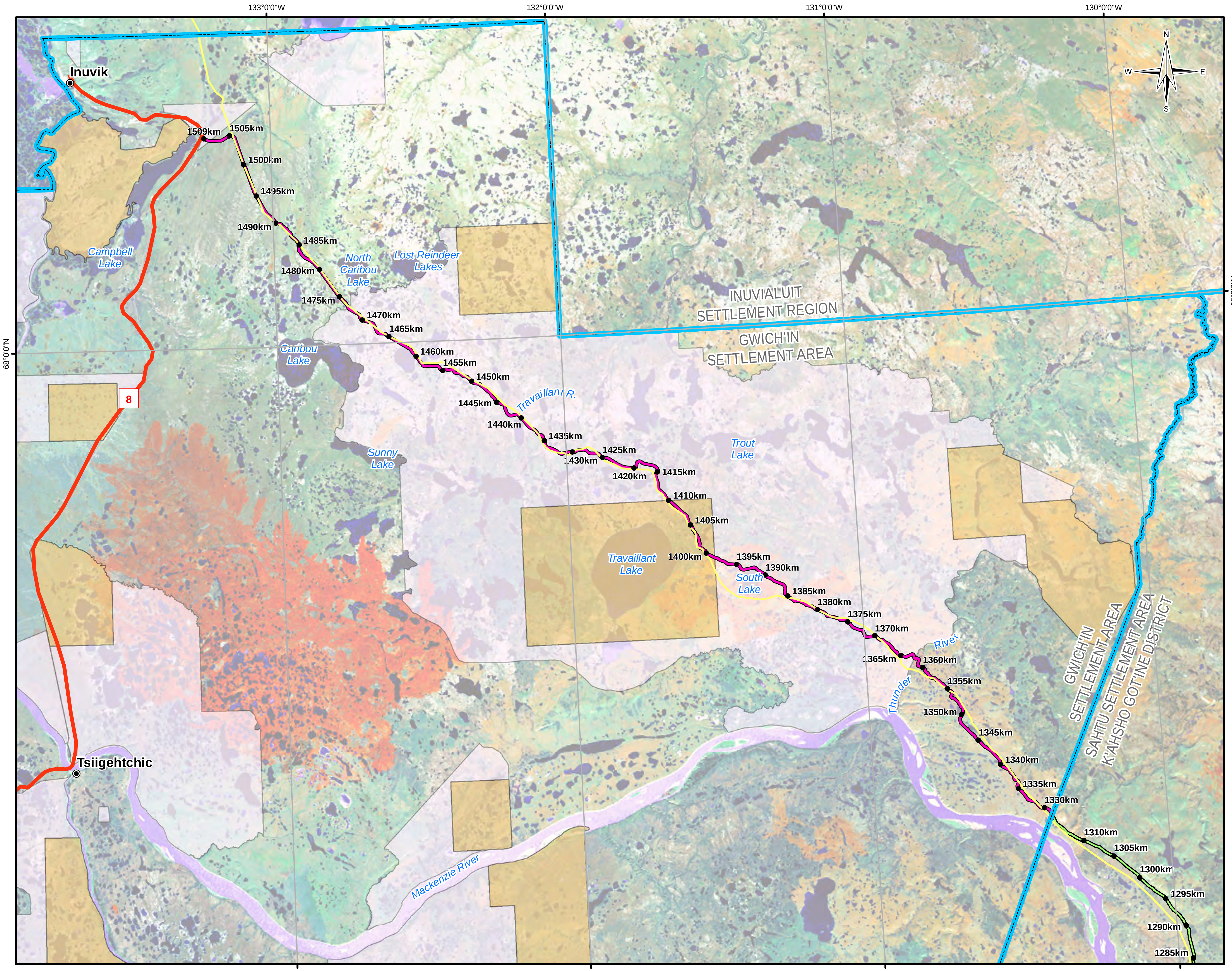
Several potential alignments for the Project had been identified prior to initiation of routing studies in 2010. These included the original Public Works Canada (PWC) alignment identified in the 1970s, the existing winter road alignment between Wrigley and Fort Good Hope and the approved Mackenzie Gas Project (MGP) corridor (IORVL 2004).

Routing studies in 2010 were undertaken to identify a preliminary alignment with site-specific alternatives. The portions of the original PWC Highway alignment that differed from the MGP alignment were not considered in the initial routing study as it did not support the primary objective of a single Transportation Corridor for multiple infrastructure developments. Available information was used in initial desktop routing studies to identify a preliminary alignment, minor alternatives, potential watercourse crossing locations, and potential borrow material sources. Identification of the preliminary desktop alignment was based on the following objectives:

- Establish a shared transportation/utilities corridor for multiple infrastructure developments;
- Utilize the existing winter road alignment from Wrigley to Fort Good Hope as much as practicable;
- 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);
- Minimize footprint through conservation and special management areas;
- Avoid potential ice rich and unstable terrain;
- Avoid steep grades and deep valleys;
- Minimize bridge lengths;
- Avoid locations of known nesting or denning areas for wildlife;
- Avoid locations with cultural or heritage resources potential;
- Situate the route on or near potential borrow sources to minimize the need and/or length of temporary or permanent access roads;
- Minimize crossing of the MGP alignment; and
- Minimize construction materials requirements.

The preliminary alignment and site-specific alignment options were developed based on the initial desktop routing studies and further refined based on design parameters, results of field studies and overview environmental studies, and comments received during consultations.

The proposed alignment for the Project is shown in Figure 1-1 with alignments through the four regions shown in Figures 3-1 to 3-4. Of the proposed route, 85.5 km follows the existing winter road alignment in the K’ahsho Got’ine District and 149 km in the Tulita District. The corresponding distance in the Dehcho Region has not been determined. The Project footprint estimates for the current preliminary design stage are available only for the Tulita (250 ha) and Gwich’in (1300 ha) segments of the highway. The exact footprint of disturbance for the Project, including access roads and material sources will be determined at the detailed design stage.



LEGEND

- Communities
- KM Post
- MVH Concept - December 2010
- MVH Concept (K'ahsho Got'ine) - AMEC
- Dempster Highway (NWT HWY 8)
- Mackenzie Gas Project Corridor
- Settlement Area Boundary

Gwich'in Lands

- Surface and Subsurface Rights
- Surface Rights

NOTES
Base data source: ESRI Base Data
NTS 1:250,000
Alignment is considered preliminary and is subject to change

STATUS
ISSUED FOR USE

MACKENZIE VALLEY HIGHWAY

Gwich'in Settlement Area

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:550,000
10 5 0 10
Kilometres

FILE NO.
Figure3_1_Gwichin.mxd

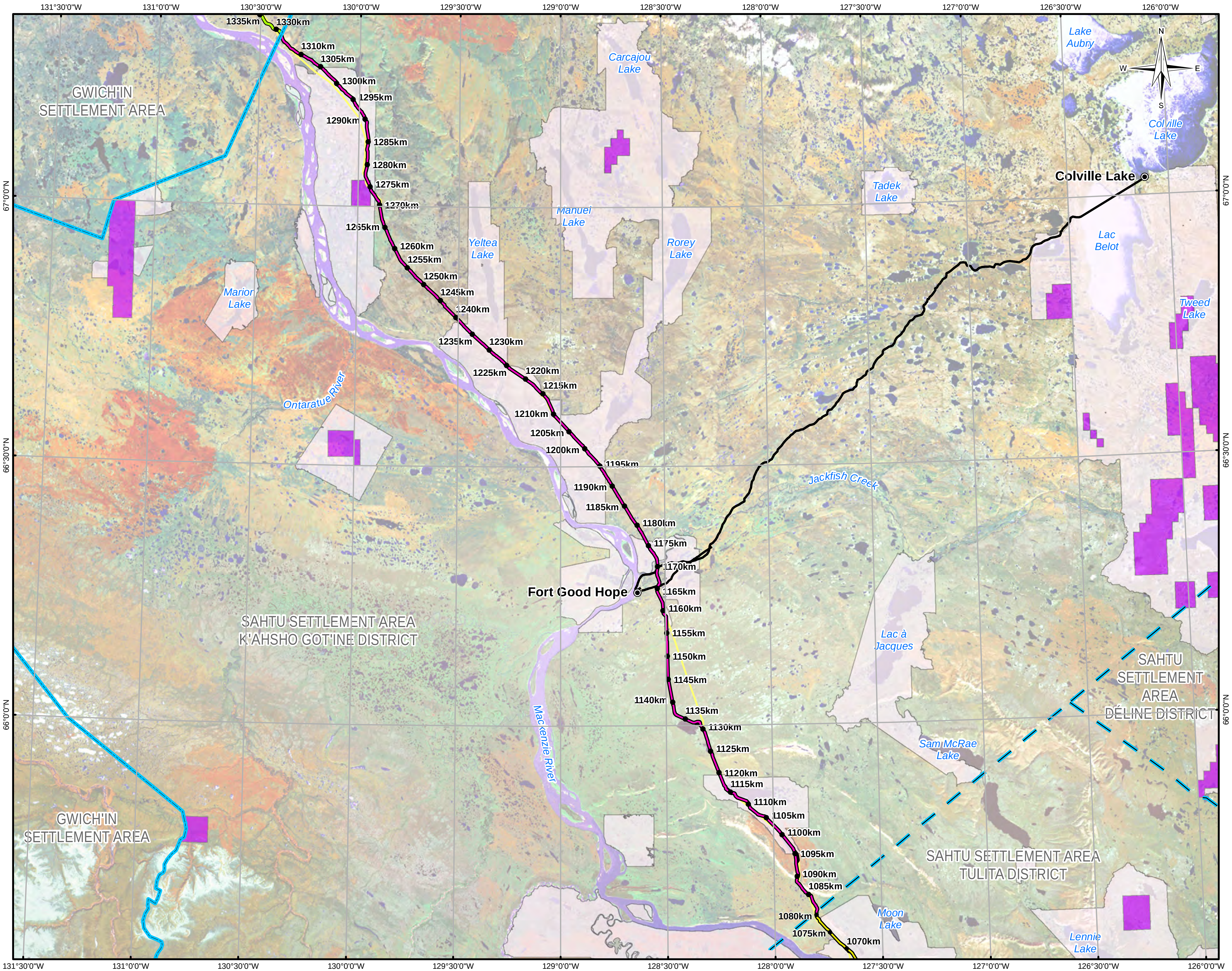
PROJECT NO.	DWN	CKD	APVD	REV
Y22101294	BA	MS	RM	0

OFFICE	DATE
EBA-RIV	July 2012

Nehtruh - EBA

Figure 3-1

M:\TRANSPORTATION\NWT_Mackenzie_Highway\Y22101294_MVH\Maps\Figure3_1_Gwichin.mxd modified 7/23/2012 by Brittney.Aldous



M:\TRANSPORTATION\NWT_Mackenzie_Highway\Y22101294_MVH\Maps\Figure3_2_KahshoGotine.mxd modified 7/23/2012 by Brittney.Aldous

LEGEND

- Communities
- KM Post
- MVH Concept - AMEC
- MVH Concept (Tulita) - EBA June 2011
- MVH Concept (GSA) - EBA December 2010
- Public Winter Road
- Mackenzie Gas Project Corridor
- Settlement Area Boundary
- District Boundary

Sahtu Settlement Lands

- Subsurface Rights
- Surface Rights

NOTES
Base Data Source: ESRI
Sahtu Settlement Lands: SLUPB
Alignment is considered preliminary and is subject to change

STATUS
ISSUED FOR USE

MACKENZIE VALLEY HIGHWAY

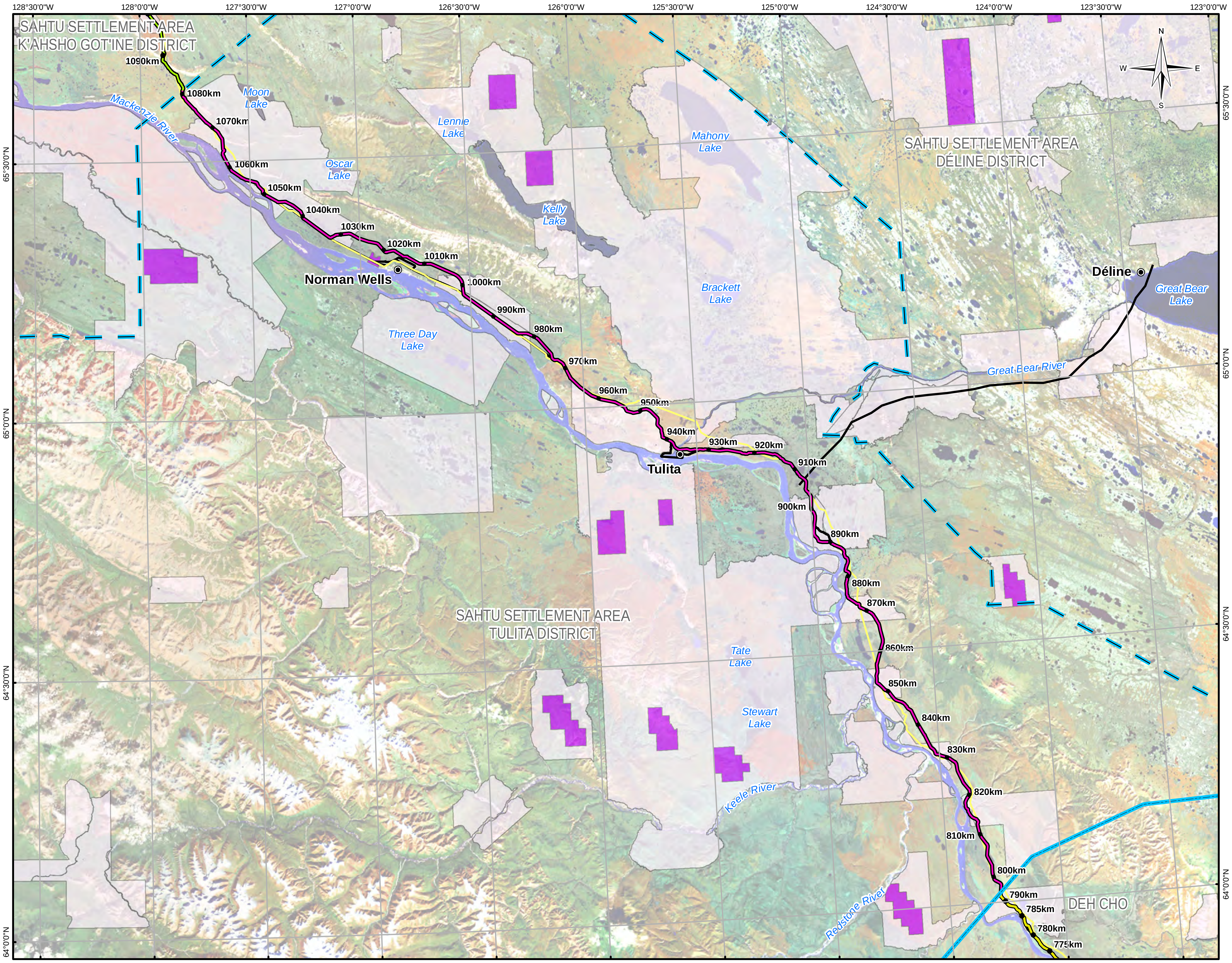
Sahtu Settlement Area K'ahsho Got'ine District

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:800,000
10 5 0 10
Kilometres

FILE NO.				
Figure3_2_KahshoGotine.mxd				
PROJECT NO.	DWN	CKD	APVD	REV
Y22101294	BA	MS	RM	0
OFFICE	DATE			
EBA-RIV	July 2012			

Figure 3-2



LEGEND

- Communities
- KM Marker
- MVH Concept - EBA June 2011 (Preferred Alignment)
- MVH Concept (Deh Cho) - Dessau November 2011
- Public Winter Road
- Mackenzie Gas Project Corridor
- Settlement Area Boundary
- District Boundary

Sahtu Settlement Lands

- Subsurface Rights
- Surface Rights

NOTES
Base Data Source: ESRI
Sahtu Settlement Lands: SLUPB
Alignment is considered preliminary and is subject to change

STATUS
ISSUED FOR USE

MACKENZIE VALLEY HIGHWAY

Sahtu Settlement Area
Tulita District

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:800,000

10 5 0 10

Kilometres

5658 NWT Ltd.

Northwest Territories

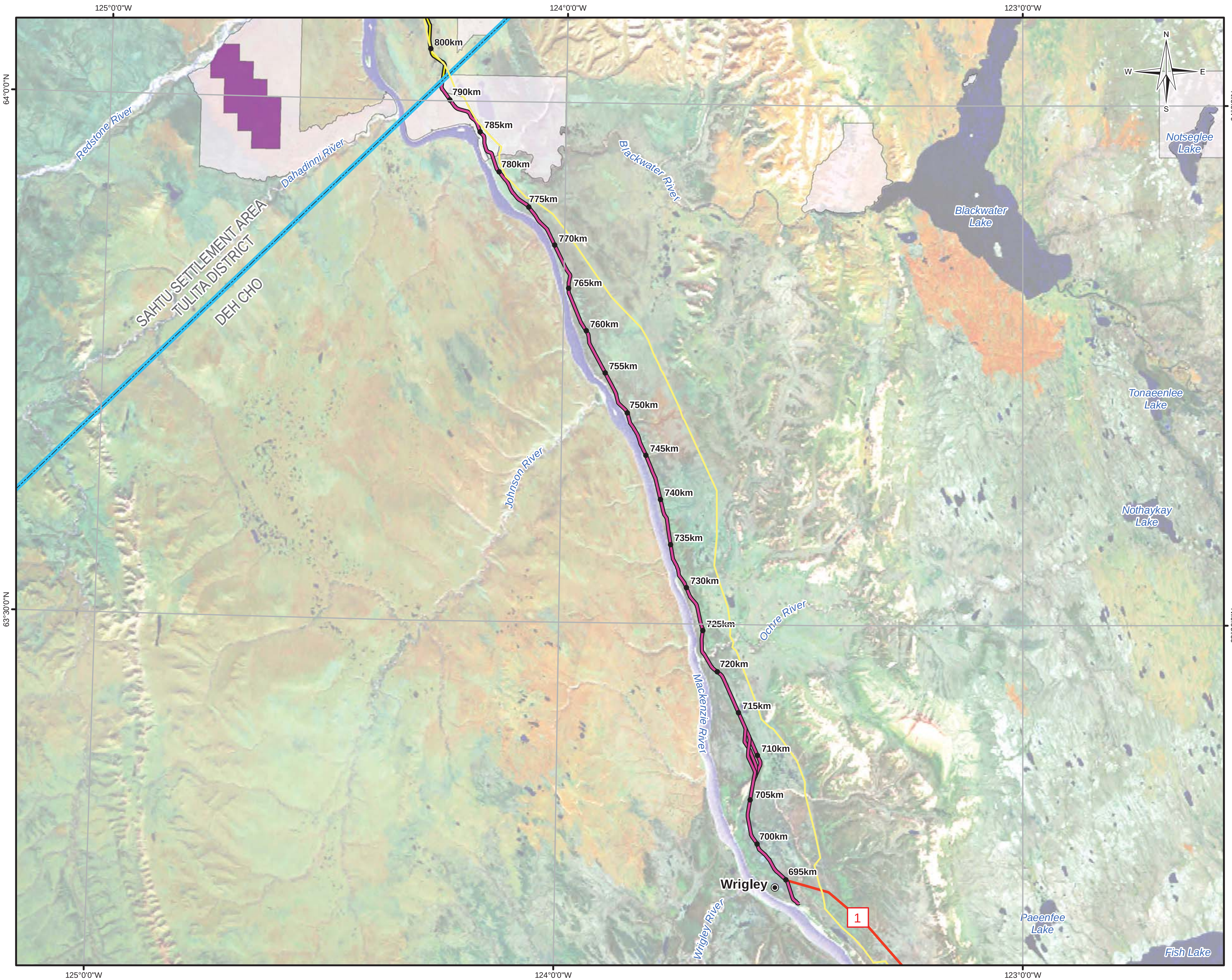
eba
A TETRA TECH COMPANY

FILE NO.
Figure3_3_Sahtu.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y22101294	BA	MS	RM	0

OFFICE	DATE
EBA-RIV	July 2012

Figure 3-3



LEGEND

- Community
- KM Post
- MVH Concept - Dessau November 2011
- MVH Concept (Tulita) - EBA June 2011
- Mackenzie Valley Highway (NWT HWY 1)
- Mackenzie Gas Project Corridor
- Settlement Area Boundary

Sahtu Settlement Lands

- Subsurface Rights
- Surface Rights

NOTES
Base data source: ESRI Base Data
NTS 1:250,000
Alignment is considered preliminary and is subject to change

STATUS
ISSUED FOR USE

MACKENZIE VALLEY HIGHWAY

Deh Cho

PROJECTION	DATUM
UTM Zone 10	NAD83

Scale: 1:400,000
5 2.5 0 5
Kilometres

FILE NO.
Figure3_4_DehCho.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y22101294	BA	MS	RM	0

OFFICE	DATE
EBA-RIV	July 2012

Northwest Territories

Figure 3-4

M:\TRANSPORTATION\NWT_Mackenzie_Highway\Y22101294_MVH\Maps\Figure3_4_DehCho.mxd modified 7/23/2012 by Brittney.Aldous

Additional details of alignment considerations and locations of site-specific alignment options are available in the four regional PDRs as follows:

- Gwich'in Settlement Area: Section 6.4 of the PDR for GSA (Gwich'in Tribal Council and Govt. Northwest Territories 2011)
- K'ahsho Got'ine District: Section 6.3 of the PDR for the KGD (K'ahsho Development Foundation and Govt. Northwest Territories 2012)
- Tulita District: Section 6.4 of the PDR for the TD (5658 NWT and Govt. Northwest Territories 2011)
- Dehcho Region: Section 3.6.2 of the PDR for the PKN (Dessau 2012)

3.3 Design Considerations

The route and operational design of the Project is further guided by:

- operational and safety requirements;
- engineering and environmental considerations; and
- incorporation of local and traditional knowledge.

The design of the Project takes into consideration and makes considerable use of data and information collected during the planning of the Mackenzie Gas Project.

3.3.1 Operational Design Parameters

The RAU-90 design designation, approved by the GWNT (TAC 2010) has been applied in all four regions. This design standard is considered to be appropriate for passenger and commercial traffic volumes of up to 100 vehicles per day (vpd), well above the estimated traffic volumes for the highway of 50 vpd (including estimated future increases due to development and tourism). The design criteria may be reduced in some areas where the existing terrain and soil conditions constrain the design alignment of the Project.

The right-of-way (ROW) will be limited to 60 m in width, except where large cut and fill sections will be required. The road surface will average 9 m in width and range between 1.6 and 2 m in depth. Using a standard side slope ratio of 3:1, the base of the embankment or footprint will range between 18.6 and 21 m in width. Standard embankment widths and depths may be altered to accommodate site specific conditions. The posted speed limit will be 80 km per hour with advisory speed posted where the design standards have been reduced.

3.3.2 Site Specific Considerations

Site specific design exceptions and operation controls are required in several locations to address challenges presented by terrain conditions. Table 3-2 identifies exceptions to standard design parameters along the proposed route.

Table 3-2 Design Parameter Exceptions

Highway Segment	KM	Notes
Gwich'in	1363	The approaches to the Thunder River bridge (both north and south) are designed with 9% grades and 190 m radius horizontal curves have been introduced that may require a reduction in operating speed to 70 km/h.
K'ahsho Got'ine	1090	The location of water bodies and bridge restrict the horizontal curve radius to 220 m. The speed limit will be reduced accordingly.
	1116	The location of the Donnelly River bridge will restrict the horizontal curve radius to 130 m. The speed limit will be reduced accordingly.
Tulita		• 100 m horizontal curve radii on approach to Steep Creek, 40 km/h posted speed limit • 10% grade at pipeline crossings, posted with appropriate warning signs • shorter than desirable vertical curves on approach to Devil's Canyon, 40 km/h posted speed limit • 150 m horizontal curve radii and 10% grade on approach to Saline River, 40 km/h posted speed limit • shorter than desirable vertical curves on approach to Seagram's Creek and 10% grades, 40 km/h posted speed limit • shorter than desirable vertical curves on approach to Little Smith Creek, 40 km/h posted speed limit • 100 m horizontal curve radii on approach to Oscar Creek, 40 km/h posted speed limit
Dehcho	692	The configuration of the Hodgson Creek Bridge restricts the horizontal radius of a curve between the starting point of the new alignment and the bridge to 150 m. Given the nearby junction with another road exiting Wrigley, travel speeds are expected to be relatively low that this location.

3.3.3 Incorporation of Traditional Knowledge

The DOT has taken into account traditional knowledge in preliminary design and planning, as made available through previously conducted studies, and as communicated during project-specific consultations.

In the Gwich'in Settlement Area, DOT was provided access to the Gwich'in Traditional Knowledge of the Mackenzie Gas Project Area (GSCI 2006). In the Tulita District, traditional knowledge was obtained from the draft Sahtu Land Use Plan (SLUPB 2010), Rakekee Gok'e Godi: Places We Take Care Of (Sahtu Heritage Places and Sites Joint Working Group 2000), Spirit of the Mountains: Shuhtagot'ine Nene and Naats'ihch'oh Traditional Knowledge Study (SENES 2009), Traditional Knowledge Study Report: Great Bear River Bridge (EBA 2006), Mackenzie Gas Project Environmental Impact Statement (IOL et al., 2004), and during consultations July 2010, March 2011 and October 2011. In the K'ahsho Got'ine District, traditional knowledge was obtained from IOL et al. (2004), SLUPB (2010) and during consultations undertaken November 2010, February 2011 and April 2011. In the Pehdzeh Ki Ndeh of the Dehcho Region, community meetings were held in 2011 and 2012.

Traditional knowledge collected during development of the PDRs informed the preliminary design with respect to:

- Avoiding important cultural, wildlife and harvesting areas;
- Identifying areas of sensitive terrain;
- Developing potential mitigations of effects; and
- Siting and practices to mitigate effects during construction and operation (e.g. siting of camps and helipads, dust control).

Traditional knowledge holders will continue to be engaged during subsequent Project phases.

3.4 Development Phases and Schedule

Project activities can be summarized by three phases: pre-construction; construction; and operation and maintenance. Subject to completion of the environmental assessment and confirmation of federal funding, construction could start in mid 2015 and continue to the fall of 2019. Construction will progress from both ends of the Project. A procurement process for this project has not been determined.

3.4.1 Pre-Construction

Pre-construction activities are not expected to be within the scope of factors to be assessed during an EA or EIR, as they are required to be undertaken to complete the assessment of environmental effects of the Project. Activities undertaken during this stage are focused on collecting the information necessary to support an environmental assessment of the development, detailed design and construction planning, and the acquisition of required development approvals. Specifically, this would include:

- LIDAR surveys
- Environmental baseline studies
- Hydrotechnical investigations at watercourse crossings
- Detailed highway and bridge design
- Preparation of an Environmental Impact Statement
- Geotechnical investigations along route and at borrow sources
- Development of monitoring and management plans
- Completion of access and benefits agreements
- Acquisition of project permits and authorizations
- Tendering of construction and supply contracts
- Offsite fabrication of bridges and mobilization

3.4.2 Construction

The construction phase includes:

- ROW clearing;
- Initial construction and operation of winter road between Fort Good Hope and the Dempster Highway;
- Development of supporting infrastructure such as camps, workspaces and staging areas, bulk fuel storage areas and airstrips;
- Construction and operation of temporary and permanent borrow sources;
- Embankment construction;
- Construction of watercourse crossing structures;
- Construction of permanent highway maintenance areas; and
- Progressive reclamation of facilities not required during operations.

Certain construction activities, such as borrow source development and staging will occur year-round, but winter road and highway embankment construction will occur primarily in winter and continue over a four year period. Construction activities and timing are summarized in Table 3-3 and details are provided in Section 3.5.

Table 3-3 Development Activities and Timing *

Project Activity	Start	Duration
Pre-Development Phase		
Site investigations and assessment (such as environmental studies and engineering and geotechnical investigations)	Summer 2013	1 year
Ongoing public engagement	May 2010	All phases
Environmental Assessment	February 2013	1 year
Detailed design and permitting	Spring 2013	2 years
Completion of Access and Benefits Agreements	Spring 2013	2 years
Contracting and Procurement	2015	Prior to construction
Construction Phase		
Right-of-way clearing	January 2016	3 years
Winter Road Construction between FGH and Dempster Highway	Winter 2015	TBD
Development and operation of camps, barge landings, staging areas, airstrips and temporary workspaces	Fall 2015	Ongoing through construction
Mobilization/demobilization	Summer 2015	4 years
Borrow source development	January 2016	3 years
Installation of watercourse crossing structures	January 2016	4 years
Embankment construction	January 2016	4 years (winter only)
Compaction and surfacing	June 2016	4 years (summer)
Progressive reclamation of borrow sources, camps, staging areas, airstrips and workspaces	Year 2	4 – 5 years

Table 3-3 Development Activities and Timing (cont'd)

Project Activity	Start	Duration
Operations Phase		
Grading, surfacing, dust control and as-required repair and maintenance	Fall 2019	Ongoing
Snow clearing, ice control	Fall 2019	Ongoing
Operation of borrow sources and maintenance facilities	Fall 2019	Ongoing
Progressive reclamation	Fall 2019	Ongoing
NOTE: *Timing is subject to completion of EA and receipt of federal funding		

3.4.3 Operation and Maintenance

The operations phase includes ongoing maintenance and repair activities to support highway operation. Operation and maintenance activities will be conducted year-round, and will be supported by permanent infrastructure such as maintenance facilities and borrow sources. Reclamation of areas used during construction and not required during operation will continue. Operations activities are summarized in Table 3-3 and details are provided in Section 3.6

3.5 Highway Construction Approach

While this application focuses on the development of the all-weather MVH, it is possible that a winter road may be constructed to extend the Mackenzie Valley Winter Road from Fort Good Hope to the Dempster Highway in advance of the all-weather highway. The winter road would follow the same alignment as the MVH and utilize established winter road construction techniques currently used along the existing Mackenzie Valley Winter Road. The remainder of this section focuses on describing the construction of the all- weather MVH.

Construction activities for the MVH will occur year round; however, the majority of activities will be undertaken during winter. A fundamental concept of the proposed construction methodology is to utilize winter construction techniques for building the embankment and accessing areas within the ROW before the highway is constructed, rather than the more typical summer construction used in southern parts of Canada. The advantages of winter (December-March) construction are as follows:

- The Project can be accessed using temporary ice roads or snow trails, without the need to construct costly all-weather access roads;
- Winter construction 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;
- Winter construction minimizes effects on wildlife, vegetation and soils;

- The cuts made in ice-rich soil areas during the winter are easier to control mainly because the exposed surfaces stay in a solid state and can be protected before the thawing period; and
- The installation of culverts may be simplified because of the diminished flow of water in streams during the winter months.

Winter construction has the following disadvantages:

- Work is challenging for both personnel and equipment, with extreme cold temperatures common at the beginning of the construction season in late December and early January;
- Activities are conducted in periods of minimal daylight;
- Excavation of frozen material in borrow sources will likely require the use of drill and blast methods to be able to source the required volumes of material for construction;
- 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; and
- Potential sensory and physical disturbance to over-wintering wildlife.

Although the majority of construction will be executed during winter, it is expected that summer and fall construction will be feasible in some locations and for some activities. Table 3-4 summarizes the seasonality of proposed construction activities.

Table 3-4 Seasonality of MVH Project Construction Activities

Season	Activities
December-January	Clearing of right-of-way and construction of winter roads; camp set up and mobilization
January-March	Borrow source development; hauling and placing of embankment material; mobilization to bridge sites and piling for bridge abutments; erection of bridge piers and abutments, culvert installation
April-June	No activities other than production and stockpiling of borrow material assuming equipment has been mobilized to the particular borrow source
July-September	Finishing and compaction of previously constructed embankment and placement of surfacing material, if feasible based on geotechnical conditions; mobilization on all-weather roads and/or river barge.
August-September	Launching of bridge girders and deck components
October-November	Any activity that does not require overland access or can be accessed by previously constructed segments of the Highway

Table 3-5 indicates the number of construction spreads (work areas) expected in each of the highway segments and the number of workers per spread. With construction expected to be completed over a 4 year period, approximately 4-5 construction spreads will be active in any given year.

Table 3-5 Personnel requirements

Highway Segment	Number of Spreads	Workers per Spread
Gwich'in	4	150-180
K'ahsho Got'ine	7	150-180
Tulita	4	150-180
Dehcho	2	150-180

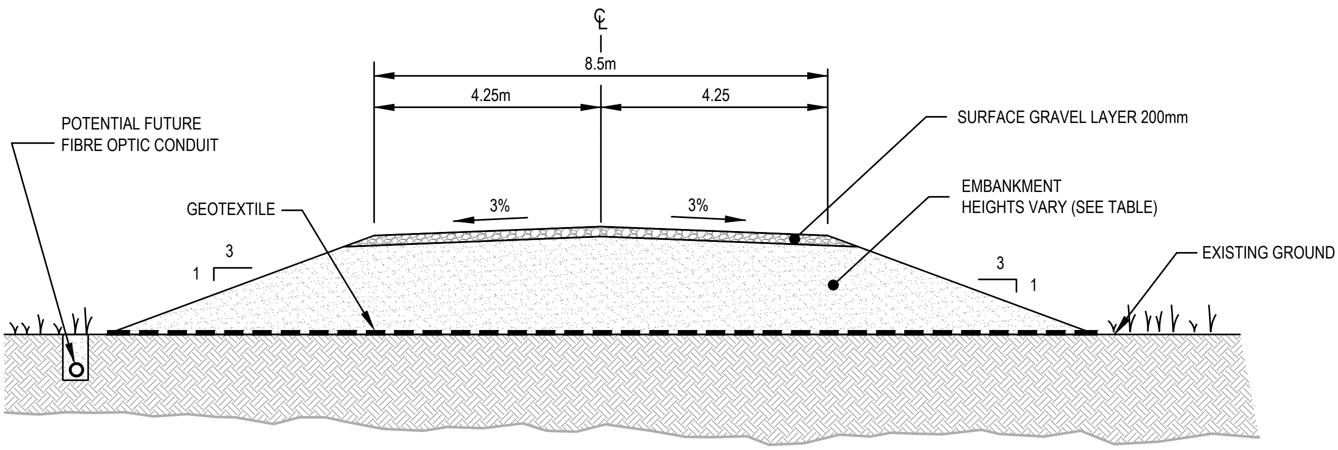
3.5.1 Embankment Construction

The highway embankment will be constructed using a fill only approach for the majority of its length. The height of the embankment will range from approximately 1.6 m to 2 m above the ground surface, and will be specific to terrain conditions. Selection of the embankment profile is based on the need to protect permafrost and ice rich soils from degradation under traffic loading and the presence of the highway infrastructure. A generalized highway cross-section is shown in Figure 3-5.

Embankment designs will be finalized during detailed design, following completion of detailed geotechnical investigations. Final embankment designs will be selected to prevent or minimize the expansion of the active layer under the embankment and will take into account predictions of ice content, as well as local terrain and permafrost characteristics.

A cut-and-fill design may be required in areas where the occurrence of near surface bedrock will impact the highway's vertical or horizontal alignment. Site-specific conditions will be evaluated to determine whether additional mitigation (such as insulation) or maintenance (such as filling areas of subsidence) may be required.

All right-of-way clearing, geotextile and fill placement, and culvert installation will occur in winter. Embankment compaction, grading, and surfacing, and base gravel placement will occur in summer. Where cut-and-fill construction is required, stripping and removal of organic material will occur in winter, and drilling and blasting of rock may occur in summer or winter. Hauling, placement, and compaction of granular base will occur in summer. Other site-specific activities, such as bedrock material stockpiling, placement of riprap, infill or low-lying areas or construction of other erosion control mitigation may occur year-round depending on site characteristics and regulatory requirements.



TYPICAL HIGHWAY CROSS 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

STATUS
ISSUED FOR USE

MACKENZIE VALLEY HIGHWAY

Typical Embankment Cross Section

PROJECTION

DATUM

Scale 1:150

1 0 1 3m

FILE NO.
Y22101294 - Typical Embankment.dwg

PROJECT NO.	DWN	CKD	REV
Y22101294	SM	RM	0

OFFICE	DATE
EBA-VANC	JULY 2012

Northwest Territories

Nehtruh - EBA

Figure 3-5

3.5.2 Watercourse Crossings

The proposed route will cross a number of watercourses requiring construction of bridges or culverts. At this time, detailed investigations of watercourse crossings have not been conducted to confirm the total number and type of watercourse crossings; however, a summary of the anticipated watercourse crossings in each of the regions is provided in Table 3-6. Major crossings are considered to be those requiring bridges or large culverts; typically those watercourses have year round flow. Minor crossings include both perennial and ephemeral watercourses requiring small culverts or, in some cases, small bridges.

Several bridges have been previously installed along the existing winter road between Wrigley and Fort Good Hope and will be utilized for the development as much as possible. Table 3-7 summarizes the existing or required major crossing structures.

Detailed geotechnical and hydrotechnical information will be collected during detailed design stages of the Project to support designs for all crossings.

Table 3-6 Estimate of Watercourse Crossings Along the MVH

Highway Segment	Major Crossings			Minor Crossings
	Existing Bridge	New Structure (bridge or large culvert)	Total	
Gwich'in	0	7	7	155
K'ahsho Got'ine	9	11	20	92
Tulita	14	12	26	262
Dehcho	6	2	8	undetermined
All	**29**	**32**	**59**	**510**

Table 3-7 Major Watercourse Crossing Structure Summary

Crossing Name	KM	Notes
Gwich'in		
Crossing #1480F	1489	New bridge, 65 m
Crossing #1470F	1479	New bridge, 70 m
Crossing #1490A	1476	New bridge, 65 m
Travaillant River	1441	New bridge, 120 m (3 spans)
Crossing #1430B	1435	New bridge, 70 m (2 spans)
Crossing #1410D	1414	New bridge, 40 m
Thunder River	1362	New bridge, 65 m
K'ahsho Got'ine		
unnamed watercourse	1313	Large Diameter Culvert or Arch Structure
unnamed watercourse	1311	Large Diameter Culvert or Arch Structure
unnamed watercourse	1281	Single-span Bridge
unnamed watercourse	1267	Single-span Bridge
unnamed / Payne Creek	1259	Large Diameter Culvert or Single-span Bridge
Tieda River	1228	Multi-span Major Bridge

Table 3-7 Major Water Crossing Structure Summary (cont'd)

Crossing Name	KM	Notes
K'ahsho Got'ine (cont'd)		
Loon River	1196	Multi-span Major Bridge
unnamed watercourse	1185	Large Diameter Culvert or Arch Structure
Hare Indian (Rabbitskin) River	1172	Multi-span Major Bridge
Jackfish Creek	1166	Large Diameter Culvert or Single-span Bridge
Lynn Creek	1154	Existing Bridge – 18 m
Tsintu Creek	1151	Existing Bridge – 30 m
Rachelle Creek	1133	Existing Bridge – 24 m
Denise (Snafu) Creek	1130	Existing Bridge – 24 m
Donnelly River	1116	Existing Bridge – 42 m
unnamed / Chick Creek	1112	Single-span Bridge or Large Diameter Culvert
Overflow Creek	1107	Existing Bridge – 18 m
Gibsons Creek North	1091	Existing Bridge – 18 m
Gibsons Creek South	1090	Existing Bridge – 24 m
Hanna Creek	1083	Existing Bridge – 30 m
Tulita		
Elliot Creek	1072.4	Remain in use in present location, 25.6 m
Oscar Creek	1050.8	Existing bridge not currently in service on the winter road, 67.6 m
"New Bridge"	1031.6	New bridge in new location along preferred alignment, 60 m
Billy Creek	1030.8	Existing Bridge, 25.6 m
Bosworth Creek	1019.8	New bridge in new location along preferred alignment, 60 m
Canyon Creek	997.5	Existing Bridge, 42 m
Francis Creek	993.5	Existing Bridge, 25.6 m
Hellava Creek	991.3	Existing Bridge, 19.6 m
Christina Creek	990.3	Existing Bridge, 19.6 m
Prohibition Creek	983.0	New longer bridge structure in new location, 100 m
Vermillion Creek North	973.4	Existing Bridge, 42.3 m
Notta Creek	971.4	Existing Bridge, 25.6 m
Jungle Ridge Creek	967.7	Existing Bridge,19.6 m
Great Bear River Bridge	937.0	New bridge along preferred alignment, 460 m (2 lanes, 5 spans)
No Name Creek	n/a	Not in use in preferred alignment.
Four Mile Creek	931.0	New longer bridge in new location, 100 m + 40 m (2 spans)
Twelve Mile Creek	922.0	New bridge in new location along preferred alignment, 20 m
Gotcha Creek	912.0	New longer bridge structure in current location (raise 3 m), 40 m
"New Bridge"	890.0	New bridge in new location along preferred alignment, 70 m + 40 m
"New Bridge"	881.0	New bridge in new location along preferred alignment, 35 m

Table 3-7 Major Water Crossing Structure Summary (cont'd)

Crossing Name	KM	Notes
Tulita (cont'd)		
Big Smith Creek	872.0	Existing Bridge, 67 m
Little Smith Creek	852.4	Existing Bridge, 78 m
Seagrams Creek	844.0	New longer bridge structure in new location, 25 m
Saline River	831.8	Existing Bridge, 128 m (2 spans)
Devil's Canyon	828.0	New longer bridge structure in current location (raise 3.5 m), 40 m
Steep Creek	816.5	Existing Bridge, 64 m
Dehcho		
Blackwater River	784.1	Existing bridge, 297 m
Dam Creek	764.4	Existing bridge, 18 m - pile foundation suitable for winter use only
Bob's Canyon Creek	753.5	New arch culvert, 50 m
Vermillion Creek South	750.1	Rehabilitation of existing bridge, 116 m
Strawberry Creek	746.5	2 New arch culverts, 23 m and 44 m,
Whitesand	731.0	Existing bridge, 89 m
Ochre River	722.4	Existing bridge, 102 m
Hodgson Creek	691.4	Replacement by new bridge (24 m) on optimized alignment recommended

3.5.3 Borrow Sources

Granular materials will be required for embankment construction, construction of temporary support facilities and permanent maintenance areas required during the operations phase. Estimated granular quantities for the construction phase are provided in Table 3-8. Material estimates will be defined to a greater level of accuracy during detailed design.

Table 3-8 Estimated Granular Requirements for Construction of the MVH Preliminary Design

Item	Quantity				
	Gwich'in	K'ahsho Got'ine	Tulita	Dehcho	Total
Embankment	6,740,000 m^3	7,470,000 m^3	8,850,000 m^3	3,780,000 m^3	26,840,000 m^3
Surfacing Gravel	331,000 m^3	473,000 m^3	522,000 m^3	220,000 m^3	1,546,000 m^3
Gravel sub base	not specified	not specified	not specified	600,000 m^3	not specified

Potential granular material sources have been identified from preliminary studies and existing information. The selection of the borrow sources to be used for development will be refined through more detailed investigation and design in the pre-development phase. Borrow source investigations will include geotechnical investigations to confirm quantity and quality of materials, access planning, evaluation of environmental constraints, consultation with landowners and preparation of management plans for those sources proposed for development. A summary of sources identified during the preliminary design stage in each region is presented below.

3.5.3.1 Gwich'in Segment

Thirteen preferred borrow sources and 33 additional potential sources have been identified along the route within the GSA (Table 3-9). Throughout the consultations, Travaillant Lake has been identified as an important source area. Borrow Source 4-060 is within the Conservation Zone around Travaillant Lake. Use of this borrow source will be considered only if necessary and critical to the overall development of the Highway.

Table 3-9 Potential Borrow Sources within the GSA

Source No.	Ownership	Distance from Alignment (km)	Station	Anticipated Source Type	Estimated Volume of Source (m^3)
Preferred Sources					
2.60		0.3 N	1508.2	sand and gravel	250,000
4.08		0.4 NE	1484.6	shale	unlimited
June 2010-1		1.5 NE	1460.3	boulders, cobble, gravel in silty matrix	NA
4-024		2.4 N	1441.0	silt and some sand	NA
4.038APA		1.5 NE	1434.6	sand and gravel	25,000,000
4.039P		2.7 N	1426.0	sand and gravel	1,000,000
4-060		1.8 SW	1405.8	sand and gravel	1,000,000
4.059AP	Gwich'in	0.0	1399.8	sandy gravel	20,000,000
June 2010-3		0.8 S	1387.4	NA	NA
4.100P		2.5 NE	1374.2	shale	unlimited
4-103		3.7 SW	1361.2	sand	5,500,000
5-014		1.8 SW	1353.4	sand	2,000,000
5.17		3.2 NE	1336.3	sand and gravel	6,000,000
Potential Sources					
2.57		6.1 NE	1504.4	sand, some gravel	3,500,000
2.59		3.5 NE	1504.3	sand and silt	15,000,000
2.64B		2.8 NE	1481.8	shale and sandstone	50,000
2.64		2 NE	1481.3	sand and gravel	NA
2.064BP		2.4 NE	1481.5	sand and gravel	NA
4.04		8.5 NE	1480.5	clay	NA
4.05		10.8 NE	1477	gravel	450,000
4.32B		10.4 SW	1457.9	silt	NA
4.26		5.8 NE	1453.3	sand and gravel	20,000,000
4.026P		5.6 NE	1452.3	sand and gravel	20,000,000
4.28		4.1 SW	1449.4	sand and gravel	100,000

Table 3-9 Potential Borrow Sources within the GSA (cont'd)

Source No.	Ownership	Distance from Alignment (km)	Station	Anticipated Source Type	Estimated Volume of Source (m^3)
Potential Sources (cont'd)					
June 2010-2		3.5 to 7.5 S	1441.9	NA	NA
4.023P		1.7 NE	1437.5	sand and gravel	4,000,000
4.23		2.5 NE	1437.1	sand and gravel	4,000,000
4.038 APB		2.7 NW	1435.5	sand and gravel	25,000,000
4.35		4.5 SW	1434.2	sand and gravel	12,000,000
4.36		3.3 NE	1432.9	shale	unlimited
4.020P		4.2 NNE	1427.9	sand and gravel	4,000,000
4.4		4.5 NW	1419.1	sand and gravel	7,500,000
4.59A		0.7 NE	1400.7	sandy gravel	20,000,000
June 2010-4		3.0 N	1382.8	sand and gravel	NA
4.54		4.4 NE	1374.2	shale	unlimited
4.102		2.0 NE	1366.8	shale	NA
4.101		6.1 NE	1364.7	sand and gravel	6,000,000
4.104		4.8 SW	1358.4	sand and gravel	10,000,000
5.12		4.7 SW	1358.4	sand and gravel	20,000,000
5.013P		5.1 SW	1358.4	sand	2,000,000
5.11		9.7 NE	1354.5	sand and gravel	5,500,000
5.15		7.0 NE	1341.5	sand and gravel	70,000
5.20		13.4 SW	1335.1	gravel, some sand	3,000,000
5.020P		11.1 SW	1334.6	gravel, some sand	3,000,000
5.25		3.4 NE	1328.3	sand and gravel	5,500,000
5.23		NE	1328	sand and gravel	40,000,000

3.5.3.2 K'ahsho Got'ine Segment

Table 3-10 lists the potential borrow sources identified within the K'ahsho Got'ine District. As depletion of borrow sources is an important consideration, the table also indicates volumes that have been estimated to be required to support the MGP (IOL et al. 2004). The estimated volumes available suggest that sufficient material exists to support both the Project and the MGP.

Table 3-10 Potential Borrow Sources within the K'ahsho Got'ine District

Name	Owner	Type	Estimated Volume of Source (m³)	Estimated Requirements (m³)	
				MGP	Highway
5.036P	Sahtu	glaciofluvial	200,000	19,000	200,000
5.041/KG-20	Sahtu	glaciofluvial	25,000,000	608,000	448,000
5.043AP	Crown	glaciofluvial	5,500,000	302,000	
6.034	Sahtu	glaciofluvial	2,000,000	94,000	485,600
6.036 AP	Sahtu	glaciofluvial	1,200,000	93,000	
6.042CP	Sahtu	glaciofluvial	4,000,000	80,000	
6.042P	Sahtu	glaciofluvial	4,000,000	20,000	237,000
6.053P	Sahtu	glaciofluvial	1,000,000	54,000	280,000
6.077P	Sahtu	glaciofluvial	2,000,000	185,600	363,400
6.080P	Sahtu	glaciofluvial	2,500,000	33,400	
6.089P	Crown	glaciofluvial	500,000	26,000	
7.003AP	Crown	bedrock	unlimited	49,000	
7.005P	Sahtu	bedrock	unlimited	15,000	100,000
7.006P	Crown	colluvial cone	550,000	15,000	
7.015P	Crown	glaciofluvial	2,500,000	73,000	350,000
20.114P	Crown	glaciofluvial	3,000,000	49,000	180,880
20.112P	Crown	glaciofluvial	unknown	186,00	286,000
20.200P	Sahtu	bedrock	unlimited	300,000	600,000
KG-1	Crown	talus slope	unlimited		
KG-1A	Crown	bedrock	unlimited		
KG-2	Sahtu	bedrock	unlimited		300,000
KG-3	Sahtu	bedrock	unlimited		
KG-3a	Crown	bedrock	unlimited		516,100
KG-4	Crown	glaciofluvial	100,0000		
KG-4a	Crown	glaciofluvial	20,000		
KG-4b	Crown	glaciofluvial	5,000		
KG-4c	Crown	glaciofluvial	5,000		
KG-5	Crown	bedrock	100,0000		
KG-5a	Crown	bedrock	unlimited		
KG-6	Crown	bedrock	unlimited		199,200
KG-7	Crown	glaciofluvial	200,000		188,500
KG-7a	Crown	glaciofluvial	50,000		
KG-7b	Crown	glaciofluvial	100,000		
KG-8	Crown	bedrock	100,0000		
KG-9	Crown	bedrock	500,000		92,200
KG-10	Crown	glaciofluvial	5,000		
KG-10a	Crown	glaciofluvial	5,000		

Table 3-10 Potential Borrow Sources within the K'ahsho Got'ine District (cont'd)

Name	Owner	Type	Estimated Volume of Source (m^3)	Estimated Requirements (m^3)	
				MGP	Highway
KG-10b	Sahtu	glaciofluvial	small		
KG-11	Sahtu	bedrock	unlimited		
KG-12	Sahtu	bedrock	unlimited		408,000
KG-12a	Sahtu	glaciofluvial	20,000		
KG-12b	Sahtu	glaciofluvial	20,000		
KG-13	Sahtu	glaciofluvial	20,000		
KG-14	Sahtu	bedrock	1,500,000		
KG-15	Sahtu	bedrock	unlimited		633,000
KG-15a	Sahtu	bedrock	unlimited		
KG-16	Crown	glaciofluvial	50,000		
KG-16a	Crown	glaciofluvial	120,000		
KG-17	Crown	glaciofluvial	20,000		
KG-18	Crown	bedrock	unlimited		512,600
KG-18a	Crown	bedrock	unlimited		
KG-21	Sahtu	glaciofluvial	25,000		
KG-21a	Sahtu	glaciofluvial	15,000		
KG-22	Sahtu	glaciofluvial	15,000		100,000
KG-23	Crown	bedrock	unlimited		1,085,000

3.5.3.3 Tulita Segment

Table 3-11 lists the potential borrow sources identified within the Tulita District.

Table 3-11 Potential Borrow Sources within the Tulita District

Source No.	Offset and Direction from Alignment (km)	Station	Estimated Requirements (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

Table 3-11 Potential Borrow Sources within the Tulita District (cont'd)

Source No.	Offset and Direction from Alignment (km)	Station	Estimated Requirements (m^3)	Estimated Volume of Source (m^3)
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

3.5.3.4 Dehcho Segment

Table 3-12 lists the borrow sources identified within the Dehcho Segment of the Project.

Table 3-12 Potential Borrow Sources within the Dehcho Region

Name	Ownership	Location	Type	Estimated Volume (1000 m^3)	Existing?	Construction
Primary Sources						
10.043P	Crown	9 km S of Wrigley	Granular	19,700	Yes	Built before MGP
10.030P	Crown	17 km N of Wrigley	Granular	684	Yes	Built before MGP
10.020P	Crown	31 km N of Wrigley	Granular	1,600	Yes	Built before MGP
10.007P	Crown	56 km N of Wrigley	Granular	1,200	Yes	Built for the MGP
9.044PB	Crown	13 km S of boundary	Granular	15,000	Yes	Built for the MGP
9.044PA						
9.037PB	Crown	2 km S of boundary	Granular	4,600	Yes	Built for the MGP

Table 3-12 Identified Borrow Sources, Dehcho Region (cont'd)

Name	Ownership	Location	Type	Estimated Volume (1000 m^3)	Existing?	Construction
Primary Sources (cont'd)						
9.037PA						
9.034PB	Crown	5 km N of boundary	Granular	3,800	Yes	Built for the MGP
9.034PB						
9.024AP	Private	18 km N of boundary	Granular	1,000	Yes	Built before MGP
Secondary Sources						
10.044BP	Crown	12 km S of Wrigley	Granular	N/A	Yes	Built before MGP
10.038PA	Crown	1 km N of Wrigley	Granular	N/A	No	Alternative source for MGP
10.0120P	Crown	9 km N of Wrigley	Granular	N/A	No	Alternative source for MGP
10.037P	Crown	3 km N of Wrigley	Granular	N/A	No	Alternative source for MGP
10.033P	Crown	12 km N of Wrigley	Granular	N/A	No	Alternative source for MGP
10.022P	Crown	29 km N of Wrigley	Granular	N/A	Yes	Built before MGP
10.014AP	Crown	38 km N of Wrigley	Granular	N/A	No	Alternative source for MGP
10.013P	Crown	43 km N of Wrigley	Quarry	N/A	No	Alternative source for MGP
10.004P	Crown	27 km S of boundary	Granular	N/A	No	Alternative source for MGP
10.003P	Crown	23 km S of boundary	Granular	N/A	No	Alternative source for MGP
10.001P	Crown	17 km S of boundary	Granular	N/A	No	Alternative source for MGP
9.091P	Crown	12 km S of boundary	Granular	N/A	No	Alternative source for MGP
9.038PB	Private	6 km S of boundary	Granular	N/A	No	Alternative source for MGP
9.038PA	Private	3 km S of boundary	Granular	N/A	No	Alternative source for MGP

3.5.4 Support Infrastructure and Activities

Construction of the Project will require a variety of temporary support infrastructure including camps, staging and stockpile areas, airstrips, barge landings, access roads, fuel storage and waste disposal sites.

3.5.4.1 Camps and Maintenance Areas

Temporary construction camps will be required to house workers, and provide project management and maintenance infrastructure. Camps are expected to be located no more than 50 km apart and will be combined with other infrastructure (e.g., borrow sources) to minimize project footprint. Primary camps will accommodate 150 -180 workers that are likely to be required on a specific construction spread. Pioneer camps accommodating up to 20 workers may be required at specific facilities such as borrow sources and staging areas.

Primary camps are expected to include the following infrastructure and activities: accommodation, offices, maintenance shops, equipment and material storage, fuel storage, helipads, water use, solid waste and wastewater disposal sites.

3.5.4.2 Staging Areas

In addition to storage areas at camps, stockpile sites and staging areas will be required to store equipment and supplies and provide workspaces during construction. Staging areas will be required at strategic locations to provide for efficient mobilization and construction. Staging areas will be accessed by existing all-weather roads, winter roads and by barge on the Mackenzie River. Potential locations include:

- Intersection of the MVH with the existing all-weather highways to the north and south;
- Within the GSA, a staging area is proposed to be located at Little Chicago;
- Adjacent to existing resupply infrastructure (e.g. communities);
- At borrow sources; and
- At other strategic locations along the proposed route.

The specific location of staging areas will be determined during the detailed design stage.

Staging areas may include:

- Laydown areas for storage of equipment and supplies (culverts, bridge components, geotextiles, etc.);
- Granular material stockpiles;
- Pioneer camps and maintenance facilities;
- Fuel storage areas;

- Waste storage areas; and
- Helicopter pad and access road

3.5.4.3 Access/Haul Roads

Access along and ahead of the construction spread, including haul roads for material sources will be in winter along the embankment and within the right-of-way. These winter roads will be constructed during the initial clearing operations in each construction year.

In some locations all-weather access roads may be required to support year round construction. All-weather access roads will be located along the proposed highway footprint as much as possible but may need to be constructed off the right of way to access borrow sites selected for permanent or long-term use.

The driving surface width of any access or haul road will likely be 10 to 11 m. The cleared width required would be approximately 50 m. The specific alignment and type of all access roads will be confirmed in the early stages of detailed design in the development of the Project.

3.5.4.4 Airstrips and Helipads

Temporary airstrips and helipads will be required during construction to support resupply (e.g., food, small parts, etc.), emergency evacuation, and rotation of personnel to the more isolated sections of the Project (i.e., borrow sources during summer and late fall). Airstrips will be designed for light fixed wing aircraft (e.g., 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 may provide greater reliability.

Temporary airstrips during construction could consist of:

- winter strips constructed on frozen lakes and/or cleared sections of the right-of-way
- summer strips 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.

3.5.4.5 Barge Landings

Equipment and supplies will be mobilized to some construction spreads by barge on the Mackenzie River. Laydown areas will be required at barge landing sites to store materials until they can be mobilized to the highway ROW by winter road.

The following existing community barge landing sites may be used:

- Inuvik
- Fort Good Hope

- Norman Wells
- Tulita
- Wrigley

The Little Chicago barge landing site is also proposed to be used to support activities in the GSA and SSA. This site will require some development to support loading and offloading, construction staging, fuel storage and a primary camp.

3.5.4.6 Explosives

Drilling and blasting operations will be required in:

- borrow pits where the granular material is frozen
- bedrock cuts and rock quarries.

Explosives used will be primarily ammonium nitrate and diesel fuel (ANFO) with commercial products used for “wet” holes. Storage of ammonium nitrate prills will be on site in a secured location and in accordance with the appropriate legislation and permits.

Drilling and blasting operations will be timed and controlled taking local fisheries, wildlife, and other relevant environmental factors into account.

3.5.4.7 Fuel and Fuel Storage

The estimated fuel requirements for construction of the Highway are summarized in Table 3-13.

Table 3-13 Estimated MVH Project Fuel Requirements

Highway Segment	**Estimated Fuel Requirements** (L)
Gwich’in	25,000,000 - 30,000,000
K’ahsho Got’ine	35,000.000 - 40,000,000
Tulita	40,000,000 - 45,000,000
Dehcho	15,000.000 - 20,000,000
Total	**115,000,000 – 135,000,000**

As construction is proposed over four years, it is likely that a maximum of 25% of the total fuel required will be on site and/or being transported at any one time. Bulk fuel storage requirements at individual camp and staging facilities will be determined during design. Fuel will be delivered by winter road and barge from suppliers to fuel storage facilities situated in the camps, staging areas, and borrow sources. Fuel will be moved from the barge landings to the highway during winter.

All fuel will be stored in accordance with the Environmental Code of Practice for Aboveground Storage Tank Systems containing Petroleum Products (CCME 2003) and conditions specified in permits and licences. Fuel management plans and emergency spill response plans will be developed prior to project commencement.

3.5.4.8 Water Use

Water used for temporary winter road construction is expected to range from 500 m^3/day to more than 1,000 m^3/day. Water will also be required during the later summer and fall months for compaction of the base course and surfacing material. The volume is estimated at 500 m^3/day.

Camp operations are estimated to require approximately 200 L/person/day. A 150 person camp would, therefore, require approximately 30,000 L or 30 m^3/day.

It is proposed that water for these purposes will be taken from lakes in proximity to the highway. Potential water source lakes will be identified during further field studies. Water extraction will follow water licence requirements and the Protocol for Winter Water Withdrawal in the Northwest Territories (DFO 2010), which sets restrictions on water withdrawal as a percentage of the available water under ice. In order to meet the conditions set out in the DFO protocol, bathymetric surveys will be necessary on some of the lakes proposed for water extraction.

3.5.4.9 Waste Management

Table 3-14 lists the wastes that will be produced during the construction of the Project. Most of the wastes will be those resulting from camps, which are expected to be similar to those of municipal solid waste (MSW) streams. To minimize risks of animal attraction to camps, all food and food contaminated waste will be stored separate from all other wastes in airtight sealed container(s), and enclosed in animal proof containers while in bulk storage prior to final transport, treatment, or disposal. Industrial waste will encompass all other wastes not defined as camp sourced MSW.

Table 3-14 Classification of Wastes

Type of Waste	Description
Camp Wastes	
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, black water
Grey water	Kitchen and washing related liquid waste
Industrial Waste	
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, container rinsings, empty drums

A Waste Management Plan will be developed to 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 Waste Management Plan will address 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
- describe food and food contaminated waste management methods to mitigate animal attraction from source to transport, treatment, or disposal.

NON- HAZARDOUS WASTES

Non-hazardous wastes will be recycled or disposed of in landfills constructed within the development footprint. Wastes will be incinerated prior to disposal in landfills designed and constructed to meet regulatory requirements. Design and operational procedures will limit the total number of landfills established during construction.

HAZARDOUS WASTE

Hazardous waste generated during construction will be stockpiled at staging areas and transported to approved disposal facilities.

Consistent with Environment and Natural Resources' requirements to track the movement of hazardous waste from registered generators, to carriers, to receivers according to the Guideline for the General Management of Hazardous Waste in the NWT, a Hazardous Waste Management Plan (HWMP) will be developed for the Project. The HWMP will encompass all phases of the development and will apply to transporting, storing, handling and disposal of hazardous wastes. 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
- description of all hazardous wastes that will be transported to approved receiving facilities.

WASTEWATER

Camps will generate wastewater in volumes similar to water use (e.g., 30 m^3/day per camp). Wastewater treatment plants will be installed at each camp to provide treatment prior to discharge or reuse in accordance with applicable legislation and licence requirements. Wastewater treatment will be addressed in the Waste Management Plan.

3.6 Operations and Maintenance

Upon completion of construction and opening of the Project, regular highway operational and maintenance activities will commence. Activities will include snow clearing, grading, production and application of gravel, dust control, inspection and repairs. At least one permanent highway maintenance camp will be established in the northern section of the Project. Over time, sections of the Project will be subject to reconstruction and structures will require repair or replacement.

3.7 Progressive Closure and Reclamation

Progressive reclamation of borrow sites and support infrastructure will occur during the construction and operational phases when facilities are no longer required. Closure will be in accordance with permit requirements.

4 EXISTING ENVIRONMENT

The following summary of the biophysical and human environment in the Project area has been summarized from more detailed information provided in each of the PDRs. This summary provides a high level overview of existing conditions to assist with scoping of the environmental assessment. More detailed information is available in the PDRs. Additional characterization of the existing environment in certain locations may be undertaken during further studies.

4.1 Biophysical Environment

4.1.1 Climate and Climate Change

The general climate of the study area is sub-arctic, characterized by long, cold winters, short, cool 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 0°C with a very short frost-free season. 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.

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. 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.

Meteorological data is available from several sites within the project area, including: the Inuvik Airport, Little Chicago, Fort Good Hope, Norman Wells, Tulita and Wrigley.

General circulation models in combination with various population and economic growth scenarios provide simulations of climate change over the period of 2010 to 2039 for the Mackenzie Valley referenced to 1961 to 1990 climate normals (Burn 2003). Projections for the Lower Mackenzie Valley are distinct from those for the Upper and Middle Valley (Burn 2003). Climate projections of future temperatures indicate greater change for northern (Lower Mackenzie) portions of the valley compared to the south (Middle and Upper Mackenzie). The mean annual temperature over the period of 2010 to 2039 in the Lower Mackenzie Valley is projected to increase by between 1.3°C and 2.5°C over the 1961 to 1990 baseline mean temperature for the region (-9.5°C at Inuvik). The rate of increase is similar to what has been observed over the past 50 years at Inuvik. Mean winter temperatures are projected to increase at a slightly faster rate in the region, with an upper estimate of 3.1°C

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 Lower Mackenzie Valley, the general circulation model projected increase in precipitation over the next 30 years is between 2.1% and 11.8% over the 1961 to 1990 baseline (257 mm for Inuvik). The 50-year plot of annual precipitation at Inuvik, however, shows a trend towards decreasing precipitation at an average rate of 1 mm/year. 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).

4.1.2 Air Quality

Air quality data is limited for the project area. The GNWT measures several air quality parameters in Inuvik and Norman Wells. SO_2 concentrations are very low at Inuvik and Norman Wells. Since industrial, commercial, and residential processes are a major contributor to SO_2, baseline levels throughout the project area are expected to be highest near Inuvik and Norman Wells, decreasing in the smaller communities and undeveloped areas.

Ambient concentrations of NO_2 measured in Inuvik and Norman Wells are well below applicable air quality objectives. Fine particulate matter ($PM_{2.5}$) is typically higher on average during winter months due to inversion conditions. Short-period peaks that exceeded air quality standards occurred during summer months due to forest fire smoke. Throughout the project area, $PM_{2.5}$ 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.

Coarse particulate matter (PM_{10}) concentrations are higher in snow-free months due to road dust and are particularly elevated in April and May due to ‘spring-time dust events’ from residual winter gravel (ENR 2010). Monthly average concentrations in Inuvik are typically in the range of 5 $\mu g/m^3$ during the winter to 25 $\mu g/m^3$ during the spring.

Ground level ozone (O_3) exhibits a springtime maximum, typical for remote locations in the Northern Hemisphere. H_2S is monitored in both Inuvik and Norman Wells due to oil and gas activity in the region. Hourly concentrations in both locations indicate essentially non-detectable levels (less than 1 $\mu g/m^3$). H_2S concentrations are expected to be zero in less disturbed areas.

4.1.3 Terrain

The proposed Project is located within the Interior Plains and Cordillera Physiographic Regions. The northern portion of the Project is predominantly an upland area with elevations generally 300 masl. Relief along the proposed alignment in the area varies from flat to gently undulating glaciolacustrine plain in the south to undulating and rolling moraine plain further north.

Within the K'ahsho Got'ine District, the Project area is underlain by Phanerozoic sedimentary rocks that are deposited in the northward extension of the Western Canada Sedimentary Basin. To the east on the Interior Plains, sedimentary rocks are commonly flat lying and relatively undeformed. To the west, sedimentary rocks are progressively more deformed in the fold and thrust belt of the Cordillera. Surficial materials in the study area are primarily the result of deposition during Quaternary glaciation. Minor reworking of glacial deposits has locally taken place in the Holocene from fluvial processes, slope processes and the development of organic layers. Till is the most common surficial material in the project area, followed glaciolacustrine and glaciofluvial deposits.

In the Tulita District, the Project is predominantly within the Mackenzie Plain geological region and crosses the Franklin Mountains geological region. The prevailing cover of the Mackenzie Plain consists of glaciolacustrine deposits and till. The bedrock in the area generally consists of weakly cemented sandstone, incompetent siltstone and shale. Terrain types common along the proposed alignment vary from relatively dry glacial till to wet, ice-rich glaciolacustrine and thick organic deposits.

4.1.4 Permafrost and Ground Ice

According to the Permafrost Map of Canada (NRC 1995), the northern part of the Project is located within the continuous permafrost zone while the southern part is located in the zone of extensive discontinuous permafrost. Project designs will focus on protection of existing permafrost and accommodating permafrost change resulting from climate change.

Permafrost-related features 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 (muskeg) terrain.

Some features indicating massive ground ice deposits are readily identifiable on air photos and from the air, such as ice wedges. Other types of the 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.

4.1.5 Vegetation

The Project is located within the Taiga Plains and Taiga Cordillera Ecozones. Both Ecozones are dominated by the influence of the Mackenzie River. Each of the Ecozones are further subdivided into ecoregions as summarized below.

4.1.5.1 Taiga Plains Ecozone

TRAVAILLANT UPLAND HIGH SUBARCTIC ECOREGION

Vegetation in this ecoregion is relatively diverse with white spruce dominated stands in the south grading to sparsely treed low-canopied woodlands in the north. Uplands are composed of rolling and eroded till veneers and blankets over bedrock in the south and hummocky till in the north. Recent fires across the ecoregion have replaced much of the forest with regenerating dwarf birch stands. Thousands of small lakes occupy pothole depressions and generally have dry shorelines without much wetland development. Ribbed fens and well-treed runnel patterns are common in the south.

ARCTIC RED PLAIN HIGH SUBARCTIC ECOREGION

This ecoregion is characterized by level to gently undulating till, mantled by peat layers. Frequent fires have produced large areas of regenerating dwarf birch and Alaska paper birch with an understorey of black spruce seedlings. Black spruce – low shrub forests, nearly treeless peat plateaus, shrubby fens, as well as regenerating burns are the dominant communities. Numerous shallow ponds and thermokarst lakes occur throughout the area, sometimes connected by small, slow-flowing creeks. Peat plateaus and shrubby horizontal fens are the most common wetland types.

NORMAN RANGE LOW SUBARCTIC ECOREGION

This ecoregion is unique because of the varied physiography, high-elevation terrain, and vegetation. Rock glaciers are a characteristic geologic feature, occurring mainly below cliffs along westerly and northerly ridges. The major landforms are bedrock ridges, eroded interior plateau, till deposits, and a large melt water channel. Vegetation and permafrost patterns indicate west to east climatic variations. Vegetation is a complex of mixed-wood forests on westerly slopes and lacustrine deposits, mixed spruce stands on the interior plateau and slopes, and extensively burned areas throughout. Runnel patterns and peat plateaus are localized in western parts, but become more common towards the east especially on easterly and northerly slopes. Sedge and shrub communities are the dominant vegetation of horizontal and channel fens and marshes along melt water and stream channels. Tundra communities occur on ridge tops above about 500 m.

NORTH MACKENZIE PLAIN LOW SUBARCTIC ECOREGION

Till deposits are dominant in the ecoregion, however, large areas of lacustrine, fluvial and glaciofluvial materials are also present. Extensive fires have had a major influence on vegetation development in the ecoregion. Most of the till uplands have burned in the recent past. Mixed spruce-shrub-moss-lichen stands are common on unburned sites, with dwarf birch and Alaska paper birch regeneration on extensive burned areas. Runnel permafrost forms are locally common in the north and south parts of the ecoregion. Peat plateaus are scattered throughout, though mainly to the north.

4.1.5.2 Taiga Cordillera Ecozone

Central Mackenzie Plain Low Subarctic Boreal 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. The 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).

4.1.5.3 Rare Plants

Rare plant surveys were conducted for the MGP in 2002 and 2003. Within the GSA, a total of two rare plants were documented near Caribou Lake (IOL et al. 2004). These are the weak sedge (*Carex laxa*) and circumpolar sedge (*Carex adelostoma*). Both species, ranked as “Critically Imperiled” in the Northwest Territories, were found in a patterned fen(s) (IOL et al. 2004).

IORVL (2004) listed six rare plant species found during field surveys in the Northern Taiga Plains. Three of these species are currently considered Sensitive and one species is Undetermined (GWNT 2011). Two species: Rolland’s bulrush (*Trichophorum pumillum*) and red pigweed (*Chenopodium rubrum*) are considered May Be At Risk (GWNT 2011). Rolland’s bulrush was associated with springs and red pigweed was associated with lakeshores (IORVL 2004).

The draft Sahtu Land Use Plan (SLUPB 2010b) identifies 70 May Be At Risk plants within the ecoregions that occur wholly or partially in the Sahtu Settlement Area (SSA). In addition, SLUPB (2010b) identifies two rare plants in the SSA. SLUPB (2010b) defines a rare plant as one that is endemic to the NWT and thus globally rare. These species are: Drummond’s bluebell (*Mertensia drummondii*) and Nahanni Aster (*Symphyotrichum naanniense*). GWNT (2011) does not document these species as occurring in the Taiga Plains.

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.

4.1.6 Wildlife

The distribution and abundance of wildlife tends to vary with season, life history stage, habitat availability, prey abundance, and hunting and trapping pressures.

Table 4-1 lists the species occurring or having the potential to occur in the project area that have been designated with special conservation status by the Canada Species at Risk Act (SARA), Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and or the Territorial general status program (COSEWIC 2010; ENR 2010a; Government of Canada 2010). For purposes of this report, a species with special conservation status is one that is listed by SARA and/or assessed by COSEWIC as Endangered, Threatened, and Special Concern or ranked by ENR as At Risk and May Be At Risk.

Species considered important to area residents, those with special conservation status, or those that commonly use habitats associated with the study area are described in further detail.

Table 4-1 Wildlife Species with Special Conservation Status[1]

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	Threatened	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
Harlequin duck (western population)	*Histrionicus histrionicus*	May Be At Risk	–	–
Common nighthawk	*Chordeiles minor*	At Risk	Schedule 1	Threatened
Olive-sided flycatcher	*Contopus cooperi*	At Risk	Schedule 1	Threatened
Grizzly Bear	*Ursus arctos*	Sensitive	Not Assessed	Special Concern
Wolverine	*Gulo gulo*	Sensitive	No Status	Special Concern
Woodland caribou (boreal population)	*Rangifer tarandus caribou*	Sensitive	Schedule 1	Threatened
woodland caribou (northern mountain population)	*Rangifer tarandus caribou*	Secure	Schedule 1	Special Concern
Barren-ground Caribou	*Rangifer tarandus groenlandicus*	Sensitive	No Status	Special Concern

NOTE:
[1] Species ranked as Sensitive in the NWT are not listed

4.1.6.1 Barren- Ground Caribou

Barren-ground caribou (*Rangifer tarandus groenlandicus)* are ranked by ENR as "Sensitive" under the general status program, Special Concern under COSEWIC but are not listed under SARA.

The Project lies within the range of three barren-ground caribou herds: Cape Bathurst, 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). In 2006 ENR estimated the non- calf caribou population of the Cape Bathurst herd at 1,821 (±149) (Nagy and Johnson 2006)

The herds may occupy the areas in the project area during winter months (November to May). Based on satellite collared caribou data, the northern portion of the route is infrequently used by the Cape Bathurst herd in the winter (Nagy et al. 2005); whereas Nagy et al. (2005) reported low to moderate frequency of winter use by the Bluenose-West herd. The southern portion of the project area is used by the Bluenose

East Herd, Nagy et al. (2005). Occupied winter ranges are known to vary annually in response to food availability, snow depth, and predator abundance.

4.1.6.2 Woodland Caribou, Boreal Population

Woodland caribou (*Rangifer tarandus caribou)* boreal population (herein referred to as boreal caribou) are listed by SARA as “Threatened”. By definition, this is a species likely to 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 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).

Boreal caribou may occur in all forested habitats in the project area; 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).

4.1.6.3 Moose

Moose (*Alces alces)* do not have any special conservation status. They are generally non-migratory and may occupy all habitats in the project area 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 to 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 suboptimal 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).

4.1.6.4 Grizzly and Black Bears

Grizzly bears (*Ursus arctos)* (including barren-ground and northern interior populations) and black bears (*Ursus americanus)* occur in all habitat types in the project area. 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. Black bears are assessed by COSEWIC as “Not At Risk”, and ranked by ENR as “Secure”.

An estimated 3,500 to 4,000 grizzly bears occur in the Northwest Territories (ENR 2010a). Black bear densities at their northern limits are estimated at 10 bears/100 km^2 (ENR 2010a). 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.

4.1.6.5 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 project area are unknown; however, they have been shown to be dependent on prey densities. Wolves are expected to occupy all habitat types available along the proposed route.

Two different groups of grey wolves can be expected to occur in the project area: migratory and resident. Migratory wolves (also known as tundra wolves) follow the barren-ground caribou herds and would occupy the study area in the winter if barren-ground caribou were present. The 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).

4.1.6.6 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).

4.1.6.7 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).

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, and berries (Banci 1994; ENR 2010b; Pasitschniak-Arts and Lariviere 1995). Wolverines occupy multiple habitats types provided sufficient food resources are present.

4.1.6.8 Lynx

Canada lynx is not noted as a species of concern in the NWT; however, the MGP considered lynx as a valued component because of socio-economic importance of trapping this animal (IORVL 2004).

Lynx are typically found south of the treeline in the NWT, though their range can extend north to the Mackenzie Delta region in periods of high abundance. Lynx typically avoid large open areas and seldom venture into the tundra (ENR 2011; Bayne *et al*. 2008).

4.1.6.9 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).

4.1.6.10 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 NWT 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.

4.1.7 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 route between wintering and breeding grounds are used each year.

4.1.7.1 Waterfowl and Waterbirds

The term waterfowl is used in this document to include swans, geese, ducks loons and grebes. 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 project area, 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. Over 50 waterfowl and waterbird species are known to breed and stage along the Mackenzie Valley.

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.

HARLEQUIN DUCK

The western population of the harlequin duck is listed as May be At Risk in the NWT (ENR 2010), but has not been assessed or listed under COSEWIC (2011) or SARA (2011). Harlequin ducks are dispersed breeders. They breed on fast-flowing streams, usually in forested regions and mountainous habitat (Robertson and Goudie 1999).

The exact distribution of the harlequin duck in the NWT is unclear. The western population of harlequin ducks is thought to be stable although population counts have not been undertaken. ENR (2011) estimates the population probably does not exceed 1000 individuals.

SNOW GOOSE

The snow goose is not a listed species of concern in the NWT or nationally. The snow goose was considered as a valued component in the MGP because of its ecological and socio-economic importance (IORVL 2004).

Snow geese migrate to the NWT from southern wintering grounds in the spring to nest, raise their young, moult, and stage before their fall migration. Snow geese typically breed on the subarctic and Arctic coastal plain near ponds, shallow lakes, and streams. Nesting occurs in a variety of habitats throughout the tundra region, and nest density in the Mackenzie Delta region can range from less than one to seven nests per hectare. Snow geese also nest in key habitat sites along the Mackenzie River and congregate during the spring migration. Islands in the Mackenzie River between Little Chicago and Fort Good Hope are important spring staging areas for snow geese (IORVL 2004).

The snow goose population is believed to be growing, and in 1997, there was an estimated North American population of approximately 6.7 million birds, of which five million were breeding birds. In 2002, there was an estimated 600,000 adults in the NWT (ENR 2011).

GREATER AND LESSER SCAUP

The greater scaup is listed as Secure in the NWT, and the lesser scaup as Sensitive (ENR 2011); neither species has been assessed at the national level. Greater and lesser scaups are considered to be a valued component by the MGP due to their regulatory status and socio-economic importance (IORVL 2004).

The greater scaup is a dispersed breeder, and its population is believed to be stable in the NWT with an estimated 114,000 birds (ENR 2011). Greater scaups migrate to tundra habitats in the spring from ocean coasts and large inland lakes, wintering primarily along the Atlantic and Pacific coasts and on the Great Lakes. Greater scaups use coastal tundra on the outer Mackenzie Delta for nesting and brood rearing, and their nests are usually in tufts of grass on slight rises near the margins of small ponds or lakes (IORVL 2004).

The lesser scaup is also a dispersed breeder. Their population appears to be stable in the NWT, at an estimated population of 1 million, though the population has experienced declines since the 1980s (ENR 2011).

LESSER YELLOWLEGS

The lesser yellowlegs is listed as Sensitive in the NWT (ENR 2011). The lesser yellowlegs breed in forested areas throughout the NWT. Breeding is typically in dry, vegetated habitats, but they will occasionally breed in wet bogs and open muskegs, in open boreal forest and in forest-tundra transitional areas. Approximately 40% of the lesser yellowlegs' range is in the NWT, and there is an estimated population of 160,000 (ENR 2011). Population trends are unknown, though the population is believed to be declining in southern parts of their range (ENR 2011)

4.1.7.2 Raptors

Raptors make up a small but important group of birds frequenting habitat in the project area. Although this group covers a small number of species, it is diverse and includes hawks, eagles and osprey, falcons, and owls.

A total of 16 raptor species potentially occur in the project area. 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 in years when prey densities are greatest. 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).

SHORT- EARED OWL

The Short-eared Owl is listed by SARA as "Special Concern" (Schedule 3), and is ranked in the Northwest Territories as "Sensitive". Under SARA Schedule 3, the Short-eared Owl requires assessment or reassessment by COSEWIC and is not yet protected under SARA.

PEREGRINE FALCON

The Peregrine Falcon (*anatum)* has been assessed by COSEWIC as "Special Concern" (April 2007), and is listed as "Threatened" under SARA. Peregrine Falcons are ranked by ENR as "Sensitive" under the Northwest Territories general status program.

4.1.7.3 Upland Birds

For the purposes of this report, the term Upland Bird refers to a group of birds that nest in upland habitats and includes perching birds, woodpeckers, kingfishers, and grouse/ptarmigan. Upland birds occupy all terrestrial habitat types along the Highway and may occur as summer or year-round residents.

GREY- HEADED CHICKADEE

In the NWT, the Gray-headed Chickadee's range is limited to the northwest Mackenzie District, including the project 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).

RUSTY BLACKBIRD

Rusty Blackbirds are listed by SARA as "Special Concern" (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).

COMMON NIGHTHAWK

Common nighthawks have been designated as At Risk in the NWT (ENR 2010), are listed as Threatened by COSEWIC (2011), and are on Schedule 1 of SARA (2011). There is no information on numbers for this species (ENR 2011). However, common nighthawks would likely be present where suitable habitat is available.

OLIVE-SIDED FLYCATCHER

The olive-sided flycatcher has been listed as At Risk in the NWT (ENR 2010), designated as Threatened by COSEWIC (2011), and is on Schedule 1 of SARA (2011). The population of olive-sided flycatchers in North America is estimated at 1.2 million, and the population is experiencing declines throughout their range (COSEWIC 2007b).

4.1.8 Amphibians and Reptiles

Two amphibians occur in the project area: the wood frog (*Rana sylvatica*) and the boreal chorus frog (*Pseudacris maculate*). Neither are listed under SARA or COSEWIC, and both are secure in NWT. No reptiles occur in the area (Fournier 1997).

4.1.9 Hydrology

The hydrology of the project area is defined by climatic factors (long cold winters, short mild summers, and low precipitation with 40- 70% falling as snow) and the properties of the underlying terrain and 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 occur due to 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 in late September or October with a noticeable drop in discharge as water is stored as ice (IOL et al. 2004). The Project will cross many rivers and streams and will pass through areas where lakes are present.

Within the GSA, the Project crosses 162 water courses, 50 of which were identified as perennial and 112 of which were assessed as ephemeral drainages. The Project would cross an estimated 112 watercourses in the K'ahsho Got'ine District, 98 of which are identified as ephemeral and 24 as perennial. Within the Tulita District 41 perennial and 247 ephemeral watercourses will be crossed by the Project. It is uncertain how many watercourses the Project would need to cross in the Dehcho Region. Excluding the Dehcho, preliminary analysis indicates that at least 562 watercourses would need to be crossed by the Project; of these, 115 are described as perennial rivers or streams.

4.1.10 Fish and Fish Habitat

The proposed Project will cross numerous ephemeral and permanent streams and pass near many lakes along its route. Previous fish and fish habitat surveys have been conducted in streams along the proposed route. Results of these surveys were summarized in the EIS for the MGP (IOL et al. 2004). Generally, these surveys identified the following fish species as having the potential to utilize habitats in watercourses along the proposed route: lake whitefish, round whitefish, inconnu, northern pike, Arctic grayling, lake trout, burbot, least cisco, ninespine stickleback, and sculpin. 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.

Table 4-2 provides a generalized summary of habitat preferences and life cycle information for each of the major fish species likely utilizing stream habitats in the vicinity of the proposed Highway. 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 route.

4.1.10.1 Burbot

Burbot (*Lota lota*) are unique in that they spawn in rivers and lakes during the winter under ice. Spawners tend to select shallow waters over gravel substrates. Eggs filter down into interstitial spaces where they develop for the next 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.

Table 4-2 Life History Information for Common Fish Species in Streams along the MVH

Fish Species	Migratory Behaviour	Spawning Period	Spawning Habitat	Hatching Period	Juvenile Freshwater Habitat Preferences	Adult Freshwater Habitat Preferences	Risk of Potential Effects from Highway Construction
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 to March • Water temp. 0°C to 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
Lake whitefish *Coregonus clupeaformis*	Resident or anadromous	Late September to early October	• Lakes and large rivers • Hard or stony substrate • Water <7.5 m	Late spring	• Larvae along steep shorelines • Juveniles move to deep water in summer	Deep water in lakes and large rivers	Low
Round whitefish *Prosopium cylindraceum*	Limited migrations to lake shallows or upstream to rivers	Late September to October	Gravelly shallows of lakes or river mouths	Spring	Near or beneath rocks	Moderate to deep lakes	Low
Least cisco *Coregonus sardinella*	Migrate upstream to spawning grounds in fall	Early October	• Clear streams • Gravel substrates	Spring	Lakes, rivers, lowest reaches of tributary streams	• Lakes and streams • Estuaries, plume of home river	Moderate

Table 4-2 Life History Information for Common Fish Species in Streams along the MVH (cont'd)

Fish Species	Migratory Behaviour	Spawning Period	Spawning Habitat	Hatching Period	Juvenile Freshwater Habitat Preferences	Adult Freshwater Habitat Preferences	Risk of Potential Effects from Highway Construction
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 m to 3 m depth • Fast current • Gravel substrate	6 months after spawning	Fry washed downstream to coastal areas or lakes	Coastal areas or lakes	Low
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
Lake trout Salvelinus namaycush	• Limited migrations, usually within resident lake or large, deep river • Migrate to near shore 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 m to 40 m water depth	May to June, depending on water temperature	Shallow, inshore waters	• Large deep lakes (common) • Large rivers (less common) • Little movement in summer	Low

Table 4-2 Life History Information for Common Fish Species in Streams along the MVH (cont'd)

Fish Species	Migratory Behaviour	Spawning Period	Spawning Habitat	Hatching Period	Juvenile Freshwater Habitat Preferences	Adult Freshwater Habitat Preferences	Risk of Potential Effects from Highway 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% to 30% fines • Good flow (25 cm/s to 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
Slimy sculpin *Cottus cognatus*	Very limited movements	Spring, after breakup	Cobble in shallow water	Hatch 30 days after spawning	Gravel/cobble substrates in streams	Rocky or gravel substrates	Low
Ninespine stickleback *Pungitius pungitius*	Very limited movements	Summer	Male builds nests of vegetation and debris	Summer	Quiet, shallow waters in vegetated areas of streams or brackish waters	• Brackish or freshwater lakes and streams • Streams: vegetated areas in quiet waters	Low

4.1.10.2 Lake Whitefish

Lake whitefish (*Coregonus clupeaformis*; "Humpback") are primarily a freshwater fish, with a preference for cool water lakes and larger rivers; however, they will enter brackish water (Scott and Crossman1973).

In lakes, 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. Lake whitefish feed on aquatic insects, mollusks, amphipods, and a variety of small fish and fish eggs.

4.1.10.3 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.

4.1.10.4 Cisco

Least cisco (*Coregonus sardinella*; "Big-Eye Herring") occur in many inland waters, including the Mackenzie River and the lower reaches of many Arctic rivers (Scott and Crossman 1973). 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 lakeshores with sand or gravel bottoms are their preferred spawning habitats. They are eaten by predacious inconnu, pike, and burbot, as well as other mammals and birds.

4.1.10.5 Inconnu

Inconnu (*Stenodus leucichthys*; "Coney") are the largest and fastest growing member of the whitefish family. They are primarily anadromous (fish 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).

However, in inland lakes such as the Great Slave, the species remains fresh water throughout the lifecycle. 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 are frequently encountered along the Highway.

4.1.10.6 Mountain Whitefish

Mountain whitefish (*Prosopium williamsoni*) are a migratory sportfish common in all major river systems along the Rocky Mountains of Canada (Scott and Crossman 1973; Nelson and Paetz 1992; Joynt and Sullivan 2003). They typically prefer large river streams over small ones and tend to inhabit the upper 5 m of the water body (Nelson and Paetz 1992). Mountain whitefish use schooling as their primary protection technique and often utilize shoreline habitat to feed and hold (Scott and Crossman 1973). In addition, they can be found holding at the downstream end of riffle sections in the spring, summer and fall, moving to deeper, calm pool habitats for overwintering (Joynt and Sullivan 2003). Spawning typically occurs in late fall/winter and requires coarse, clean cobble/gravel substrate to scatter their eggs over (Scott and Crossman 1973).

4.1.10.7 Northern Pike

Northern pike (*Esox lucius*) are 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.

4.1.10.8 Lake Trout

Lake trout (*Salvelinus namaycush*) are representatives of the char family that live exclusively in deep, cold lakes throughout their life cycle. They spawn during early fall over clean cobble substrates in water that is generally less than 16 m deep (Marsden and Chotkowski 2001). Lake trout may also occur in large rivers and brackish waters. However, 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.

4.1.10.9 Arctic Grayling

Arctic grayling (*Thymallus arcticus*), are game fish of clear, cold streams and are known for their beautiful colours and 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.

4.1.10.10 Arctic Lamprey

Arctic Lamprey (*Lethenteron japonicum*) are an anadromous species that are found along coastal waters and in rivers flowing into the Arctic Ocean like the Mackenzie River. Arctic lamprey are parasitic and have been known to prey on pygmy whitefish, lake trout, lake whitefish, chinook salmon, cisco, longnose sucker and burbot. Arctic lampreys spawn from late May to early June in areas of the main current of moderate flow (Scott and Crossman 1973). Nests are built by both species on coarse substrate that vary from a mere depression in the gravel to a pit 75 mm deep (Scott and Crossman 1973). Arctic lamprey overwinter in the deep sections of the Mackenzie River, coastal waters and estuarial waters.

4.1.10.11 Flathead Chub

Flathead chub (*Platygobio gracilis*) can be found throughout west central North America from New Mexico to the Mackenzie River delta. Flathead chub are typically found in turbid flowing waters in main channels of large rivers throughout the range and will move into small rivers to spawn (Scott and Crossman 1973). Small schools will congregate in scour holes behind woody debris and boulders (Stewart and Watkinson 2007). They feed on a variety of terrestrial and aquatic insects, fish and even small rodents (Scott and Crossman 1973). Not much is known about its life cycle, but from limited information spawning is assumed to take place in the summer.

4.1.10.12 Lake Chub

Lake chub (*Couesius plumbeus*) are found in lakes, rivers and small creek throughout Canada and are often extremely abundant (Scott and Crossman 1973). They prefer cool water and live in a wide range of depths from shallow stream, rocky habitat along lakeshores to depth of 178 m in Lake Superior (Stewart and Watkinson 2007). They feed on crustaceans, aquatic insects and algae. Spawning occurs from April to mid-August depending on latitude (Nelson and Paetz 1992, Stewart and Watkinson 2007). Lake chub deposit non-adhesive eggs among cobble and boulder substrate (Stewart and Watkinson 2007).

4.1.10.13 Longnose Sucker

Longnose sucker (*Catostomus catostomus*) are found in rivers and lakes throughout Canada with the exceptions of eastern Labrador, Newfoundland and the extreme southwestern British Columbia. Longnose suckers are generally restricted to freshwater (Scott and Crossman 1973). However, they have been reported in brackish water at the mouths of arctic streams. Longnose suckers spawn in the spring over gravel substrate and in depths ranging from 0.15 m to 0.28 m. In areas where both longnose sucker and white sucker occur together, longnose suckers spawn first (Stewart and Watkinson 2007). They are bottom feeders consuming molluscs, crustaceans, insects and worms (Scott and Crossman 1973).

4.1.10.14 Emerald Shiners

Emerald shiners (*Notropis atherinoides*) occur in many lakes and rivers throughout central Canada and United States. Emerald shiners are pelagic or open water swimmer that tend to occur offshore during the summer months near the surface in schools (Scott and Crossman 1973). Emerald shiners prefer pools and runs with sand or gravel substrates (Nelson and Paetz 1992). In the fall, they congregate near shore eventually moving into deep water for overwintering. Emerald shiners feed on micro-crustaceans, midge larvae and algae. Spawning occurs between late spring to early summer (Scott and Crossman 1973).

4.1.10.15 Ninespine Stickleback

Ninespine stickleback (*Pungitius pungitius*) are found in streams, lakes and coastal waters throughout the Northern Hemisphere. Adults do not have a strong attraction for root aquatic plants, as do the adults of brook stickleback, preferring open water (Scott and Crossman 1973). Spawning occurs during the summer months and like other stickleback, the male builds a nest attached to vegetation (Stewart and Watkinson 2007). They feed primarily on aquatic insects and crustaceans.

4.1.10.16 Pond Smelt

In Canada, pond smelts (*Hypomesus olidus*) are found in the Peel River, Yukon, and the Mackenzie River from Inuvik to Great Bear Lake of the NWT. Spawning occurs in streams and ponds from April to May in littoral areas with organic cover bottoms (Scott and Crossman 1973).

4.1.10.17 Slimy Sculpin

In North America, the slimy sculpin (*Cottus cognatus*) occupies the more northerly waters. Slimy sculpin are generally found in cool rocky streams and live between and under rocks (Nelson and Paetz 1992). They feed on aquatic insects, crustaceans, small fish and plant material (Nelson and Paetz 1992). Spawning occurs in May and early June with the male preparing a nest site under a rock (Nelson and Paetz 1992).

4.1.10.18 Walleye

Walleye (*Stizostedion vitreum*) typically occur in fresh water and are found in the Mackenzie River to the delta. The preferred cover types for juvenile walleye include turbid regions of the river, dark waters, logs and bank margins (Ford *et al*. 1995). Adult walleye prefer deep and turbid rivers with ample hiding cover associated with turbid and dark areas (Scott and Crossman 1973). As adults, walleye feed on a variety of fish species dependent on availability. Spawning usually begins after ice breaks up between April and June depending on latitude and water temperature. In streams, spawning occurs over coarse bed material with good flows or on boulder, to coarse-gravel shoals of lakes Scott and Crossman 1973).

4.2 Human Environment

The proposed Project will provide all-weather road access for the first time to Tulita, Norman Wells and Fort Good Hope. Deline and Colville Lake will continue to be serviced by winter road; however, their winter roads will now connect directly with an all-weather road. In addition to these communities potentially directly affected by the MVH Project, communities in proximity to the development (i.e., Inuvik, Aklavik, Tsigethcic, Fort McPherson, Wrigley) may experience effects from the Project. An overview of each of these communities is included below.

4.2.1 Communities

4.2.1.1 Aklavik

The Hamlet of Aklavik is located on the west shore of the Peel Channel in the Mackenzie Delta. It is accessible by air from Inuvik year round and an ice road connects Aklavik to Inuvik and other communities in the winter. During the summer months, a barge is used to transports bulk supplies and food to the community [Legislative Assembly of the Northwest Territories ND (a)]. Aklavik would not be directly accessible by the Project.

Aklavik has historically been populated by Gwich'in, Inuvialuit, Métis, and non-aboriginal cultures. The community became the primary trapping, commercial, and transportation centre of the Western Arctic. In the 1920s, the Anglican and Roman Catholic missions, the western Arctic headquarters of the RCMP, and a Royal Canadian Corps of Signals station were established in the community. The population increased to approximately 1,600 by 1952, with the expansion of the mission hospitals, residential school, and government regional administrative offices. Due to serious flooding and erosion problems, the federal government recommended the community be relocated to a new site, called East Three (Inuvik). The new town of Inuvik was completed in 1961 and all major facilities were transferred there; however, many residents remained in Aklavik.

Aklavik's population has decreased from 756 to 645 between 1996 and 2009, indicating an average annual growth rate of -1.2 since 1996 (GNWT Bureau of Statistics 2010). Between 2004 and 2006, the population decreased to a low of 616 residents. The population is projected to continue to decrease from 2009 until 2024. Approximately 91.6% of Aklavik's population is Aboriginal (GNWT Bureau of Statistics 2010).

4.2.1.2 Inuvik

The Town of Inuvik is located on the east channel of the Mackenzie River Delta. Inuvik is accessible year round by air. It is accessible by the Dempster Highway year round except during freeze-up (fall) and break-up (spring) of the river crossings. Ice roads also link Inuvik with Aklavik and Tuktoyaktuk during the winter months [Legislative Assembly of the Northwest Territories ND (b)].

Inuvik was seldom visited until 1954, when it became the site selected for the relocation of the Hamlet of Aklavik following the severe flood damage in Aklavik in the 1950s. The site was selected because of its large, level area, the opportunities for modern airport facilities, and the presence of gravel materials for construction. Originally known as East Three, the Town of Inuvik was constructed between 1955 and 1961.

With the discovery of oil in the Beaufort Sea, the population of Inuvik increased significantly. In 1986, the Canadian Armed Forces station closed, causing the population to decline by 700 residents. The station was converted into the Aurora College Campus. Inuvik continues to be the Forward Operating Location for F18 military jets and is the resupply base for the western portion of the North Warning System.

With the collapse of oil prices in 1986, oil exploration activities declined. With the uncertainty in oil, attention has shifted to natural gas. If the recently approved MGP is constructed, the community is projected to increase in population. Currently, the economy is based on regional government services, oil and gas exploration, and other services [Town of Inuvik 2010; Legislative Assembly of the Northwest Territories ND (b); Outcrop Ltd. 1990].

Inuvik's population has increased from 3,461 to 3,586 between 1996 and 2009, indicating an average annual growth rate of 0.3 since 1996. Between 1996 and 2001, the population decreased to a low of 3,313. The population is projected to increase significantly between 2010 and 2024. Approximately 62.9% of Inuvik's population is Aboriginal (GNWT Bureau of Statistics 2010).

4.2.1.3 Fort McPherson

The Hamlet of Fort McPherson is located on the east bank of the Peel River. Fort McPherson is accessible year round by air and road (Dempster Highway), with the exception of break-up and freeze-up periods of the river crossings [Legislative Assembly of the Northwest Territories ND(c)].

Historically, the area of Fort McPherson was used by the Gwich'in. Sir John Franklin was in the area during his second expedition (1825 to 1828) and advised the Hudson's Bay Company that the area was rich in furs. The Hudson's Bay Company first established a post on the Peel River in 1840, which was relocated 6 km downriver in 1848 to its present location. The area was named after Murdoch McPherson, the chief trader for the Hudson's Bay Company. By 1852, a Loucheux village moved to Fort McPherson and an Anglican Mission was established in 1860. The Loucheux maintained their traditional hunting lifestyle well into the 1960s. The current economy is based on hunting, trapping, and oil exploration [GSCI 2010; Legislative Assembly of the Northwest Territories ND(c); Outcrop Ltd. 1990].

Fort McPherson's population has decreased from 915 to 791 between 1996 and 2009, indicating an average annual growth rate of -1.1 since 1996 (GNWT Bureau of Statistics 2010). The population's steepest decline occurred between 1996 and 1998, with the population stabilizing between 2002 and 2008. The population is projected to continue to decrease in 2014, 2019, and 2024. Approximately 93.3% of Fort McPherson's population is Aboriginal (GNWT Bureau of Statistics 2010).

4.2.1.4 Tsiigehtchic

Tsiigehtchic is located at the confluence of the Mackenzie River and the Arctic Red River. The community is accessible by road (Dempster Highway) with the exception of break-up and freeze-up periods of the river crossings and is also accessible from Inuvik and Fort McPherson by ferry and by barge from Hay River in July [Legislative Assembly of the Northwest Territories ND (d)]. Tsiigehtchic does not have an airstrip, so helicopter is the only means of accessing the community during the break-up and freeze-up period.

Formerly called Arctic Red River, the community officially changed its name to Tsiigehtchic in 1994.

This location has a very long history as a summer fish camp for the Gwichya Gwich'in and was the site of many gatherings and trade between the Gwichya Gwich'in, Dene, and Inuvialuit (GSCI 2010).

Missionaries established a Roman Catholic Church in the area in 1868, which was followed by a Hudson's Bay Company trading post in the early 1870s. Many families continued to winter in the mountains until the 1960s, with only a few families living year-round in the community. Construction of the Dempster Highway in the 1970s brought wage based employment opportunities, and some local residents operate the ferry that carries summer traffic across the Mackenzie and the Arctic Red Rivers. With access to larger communities, Tsiigehtchic attracted more residents. Traditional activities of trapping, fishing, and hunting are still conducted, while other jobs are provided by the ferry crossing and local store/post office [GSCI 2010; Legislative Assembly of the Northwest Territories ND(d); Outcrop Ltd. 1990].

Tsiigehtchic's population has decreased from 168 to 136 between 1996 and 2009, indicating an average annual growth rate of -1.6 since 1996 (GNWT Bureau of Statistics 2010). Between 1998 and 2002, the population increased to a high of 212, but has since decreased to 136. The population is projected to decrease to less than 100 residents by 2024. Approximately 94.9% of Tsiigehtchic's population is Aboriginal (GNWT Bureau of Statistics 2010).

4.2.1.5 Fort Good Hope

Fort Good Hope or Radilih Koe ("home at the rapids") was established in 1805 as the first fur trading post on the lower Mackenzie River. It was relocated several times before the present location was established in 1839. It is 27 km below the Arctic Circle, 805 miles northwest of Yellowknife, and downstream of the Ramparts Rapids, on the Mackenzie River (Legislative Assembly 2011; SLUPB 2010a).

Fort Good Hope is accessible year round by air from Norman Wells and Inuvik. Bulk supplies and food are delivered by barge during the summer months. In the winter, Fort Good Hope is connected to the Mackenzie Highway system by a winter road (Legislative Assembly 2011).

The community economy is based on traditional activities including hunting and trapping. Wage employment is primarily in government agencies as well as local businesses and services.

The population of Fort Good Hope was 567 in 2009. The population has declined by an average of 1.6% per year over the period between 1996 to 2009 period. The largest decline in the Fort Good Hope population occurred between 1996 and 2004 when the population declined from 699 to 553; since then, population changes in Fort Good Hope have been both positive and negative with a total 2.5% gain between 2004 and 2009. The population is primarily Aboriginal.

4.2.1.6 Colville Lake

Colville Lake or K'abami Tue ("ptarmigan net lake") was originally an outpost camp where several families had established their homes. Located 745 air miles northwest of Yellowknife, organization of the community began in 1962 when the Roman Catholic Mission was created there. Colville Lake is now home to Behdzi Ahda First Nation, one of the most traditional communities in the NWT, and continues to be an important fishing and trapping area. The community economy is based on game hunting, fishing and trapping with some tourism (Legislative Assembly 2011; SLUPB 2010a). Colville Lake would be connected to the Project by way of existing winter road to Fort Good Hope.

The population of Colville Lake was 147 in 2009. Between 1996 and 2009 the population increased by 3.9% per year on average. The population is primarily Aboriginal.

4.2.1.7 Norman Wells

The Town of Norman Wells is located on the east bank of the Mackenzie River, approximately 684 km northwest of Yellowknife and 80 km northwest of Tulita. 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. 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. 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.

Norman Wells remains the hub of transportation for the Sahtu 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).

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 (GNWT Bureau of Statistics 2011).

4.2.1.8 Deline

Deline is accessible year round by air from Norman Wells and Yellowknife. Deline would be connected to the Project by way of existing winter road. The community economy is based on traditional activities including hunting and trapping and the wage economy. Approximately 42% of the population 15 years or older were employed in 2009 (NWT Bureau of Statistics 2011).

The population of Deline was 552 in 2011 (NWT Bureau of Statistics 2011). The population has declined by 0.3% over the period between 2001 and 2011. The population is primarily Aboriginal.

4.2.1.9 Tulita

The Hamlet of Tulita is located on the east bank of the Mackenzie River, at its junction with the south bank of the Great Bear River. 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).

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 (GNWT Bureau of Statistics 2011).

4.2.1.10 Wrigley

The community of Wrigley is located on the east bank of the Mackenzie River in the Dehcho Region of the NWT. Known in the South Slavey language as Pehdzeh Ki or “clay place", Wrigley is the third settlement of the Slavey Dene since the mid to late nineteenth century. Initially the Slavey Dene settled at Old Fort Island, which was located 32 km north of the present site of Wrigley, where a Hudson’s Bay Company trading post was established in 1870. In the late 1950s, a power plant and school teachers' residence were built and the population grew to 128 by 1960 (Legislative Assembly of the NWT 2011). In 1965, the settlement was moved to the present site of Wrigley where there was a well-maintained wartime airstrip constructed by the U.S. military. Currently, Wrigley is the northernmost point of the existing Mackenzie Highway (Hwy 1), an approximate 225 km drive north of Fort Simpson, which is the main transportation hub for the region

Residents of Wrigley continue to carry on their traditional livelihoods. In 2008, 42.9% of the community participated in traditional activities such as hunting and fishing, 21% trapped, 22% produced arts and crafts and 74% of households consumed country foods (Bureau of Statistics 2010). Within the community, the formal economy is limited to businesses that provide for the essential needs of the community.

Wrigley’s population has decreased from 173 to 113 between 1996 and 2010, representing a growth rate of -35.0% (Bureau of Statistics 2010). By 2025, it is anticipated the population will grow minimally to 115 persons (Bureau of Statistics 2010). Approximately 96% of Wrigley’s population is Aboriginal. (Dessau 2012).

4.2.2 Archaeological and Heritage Resources

Evidence of human occupation and use of the Mackenzie Valley dates back 6,000 years to the Middle Prehistoric Period. In 1973 an archeological study of the Mackenzie Valley covering three km either side of the river from Fort Providence to Arctic Red River was completed, the first of many archeological studies along potential pipeline corridors (Clarke and Webster 2005). Beginning in 1985, the Archaeological Survey of Canada began several years of research in the Mackenzie Valley under a program known as NOGAP prompted by anticipation of extensive oil and gas exploration and development activities (Pilon 1985, 1988, 1992). Since the mid-1980s, most archeological investigations have related to Mackenzie Valley pipeline proposals. In 1999, archaeological studies were conducted of proposed upgrades to the existing winter road between Wrigley and Fort Good Hope. These involved field assessments of 17 proposed bridges and 12 potential culvert locations (Ronaghan 2000).

Beginning in 2002, four field seasons of archaeological investigations were completed for the Mackenzie Gas Project (MGP) (Clarke et al. 2003, Clarke et al. 2004, Clarke and Webster 2005, Webster et al. 2007). The first three years of these studies consisted of examination of selected high archaeological potential portions of a 1 km wide possible pipeline corridor as well as specific borrow sources and infrastructure locations. The entire pipeline routing was not assessed. The 2006 season focused mainly on revised borrow and infrastructure locations. Many archaeological sites near proposed pipeline and highway corridors have been identified; however, not all areas have been subject to field investigations as previous regional archaeological studies specific to the MGP corridor 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.

5 TRADITIONAL AND OTHER LAND USES

5.1 Traditional Land Use

Traditional Dene and Métis life was defined by the changing seasons, movement of wildlife and the availability of resources for food, shelter, and tools. The Dene and Métis have used and continue to use the lands and waters in the vicinity of the proposed Project at different times of the years for travel, subsistence harvesting and cultural and spiritual events. The knowledge of how to live on the land and the relationships among people and with the land can be described as traditional knowledge. The significance of the land for the Aboriginal people is represented in many elements of the culture. There are a vast number of traditional names for locations on the land with stories about each location. Traditional names often represent an activity or feature of importance at that location.

Traditional land use activities and locations have been documented in a number of studies such as the Gwich'in Traditional Knowledge Study for the Mackenzie Gas Project, other project-specific studies (e.g., Great Bear River Bridge Traditional Knowledge Study), and supporting studies for land use plans in the GSA, SSA and Dehcho Regions. Traditional land uses in the vicinity of the Project are summarized in each of the PDRs.

5.2 Protected Areas

There are several sites in the Project area that are being considered for protection under the Northwest Territories Protected Areas Strategy:

- 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).
- 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).
- The Pehdzeh Ki Ndeh is at Step 3 of the 8-step process for Protected Area Strategy designation, in which assessment work is being conducted.
- 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).

5.3 Land Use Plans

Land use plans establish the context and parameters for land and water use in the region which they cover. The *Mackenzie Valley Resource Management Act* (*MVRMA*) requires regulatory and permitting agencies to ensure developments comply with the provisions of an approved plan before approvals can be issued. Application of approved land use plans is not affected by land ownership and applies to all activities carried out on Crown Land, Commissioner's Land, and Settlement Lands.

The Gwich'in Land Use Plan (GLUP) is approved and in force, while the Sahtu and Dehcho land use plans are currently in draft status. Summary information about the land use plans and their relevance to the proposed Project is presented below.

5.3.1 Gwich'in Land Use Plan

The *GLUP* was brought into effect in August 2003 and has been used to assess proposed activities and developments since that time. In April 2010, the GLUP Board issued the *Draft GLUP Revisions* for review. For the purposes of this analysis, both the 2003 approved plan and the 2010 draft revision have been referenced in order to represent the most current information concerning land use plans in the GSA.

GWICH'IN CONSERVATION ZONES

The 2010 draft revision to the *GLUP* (GLUPB 2010) identifies 11% of the GSA being designated as Gwich'in Conservation Zones. These areas represent:

- Core areas the communities would like to have protected based on a variety of values ranging from current and historical use, heritage resources, wildlife, fish, forests, vegetation, and water resources.
- Core areas the scientific community would like to have protected based on critical wildlife habitat and populations, outstanding heritage sites, unique land features, and ecological processes.
- Five out of the six ecoregions of the GSA, and areas that do not unreasonably limit the ability of resource development to occur in the GSA.

The status of Conservation Zones is such that they require year round protection. Section 4.6.1 of the *Draft GLUP Revisions* (2010) identifies activities, mostly industrial and commercial, that are not permitted within Conservation Zones.

GWICH'IN HERITAGE CONSERVATION ZONES

Gwich'in Heritage Conservation Zones are areas of "outstanding historical or cultural significance" in the GSA. They hold the same status as Gwich'in Conservation Zones.

GWICH'IN SPECIAL MANAGEMENT ZONES

Gwich'in Special Management Zones comprise approximately 42% of the GSA (GLUPB 2010). Special Management Zones allow all land uses provided that the zone-specific conditions are met and appropriate regulatory authorizations are obtained. There are no restrictions on traditional land use in Special Management Zones.

TRANSPORTATION SPECIAL MANAGEMENT ZONE

The Transportation Special Management Zone for the Dempster Highway allows for activities 1,000 m on either side of the right-of-way, such as access from the Dempster Highway for permitted hunting or harvesting, or access to granular sources. The zone is partitioned into three areas to address primary values specific to each area, which, spanning the length of the Dempster Highway in the GSA, include: Porcupine caribou; tourism; granular resource/pit management; waterfowl; water quality and quantity; and peregrine falcons and other raptors. Management activities include examples such as assigning monitors to assess the presence of migrating caribou, and instructing the DOT to preserve scenery and tourism values as they maintain and operate the highway. In this way, the *GLUP* contains elements that provide for the responsible design, construction, and operation of current and future highways in the GSA.

The proposed Project passes through, or is adjacent to the following Conservation and Special Management Zones in the Gwich'in Settlement Area:

- Gwich'in Conservation Zone C: Kaii luk, Nagwichoonjik, Dachan choo gehnjik (Travaillant Lake, Mackenzie River, and Tree River), for a distance of 20.1 km.
- Gwich'in Heritage Conservation Zone H03: Vihtr'ii tshik (Thunder River) located southwest of the proposed alignment. The closest approach is 4 km.
- Gwich'in Special Management Zone 6: Gwieekajilchit tshik (Campbell Creek). The Project passes adjacent to the southern boundary.
- Gwich'in Special Management Zone 12: Van Kat Khaii Luk Gwindii (Lakes Around Travaillant Lake). The Project passes through Zone 12 for a distance of 101.7 km.

The *GLUP* provides special consideration for the extension of the Mackenzie Highway, stating that "Schedule XVII in Appendix F (volume 2) of the [Gwich'in Land Claim] agreement is a notice of intent for the expropriation of Gwich'in lands for the proposed Mackenzie Highway" (GLUPB 2010 p. 97). The *GLUP* allows flexibility for additional studies and consultation to be done prior to a final route being selected. It urges the likely Proponent, DOT, to consider a combined Transportation Corridor for potential linear infrastructure developments, namely a highway, a fibre optic cable and a pipeline.

The *GLUP* informs the DOT that after the route has been selected, the GLUPB will review the proposal against the *GLUP* to assess the potential effect of the Highway on other land uses. The Board advises that it "may propose amendments" (GLUPB 2010 p. 98) in response to the proposal.

The Transportation Special Management Zone concept applied to the Dempster Highway illustrates one possible approach for protecting resource values in the vicinity of a highway. It is conceivable that a similar approach may eventually be developed and implemented for the Project.

5.3.2 Sahtu Land Use Plan

Under the authority of the Sahtu Dene Métis Comprehensive Land Claim Agreement (*SDMCLCA)* and the *MVRMA*, the Sahtu Land Use Planning Board (SLUPB) is in the process of developing the Sahtu Land Use Plan (*SLUP)*. 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 Sahtu Settlement Area (SSA).

According to the draft *SLUP* (SLUPB 2010), four types of zoning apply to the land along the proposed Project:

- 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 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. A portion of this section of highway is located within the Bear Rock Conservation Zone. Development within Conservation Zones and Proposed Conservation Initiatives may be allowed on a restricted basis.

According to the draft *SLUP*, the majority of the proposed alignment is located within areas zoned for Special Management and/or Conservation, summarized as follows:

LITTLE CHICAGO SPECIAL MANAGEMENT ZONE (ZONE #2)

The Little Chicago Special Management Zone is located on the Mackenzie River in the northern portion of the SSA, near its boundary with the GSA. The 1.5 km buffer around the islands and shoreline were set to include all cabins and heritage locations as well as the airstrip and barge landing sites to enable future development and use of the area. Little Chicago is of valuable cultural significance. The Special Management Zone is in place to protect physical heritage in the form of heritage buildings, grave sites, traditional trails, camp sites, cabins and archaeological sites. The zone continues to be a destination for subsistence use where families and hunters camp, hunt and fish. This Special Management Zone provides for the continued use of important infrastructure for economic development such as barge landing sites, airstrips, equipment staging areas and access roads.

LOON RIVER TO FORT ANDERSON TRAIL SPECIAL MANAGEMENT ZONE (ZONE #5)

The trail begins at the mouth of the Loon River, at its confluence with the Mackenzie River. The trail heads northeast to Loon Lake, on to Rorey Lake, following the west shore, overland to Round Lake (by the west shore), on to Carcajou Lake, Canot Lake, and overland to the Carnwath River. It then follows the bank of the river to Anderson Forks and down the right bank of the Anderson River to Fort Anderson. The primary reason for the Loon River to Fort Anderson Trail Special Management Zone is to preserve its heritage and cultural values. The trail was used for generations as one of the main routes to the barrenlands for summer and fall caribou hunting. Many stories, heritage sites and named places are associated with this trail and occur along its path.

HARE INDIAN (RABBITSKIN) RIVER SPECIAL MANAGEMENT ZONE (ZONE # 6)

A 1 km buffer is applied around the main branch of the Hare Indian River from its confluence with the Mackenzie River to Tirato (Smith Arm), of Great Bear Lake. Mid-way, the zone connects with the Underground River south of Belot Lake. The community of Fort Good Hope requested that a number of rivers and large creeks in the K’ahsho Got’ine District be given a 1 km buffer along each side of the shores to protect a combination of recreational and subsistence uses. The buffer was also requested for ecological reasons, namely, to protect the shorelines and to help maintain water quality at current levels. The Hare Indian River has been identified as an Important Wildlife Area for both moose and muskox at different locations.

BLUEFISH CREEK TO TSINTU RIVER SPECIAL MANAGEMENT ZONE (ZONE #7)

A 1 km special management buffer has been applied on both shores of the rivers and creeks. The buffer begins around Bluefish Creek from its confluence with the Mackenzie River and ends at Tsintu River. The community of Fort Good Hope requested that a number of rivers and large creeks in the K’ahsho Got’ine District be given a 1 km buffer along each side of the shores to protect a combination of recreational and subsistence uses. The buffer was also requested for ecological reasons, namely, to protect the shorelines and to help maintain water quality at current levels. Bluefish Creek connects the Mackenzie River to a number of small lakes where bluefish den and overwinter. The lakes at the western end of the Creek are a source for bluefish populations.

NORMAN RANGE SPECIAL MANAGEMENT ZONE (ZONE #10)

The zone encompasses the entire Level IV Norman Range Ecoregion. It includes Sam McRae Lake, Turton Lake, Chick Lake, Oscar Lake, Kelly Lake, Lennie Lake, a number of other small lakes and Yamoga Rock. It is bound to the north by Yamoga Rock and Lac a Jacques, to the west by the Mackenzie River Special Management Zone, and to the south by the Willow Lake Wetland Special Management Zone. To the east are General Use lands. The Norman Range Special Management Zone encompasses a number of traditional and cultural use areas. The zone 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 entire Level IV Norman Range Ecoregion has been taken as the zone boundary to protect wildlife habitat and harvest locations. The SMZ allows for the protection of specific values while allowing for the development of a range of economic development opportunities.

BEAR ROCK CONSERVATION ZONE (ZONE #56)

This zone lies within the Mackenzie River Special Management Zone. It is located at the confluence of the Great Bear and Mackenzie Rivers, northwest of Tulita. 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).

GREAT BEAR RIVER SPECIAL MANAGEMENT ZONE (ZONE #14)

This zone 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. The buffer will ensure community access to the shoreline and will help protect water quality (SLUPB 2010).

MACKENZIE RIVER (DEHCHO) SPECIAL MANAGEMENT ZONE (ZONE #3)

This zone 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).

MIO LAKE CONSERVATION ZONE (ZONE #54)

This zone 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)

This zone 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)

This zone 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).

5.3.3 Dehcho Land Use Plan

The Dehcho Land Use Planning Committee (DLUPC) submitted a *draft Dehcho Land Use Plan* (*DLUP*) to the GNWT and the Department of Aboriginal Affairs and Northern Development Canada (AANDC). As of 2006, the land use plan has been in draft form and under review by the parties. The plan includes specific guidelines directed at preserving natural and cultural resources (DLUPC 2006a). The most recent version of the plan is referenced herein.

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

PEHDZEH KI NDEH CONSERVATION ZONE

The proposed Pehdzeh Ki Ndeh Conservation Zone is a 16,400 km^2 portion of land located to the northeast of Wrigley. The proposed Conservation Zone is intended to protect the local Pehdzeh Ki First Nation (PKFN)'s subsistence harvesting needs (PAS 2009). The area provides "significant ecological and cultural values", including habitat for moose, woodland and barren-ground caribou, black bears, wolves, migratory birds and fish, and represents an important cultural area for the community of Wrigley.

The Pehdzeh Ki Ndeh Conservation Zone contains the Old Wrigley town site, as well as burial sites and traditional travel routes near its western boundaries. Within the draft *DLUP*, the Pehdzeh Ki First Nation has identified numerous sacred sites in the proposed Pehdzeh Ki Ndeh Area (DLUPC 2006a). Additionally, there are a number of cabins and traplines found in the area around the lakes that connect to Wrigley by traditional trails, several of which are found along the winter road alignment (DLUPC 2006b).

Currently the PKFN is attempting to protect the area through the NWT Protected Areas Strategy (PAS 2009). As of November 2011, the Pehdzeh Ki Ndeh is at Step 3 of the 8 step process for PAS designation, in which assessment work is being conducted.

Special allowances for the construction of the Mackenzie Gas Project are also included within the draft *DLUP* for the Pehdzeh Ki Ndeh Conservation Zone.

MACKENZIE SPECIAL INFRASTRUCTURE CORRIDOR

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

5.4 Other Land Uses

The area of and adjacent to the proposed Project has been and continues to be subject to other non-traditional land use activities.

The Mackenzie Valley Winter Road is built annually along an established corridor between Wrigley and Fort Good Hope. This winter road operates for 2-3 months annually, providing for community resupply, inter- community travel and access for resource exploration and development. A buried oil pipeline originates in Norman Wells, continuing south through the project area to Zama, Alberta.

Other land uses in the Project area are limited and include exploration for oil and gas, aggregate extraction, tourism, recreation and communications. The MGP is proposed to deliver natural gas from the Mackenzie Delta to southern Canada. The Project is proposed to occupy a common corridor with the MGP as much as possible.

6 PUBLIC INVOLVEMENT

During the development of the regional PDRs, numerous public and agency meetings were held to provide information about the proposed Project and to gather input from participants. This section provides a summary of engagement activities; further detail is available in each of the PDRs.

6.1 Community and Public Engagement

The intent of community and public engagement during the development of the regional PDRs was to provide participants with information about the proposed Project and provide an opportunity for local input during the preliminary design stage. Community engagement sessions commenced with a presentation by the team leading the development of the PDR, followed by an opportunity to ask questions and provide input on the design, construction and operation of the proposed Project. Several public sessions were held in each community, with updated project information provided in each subsequent meeting. Table 6-1 provides the dates of the public engagement sessions in each community.

Table 6-1 Summary of Community Engagement Sessions

Community	Meeting Dates
Fort McPherson	May 25, 2010, November 26, 2010, March 17, 2011
Aklavik	May 27, 2010, November 23, 2010, March 14, 2011
Inuvik	May 28, 2010, November 24, 2010, March 16, 2011
Tsiigehtchic	July 27, 2010. November 25, 2010, March 15, 2011
Fort Good Hope	November 9-10, 2010, April 12-14, 2011, September 13, 14, 25, 2011
Norman Wells	July 28, 2010, March 28, 2011, October 4, 2011
Tulita	July 29, 2010, March 29, 2011, October 5, 2011
Wrigley	November 22, 2010, July 7, 2011, January 25-26, 2012

6.2 Issues and Concerns

Many questions and comments were raised at the community engagement sessions. A selection of commonly raised comments is presented below. All comments received are reported in each of the PDRs.

PROJECT DEVELOPMENT/GENERAL

Comments related to project design and development included:

- Relationship of development of the Project to the construction of the MGP – are they interdependent?
- A lot of studies were completed for the proposed pipeline. This information should be used when considering the requirements for the Highway.

- Mistakes were made when the Dempster Highway was constructed. The designers should learn from those mistakes.
- Communication and consultation about the Project is important.
- Need to consider traditional knowledge and local input on location of highway alignment and local infrastructure.
- Development schedule and seasonality of activities is of interest to people.

BIOPHYSICAL ENVIRONMENT

Comments included:

- Potential effects of the Project on water, wildlife, plants, berries, etc. These need to be protected.
- Potential effects on permafrost and effects of climate change
- Need to avoid or protect important wildlife areas and sensitive environments
- The area around Travaillant Lake is very special to the Gwich'in and must be protected, including the interconnected waterbodies in the area.
- What chemicals will be used to construct the highway
- The Project needs to avoid special areas
- Concern regarding increased access to the area for exploration.
- Concern about minimal damage to the environment and the job being done properly.
- What chemicals will be used to construct the highway?
- What are the plans to mitigate dust?

HUMAN ENVIRONMENT

Comments received covered a number of areas:

- Need to ensure local participation in all aspects of development
- The Project should provide business and employment opportunities for communities along the highway
- Training to access employment opportunities is necessary
- Use community contractors and heavy equipment operators
- Local businesses may invest to participate in the Project and be over-extended after construction is complete
- Local economic and social benefits should be maximized;
- Skills training and job creation are expected within the community;
- There is a need for heavy equipment training; and,

- It's important to start training people now for the jobs that will be available during construction and operation of the Highway, including environmental monitors.
- Concerned that the Project will create big change, and not sure if it have positive or negative impacts for the community.
- Need to consider social impact on community
- Prices of goods in the stores are expected to decrease
- Community did not experience many negative impacts from the winter road
- Potential social effects, including substance abuse, loss of culture.
- Development can provide benefits, but need to consider the negative effects.
- Highway study should consider community safety and effects on the community
- More drugs and alcohol could come into the community because of the highway
- Increased travel by residents could have negative impact on Dene culture
- Will provide more freedom to travel year round
- Workers from outside the District should be hired elsewhere and transported to and from the camps and not come into the community
- Keep workers from outside of region away from the communities.
- People will be free to roam on our territory, restrictions should be considered. There will be too many people on our land.
- Potential effects on traditional pursuits such as hunting, fishing and trapping.
- How will the Highway affect traditional pursuits on the land?
- Will the Highway interfere with traditional pursuits such as hunting, fishing, and trapping?
- Will compensation be available for those people who are affected by the Highway?
- Highway would provide trappers better access to trapping areas.
- Highway goes through prime trapping areas; what happens to trappers?

6.3 Agency Engagement

In addition to community engagement sessions, meetings were held with regulatory agencies, co-management organizations and government agencies with potential involvement or interest in the development. Organizations which were contacted during preparation of the PDRs and this Scoping Document included:

- Gwich'in Land and Water Board
- Gwich'in Land Administration
- Gwich'in Social and Cultural Institute

- Hamlet of Tulita
- Fort Norman Métis Land Corporation
- Tulita Renewable Resource Council
- Tulita Land Corporation
- Town of Norman Wells
- Norman Wells Land Corporation
- Norman Wells Renewable Resource Council
- Sahtu Renewable Resource Board
- Sahtu Land and Water Board
- Sahtu Land Use Planning Board
- Aboriginal Affairs and Northern Development Canada
- Department of Fisheries and Oceans
- Transport Canada
- Department of Environment and Natural Resources, GNWT
- Department of Municipal and Community Affairs, GNWT
- Prince of Wales Northern Heritage Centre, GNWT
- Aurora Research Institute
- Mackenzie Valley Land and Water Board
- Mackenzie Valley Environmental Impact Review Board

7 ENVIRONMENTAL EFFECTS SCOPING

The four regional PDRs provide a preliminary consideration of potential environmental effects of the proposed Project. It is anticipated that the identified interactions between the Project and the environment, potential environmental effects, and other issues of concern provide an important contribution to the development of the scope (factors to be considered in) of the environmental assessment of the Project.

7.1 Issues Identified During Engagement

Public engagement sessions were undertaken during preparation of each of the PDRs as reported in Section 6. Project-specific issues and concerns identified during agency and stakeholder engagement broadly include:

- Potential effects on water, wildlife and the environment;
- Potential effects on permafrost and climate change;
- Avoidance of important wildlife habitat, sensitive environments and cultural places;
- Local participation in all aspects of development;
- Provision of business and employment opportunities for communities along the Project;
- Training needed to access development opportunities;
- Potential effects on traditional pursuits such as hunting, fishing and trapping;
- Potential social effects, including substance abuse, loss of culture; and
- Potential effects of outside workers in communities.

7.2 Regulatory Setting

The following legislation will apply to the implementation of the MVH Project:

- *Mackenzie Valley Resource Management Act and associated Regulations*
- *Fisheries Act*
- *Species at Risk Act*
- *Migratory Birds Convention Act*
- *Navigable Waters Protection Act*
- *Canadian Environmental Protection Act and associated Regulations*
- *Northwest Territories Waters Act and associated Regulations*
- *Territorial Lands Act and associated Regulations*

- *Public Health Act*
- *Explosives Act*
- *Commissioner's Lands Act*
- *Gwich'in Comprehensive Land Claim Agreement*
- *Sahtu Dene and Métis Land Claims Agreement*
- *NWT Wildlife Act*
- *NWT Species at Risk Act*
- *NWT Act*
- *Historical Resources Act*

7.3 Project Environment Interactions

Interactions are expected to occur between the biophysical and human environments and Project activities during construction, operations and reclamation. A summary of potential Project–environment interactions is presented below:

Table 7-1 Potential Project-Environmental Interactions by Phase

Project Phase	Atmospheric Environment	Aquatic Resources	Fish and Fish Habitat	Terrain	Vegetation	Wildlife and Wildlife Habitat	Human Environment
Construction	Y	Y	Y	Y	Y	Y	Y
Operation	N	Y	Y	Y	Y	Y	Y
Reclamation	N	N	Y	Y	Y	Y	Y

While the above interactions may occur during the Project, potential effects on some of these environmental parameters are expected to be minimal and with mitigations may not result in residual effects. Potential Project-environment interactions and associated effects will receiver further analysis during the environmental assessment.

7.4 Valued Components

Valued components (VCs) are considered to be elements of the social, economic, biophysical or cultural environment that are important (MVEIRB 2004). An assessment of potential effects on VCs will be required during the EA or EIR process. A preliminary list of VCs has been identified, and will be refined based on the following considerations:

- Issues and concerns of regulatory authorities, the public and stakeholders and their expectations of the environmental assessment;
- Regulatory requirements for the Project
- Professional judgment regarding the potential interactions and the sensitivity of environmental components to project-related perturbations

The regional PDRs provide a contribution to the selection of VCs for the assessment as a result of their overview of environmental conditions, agency and stakeholder engagement and preliminary identification of project–environmental interactions, mitigations and potential environmental effects. The following table presents the proposed VCs to be the focus of the environmental assessment or EIR for the MVH.

Table 7-2 Potential VCs for the Assessment

Potential VC	Potential Project Effects	Potential Measurable Parameters	Rationale for Selection
Biophysical Environment			
Air	Change in air quality	Particulates; NO_x; SO_x; GHGs	Potential to affect humans, vegetation and habitat
Water Resources	Changes to surface water quantity, flows and quality	Stream hydrology; bathymetry; water chemistry;	Potential to affect humans, wildlife, vegetation and fish; regulatory requirements; community concern
Fish and Fish Habitat	Changes in fish populations, fish health and habitat availability	Fish species distribution and abundance; habitat studies; benthos; harvest studies; fish mortality	Regulatory requirements; community concern
Terrain and Permafrost	Changes in terrain characteristics; permafrost degradation; mass movement	Permafrost distribution; active layer depth; ice content; subsidence; terrain mapping	Potential effects to water quality ,hydrology, fish, habitat availability; safety; community concern; regulatory requirements
Vegetation	Changes in species distribution and abundance	Rare plant distribution; invasive species distribution; species diversity	Regulatory requirements; community concerns; resource managers concerns
Wetlands	Changes in wetland distribution, characteristics and function	Vegetation mapping; hydrology	Community and resource managers concerns

Table 7-2 Potential VCs for the Assessment (cont'd)

Potential VC	Potential Project Effects	Potential Measurable Parameters	Rationale for Selection
Biophysical Environment (cont'd)			
Wildlife and Wildlife Habitat	Changes in habitat availability; habitat quality; habitat connectivity; increased risk of direct mortality; increase in harvest; changes in health	Wildlife species distribution and numbers; harvest data; mortality data; contaminant levels; direct habitat loss	Potential changes to habitat Regulatory requirements; community concerns; resource managers concerns
Human Environment			
Employment	Change in employment; income and well-being	Employment levels and opportunities; salaries	Community concerns; government concerns; land claim requirements
Training	Changes in skills and employment opportunities	Training and development opportunities Employment opportunities	Community concerns; government concerns
Business	Changes in business opportunities; changes to local, regional and territorial economies	Number of businesses and business services; business income; business opportunities	Community concerns; government concerns; land claim requirements
Demographics	Changes in demographics; availability of infrastructure and services	Population; age; birth rates	Community concerns; government concerns
Human Health and Well being	Changes in community and individual health and wellness	Diet; alcohol and substance abuse; availability of infrastructure and services	Community concern; government concerns
Traditional Land Use	Changes in traditional land use	Resource availability; harvest data; harvest distribution; land use conflicts	Community concerns; land claim requirements
Tourism and other land uses	Changes to land use and access; changes to local and regional economies	Accessibility; park statistics; visitor experience	Community concerns; government concerns
Culture	Changes to cultural well being	Aboriginal language use; engagement in cultural traditions and activities	Community concerns; government concerns
Archaeology and Historical Resources	Disturbance to resources; resource identification	Documentation of archeological sites and resources	Regulatory requirements; community concerns; land claim requirements
Aesthetics	Changes to aesthetic value of areas	Visitor experience; local input	Community concerns

7.5 Assessment Boundaries

7.5.1 Project Footprint

The Project footprint will include the highway ROW, and all supporting permanent or temporary infrastructure such as access roads, borrow sources, camps, airstrips and laydown areas along the route between the current terminus of Highway # 1 (south end) and the junction of the Project with the Dempster Highway near Inuvik (north end).

7.5.2 Spatial Boundaries

The scope of the assessment for biophysical VCs will reflect the characteristics of the VC (e.g., range) and the scale and geographic extent of potential impacts from the Project. As such it is likely that the spatial scope of the assessment will vary between VCs. The spatial scope of the human environment assessment should include the communities directly connected to the proposed development (i.e., Wrigley, Tulita, Norman Wells and Fort Good Hope) and their traditional land use territories.

7.5.3 Temporal Boundaries

The temporal boundaries for the assessment are based on the timing and duration of potential effects from the Project. Assessments typically address the period of all major project phases, including construction, operation and reclamation. While the expected duration of the construction phase has been estimated at 4 years, the operational phase is expected to be indeterminate and, hence, the timing of a final reclamation phase is uncertain. To address potential effects resulting from operation of the Project, it is suggested that the temporal boundary for assessment of operation effects be set at 25 years.

7.6 Cumulative Effects

The potential contribution of residual Project effects to cumulative effects from past, present and reasonably foreseeable developments will be included in the overall effects assessment of the Project.

7.7 Other Considerations

The effects assessment should identify potential accidents and malfunctions, the probability of their occurrence and the potential effects to the VCs considered during the effects assessment of routine operations.

Additionally, the effects of the environment and climate change on the Project should be considered. Environmental considerations which may impact the Project include fires and weather-related events. The Project is to be constructed in areas of widespread discontinuous and continuous permafrost and, therefore, climate change impacts to permafrost and hydrology and their potential effects on the Project require consideration.

8 FOLLOW-UP MONITORING AND ADAPTIVE MANAGEMENT

Follow-up monitoring to assess the accuracy of environmental effect predictions and mitigations will be incorporated into Project planning. Proposed follow-up monitoring and adaptive management plans will be developed during the environmental assessment of the Project.

9 MANAGEMENT PLANS

The following management plans are expected to be developed to support project environmental assessment and permitting:

- Environmental Management Plans
- Waste Management Plan
- Spill Contingency Plan
- Reclamation Plan
- Health and Safety Plan
- Training, Employment and Contracting Plan

10 DEVELOPER'S COMMITMENTS

A preliminary list of developer's commitments will be presented during the EA or EIR of the Project.

11 REFERENCES

5658 NWT Ltd., and Government of the Northwest Territories. 2011 - Project Description Report for Construction of the Mackenzie Valley Highway Tulita District, Sahtu Settlement Area

Banci, V. A. 1994. Wolverine. Pages 99-127 in L. F. Ruggiero, K. B. Aubry, S. W. Buskirk, L. J. Lyon, and W. J. Zielinski, editors. The scientific basis for conserving forest carnivores, American marten, fisher, lynx and wolverine in the western United States. U.S. Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM 254, Fort Collins, Colorado, USA.

Bayne, E.M., S. Boutin, and R.A. Moses. 2008. Ecological factors influencing the spatial pattern of Canada lynx relative to its southern range edge in Alberta, Canada. Canadian Journal of Zoology 86: 1189-1197.

Beauchamp, D.A. 1990. Movements, Habitat Use, and Spawning Strategies of Arctic Grayling in a Sub-alpine Lake Tributary. Northwest Science 64(4).

Blood, D.A. and G.G. Anweiler. 1994. Status of the Bald Eagle in British Columbia. Wildlife Working Report No. WR-62. Prepared for the Wildlife Branch of the Ministry of Environment, Lands and Parks, Victoria, BC.

Bromley, M. 1992. Update Report on the Status of Tundra Peregrine Falcons in Canada. Prepared for the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Bureau of Statistics (GNWT). 2010. Community of Wrigley Statistical Profile. Website accessed September 19, 2011

Bureau of Statistics (GNWT). 2011. Community Profiles. http://www.stats.gov.nt.ca/community-data/community-profiles/. (June 23, 2011).

Burn, C.R. 2003. Climate Change Scenarios for the Mackenzie Gas Project. Prepared for Indian and Northern Affairs Canada.

Canadian Council of Ministers of the Environment (CCME). 2003. Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products. PN 1326, 2003. Web access: http://www.ccme.ca/assets/pdf/pn_1326_eng.pdf

Clarke, G. and S. Webster. 2005. Mackenzie Gas Project 2004 Heritage Resources Program. Northwest Territories Permit No. 2004-956. Report on file, Prince of Wales Northern Heritage Centre, Yellowknife.

Clarke, G., D. Dalmer, and J. McKillop. 2003. Heritage Resources Focussed Reconnaissance of the Mackenzie Gas Project. Northwest Territories Permit No. 2002-916. Report on file, Prince of Wales Northern Heritage Centre, Yellowknife.

Clarke, G., V. Balls, D. Dalmer, L. Bouchet-Bert, and A. Mason. 2004. Heritage Resources Focused Reconnaissance of the Mackenzie Gas Project. Northwest Territories Permit No. 2003-933. Report on file, Prince of Wales Northern Heritage Centre, Yellowknife.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2011. Database of listed species at risk in Canada. Available at: http://www.cosewic.gc.ca/eng/sct2/index_e.cfm.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2007b. COSEWIC assessment and status report on the Olive-sided Flycatcher *Contopus cooperi* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. 25 pp.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2010. Wildlife Species Search. Web access: http://www.cosewic.gc.ca/eng/sct1/index_e.cfm (October 2010).

Dessau Inc. 2012. Mackenzie Valley Highway Extension, Pehdzeh Ki Ndeh – Dehcho Region, Project Description Report

Department of Fisheries and Oceans/Fisheries and Oceans Canada (DFO). 1998. Stock Status Report D5-04. Central and Arctic Region. Retrieved from: http://www.grrb.nt.ca/pdf/fisheries/MackenzieRiver Inconnu.pdf.

Department of Fisheries and Oceans/ Fisheries and Oceans Canada (DFO). 2005. Protocol for Winter Water Withdrawal in the Northwest Territories. Yellowknife, 3 pp.

Dehcho Land Use Planning Committee (DLUPC). 2006a. Respect for the Land: The Decho Land Use Plan. http://dehcholands.org/docs/dehcho_final_draft_june_02_06/Final%20Draft%20Dehcho%20Land%20Use%20Plan_June%202-06.pdf (Site accessed September 2011).

Dehcho Land Use Planning Committee (DLUPC). 2006b. Generalized Density of Traditional Land Use and Occupancy (map). http://dehcholands.org/atlas/Maps%20from%20Final%20Draft%20Background%20Report%20-%20May%202006/Map%2002%20-%20Density%20of%20TLUOS.pdf (Site accessed September 2011).

EBA Engineering Consultants Ltd. (EBA). March 2006. Traditional Knowledge Study Report: Great Bear River Bridge. Prepared for Government of Northwest Territories Department of Transportation for submission to the Sahtu Land and Water Board. EBA Project No: 1700157.001.

Ecosystem Classification Group. 2010. Ecological Regions of the Northwest Territories-Cordillera. Department of Environment and Natural Resources, Government of the Northwest Territories, Yellowknife, NT, Canada.

Environment and Natural Resources, Government of Northwest Territories (ENR). 2010. Northwest Territories Annual Air Quality Report 2009. Environment Division.

Environment and Natural Resources, Government of Northwest Territories (ENR). 2010a. Dehcho Boreal Caribou Study Progress Report [internet resource]. Fort Simpson, NT. Available online: http://www.enr.gov.nt.ca/_live/documents/content/ProgRep6_Dehcho_Boreal_Caribou_Study_AbsoluteFinal.pdf. (Site accessed September 2011).

Environment and Natural Resources, Government of Northwest Territories (ENR). 2010b. Ecosystem Classification Group. Ecological Regions of the Northwest Territories – Cordillera. Government of the Northwest Territories, Yellowknife, NT, Canada. x + 245 pp. + insert map.

Environment and Natural Resources, Government of Northwest Territories (ENR). 2011. Wildlife Research Permits. http//wwwenr.gov.nt.ca/_live/pages/wpPages/Wildlife_Research_Permits.aspx. (Site accessed October 2011)

Environment Canada. 2008. Scientific Review for the Identification of Critical Habitat for Woodland Caribou (Rangifer tarandus caribou), Boreal Population, in Canada. August 2008. Environment Canada, Ottawa.

Ford, B.S., P.S. Higgins, A.F. Lewis, K.L. Cooper, T.A. Watson, C.M. Gee, G.L. Ennis and R.L. Sweeting. 1995. Literature Reviews of the Life History, Habitat Requirements and Mitigation/Compensation Strategies for Thirteen Sport Fish Species in the Peace, Liard, and Columbia River Drainages of British Columbia. Can. Manuscr. Rep. Fish. Aquat. Sci. 2321: xxiv+342 p.

Fournier, M. and J. Hines. 1999. Breeding ecology of the Horned Grebe Podiceps auritus in subarctic wetlands. Occasional Paper No. 99. Canadian Wildlife Service, Yellowknife, NT.

Government of Canada. 2010. Species at Risk Public Registry. Web access: http://www.sararegistry.gc.ca/ default_e.cfm (October 2010).

Government of the Northwest Territories. 2000 - *Investing in Roads for People and the Economy: A Highway Strategy for the Northwest Territories.*

Government of the Northwest Territories (GNWT). 2011. Our Wildlife (Species Descriptions). Department of Environment and Natural Resources. Available at Website: http://www.enr.gov.nt.ca/_live/pages/wpPages/Our_Wildlife.aspx. Accessed: February 2011.

Gwich'in Land Use Planning Board. 2010. Draft Gwich'in Land Use Plan. Web access: http://www.gwichinplanning.nt.ca/publications.html (October 2010).

Gwich'in Social and Cultural Institute. 2005. Gwich'in Traditional Knowledge Study of the Mackenzie Gas Project Area. Prepared by the Gwich'in Social and Cultural Institute under contract to Imperial Oil Resources Ventures Limited. Published by the Gwich'in Social and Cultural Institute.

Gwich'in Tribal Council and the Government of the Northwest Territories. 2011. Project Description Report for the Construction of the Mackenzie Valley Highway Gwich'in Settlement Area. Prepared for the Gwich'in Tribal Council. January 2011.

Hengeveld, H. 1997. The science of climate change. In: Responding to Global Climate Change in British Columbia and Yukon, Volume I of the Canada Country Study: Climate Impacts and Adaptation. Edited by: E. Taylor and B. Taylor. Aquatic and Atmospheric Sciences Division, Pacific and Yukon Region, and the Air Resources Branch, British Columbia Ministry of Environment, Lands and Parks, Vancouver, BC.

Imperial Oil Resources Ventures Limited (IORVL). 2004. Environmental Impact Statement for the Mackenzie Gas Project. Submitted to the National Energy Board. IPRCC.PR.2004.01.

Joynt, A. and M.G. Sullivan. 2003. Fish of Alberta. Lone Pine Publishing. Edmonton, Alberta. 176 pp.

K'ahsho Development Foundation. 2012 - Project Description Report for Construction of the Mackenzie Valley Highway K'ahsho Got'ine District, Northwest Territories.

Kokelj, S. A. 2001. Hydrologic Overview of the Gwich'in and Sahtu Settlement Areas. Water Resources Division Indian and Northern Affairs Canada. Yellowknife, NWT. December 2001.

Legislative Assembly of the Northwest Territories. 2011. Community Profile of Wrigley, NWT. http://www.assembly.gov.nt.ca/_live/pages/wpPages/mapwrigley.aspx (Site accessed September 2011).

Legislative Assembly of the Northwest Territories. No Date (a). Aklavik. Retrieved September 30, 2010 from http://www.assembly.gov.nt.ca/_live/pages/wpPages/mapaklavik.aspx.

Legislative Assembly of the Northwest Territories. No Date (b). Inuvik. Retrieved September 30, 2010 from http://www.assembly.gov.nt.ca/_live/pages/wpPages/mapinuvik.aspx.

Legislative Assembly of the Northwest Territories. No Date (c). Fort McPherson. Retrieved September 30, 2010 from http://www.assembly.gov.nt.ca/_live/pages/wpPages/mapfort mcpherson.aspx.

Legislative Assembly of the Northwest Territories. No Date (d). Tsiigehtchic. Retrieved September 30, 2010 from http://www.assembly.gov.nt.ca/_live/pages/wpPages/ map tsiigehtchic.aspx.

Marsden, J.E. and M.A. Chotkowski. 2001. Lake Trout Spawning on Artificial Reefs and the Effect of Zebra Mussels: Fatal Attraction. Journal of Great Lakes Research. 27:33-43.

Mackenzie Valley Environmental Impact Review Board (MVEIRB). 2004. Environmental Impact Assessment Guidelines. March 2004.

Nagy, J.A. and D. Johnson. 2006. Estimate of the Number of Barren-ground Caribou in the Cape Bathurst and Bluenose West Herds and Reindeer/Caribou on the Upper Tuktoyaktuk Peninsula Derived Using Post Calving Photography, July. Department of Environment and Natural Resources, Manuscript Report No. 171.

Nagy, J.A., D. Auriat, W. Wright, T. Slack, I. Ellsworth, and M. Kienzler. 2005. Ecology of Boreal Woodland Caribou in the Lower MacKenzie Valley, NT. Department of Resources, Wildlife, and Economic Development, Yellowknife, Northwest Territories, Canada.

Nelson, J.S. and M.J. Paetz. 1992. The Fishes of Alberta. The University of Calgary Press. Calgary, Alberta. 437 pp.

Outcrop Ltd. 1990. Northwest Territories Data Book: 1990/91. Yellowknife, NWT.

Northwest Territories Protected Areas Strategy (PAS) Secretariat. 2009. Pehdzeh Ki Ndeh. http://www.nwtpas.ca/area-pehdzeh.asp (Site accessed September 2011).

Pasitschniak-Arts, M. and S. Lariviere. 1995. Gulo gulo. The American Society of Mammalogists 289: 1- 8. In: Haysson, V. (editor). Mammalian Species online reference. Web access: http://www.science.smith.edu/departments/Biology/VHAYSSEN/msi/pdf/i0076-3519-499-01-0001.pdf (November 2010).

Peek, J.M. 1998. Habitat relationships. A.W. Franzmann and C.C. Schwartz, eds. Ecology and Management of North American Moose. Smithsonian Institution Press, Washington.

Natural Resources Canada. 1995. Canada Permafrost (map at a scale of 1:7 500 000). The National Atlas of Canada, 5th Edition.

Pilon, J.-L. 1985. Mackenzie Valley Archaeological Survey Field Report. Northwest Territories Permit No. 85-585. Report on file, Prince of Wales Northern Heritage Centre, Yellowknife.

Pilon, J.-L. 1988. Report of the 1987 NOGAP Archaeological Field Activities in the Southwest Anderson Plain, District of Mackenzie, Northwest Territories. Northwest Territories Permit No. 87-616. Report on file, Prince of Wales Northern Heritage Centre, Yellowknife.

Pilon, J.-L. 1992. Report of the 1991 NOGAP Archaeological Field Activities in the Southwest Anderson Plain and in the Mackenzie Valley, District of Mackenzie, Northwest Territories. Northwest Territories Permit No. 91-698. Report on file, Prince of Wales Northern Heritage Centre, Yellowknife.

Robertson, G.J. and R.I Goudie. 1999. Harlequin Duck (*Histrionicus histrionicus*). The Birds of North America Online (A. Poole. Ed.). Ithaca: Cornell Lab of Ornithology; Available at website: http://bna.birds.cornell.edu/bna/species/466/articles/introduction. Website accessed: February 2011.

Ronaghan, B. 2000. Heritage Resources Impact Assessment Department of Transportation Mackenzie Valley Winter Road Upgrade Programme Northwest Territories Archaeologist’s Permit 99-892. Report on file, Prince of Wales Northern Heritage

Sahtu Heritage Places and Sites Joint Working Group (SHPSJWG). January 2000. Rakekee Gok’e Godi: Places we take care of. http://pwnhc.learnnet.nt.ca/research/sahtu_report/index.asp. (October 16, 2010).

Species at Risk Act (SARA). 2011. Available at: http://www.sararegistry.gc.ca/default_e.cfm.

Scott, W.B. and E.J. Crossman. 1973. Freshwater Fishes of Canada. Fisheries Resources Board Canada Bulletin 184 (Reprinted 1990).

SENES Consultants Ltd. (SENES). December 2009. Spirit of the Mountains: Shuhtagot'ine Nene and Naats'ihch'oh Traditional Knowledge Study. Prepared for Tulita District Land Corporation.

Sahtu Land Use Planning Board (SLUPB). July 2010. Sahtu Land Use Plan Draft 3. http://www.sahtulanduseplan.org/website/web-content/index.html. (October 16, 2010).

Sahtu Land Use Planning Board (SLUPB). 2010a. Sahtu Land Use Planning Board.

Stewart K.W. and D.A. Watkinson. 2007. The Freshwater Fishes of Manitoba. The University of Manitoba Press. Winnipeg, Manitoba. pp 278.

Transportation Association of Canada (TAC). 2010. Guidelines for Development and Management of Transportation Infrastructure in Permafrost Regions. Transportation Association of Canada (May 2010).

Town of Inuvik. 2010. Inuvik History. Retrieved September 30, 2010 from http://www.inuvik.ca/tourism/inuvikhistory.html.

Town of Norman Wells. 2010(a). Visit Norman Wells: A Proud History. http://www.normanwells.com/visit/proud history.html. (October 8, 2010).

U.S. Geological Survey (USGS). 2010. Migration of Birds: Routes of Migration. Web access: http://www.npwrc.usgs.gov/resource/birds/migratio/routes.htm (November 2010).

Webster, S., V. Balls, H. Evans, and J. Harris. 2007. Mackenzie Gas Project 1002 Heritage Resources Program Northwest Territories Permit No. 2006-978. Report on file, Prince of Wales Northern Heritage Centre, Yellowknife.