Foundation for a Sustainable Northern Future

REPORT OF THE JOINT REVIEW PANEL FOR THE MACKENZIE GAS PROJECT

VOLUME I — CHAPTERS 1 TO 10

DECEMBER 2009

Joint Review Panel
for the Mackenzie Gas Project

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For the purposes of identifying references, please consider the following examples:

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INAC	acronym assigned to each participant, group of participants or government department/regulatory agency (Other examples: OHP – Other Hearing Participants, LOC – Letter of Comment)
00177	number assigned to each filing on the public registry
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Joint Review Panel
for the Mackenzie Gas Project

Foundation for a Sustainable Northern Future:

Report of the Joint Review Panel for the Mackenzie Gas Project

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The opinions and views outlined in this report are those of the Joint Review Panel appointed to review the environmental impacts of the proposed Mackenzie Gas Project (the Joint Review Panel for the Mackenzie Gas Project). They are not necessarily the opinion or views of the Government of Canada.

This report was written and transmitted in English. This report has been translated into French. Audio-Interpretation of the Executive Summary is available in Inuvialuktun, Gwich'in, North Dene, South Dene and Dene Tha'.

COPIES ARE AVAILABLE ON REQUEST FROM:

Northern Gas Project Secretariat offices

Yellowknife: 5114 - 49th Street, Yellowknife NT X1A 1P8 Canada
Inuvik: Box 2412, Suite 302, 125 Mackenzie Road, Inuvik NT X0E 0T0 Canada
Norman Wells: Box 299, Norman Wells NT X0E 0V0 Canada
Fort Simpson: Box 120, Fort Simpson NT X0E 0N0 Canada
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Canadian Environmental Assessment Agency
Place Bell Canada, 22nd floor, 160 Elgin Street, Ottawa ON K1A 0H3 Canada
E-Mail Address: publications@ceaa-acee.gc.ca
Telephone: 1-866-582-1884
Electronic version of this report is also available at www.ceaa-acee.gc.ca

Inuvialuit Game Council
Box 2120, Inuvik NT X0E 0T0 Canada
Telephone: (867) 777-2828
Electronic version of this report is also available at http://www.jointsecretariat.ca/documents.html

Mackenzie Valley Environmental Impact Review Board
200 Scotia Centre, Box 938, 5102-50th Ave, Yellowknife, NT X1A 2N7 Canada
Telephone: (867) 766-7050
Electronic version of this report is also available at http://www.reviewboard.ca/registry/project.php?project_id=36

National Energy Board
Publications Office, 444 Seventh Avenue SE, Calgary, AB T2P 0X8 Canada
Telephone: (403) 299-3562 Toll Free: 1-800-899-1265
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Joint Review Panel
for the Mackenzie Gas Project

Suite 302, 125 Mackenzie Road
P.O. Box 2412
Inuvik, NT X0E 0T0
Phone: (867) 678-8604; Fax: (867) 777-3105

December 30, 2009

The Honourable Jim Prentice
Minister of Environment

The Honourable Chuck Strahl
Minister of Indian Affairs and Northern Development

The Honourable Gail Shea
Minister of Fisheries and Oceans

The Honourable John Baird
Minister of Transport

The Honourable J. Michael Miltenberger
Minister of Environment and Natural Resources

Mr. Richard Edjericon
Chairperson, Mackenzie Valley Environmental Review Board

Mr. Frank Pokiak
Chair, Inuvialuit Game Council

Mr. Gaétan Caron
Chair, National Energy Board

Dear Madam and Sirs:

In accordance with the Joint Review Panel Agreement issued on August 18, 2004, the Joint Review Panel has completed its environmental assessment of the Mackenzie Gas Project and the associated Northwest Alberta Facilities.

The Joint Review Panel is pleased to submit its report for your consideration. Subject to the full implementation of the Panel's recommendations, the Panel has concluded that the adverse impacts of the Mackenzie Gas Project and the Northwest Alberta Facilities would not likely be significant and that the Project and those Facilities would likely make a positive contribution towards sustainability.

The Panel is of the view that the Mackenzie Gas Project could provide a foundation for a sustainable northern future.

Yours truly,

Gina Dolphus

Barry Greenland

Percy Hardisty

Rowland J. Harrison, Q. C.

Tyson Pertschy

Peter J. Usher

Robert Hornal

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The Joint Review Panel was fortunate to have been surrounded by a team of dedicated professionals during its review process and wishes to express its appreciation to the individuals and organizations that assisted it in various ways to carry out this important task.

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PREFACE

In undertaking its review of the Mackenzie Gas Project (MGP) and the associated Northwest Alberta Facilities, the Joint Review Panel set out to answer a core question. In doing so, the Panel recognized that key sustainability objectives are to ensure net gains without significant adverse impacts during the life of the Project and effective use of the Project and associated opportunities as a bridge to a desirable and durable future, especially in the Project Review Area. In light of these objectives, the core question asked by the Panel was:

> **Can we be reasonably confident that the Project as Filed, if built and operated with full implementation of the Panel's recommendations, would deliver valuable and lasting overall benefits, and avoid significant adverse environmental impacts?**

In the Panel's view, the MGP offers a unique opportunity to build a sustainable future in the Mackenzie Valley and Beaufort Delta regions. The Project itself, as long-term infrastructure, provides a key basis for future economic development. This opportunity carries the risk of adverse impacts, however. The Proponents' mitigations and enhancements, the measures governments would put in place, and the Panel's recommendations would, in combination, mitigate adverse impacts, reduce the risk and enhance the opportunities. Together they would provide the foundation for a durable and sustainable future in the Mackenzie Valley and the Beaufort Delta regions. With these three elements in combination, the regions could benefit from the Project for a long time to come. Without them, the foundation for the future would be less secure, and the likelihood of significant adverse impacts much greater.

The MGP as filed in applications to the National Energy Board (NEB) would have an initial capacity of 1.2 Bcf/d, with an identified gas supply of 0.83 Bcf/d, or approximately 70 percent of the applied-for capacity. The Project as described in the NEB applications, together with an associated project in Northwest Alberta, is referred to by the Panel as the "Project as Filed" and is the central focus of the Panel's review.

While the initial capacity of the MGP would be 1.2 Bcf/d, the Mackenzie Valley Pipeline is being designed with the possibility of its future expansion to a capacity of 1.8 Bcf/d. Neither the Proponents nor other participants identified specific sources of the additional gas supply beyond 0.83 Bcf/d required to fill the pipeline at its initial capacity of 1.2 Bcf/d or at its expanded capacity of 1.8 Bcf/d. However, the Panel regards such developments as "reasonably foreseeable" with respect to reviewing the potential impacts of the Project in combination with future developments.

The Project would likely entrain many other developments, some implicit in the Project design and reasonably foreseeable, and others that might be induced by the Project but not necessarily directly related to it. The prospect of these additional developments was the basis of both the aspirations and the apprehensions the Panel heard with respect to the Project.

A decision to proceed with the Project would therefore be the occasion for major change throughout this important region of Canada. This change could be positive or negative depending on what others do with it. Such an occasion comes perhaps once in a generation, and presents an opportunity to build a sustainable future that should not be lost.

The Proponents have committed to provide certain mitigations and enhancements with respect to the Project, the most important of which include the establishment of the Aboriginal Pipeline Group, the negotiation of Access and Benefits Agreements with Aboriginal authorities, and their commitments to train and employ northern residents. Governments have also committed to providing important mitigations and enhancements, the most notable being the creation of the Mackenzie Gas Project Impacts Fund.

The Panel's recommendations are intended not only to ensure and enhance the benefits that the Proponents and governments would provide, but also to provide a firm foundation for avoiding or minimizing negative impacts and for anticipating and responding to the cumulative impacts that the Project, in combination with other developments, would almost certainly bring. Key Panel recommendations that would avoid or minimize adverse impacts on the biophysical environment addressed the need to: provide for offsets for habitat loss in the Kendall Island Bird Sanctuary and strengthen the regulatory regime there; fulfill the requirements of the *Species at Risk Act* (particularly with respect to the identification of critical habitat); implement the Protected Areas Strategy; complete and approve regional land use plans that incorporate development thresholds; and establish a special management area in the Mackenzie Delta.

To enhance socio-economic benefits, and also to promote equity among regions, communities and persons, the Panel has made recommendations to: enhance training programs; reduce barriers to employment relating to gender and diversity equity; minimize the impacts of rotational employment and in-migration, and the impacts of alcohol and drug abuse; ensure that vulnerable sectors of the population are not left without support; and provide for a resource revenue sharing agreement and for transition planning that would ensure a lasting beneficial legacy of the Project for the people of the North.

The Panel has recommended that there be a follow-up program for monitoring and managing Project impacts, and that the Cumulative Impacts Monitoring Program, required under the *Mackenzie Valley Resource Management Act*, be implemented to provide both for regional cumulative impacts monitoring and for direction to the follow-up program. Finally, to address public concerns about government preparedness and commitment, the Panel has recommended the establishment of an independent mechanism to monitor the performance of governments in implementing the Panel's recommendations.

Most of the Panel's recommendations to the Proponents are intended to ensure that, should the Project proceed, detailed Project designs, prevention or mitigation plans and baseline information not available at the time of the hearings are provided as needed to regulators, as for the most part the Proponents committed to do. Some Panel recommendations require monitoring and reporting during construction and operations. Some require best practice or best available technology, or higher standards during construction and operations. The Panel's recommendations do not require major Project rerouting.

There was a broad consensus among participants (although by no means unanimity) that the Project on its own could be acceptable and indeed beneficial, with few modifications to the Project itself, and with the appropriate responses from governments. The Panel has made numerous recommendations intended to improve or enhance the Proponents' designs, mitigations and enhancements, and the measures proposed by governments. These recommendations, if implemented, would provide greater certainty and assurance that the potential adverse effects of the Project would be minimized or avoided, and that the Project's benefits would be enhanced or made more likely.

For the Panel, answering the larger question of "What will the Project bring?" or "What will the Project mean for the future?" meant considering the cumulative impacts of the Project with other future developments as was required in the definition of "impact on the environment" in the Panel's Mandate.

The Panel's recommendations to governments address mainly the need to be prepared for cumulative impacts of the Project in combination with future developments. These recommendations provide a basis for managing future development and change, by establishing anticipatory and continued protection of the biophysical environment, capturing the socio-economic opportunities and addressing associated risks and problems, ensuring equitable distribution of the benefits and challenges, and using the resources and other opportunities from the Project and related activities for a transition to a more sustainable future.

The Panel has recommended that the Government of Canada engage in the activities and commit the funding required to implement things it has already committed to do, such as fulfilling its obligations under the *Species at Risk Act*, the *Mackenzie Valley Resource Management Act*, and the Protected Areas Strategy. The Panel has also recommended that the Government of the Northwest Territories fully meet the needs of existing programs and services, ensure that Project demands during the construction phase do not impair these programs and services, and mitigate Project impacts as it has committed to do under the Socio-Economic Agreement. In recognition of the limited fiscal capacity of the Government of the Northwest Territories, the Panel has recommended a revenue sharing agreement with the Government of Canada. In the Panel's view, there is an obligation on the part of Canada, which would be the chief beneficiary of Project revenues to governments, to ensure that those jurisdictions that must bear the costs of the Project are able to do so.

In answer to its core question, the Panel is confident that the Project as Filed, if built and operated with full implementation of the Panel's recommendations, would deliver valuable and lasting overall benefits, and avoid significant adverse environmental impacts, recognizing that the sustainability objective is to ensure not just net gains without significant adverse effects during the life of the Project, but also effective use of the Project and associated opportunities as a bridge to a desirable and durable future, especially in the Project Review Area but also beyond.

The Panel adds that this future would be a better one than a future without the Project. Without the Project, the opportunities for economic and social improvement would be missed, without any corresponding improvement in the prospects for environmental sustainability.

In the Panel's view, the Mackenzie Gas Project and the associated Northwest Alberta Facilities would provide the foundation for a sustainable northern future. The challenge to all will be to build on that foundation.

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Defined Terms

abandonment — The permanent relinquishment of control over or responsibility for a facility, subject to any ongoing monitoring requirements and potential financial liability.

Anchor Fields — The three natural gas fields in the Mackenzie Delta namely: Taglu, Parsons Lake, and Niglintgak.

Commencement of Construction — To include the clearing of vegetation, ground-breaking and other forms of right-of-way and station site preparation that may have an effect on the environment, but does not include activities associated with normal surveying operations or data collection activities.

Decision to Construct — With respect to each portion of the Facilities, the earliest of the date on which (i) the Owners make an unconditional decision to proceed with construction of such portion; or (ii) all conditions of a decision by the Owners to proceed with construction have been satisfied or waived for such portion; or (iii) all necessary Regulatory Authorizations for the commencement of construction of such portion have been received and physical construction activities thereon have actually commenced. For purposes of this definition, physical construction activities do not include surveying activities, environmental, archaeological and geotechnical investigations, data gathering and other activities of a similar investigative nature, and preparation of staging areas.

decommissioning — The steps that would be taken at the end of the operating life of any specific facility to permanently remove that facility from service, including steps to ensure the safety of the facility, to mitigate any anticipated environmental impacts, and to reclaim the biophysical environment. Expansion Capacity Scenario — The pipeline is being designed with the potential, with the installation of 11 additional compressor stations and other facilities, to expand from an initial capacity of 1.2 Bcf/d to an expansion capacity of 1.8 Bcf/d. This Expansion Capacity Scenario would proceed only if additional natural gas fields, other than that of the Anchor Fields, were discovered, developed and put into production, probably involving parties other than, or at least in addition to, any of the Proponents.

Government Response — The response to the Panel's Report by the Government of Canada that is required under the provisions of the *Canadian Environmental Assessment Act* and for which there is provision in the *Mackenzie Valley Resource Management Act*.

Leave to Open — The date of the granting of leave by the National Energy Board to open the Mackenzie Valley Pipeline, as required under the provisions of the *National Energy Board Act* (or the issuance of an order by the NEB exempting the MVP from that requirement).

Mackenzie Gathering System — That portion of the Facilities comprised of the proposed natural gas gathering system consisting of gathering lines from the outlet of the gas conditioning facilities at each of the Anchor Fields to and including a gas processing facility in the vicinity of the Town of Inuvik and including the Natural Gas Liquids Pipeline, together with all related temporary and permanent infrastructure located in the Northwest Territories, as any of them may be modified (including through the addition of compression), replaced, repaired, expanded or improved from time to time.

Mackenzie Valley Pipeline — That portion of the Facilities comprised of the proposed natural gas transmission pipeline or pipelines from the outlet of the gas processing facility in the vicinity of the Town of Inuvik to northwestern Alberta, together with all related temporary and permanent infrastructure located in the Northwest Territories, as they may be constructed, modified (including through the addition of compression), replaced, repaired, expanded or improved from time to time.

Natural Gas Liquids Pipeline — That portion of the Mackenzie Gathering System comprised of the proposed liquids line from the outlet of the gas processing facility in the vicinity of the Town of Inuvik to an interconnection with an existing pipeline at Norman Wells, together with all related temporary and permanent infrastructure located in the Northwest Territories, as they may be constructed, modified, replaced, repaired, expanded or improved from time to time.

Northwest Alberta Facilities — Facilities to be constructed in northwest Alberta to connect the Mackenzie Valley Pipeline to the existing pipeline system operated by NOVA Gas Transmission Ltd.

Other Future Scenarios — Scenarios going beyond the Expansion Capacity Scenario of the Mackenzie Valley Pipeline.

Project as Filed — The Project as defined by the Joint Review Panel for the purposes of its review. It comprises the following elements:

- development of and production from the three Anchor Fields at a rate of 830 Mcf/d (0.83 Bcf/d), together with the other components of the Mackenzie Gathering System;
- the Mackenzie Valley Pipeline, with three compressor stations, one heater station and associated facilities, with a capacity of 1.2 Bcf/d; and
- the Northwest Alberta Facilities.

The Project as Filed also provides for the possibility of future expansion as it includes, among other things, installing block valves at the locations of the 11 additional compressor stations.

Project Review Area — The term "Project Review Area" is a generic term established by the Panel for use in this report to describe the area that encompasses the subject matter referred to in comments and submissions from participants in the Panel's proceedings. While it may overlap areas covered by the terms 'Project Area', 'Project Study Area', 'Regional Study Area' and 'Local Study Area' that were developed and used by the Proponents in their EIS, "Project Review Area" is not to be confused with those terms. Although the focus is primarily related to the western NWT, Yukon and northwest Alberta, the subject matter considered during the Panel's review, in some cases extended beyond that area. As such the Project Review Area is not a single geographic area with a fixed geographical boundary. It is a term of convenience that is context sensitive and has no legal status.

Proponents — The proponents of the Mackenzie Gas Project are: Imperial Oil Resources Limited, Imperial Oil Resources Ventures Limited, ConocoPhillips Canada (North) Limited and ConocoPhillips Northern Partnership, ExxonMobil Canada Properties, Shell Canada Limited and Mackenzie Valley Aboriginal Pipeline Limited Partnership (generally referred to as the Aboriginal Pipeline Group, or APG).

Abbreviations and Acronyms

AB	Alberta
ACIA	Arctic Climate Impact Assessment
AEUB	Alberta Energy and Utilities Board
ANC	Alternatives North Coalition
APG	Aboriginal Pipeline Group
ARD	Acid Rock Drainage
ASEP	Aboriginal Skills and Employment Partnership
BACI	Before-After-Control-Impact Approach
BDR	Beaufort Delta Region
BTEX	benzene, toluene, ethylbenzene and xylene
CAC	criteria air contaminant
CAN	Canada
CAPP	Canadian Association of Petroleum Producers
CARC	Canadian Arctic Resources Committee
CBC	Canadian Broadcasting Corporation
CCME	Canadian Council of Ministers of the Environment
CEAA	Canadian Environmental Assessment Agency
CEAA, CEA Act	*Canadian Environmental Assessment Act*
CEAM	Cumulative Effects Assessment and Management
CEAMF	Cumulative Effects Assessment and Management Framework
CH	Community Hearing
CIMP	Cumulative Impacts Monitoring Program
CN Rail	Canadian National Railway Company
CO	carbon monoxide
CO_2	carbon dioxide
COGOA	*Canada Oil and Gas Operations Act*
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CPAWS	Canadian Parks and Wilderness Society
CPCN	Certificate of Public Convenience and Necessity
CPCNL	ConocoPhillips Canada (North) Limited
CSA	Canadian Standards Association
DAS	Dehgah Alliance Society
DCR	Dehcho Region
DFN	Dehcho First Nations
DFO	Fisheries and Oceans Canada
DGGDC	Deh Gah Go'tie Dene Council
DHC	Dehcho Harvesters Council
DPA	Development Plan Approval
DTFN	Dene Tha' First Nation
EC	Environment Canada
ECNO	Ecology North
ECO_2	Equivalent CO_2 units
EIA	environmental impact assessment
EIS	Environmental Impact Statement
EL	Exploration Licence
EMAB	Environmental Monitoring Advisory Board
ENR	Department of Environment and Natural Resources, GNWT
EPP	environmental protection plan
EPR	emergency preparedness and response
ERCB	Alberta Energy Resources Conservation Board
EUB	Alberta Energy and Utilities Board
FJMC	Fisheries Joint Management Committee
GCF	Gas Conditioning Facility
GDP	Gross Domestic Product
GEN	General Letter of Comment
GH	General Hearing
GHG	greenhouse gas
GLJ	Gilbert Laustsen Jung Associates Ltd.
GLWB	Gwich'In Land and Water Board
GNWT	Government of the Northwest Territories
GRRB	Gwich'in Renewable Resources Board
GSA	Gwich'in Settlement Area
GTC	Gwich'in Tribal Council
H_2S	hydrogen sulphide
HADD	harmful alteration, disruption or destruction of fish habitat
HC	Health Canada
HCVA	High Conservation Value Area
HDD	horizontal directional drilling.

HT	Hearing Transcript
HTC	Hunters and Trappers Committee
IAF	Inuvik Area Facility
IBA	Important Bird Area
ICC	Inuvik Community Corporation
ICC	industrial and commercial centre
IEMA	Independent Environmental Monitoring Agency
IFA	*Inuvialuit Final Agreement*
IGC	Inuvialuit Game Council
ILA	Inuvialuit Land Administration
INAC	Indian and Northern Affairs Canada
IORL	Imperial Oil Resources Limited
IORVL	Imperial Oil Resources Ventures Limited
IRC	Inuvialuit Regional Corporation
ISDM	Integrated Service Delivery Model
ISO	International Standards Organization
ISR	Inuvialuit Settlement Region
ITI	Industry Trade and Investment, department of GNWT
JRP	Joint Review Panel for the Mackenzie Gas Project
JRPA	Joint Review Panel Agreement
KCAC	Keeping Clean Areas Clean
KIBS	Kendall Island Bird Sanctuary
KPIA	*Kyoto Protocol Implementation Act*
LMCI	Land Matters Consultation Initiative
LNG	liquefied natural gas
LSA	Local Study Area
Mac	Mackenzie
MACA	Department of Municipal and Community Affairs, GNWT
Mack	Mackenzie
MGP	Mackenzie Gas Project
MGPIF	Mackenzie Gas Project Impacts Fund
MGS	Mackenzie Gathering System
MOU	Memorandum of Understanding
MVEIRB	Mackenzie Valley Environmental Impact Review Board
MVLWB	Mackenzie Valley Land and Water Board
MVP	Mackenzie Valley Pipeline
MVRMA	*Mackenzie Valley Resources Management Act*
N_2O	nitrous oxide
NC	Nature Canada
NEB	National Energy Board
NEB Act	*National Energy Board Act*
NGL	natural gas liquid
NGO	Non-Governmental Organization
NGPS	Northern Gas Project Secretariat
NGTL	NOVA Gas Transmission Ltd.
No.	number
NO_2	nitrogen oxide
NOx	oxides of nitrogen
NPPL	Northern Pipeline Projects Ltd.
NPS	nominal pipe size
NRCan	Natural Resources Canada
NOTAM	Notice to Airmen
NRTEE	National Roundtable on the Environment and the Economy
NSMA	North Slave Métis Alliance
NT	Northwest Territories
NTCL	Northern Transportation Company Limited
NW	Northwest
NWML	Northwest Mainline
NWT	Northwest Territories
NWTCC	Northwest Territories Chamber of Commerce
NWT-PAS	Northwest Territories Protected Areas Strategy
NWTWB	Northwest Territories Water Board
OPS	Operational Policy Statement issued by the Canadian Environmental Assessment Agency
PAI	Pacific Analytics Inc
PFOTP	Pipeline Facilities Operations Training Program
PM	particulate material
PWNHC	Prince of Wales Northern Heritage Centre
Q.C.	Queen’s Counsel
RCMP	Royal Canadian Mounted Police
RLE	Regional Legal Entity
ROW	right-of-way
RRC	Renewable Resources Council
RSA	Regional Study Area
RWED	Department of Resources, Wildlife and Economic Development, GNWT
RWG	Regional Working Group
SARA	*Species at Risk Act*

SCC	Sierra Club of Canada
SCL	Shell Canada Limited
SDL	significant discovery license
SEA	Socio-Economic Agreement between the GNWT and the Mackenzie Gas Project
SEAB	NWT Oil and Gas Socio-Economic Advisory Board
SEIA	socio-economic impact assessment
SEIF	Socio-Economic Impact Fund
SKDB	Sambaa K'e Dene Band
SLWB	Sahtu Land and Water Board
SRD	Department of Sustainable Resource Development, Alberta
SSA	Sahtu Settlement Area
STI	sexually transmitted infection
SWC	Status of Women Council of the NWT
TC	Transport Canada
TCPL	TransCanada PipeLines Limited
TDLC	Tulita District Land Corporation
TFF	Territorial Formula Financing
TH	Technical Hearing
TK	Traditional Knowledge
TOR	Terms of Reference
TS/GH	Topic Specific General Hearing
TSS	Total Suspended Solids
V	Volume
VC	valued component
VEC	valued ecosystem component
VLM	very large modules
WMAC(NWT)	Wildlife Management Advisory Council (Northwest Territories)
WMR	Wright Mansell Research Ltd.
WWF	World Wildlife Fund Canada
YHR	Yellowknife/Hay River

SYMBOLS, WEIGHTS AND MEASURES

$	dollar(s)
%	percent
<	less than
>	greater than
°C	degree(s) Centigrade
µg/m^3	micrograms per cubic metre
Bcf/d	billion cubic feet per day
Btu	British thermal unit
cf	cubic feet
cf/d	cubic feet per day
cf/s	cubic feet per second
cm	centimetre(s)
dB	decibel(s)
dBA	A-weighted decibel(s)
G	Giga (= billion or 10^9)
g/GJ	grams per gigajoule
GJ	gigajoule
GJ/a	Gigajoules per annum
Gm^3	billion cubic metres
ha	hectare
kg	kilogram(s)
kHz	kilohertz
km	kilometre(s)
kt	kilotonne(s)
km^2	square kilometers
kt/a	kilotonnes per annum
L	litre(s)
L/d	litres/day
L_{eq}	energy-equivalent sound level
m	metre(s)
M	million(s)
m^3	cubic metres
m^3/d	cubic metres per day
m^3/s	cubic metres per second
MBtu/d	million British thermal units per day
mcf	thousand cubic feet
mcf/d	thousand cubic feet per day
Mcf/d	million cubic feet per day
mg/L	milligrams per litre
ML	million litres
mm	millimetre
Mm^3	million cubic metres

Mm^3/d	million cubic metres per day
Mpa	megapascal(s)
Mt	million tonne(s)
MW	million watt(s)
pH	measure of acidity/alkalinity
PM_{10}	particulate matter less than or equal to 10 microns
$PM_{2.5}$	respirable particulate matter smaller than 2.5 microns in diameter
t	tonne(s)
T	trillion(s)
t/a	tonnes per annum (tonnes per year)
Tcf	trillion cubic feet

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Project Context

1.1 THE LAND

The Mackenzie is one of the world's great rivers, and the largest in Canada. Its basin in the Northwest Territories (NWT), from Great Slave Lake to the Beaufort Sea, encompasses a diversity of landscapes and ecosystems: Arctic and alpine tundra, upland and lowland boreal forest, large tributary rivers and a multitude of streams, lakes and wetlands. The Mackenzie River reaches the sea through one of the largest deltas in the world, and its sediments and fresh water dominate the adjacent marine environment. These coastal marine waters are among the most productive in the Arctic Ocean. The Mackenzie River basin experiences the extremes of arctic and subarctic climates, and it is underlain by permafrost — ground continuously frozen at depth.

Northern ecosystems are relatively simple systems with low biodiversity. Natural conditions (especially climate, permafrost and soil) constrain biological productivity and growth. Yet the right combination of such factors as moisture, slope and vegetation on land, and temperature, nutrients and mixing in aquatic and marine environments, can create critical habitats for fish and wildlife, areas of high productivity or essential shelter conditions. These critical habitats — that have provided the basis for human survival for centuries — are vulnerable to change, natural or otherwise, and especially to changes in climatic conditions. The fish and wildlife populations they support are also vulnerable to change and over-exploitation. Population declines can be sudden, recovery is usually much slower, success is not assured, and the resulting hardship on people and communities dependent on wildlife can be immediate and long-lasting.

Even the landscape itself is vulnerable to change. Permafrost has been warming at its margins — near the surface and at its southern limits — in recent decades, and is predicted to continue doing so. Where there is high ice content, the seemingly solid ground underfoot would not still be so if it thaws. The outer Mackenzie Delta and adjacent Arctic coastlines are subject to wave erosion, apparently increasingly so as ice cover becomes less prevalent.

For all of these reasons, environmental management in the Mackenzie Basin and Beaufort Sea is particularly challenging, even if the human imprint on the landscape appears light.

1.2 THE PEOPLE

Since Canada acquired the NWT in 1870, it has, in fits and starts, looked to the Mackenzie Valley as both a potential source of wealth and essential to the defence of the nation. In 1888, a Senate Committee was established to inquire into the resources of the great Mackenzie Basin. Treaty making with Aboriginal people followed — the first time in 1899 (after a flood of gold seekers came down the Mackenzie on their way to the Klondike gold fields), and the second in 1921 (after the discovery of oil at Norman Wells). World War II and the Cold War brought new activities to the Mackenzie Valley and the Arctic coast. Renewed interest in oil and gas exploration began in the 1960s and continued at a varying pace into the mid-1980s. In 1985 an oil pipeline was constructed from Norman Wells to Zama, Alberta. All of these events brought short-term booms and sometimes longer-term busts, in the course of which many southern Canadians settled in the North, and almost as many left.

Several distinct Aboriginal populations historically inhabited the Project Review Area. Today the major political and administrative regions within the NWT portion of the area are:

- the Beaufort Delta region (inhabited by the Inuvialuit and Gwich'in) for which the regional centre is Inuvik;
- the Sahtu region, for which the regional centre is Norman Wells; and
- the Dehcho region, for which the regional centres are Hay River and Fort Simpson.

In 2001, these three regions had a total population of 15,000 with Aboriginal and non-Aboriginal people in roughly equal proportions. Just over half the population, which includes almost all of the non-Aboriginal population, lives in the four regional centres (see Figure 1-1). These places — Inuvik, Norman Wells, Fort Simpson and Hay River — are the hubs of economic activity, transport and government services for their respective regions. The rest of the population resides in 18 small communities. The average population of those small communities is less than 400 (ranging from 40 at Kakisa to 930 at Tuktoyaktuk), and is almost entirely Aboriginal. In the Beaufort Delta region, the population is almost evenly divided between Inuvik and the small communities; in the Sahtu, the great majority live in small communities; in the Dehcho, the population is concentrated in Hay River and Fort Simpson.

The territorial capital, Yellowknife, is located several hundred kilometres from the Project and is the regional centre for the entire Project Review Area within the NWT. The population for the City of Yellowknife — at 16,450 in 2001 — is greater than that of the three regions combined. The Panel heard the views of numerous Yellowknife residents.

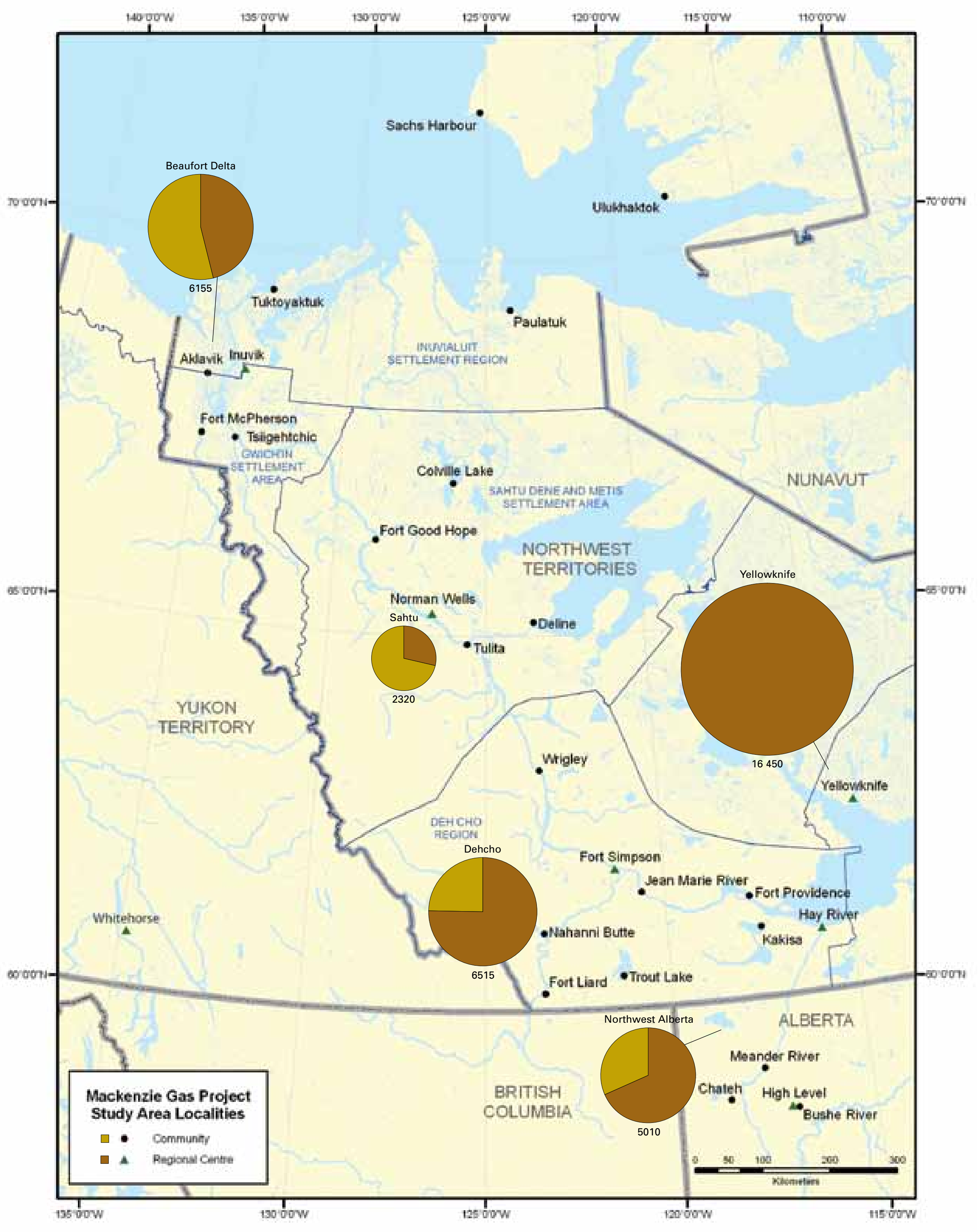
The Aboriginal population of Northwest Alberta, that is the Dene Tha' First Nation, resides mainly on three reserves. The regional centre is the town of High Level.

Within living memory, life in the Mackenzie Valley was dominated by the fur trade. Most people spent much of the year on the land, trapping, fishing and hunting for their livelihood. The only major

Young explorer

Source: Terry Halifax

Figure 1-1 Project Review Area Population Centres, Showing Population Distribution by Region, and by Regional Centres and Other Communities



Source: Panel Figure

resource extraction industry in the region was at Norman Wells, then a single-industry town that employed few Aboriginal people.

The construction of the Distant Early Warning line (DEWline) stations in the 1950s, and the establishment of Inuvik as a regional centre shortly after, coincided with a downturn in the fur trade. These and other factors brought schools and nursing stations to the communities, and opportunities for wage work, particularly in the public sector. These developments brought work for some, but not for all, especially in the smaller communities. The need for food, shelter and cash outstripped work opportunities and what the land could provide. As a result, personal dependence on transfer and welfare payments grew.

There was greater security from want, but the boom and bust pattern dating back to the days of whaling and trapping remained. The construction boom associated with Inuvik and the DEWline was followed by a bust, followed by occasional spikes of oil and gas exploration activity. For many Aboriginal residents, the memory of those years was of watching outsiders employed in the secure and well-paid jobs, whether in government or industry. In the early 1970s, many northerners still depended on trapping and hunting for their living, and if that failed, on government assistance.

Historically, the federal government retained jurisdiction over much of the land and resource base in the Mackenzie Valley, including oil and gas, minerals, water and fisheries. The territorial government provides health, education, social services and community infrastructure, and also has jurisdiction over wildlife and forests.

1.3 THE EVOLVING NORTH

For many participants in the Panel's review, the Mackenzie Valley Pipeline Inquiry, conducted by Justice Thomas Berger in the mid-1970s was a key point of reference. Justice Berger's report — the Berger Report — was often referred to as a benchmark for understanding conditions in the North 35 years ago and how these conditions could be affected by a major gas pipeline project and the industrial development that would follow.

The Berger Report recommended that:

- no pipeline be built in the critical habitat of the northern Yukon; and
- a Mackenzie Valley pipeline be postponed for ten years until land claims could be settled, and new programs and institutions established.

The title of his report, *Northern Frontier, Northern Homeland*, neatly encapsulated the gulf that separated the perspectives and sensibilities of the North's permanent residents from those of most other Canadians. In the outcome, much of what Justice Berger recommended was effected and, with other developments, brought fundamental changes to the North.

Yet today, as in those days, the Aboriginal inhabitants of the Mackenzie Basin see themselves as part of the land. In the communities visited by the Panel, everyday life is full of conversations about the integrity and health of the environment. Details of the subtlest variations in weather patterns and wildlife behaviour, and the abundance and quality of the harvest are day-to-day concerns. The elders sometimes refer to the abundance of wildlife as money in the bank, a source of security in times of economic uncertainty.

Now, however, most households rely on employment for the bulk of household cash income, even in small communities where harvesting is essential to livelihood and the seasonal rhythm of life on the land predominates. Public sector employment in health and education and other government services provide greater economic stability in many communities. There has also been substantial, if not entirely steady, employment in resource development activity, particularly oil and gas exploration and development.

Dependency now takes a different form. The main subsidy to households in communities of the NWT is in shelter: a public housing system that provides shelter to most households below cost. As most small communities have little if any tax base, the basic public services and community infrastructure are provided by the territorial government, largely from funds transferred from the federal government. The North continues to be a high-cost environment in which to maintain the basic food, shelter and health needs of the population and to provide the level of public infrastructure and services that Canadians now expect.

The federal and territorial governments have been negotiating a devolution agreement for many years. This agreement would transfer control of crown-held surface land as well as subsurface oil, gas and mineral resources from the federal to the territorial government. However no such agreement is yet in place, and royalty revenues from resource development on Crown lands do not flow to the territorial government.

Between 1984 and 1994, three of the four Aboriginal groups in the Project Review Area (the Inuvialuit, the Gwich'in, and the Sahtu Dene and Métis) concluded land claim settlements with the federal Government. Land claim negotiations between the federal Government and the Dehcho First Nations are ongoing.

The settlement of land claims has provided Aboriginal groups with:

- title to substantial areas of land within their traditional territories (mostly to the surface only but also to smaller areas of the sub-surface);
- economic benefits including capital transfers, resource revenue sharing and equitable access to government contracting, procurement and economic programs;
- rights to participate in co-managed land, resource and environment regimes; and
- preferential or exclusive harvesting rights to fish and wildlife.

The land claim settlements also provide for shared institutional structures for the management of lands and renewable resources throughout a settlement region. In part, these agreements have helped develop entrepreneurial skills and provide business opportunities to Aboriginal people. These arrangements form the basis of constitutionally protected Aboriginal rights in much of the Project Review Area. Perhaps less obvious is that these arrangements entail continuing legal obligations of consultation and accommodation that now permeate the everyday understandings and operations of governance in the region.

The Inuvialuit, Gwich'in and Sahtu people have more recently embarked on a process of negotiating self-government agreements with the governments of Canada and the Northwest Territories. Self-government agreements would provide an important legal basis for Aboriginal governments to assume powers and responsibilities in some areas that are typically the jurisdiction of the federal or territorial government. In particular (with regard to taxation, social programs, education, health care and justice), self-government agreements would provide a means for Aboriginal governments to establish laws, collect revenues and deliver programs that may better serve the needs and requirements of their citizens. However, no final self-government agreements have been completed in these regions. Until they are, the Panel understands that an important set of tools — in addition to those provided in land claim agreements — for managing the impacts and capturing certain benefits of development is not yet available.

The vision of the North as a frontier and a land of economic opportunity continues in Canada. But increasingly, Canadians also see the North as an environment to conserve for its ecological assets. They value these assets — its forests and tundra, its wetlands, streams and rivers — not merely as "pristine wilderness" but also as the basis for Canada's future well-being. The Canadian Boreal Initiative in its report submitted to the Panel, *The Real Wealth of the Mackenzie Region: Assessing the Natural Capital Values of a Northern Boreal Ecosystem*, stated:

> Accounting for the value of natural capital — in physical, quality and economic terms — would help to reveal their present condition and importance to our economic well-being now, and more important, in the future, as natural landscapes untouched by human development become scarce. (J-OHP-00292, p. 13)

Wildlife and environmental management issues rank high in public policy consideration in the NWT. As a result, these issues have a strong influence on government programming, research and spending in the NWT. It is notable that modern day land claim agreements devote much attention to these matters, and they establish important conservation objectives and specific management arrangements to address them. The agreements establish shared environmental management regimes. These shared regimes or institutions of public governments, through representatives of Aboriginal organizations and federal and territorial governments, manage wildlife and habitat, northern research, environmental impact screening and review, land use and conservation planning and environmental monitoring.

The land claim agreements and the recent case law pertaining to the Crown's duty to consult with Aboriginal people regarding potential infringement of their Aboriginal and treaty rights by proposed developments have altered the environment in which environmental assessments of major projects are conducted and the arrangements by which affected Aboriginal people and their communities are consulted and their concerns accommodated. While the interpretation of case law — including the scope and nature of its implications — may be subject to public and legal debate, it is clear that the level of scrutiny is very high for environmental assessments of major developments that may affect the rights and interests of Aboriginal people in their traditional territories.

In sum, a distinctive set of institutional arrangements for environmental assessment and management has been established in the Northwest Territories. These arrangements have led to a distinctive approach to these issues, one that expects both old practices and new developments to contribute to the goals that northerners have set for themselves including environmental integrity, cultural continuity and economic sustainability.

1.4 ASPIRATIONS AND APPREHENSIONS

The regional context of the current Mackenzie Gas Project (MGP) proposal is very different from the pipeline project reviewed by Justice Berger more than thirty years ago. The hopes and aspirations that many northerners, and especially Aboriginal northerners, hold for the proposed MGP are much more positive than was the case in the 1970s. In no small measure this is because many feel they have since obtained the tools — through land claims, increased self-governance, better education and training, and perhaps above all through experience with industrial development (mainly in the oil and gas industry) — to take advantage of the opportunities the Project would provide. Yet the doubts and apprehensions that many also express have not changed much from the days of the Berger Inquiry.

In the Panel's first community hearing in Fort McPherson, Abe Wilson, President of the Renewable Resources Council and a hamlet councillor observed that:

> It has been almost 30 years since the Berger report came out. I was wondering if any one of you had a chance to go through the report and look and see what's in the report. Because I went through the report last night and what we're talking about and what you're hearing, and what you're going to hear for the next nine months is basically all in that report. But the difference is that that report was 30 years ago, so things have changed and our way of life has changed. So

> I was just wondering if any of you panel members had a chance to look at it and you're going to see things that they talk about, the social issues, the climate change, economic development, cultural impact; it's all there. It just happened 30 years ago. (HT V4, p. 314)

What has not changed since the mid-1970s is that the public still regards the Project not simply as another industrial development, but as a force that would irrevocably change the life of the region, whether for better or worse. Many participants expected the Panel to consider what those larger, longer-term changes would bring, i.e. what the cumulative impacts of the Project might be, not just the impacts of the Project itself. What has indeed changed is the variety of views about the Project that reflect the greater diversity and complexity of life in the region today.

Also unchanged since the Berger Inquiry is the basic pattern of settlement in the Project Review Area. Despite the distinctive character of the regions — and indeed of each place the Panel visited in the NWT — there are strong commonalities among the small communities on the one hand, and among the larger regional centres on the other, and a great difference between the two. The difference is not limited to size. The communities and the regional centres differ in demographics, economic activity and organization, labour force characteristics, infrastructure, governance and circumstances of life. The dynamics and trends of life in the communities differ in important respects from those in the regional centres.

Expectations are high in the Project Review Area about the economic and social benefits that could come from the Project.

The Government of the Northwest Territories (GNWT) said, in its opening statement:

> Our government is committed to our vision of self-reliant individuals and families sharing the rewards and responsibilities of healthy communities in a prosperous and unified Northwest Territories. … This project will provide significant opportunity for residents of the Northwest Territories to take control of their economic future. (Michael Miltonberger, HT V1, p. 8)

The GNWT added, in its closing statement:

> The Government of the Northwest Territories recognizes the Mackenzie Gas Project is critical to the long-term strategic interests of the Northwest Territories and the future of our residents. Our priority is to ensure development of oil and gas reserves in the Northwest Territories occur in a manner that is environmentally, socially, culturally and economically sustainable.
>
> …
>
> As a catalyst for northern hydrocarbon development, this Project is critical to the long-term strategic interests of the Northwest Territories and to the social and economic future of our residents and communities. It is imperative this Project set the standard for other projects that will follow. (J-GNWT-00324, p. 4)

Fred Carmichael spoke to the Panel on behalf of the Gwich'in Tribal Council about the need for the Project to provide the people of the north with the resources needed to manage their own affairs:

> We see this project as providing capacity for our people so that we take control and care of our land and environment. … it is clear that all of the above will require dollars. It takes money to deal with these issues. With an economic base that this project will provide, we will be able to deal with the environment and the social and the governments' issues. There will also be many positive spin-offs in terms of business opportunities, job opportunities, training opportunities for our people. We see the Mackenzie Gas Project as the first step towards self-sufficiency for our people. Mr. Chairman, Panel Members, you have a very important decision to make. Your decision will affect the Aboriginal people and all northerners in terms of their future economic health of this territory. Your decision will impact our capability for stewardship over our land, environment and overall well-being. For well over 100 years, the fur traders, religious organizations, colonial governments have dictated what they thought was best for us, often to our detriment. And if you look today just the mess and the hardships the residential schools have put on our people today, and a lot of our social problems today is as a result of that. That's just one example. The current fiscal environment of the Northwest Territories is one where there are insufficient funds for health, education, housing and infrastructure, and so on. In an area with some of the highest suicide and addiction rates in the country, there are not enough counsellors or treatment centres. With the resources from the Mackenzie Gas Project, we can take charge and create a healthier future for our people. I urge you at this time to please listen to the people who live here. Please remember that at the very beginning of discussions on this pipeline, in 1999–2000, over 30 Aboriginal leaders came together and decided to be a dynamic partner in this project, and today the majority of Aboriginal people and northerners are supporting and want this project. We see this project as the first step towards economic self-sufficiency for our people. Our people will regain their pride and their independence. Mr. Chairman, Panel Members, this time, please let us decide what is best for us. (HT V114, pp. 11418–19)

Chief Charlie Furlong of the Aklavik Indian Band, was similarly supportive of the Project and spoke about why, in his view, it was needed for the opportunities it would bring to his people. He explained that with the settlement of the Gwich'in Land Claim, the Gwich'in had the tools they needed to manage development that would take place on their lands and that the Agreement outlines processes to be followed if the Gwich'in want to develop their resources:

> The Land Claim Agreement speaks about protection of the environment, protection of the air, protection of the water. It calls for partnerships with various government agencies, Fisheries and Oceans, Department of the Environment. All

> of this allows the Gwich'in to be partners in protecting their land and environment. It brings us all together. During the Berger hearing, I spoke out against the pipeline because we didn't have this. Now today, I have faith in this. The Gwich'in from Aklavik whom I represent see business opportunities and jobs that [are] going to benefit our people right now. Right now, we have nothing. There is much potential that will continue to the project. One of them is gravel. The development of our gravel sources will provide many jobs for Aklavik, many jobs for the small business sector. It will encourage education. It will encourage our younger people to go out and get that education so they can take control of the very management boards that are in this Land Claim Agreement. I envision in 20 years to see our people with lawyer degrees, people with university education to take control of those managing boards where they can compete on an equal level with government and industry and fight to protect our land. This is what this Land Claim Agreement means to me and it means to the future generation of our younger people. (HT V114, pp. 11419–20)

The NWT Chamber of Commerce stated that:

> It is our expectation that one of the legacy items of this build will be the development of a northern based service industry that will not only have the capability, but also, be well-positioned to meet the needs of the next phase of industrial growth. (J-NWTCC-00005, p. 4)

Mayor Gordon Yakeleya of Tulita commented:

> If the pipeline was ever to be built, we the people who live around the pipeline route look forward to the pipeline with both a lot of hope, with a lot of — some concern; hope for our economy, hope for jobs for our young people, and hope for obtaining training and new skills, which will help us both be economically successful during the pipeline construction and operation, as well as into the future beyond the pipeline. (Tulita, HT V17, p. 1719)

In her closing remarks on behalf of the Inuvialuit Regional Corporation, Nellie Cournoyea reminded the Panel that the majority of Project-related activities would be taking place in the Inuvialuit Settlement Region and, unlike in other regions along the route of the Mackenzie Valley Pipeline, would take place over the life of the Project. She was confident that the Inuvialuit could achieve a balance by taking advantage of the needed economic opportunities presented by the Project while managing any adverse impacts it would present. She stated:

> The Inuvialuit clearly recognize the major environmental and social challenges that will walk hand in hand with the pipeline project. We have already stated that, if industry and government follow through in a timely and responsible manner on the commitments they have already made — through the access and benefits agreements, the Mackenzie Gas Project Impact Fund — and are respectful of the co-management processes established under our Land Claim[s] Agreement, we can welcome this project, and we can manage its impacts upon our communities and our environment. … In closing, Mr. Chair and Panel Members, we have made our thoughts and our recommendations clear with regard to this basin-opening project. We look forward to your recommendations, as they recognize both the need for the economic opportunity this project will provide to our communities and to the collective ability of the Inuvialuit to manage both the associated environmental and social impacts. (HT V114, pp. 11387–88)

For many Aboriginal leaders, these were not just words. They had already established the Aboriginal Pipeline Group (APG) as an expression of confidence in the Project and in the possibility of Aboriginal people taking an active share in it. At the founding meeting to establish this business partnership with industry, Chief Harry Deneron of Fort Liard remarked:

> We went around the table and gave everybody a chance to raise their voice about this, we're here to see what we thought of the pipeline and that I think around the table everybody wants to take control and ownership of the pipeline. For the leaders around the table to come and talk about the pipeline and want to take control of it is very significant and I know that this is just the beginning. (J-ADK-00011, p. 30)

Speaking on behalf of the APG, Fred Carmichael said:

> Today our people are looking for a way to become self-sufficient again. We realize for this to happen we must have an economic base. As there are no other industries in this area, such as mines and so on, we see this opportunity in oil and gas and pipeline development as a way to provide that economic base. (HT V2, p. 69)

These interveners perceived the need for the Project not simply in its own terms, but as an opportunity and a catalyst to open up the NWT to further development and the establishment of a northern-based petroleum industry attended by opportunities for employment, business opportunities and wealth generation.

Just as many participants spoke to the Panel of their aspirations for the future, many also spoke of their apprehensions. Some spoke of their hopes and, at the same time, of their fears. In doing so, they struggled with a universal preoccupation of humankind: "What does the future hold?" Specifically, what would the MGP mean for the future of the North? For some, the answer was opportunity, for others risk of the unknown. Some who saw the MGP as an opportunity also acknowledged that that opportunity would come with its own risks.

Some doubted the capacity of northern governments and institutions to ensure that there would be durable benefits, fairly distributed. Alternatives North Coalition acknowledged the desires of northerners for jobs and other opportunities from such a large-scale project, but stated:

> Our governments and many northerners are not ready for development of this scale and pace. We do not have in place, and cannot expect to have in place in time for the MGP, adequate and specific measures and plans to protect the environment and residents, or to ensure a fair and equitable distribution of the costs and benefits of the MGP. (J-ANC-00085, p. 4)

> Natural resources belong to the people of the North. They are our gift from the creator. Once they are gone, they are gone. We have one opportunity to benefit from resource extraction. How can we ensure a fair return to the public purse to extract and export gas from the NWT and Canada? What portion of the economic rent do we set aside in a trust fund for future generations? What are the true costs and benefits of the project? What are the incremental costs to different levels of government and to the environment? What are the benefits of employment and economic rent, and how do the true costs balance with the true benefits? Is this sustainable? (Suzette Montreuil, HT V1, pp. 17–18)

The Inuvialuit Regional Corporation expressed caution as well as hope:

> The project's impact upon the social fabric and well-being of our communities is of paramount concern to all Inuvialuit. The scope, size and immediacy of this basin opening project will impact every element of our lives, both during the construction and in the decades ahead as others follow through where the pipeline proponents now lead. … The project that is now before us has been anticipated by the Inuvialuit for over 30 years. … It is a challenge we face with both enthusiasm and caution. Our enthusiasm flows from the many economic opportunities the project will provide the Inuvialuit during the construction period and to our youth and future generations as development of these new hydrocarbon basins advance over time. Our caution is fuelled by the understanding that there will be unavoidable social impacts from this and other hydrocarbon projects in the years ahead, and also by the recognition that we must be eternally vigilant in ensuring our natural environment is not diminished by the very forces that feed our economic well-being. (Nellie Cournoyea, HT V1, pp. 10–11)

Many participants voiced concerns about persistent health and social problems in northern communities. These issues included alcohol and substance abuse, domestic violence, unemployment, incarceration, suicides and infant mortality. The Proponents, as well as most participants, agreed that health, family, community and social conditions in the NWT in general, and the Mackenzie Valley communities in particular, were often unhealthy. In the view of some participants, these conditions would be aggravated by the Project:

> There's about five other projects that's — we're going to be surrounded by development, and we're going to have a lot of social effects that affects us already happening now because of a camp that's located across the river. We see a lot of increase in alcohol, and I'm sure there's drugs in our community too. (Jessie Campbell in Tulita, HT V17, p. 1702)

Steven Kakfwi, a former premier of the NWT, stressed the need for self-government agreements to ensure that communities could in fact realize the potential benefits of the Project, and asked Canada to:

> guarantee to Aboriginal governments in the Northwest Territories, and particularly for communities along the right-of-way, that they will have a direct flow of revenue from resource development; agreements that would provide for a net benefit so that every Aboriginal government that is set up, whether it's a provisional government made up of a Chief and Council and Land Corporations, or whatever local institution we use, that they have, as any other government in this country would, some source of revenue. Not a gift, not a benevolent payment, not core funding, not grants, not contributions, but revenue from the resources of our own land to provide for ourselves. (Fort Good Hope, HT V23, pp. 2125–26)

Some participants acknowledged a need for gas in the global market but felt that if the Project were to be developed to meet that need, it should be "green" in that it should be required to be carbon neutral. Ecology North saw the need to end dependency on fossil fuels in order to reduce emission levels of greenhouse gases (GHGs). Ecology North cited international efforts to reduce that dependency and advocated that if the Project were to proceed, the Proponents should be required to purchase carbon credits to offset the Project's GHG emissions.

Other participants expressed reservations about how the Project would alter what they most deeply valued about life in the North:

> This is my home; not in a proprietary way, but in the sense that I have chosen, with all my heart and soul, to be here, and I care deeply about the land and its people. You may think that I am here to talk to you about the pipeline, but I'm not. To me, this is not a public hearing on the Mackenzie Gas Project but on whether or not we want industrialization of the Mackenzie Valley.

> We are told this is the next Alberta, but we must learn from the experience of others in Alberta. … Is this the best we can do? To import and replicate the Alberta model of oil and gas development is the only thing we can think of? This is all our best and brightest have come up with? Have we lost all creativity, spirit, and imagination? We are supposed to have moved forward in the last 30 years, but have we really? (France Benoit in Yellowknife, HT45 V45, pp. 4270, 4272, 4274)

The apprehensions of many participants appeared to the Panel to stem mainly from two specific sources. Firstly, many were sceptical that the Project would in fact be built and operated in full compliance with all conditions and commitments, on the part of both the Proponents and governments. The Panel addresses this concern in its detailed consideration in Chapter 18, "Monitoring, Follow-up and Management Plans," and in Chapter 19, "Sustainability and Net Contribution," with its overarching recommendation that the implementation of government commitments with respect to the Project be subject to independent monitoring.

The second source of concern was the absence or unreliability of information with respect to future developments beyond the Project itself. The MGP presents unique challenges in this regard. The components of the Project — as it is proposed in the regulatory applications that have been filed (referred to by the Panel as the Project as Filed, as explained in Chapter 3, "Potential Future Developments") — are known and their impacts can be predicted with reasonable confidence. The Project is, however, likely to lead to further developments. The Panel has concluded it is reasonably foreseeable that gas field developments to support throughput on the MVP at its initial design capacity of 1.2 Bcf/d would occur. It is not, however, possible at this time to identify their specific scope or location. Given that the MVP would be designed for the possibility of its later expansion to a capacity of 1.8 Bcf/d, the development of still further gas fields may well follow, but even less can be known now about their nature or scale. Yet other potential developments that were suggested to the Panel enter the realm of speculation.

As the Panel and others look forward beyond the Project itself, they are faced with the potential for other developments about which there is increasingly less information the further one projects into the future. While many participants expressed concerns about the impacts of the Project itself, the fundamental concerns of many were grounded in this uncertainty about future developments that might follow from the Project as Filed. At the same time, some participants saw the real opportunities that the Project would provide as flowing from those future developments beyond the Project as Filed.

This has led the Panel to approach uncertainties about future developments that might follow from the Project as an opportunity versus risk matrix, reflecting aspirations and apprehensions arising from the Project. This is discussed further in Chapter 19, "Sustainability and Net Contribution."

1.5 THE FUTURE AND SUSTAINABLE DEVELOPMENT

Much of the public discussion around pipelines in the North over the last 30 years has focused on two important and enduring questions: what will the future bring? And what future do northerners and other Canadians want? Both questions remain relevant today, and at the heart of much of the evidence that the Panel heard throughout its hearings.

Jim Antoine observed with respect to the first question:

> I don't only see this as a pipeline, but what is following it afterwards is also a big concern, because it's like opening the door for more development of this kind in terms of opening up more land for exploration to keep this pipe running into the future. So that is an unknown right now. You know, what are the time frames that we're looking at in the future? The cumulative effect of this pipeline — that is also a concern. It may just be a ribbon of steel that goes through our area for the time being, but then, in the future, what does that translate into? This is also a question that needs to be answered: What does it mean in the long term? (Fort Simpson, HT V25, pp. 2279–80)

The answer to the second question — What northern future do northerners and other Canadians want? — remains as important and relevant today as it was 30 years ago, when Justice Berger asserted:

> What happens in the North, moreover, will be of great importance to the future of our country; it will tell us what kind of a country Canada is; it will tell us what kind of a people we are. (*Northern Frontier*, *Northern Homeland*, Berger 1977, V 1, p. 1)

Important progress has been made in answering this second question. The opening section in each of the three northern land claims agreements in the Western Arctic and Mackenzie Valley establishes the following as fundamental objectives:

(a) the preservation of cultural identify and values within a changing northern society, including the importance of the cultural and economic relationship of the Aboriginal people to the land;

(b) the full participation of the Aboriginal people in the economies and society of the North and Canada; and

(c) the protection and preservation of Arctic wildlife and the environment.

These are the jointly stated aspirations of the Aboriginal signatories and of the Government of Canada, signing on behalf of the people of Canada. The Panel understands these objectives to be consistent with the hopes of the great majority of people who participated in its review. In sum, if the Project were to proceed, participants want it to bring durable benefits to the Mackenzie Valley and the Western Arctic, and to contribute positively to the sustainability of the region's environment and of its economic and social life. Many of the reservations expressed about the Project appear to the Panel to have been grounded in the long experience of boom and bust, and the concern over what northerners will be left with after the Project has come and gone. Northerners are a proud, self-reliant people to whom past developments have brought a mix of improved well-being but increasing dependency. Participants throughout the Project

Review Area made clear their desire that the Project help restore self-reliance and decrease vulnerability.

In the view of so many participants, the Project would inevitably bring much else in its wake, with both positive and negative impacts. That is why the Panel has considered, in its review of the Mackenzie Gas Project and in accordance with its mandate, not only the specifics of the Project described by the Proponents, but also its cumulative impacts and ultimately its contribution to sustainability.

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2.1 INTRODUCTION

2.1.1 PROJECT OVERVIEW

The review conducted by the Joint Review Panel included the construction, operation, maintenance, decommissioning and abandonment of the proposed Mackenzie Gas Project and Northwest Alberta Facilities.

MACKENZIE GAS PROJECT

The proposed Mackenzie Gas Project would develop three onshore natural gas fields in the Mackenzie Delta and transport the natural gas and natural gas liquids (NGL) produced from those fields by pipeline to market.

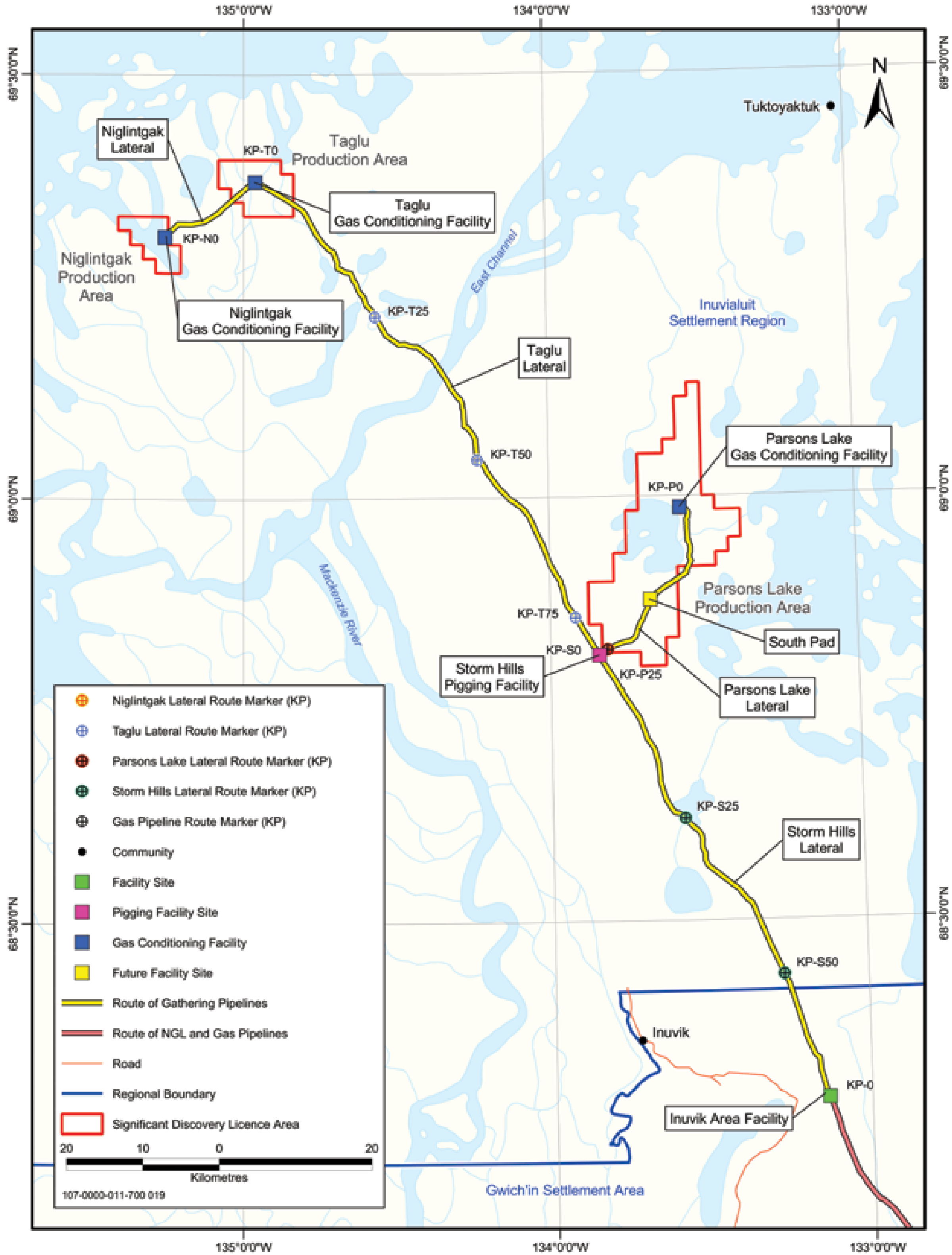
The Mackenzie Gas Project consists of five major components, collectively referred to as the MGP or the Project:

- three natural gas fields at Niglintgak, Taglu and Parsons Lake (production from these three fields would underpin the Project and, accordingly, they are referred to collectively as the Anchor Fields);
- the Mackenzie Gathering System, consisting of gathering pipelines carrying unprocessed natural gas from the Anchor Fields to the Inuvik Area Facility for processing, and a 10-inch pipeline carrying NGL from the Inuvik Area Facility to the existing Norman Wells Oil Pipeline (the Norman Wells Oil Pipeline was not part of the Panel's review process); and
- the Mackenzie Valley Pipeline: a 30-inch pipeline, with three compressor stations and a heater station, carrying gas from the Inuvik Area Facility to a proposed interconnection 10 metres south of the NWT–Alberta border, a distance of approximately 1,196 km, with new facilities to be constructed in northwest Alberta.

Figure 2-1 shows the Project's components in the gas production area, including the Anchor Fields and the Inuvik Area Facility.

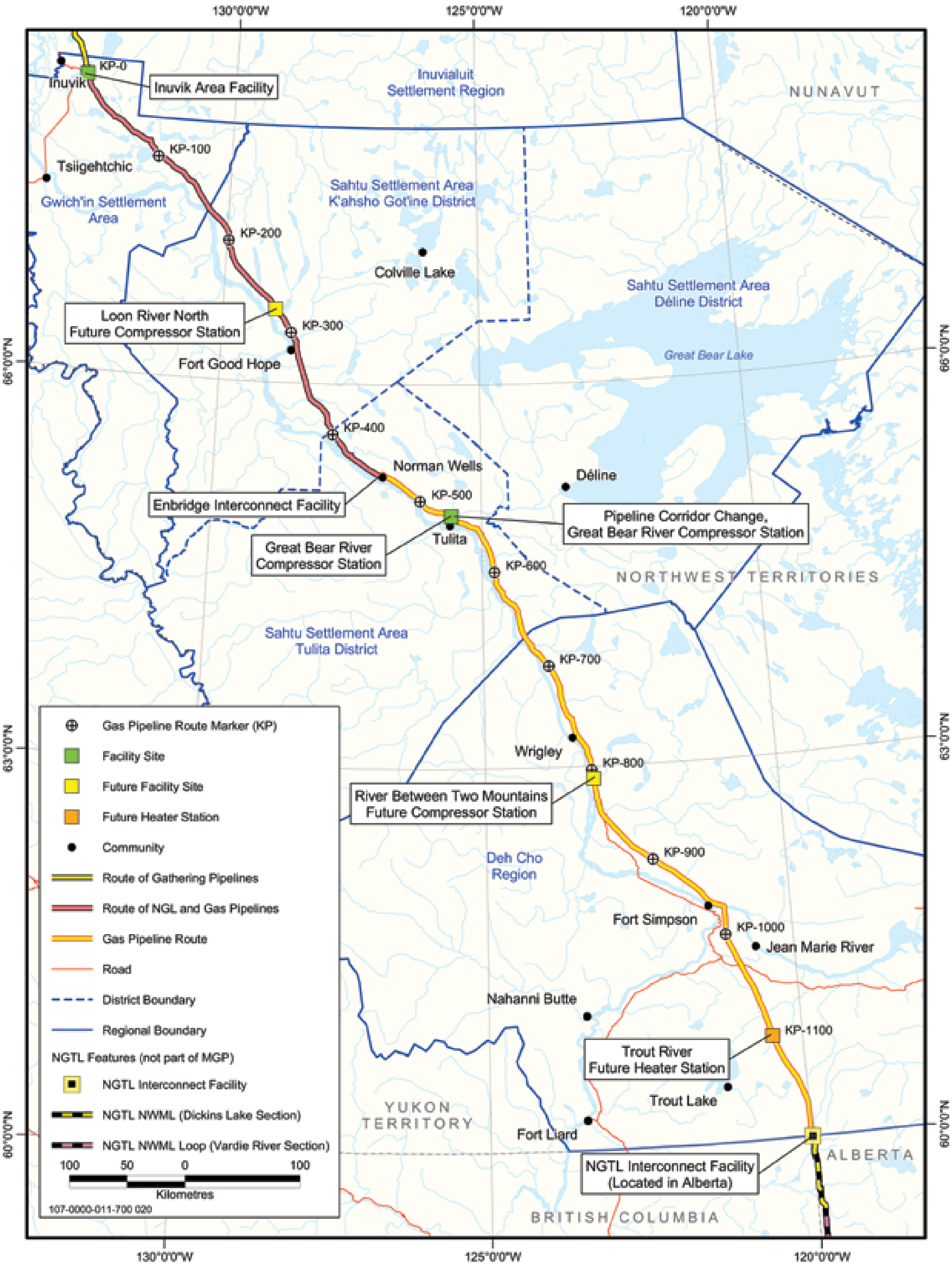
Figure 2-2 shows Project components along the pipeline corridor.

Figure 2-1 Regional Overview Map of the Mackenzie Gas Project Production Area



Source: J-IORVL-00953, Section 1, Figure 1-1

Figure 2-2 Regional Overview Map of the Mackenzie Gas Project Pipeline Corridor



Source: J-IORVL-00953, Section 1, Figure 1-2

NORTHWEST ALBERTA FACILITIES

The components of the new facilities to be constructed in northwest Alberta (collectively referred to as the Northwest Alberta Facilities) are:

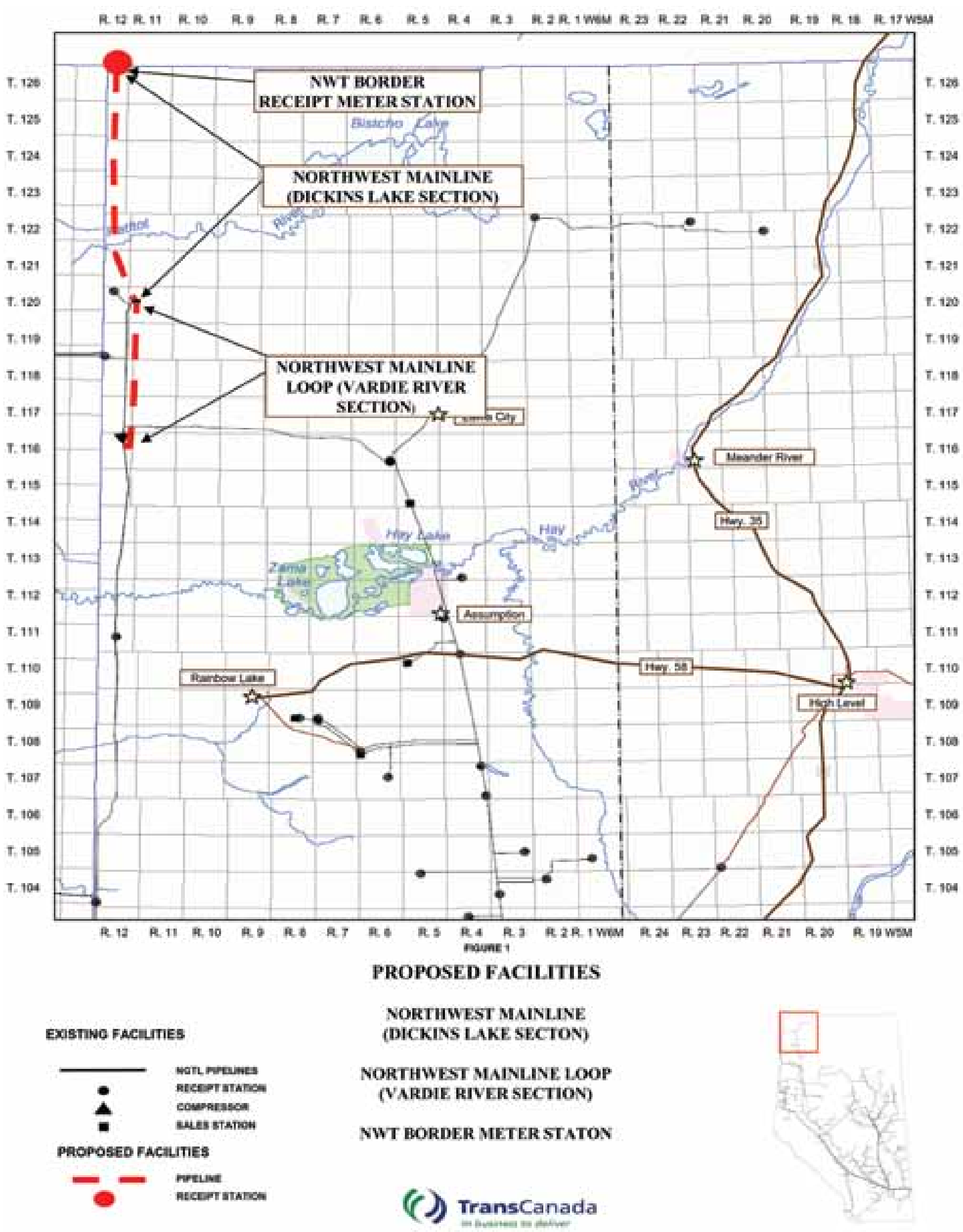
- the interconnect facility;
- the Dickins Lake Section pipeline from the interconnect facility to the Vardie River Section; and
- the Vardie River Section pipeline from the Dickins Lake Section to the existing Thunder Creek Compressor Station on the NOVA Gas Transmission Ltd. (NGTL) system.

Figure 2-3 shows the components of the Northwest Alberta Facilities.

The Northwest Alberta Facilities are not part of the Mackenzie Gas Project. However, as required by the Panel's Mandate, they were included in the review undertaken by the Panel.

The connection of the Mackenzie Valley Pipeline to the existing NGTL system through the Northwest Alberta Facilities would link natural gas transported in the pipeline to the North American gas pipeline infrastructure, thereby providing access to the North American natural gas market.

Figure 2-3 Proposed Facilities: Northwest Mainline (Dickins Lake Section), Northwest Mainline Loop (Vardie River Section) and NWT Border Meter Station



Source: J-IORVL-00599, Figure 1

2.1.2 PROPONENTS

The parties proposing to develop the Mackenzie Gas Project, collectively referred to as the Proponents, are:

- Imperial Oil Resources Limited (IORL);
- Imperial Oil Resources Ventures Limited (IORVL);
- Shell Canada Limited as managing partner of Shell Canada Energy (referred to as Shell);
- ConocoPhillips Canada (North) Limited and ConocoPhillips Northern Partnership (collectively referred to as ConocoPhillips);
- ExxonMobil Canada Properties (referred to as ExxonMobil); and
- Mackenzie Valley Aboriginal Pipeline Limited Partnership, generally referred to as the Aboriginal Pipeline Group (APG).

Table 2-1 lists the Proponents' ownership interest in the Project's components.

NGTL proposes to construct and operate the Northwest Alberta Facilities. NGTL participated in the Panel's proceedings as a registered Intervener and was represented on the Proponents' panels in some cases.

2.1.3 CAPACITY

Project facilities for which regulatory applications have been filed with the National Energy Board (NEB) would allow for the shipment of up to 1.2 Bcf/d of natural gas through the Mackenzie Valley Pipeline and up to 4,000 m^3/d of NGL through the NGL pipeline to Norman Wells. These volumes would represent the initial capacity of the Project, also referred to as the Project as Filed. Chapter 3, "Potential Future Developments," further describes the Project as Filed.

Production of natural gas from the three Anchor Fields would be at a combined rate of 830 Mcf/d. No other volumes of natural gas had been committed to the Project at the close of the Panel's record. Without the commitment to the Mackenzie Valley Pipeline of natural gas production in addition to that from the Anchor Fields, the Project would be built to operate at start-up at less than its initial capacity.

Table 2-1 Ownership Interests in the Mackenzie Gas Project

	Niglintgak	Taglu	Parsons Lake	Mackenzie Gathering System	Mackenzie Valley Pipeline
IORL		x		x	x
IORVL				x	x
Shell	x			x	x
ConocoPhillips			x	x	x
Exxon Mobil			x	x	x
APG					x

Source: Adapted from J-IORVL-00418, p. 2

Production of NGL from the Anchor Fields after processing at the Inuvik Area Facility would be at the rate of approximately 2,000 m³/d. No other volumes of NGL had been committed to the Project at the close of the Panel's record. Therefore, throughput on the NGL pipeline to Norman Wells at start-up might be less than the NGL pipeline's capacity.

With the installation of up to 11 additional compressor stations, the capacity of the Mackenzie Valley Pipeline could be expanded to 1.8 Bcf/d, which would represent the expansion capacity of the Mackenzie Gas Project, also referred to as the Expansion Capacity Scenario. Chapter 3, "Potential Future Developments," further describes the Expansion Capacity Scenario.

The capacity of the Northwest Alberta Facilities would be 1.2 Bcf/d, expandable to 1.8 Bcf/d.

2.1.4 PROJECT SCHEDULE

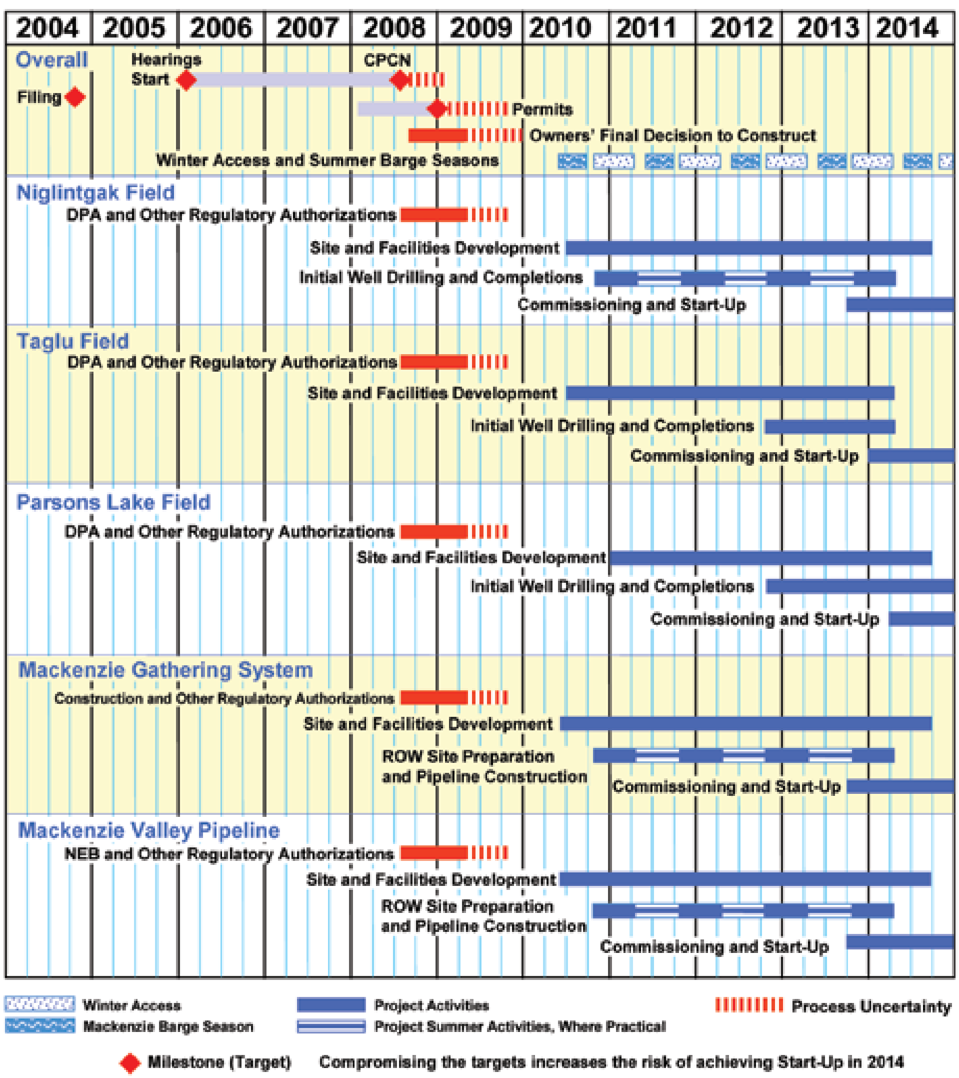
SUMMARY SCHEDULE

The most recent summary of the Project's schedule filed with the Panel assumed that the Project would receive authorizations by the following dates:

- Certificate of Public Convenience and Necessity for the Mackenzie Valley Pipeline and a construction authorization for the Mackenzie Gathering System in 2008;
- Development Plan Approvals for the Anchor Fields in 2008; and
- remaining approvals and authorizations in 2008 to 2009.

Figure 2-4 provides a summary of the Project's schedule.

Figure 2-4 Mackenzie Gas Project Summary Schedule



Source: J-IORVL-00953, Section 1, Figure 1-3

Note: These dates are no longer achievable. Therefore, the Panel's review has proceeded on the assumption that the Project would generally follow the sequence and number of years from receipt of Project approvals that are reflected in this figure as filed with the Panel.

The Panel's review has proceeded on the assumption that the schedule for construction of the Project and the commencement of operations would generally follow the sequence and number of years from receipt of Project approvals that are reflected in the schedule filed with the Panel. The Proponents would decide whether to proceed with the Project after assessing the terms and conditions in any regulatory approvals that were granted.

NGTL would be responsible for building the Northwest Alberta Facilities in time to allow tie-in and start-up activities for the Project. NGTL has filed applications with the former Alberta Energy and Utilities Board (AEUB) for authorizations to construct and operate these facilities.

PROJECT PHASES

The Project would be developed in three phases:

- a definition phase;
- a design and construction phase (six years); and
- an operations phase (from commencement of production for as long as there was economic gas production).

Activities in the definition phase would include:

- completing conceptual and preliminary engineering design;
- conducting field investigation programs to support preliminary design;
- completing a preliminary construction execution plan;
- conducting biophysical and socio-economic studies and assessments;
- developing access agreements and benefits plans;
- consulting with the public, particularly northern communities;
- developing and submitting applications for regulatory approvals; and
- participating in the regulatory review process.

The design and construction phase would take about six years and would begin after a decision by the Proponents to proceed with the Project. Construction activities would be completed in approximately four and a half years. Activities in this phase would include:

- conducting field investigation programs required to support detailed design;
- completing the detailed engineering design;
- complying with conditions specified in approvals, authorizations and permits;
- purchasing goods and services;
- consulting with the public, particularly northern communities;
- transporting materials and equipment to sites;
- developing and constructing infrastructure sites, such as borrow sites;
- drilling and completing wells at the Anchor Fields;
- constructing production facilities and flow lines at the Anchor Fields;
- constructing the gathering system; and
- constructing the gas pipeline and associated facilities.

The Panel understands that some construction activities would be undertaken after the commencement of the operations phase of the Project. Therefore, the construction and operations phases of the Project are overlapping rather than sequential.

The operations phase would begin with the flow of natural gas and would continue while there was economic gas production in the region, which is expected to be at least 20 years. Activities in this phase would include:

- commissioning and starting up the Anchor Fields, pipelines and associated facilities;
- processing raw natural gas and transporting natural gas and NGL to market by pipeline;
- operating and maintaining the Anchor Fields, including adding compression facilities;
- drilling, completing and connecting wells;
- servicing wells;
- operating and maintaining pipelines and facilities;
- adding two compressor stations and a heater station when shipping commitments to support the Project's initial capacity were made; and
- continuing ongoing consultation with the public, particularly northern communities.

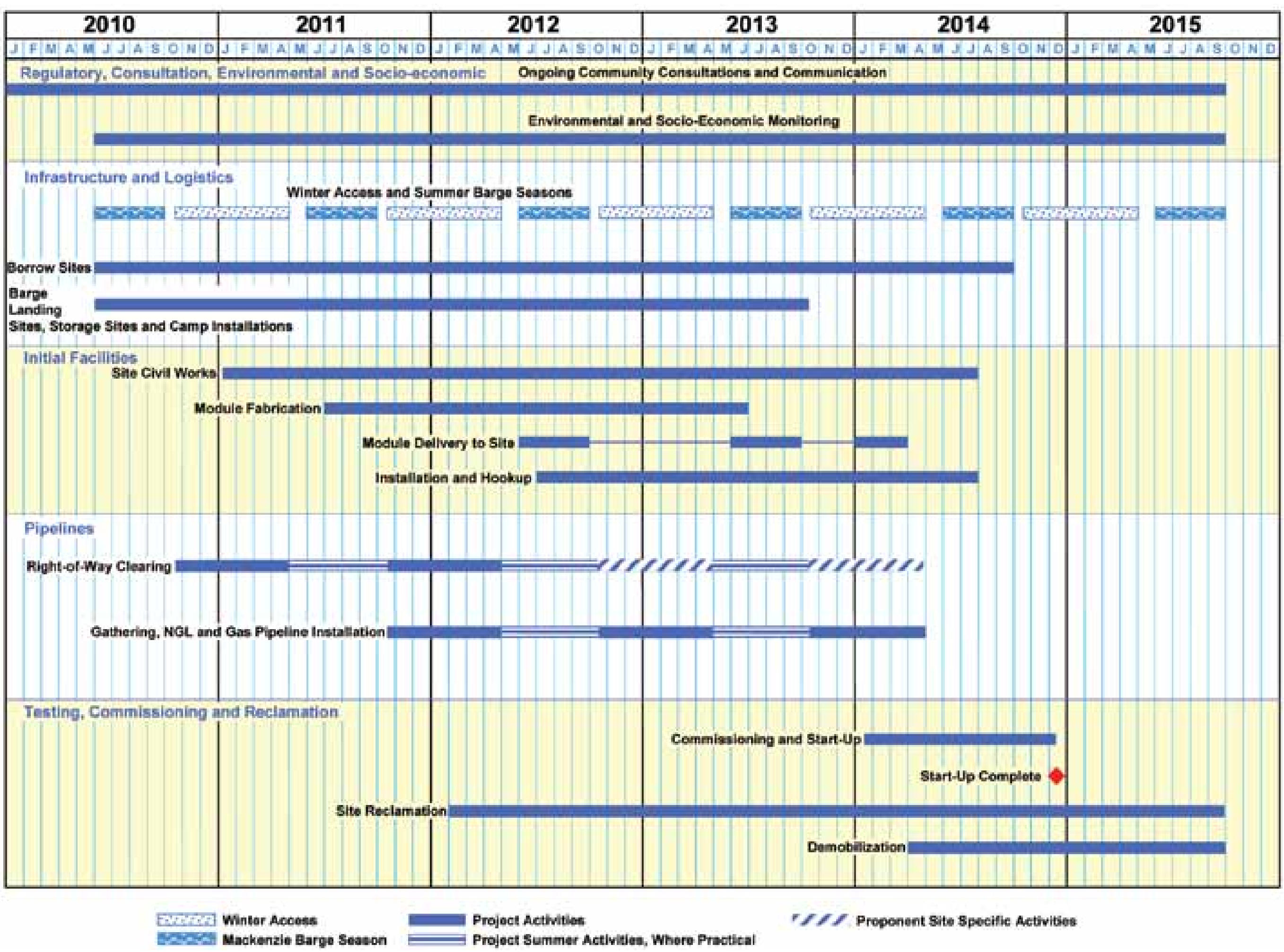
CONSTRUCTION PLAN

Figure 2-5 shows a summary schedule for construction of infrastructure, pipelines and associated facilities. During this phase, the Project would have the most interaction with the surrounding natural environment and communities. The first year would involve preparation activities, such as building the infrastructure needed for construction and clearing the right-of-way for the first season of pipeline installation.

Pipeline and pipeline facilities installation would begin a year later and would be completed three years thereafter. The construction area would be divided into four zones (A, B, C and D), with each zone divided into three construction spreads. Figure 2-6 shows the pipeline construction spreads. Construction activities within each construction spread would include:

- an initial winter for preparation activities, including clearing the right-of-way, collecting data required for construction and confirming site-specific designs;
- a winter for pipeline installation and initial construction cleanup; and
- a winter for final cleanup and reclamation.

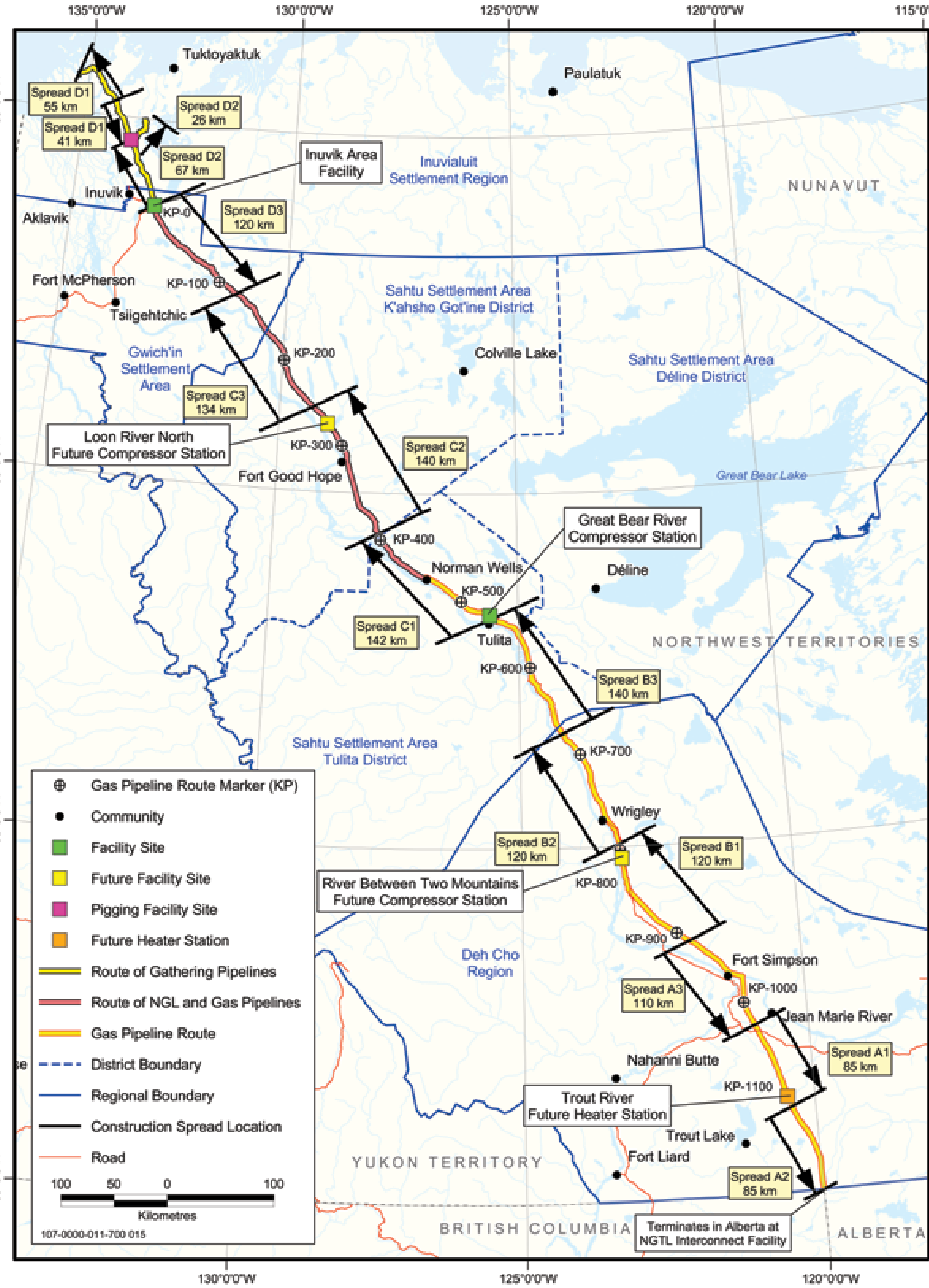
Figure 2-5 Construction Schedule for Pipeline and Initial Facilities



Source: J-IORVL-00953, Section 3, Figure 3-1

Note: These dates are no longer achievable. Therefore, the Panel's review has proceeded on the assumption that the Project would generally follow the sequence and number of years from receipt of Project approvals that are reflected in this figure as filed with the Panel.

Figure 2-6 Pipeline Construction Spreads



Source: J-IORVL-00953, Section 3, Figure 3-2

2.2 MAJOR PROJECT COMPONENTS

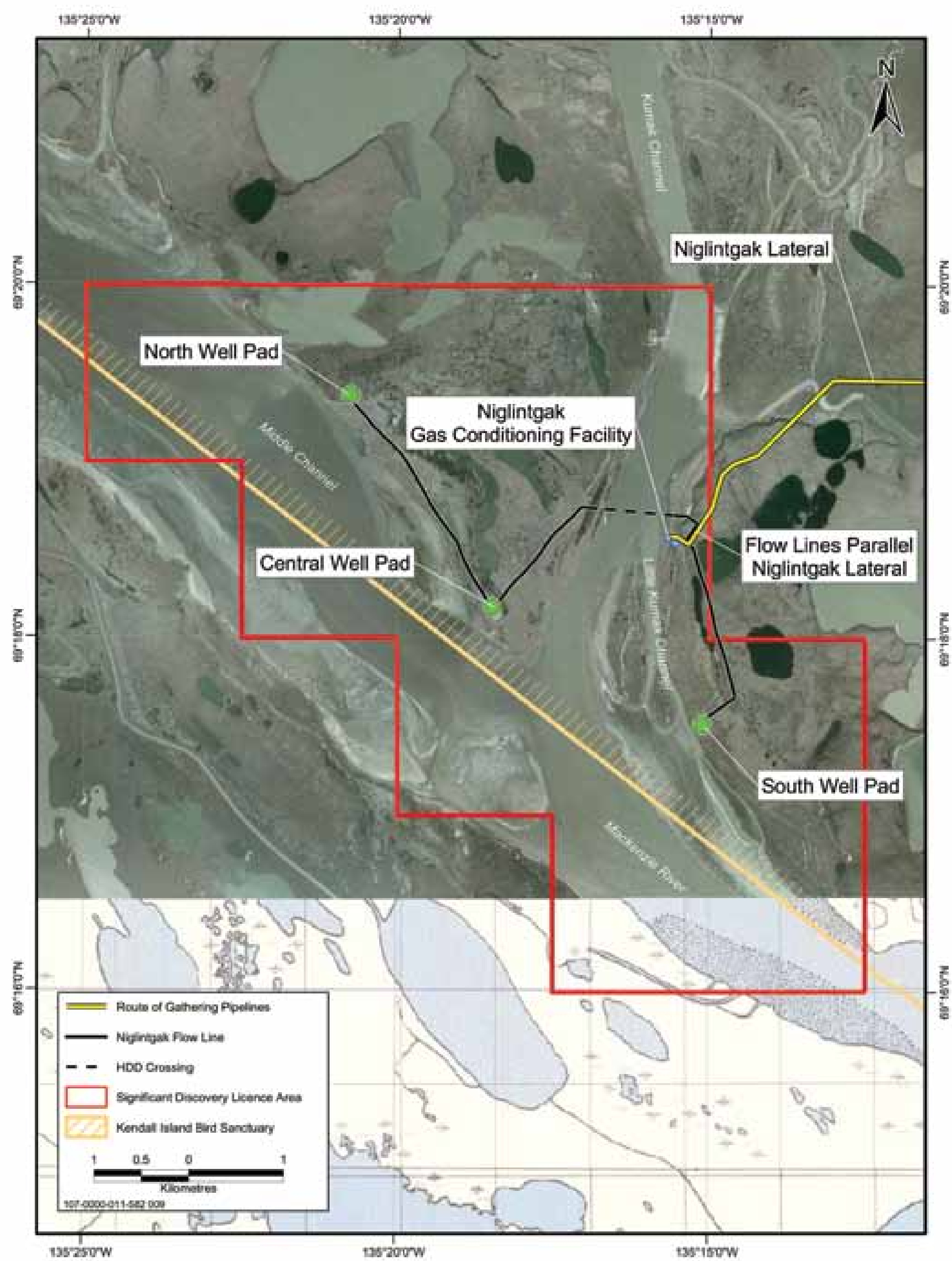
2.2.1 ANCHOR FIELDS

NIGLINTGAK

Location

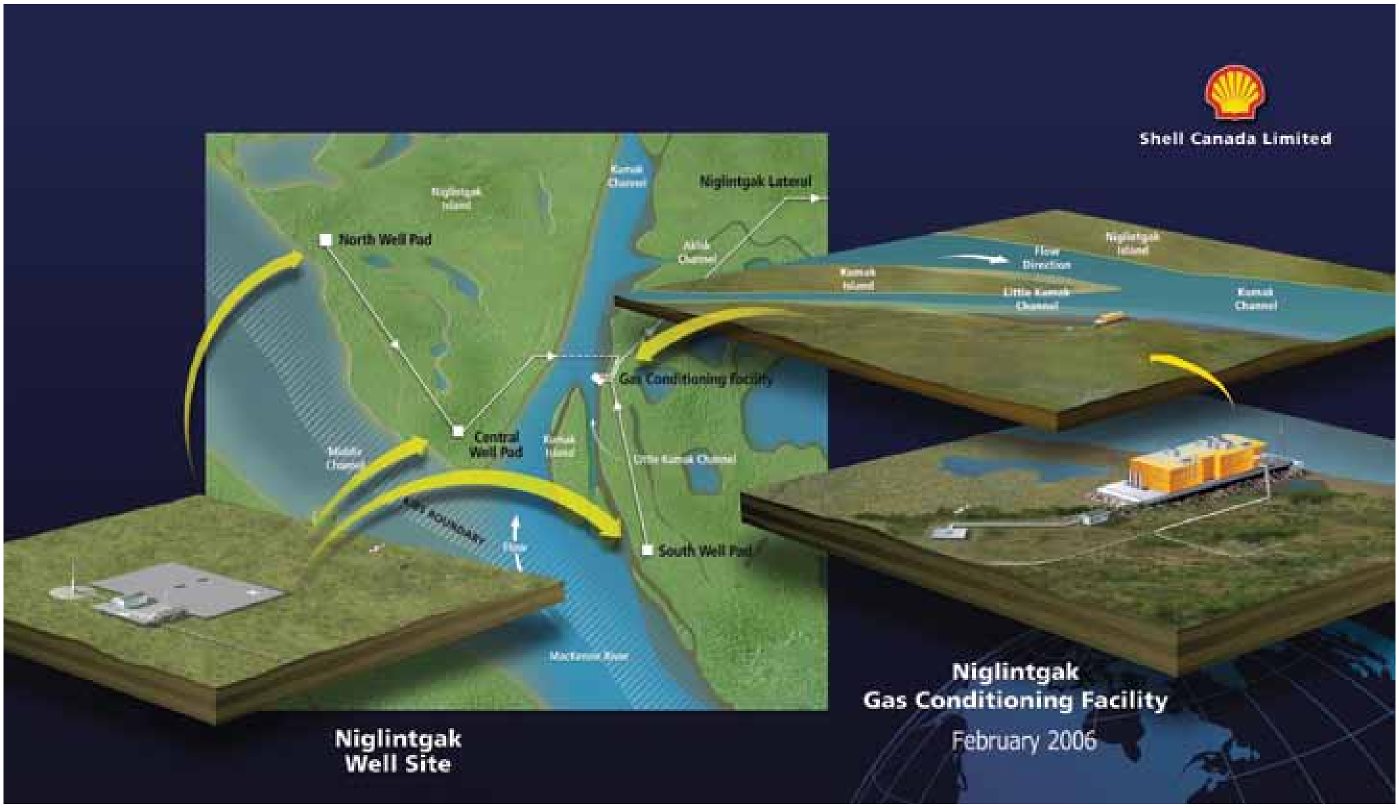
The operator of the Niglintgak natural gas field is Shell. The gas field is near the southern end of Niglintgak Island in the Mackenzie Delta within the Kendall Island Bird Sanctuary. The field is about 120 km northwest of Inuvik and 85 km west of Tuktoyaktuk. Figure 2-7 shows an aerial photograph of the Niglintgak gas field site, and Figure 2-8 shows an artist's impression.

Figure 2-7 Niglintgak Aerial Photograph



Source: J-IORVL-00953, Section 2, Figure 2-1

Figure 2-8 Niglintgak — Artist's Impression



Source: J-IORVL-00953, Section 2, Figure 2-2

Production

The Niglintgak development plan is based on an estimated 27 Gm^3 (1 Tcf) of raw natural gas. The field would produce primarily lean dry natural gas for about 25 years. The Panel understands that the daily rate of production may vary over the life of the field. The Panel also understands that production rates are considered by the NEB in the development plan approval process. Field operators are required by regulation to produce gas using good production practices to achieve the maximum recovery of gas and at the applicable rate consistent with the rate specified in the approved development plan.

Major Facilities

The Niglintgak field development would include:

- 3 well pads (north, south and central);
- 6 wells initially and up to 6 future wells if needed to maintain the proposed gas production rates;
- a disposal well at the south well pad;
- 10 km of above-ground flow lines, including a horizontal directionally drilled (HDD) crossing under the Kumak Channel;
- a barge-based gas conditioning facility including compression facility; and
- a flare stack.

Infrastructure

The supporting infrastructure would include:

- temporary ice roads for ground transportation;
- the existing permanent airstrip at Camp Farewell;
- a temporary ice airstrip at Niglintgak;
- permanent helipads at each of the well pads and onshore adjacent to the gas conditioning facility;
- the existing barge landing site at Camp Farewell;
- Borrow Site 1.009P at Yaya River for 100,000 m^3 of granular materials;
- the existing 32-bed camp and a temporary 150-bed camp at Camp Farewell;
- a temporary 100-bed drilling camp at Niglintgak;
- a 10-person permanent camp adjacent to the gas conditioning facility;
- water sourced from the Mackenzie or Yaya rivers during the winter and from nearby unnamed lakes in the summer;
- 2.0 ML of existing fuel storage and up to 1.5 ML of temporary fuel storage at Camp Farewell;
- up to 0.4 ML of temporary fuel storage at Niglintgak; and
- a stockpile site.

Footprint

The area subject to the significant discovery licence for the Niglintgak field is 3,665 ha. The total area of physical surface disturbance would be 73 ha, 10 ha of which would be permanent disturbance. The Panel understands that the area of sensory impacts would likely extend beyond this area. The gas conditioning facility, located on the flood plain of the Kumak Channel, would require up to 50,000 m^3 of primarily winter-based excavation. The draught of the barge-based gas conditioning facility would be 1.5 m. A 6-km section of the existing shipping channel in the Kittigazuit S-bends would require dredging of 148,000 m^3 of riverbed material.

TAGLU

Location

The operator of the Taglu natural gas field is IORL. The field is located at the confluence of the Harry Channel and Kuluarpak Channel of the Mackenzie River, inside the easternmost boundary of the Kendall Island Bird Sanctuary. The field is about 120 km northwest of Inuvik and 70 km west of Tuktoyaktuk. Figure 2-9 shows an aerial photograph of the Taglu gas field site, and Figure 2-10 shows an artist's impression.

Production

The Taglu development plan is based on about 81 Gm^3 (2.8 Tcf) of raw natural gas. IORL estimates the production lifespan to be about 30 years. The Panel understands that the daily rate of production may vary over the life of the field. The Panel also understands that production rates are considered by the NEB in the development plan approval process. Field operators are required by regulation to produce gas using good production practices to achieve the maximum recovery of gas and at the applicable rate consistent with the rate specified in the approved development plan.

Major Facilities

The Taglu field development would include:

- 1 well pad;
- 10 to 15 production wells;
- 1 or 2 disposal wells;
- above-ground flow lines to connect the wells to the gas conditioning facility;
- the gas conditioning facility; and
- a flare stack and compression facility.

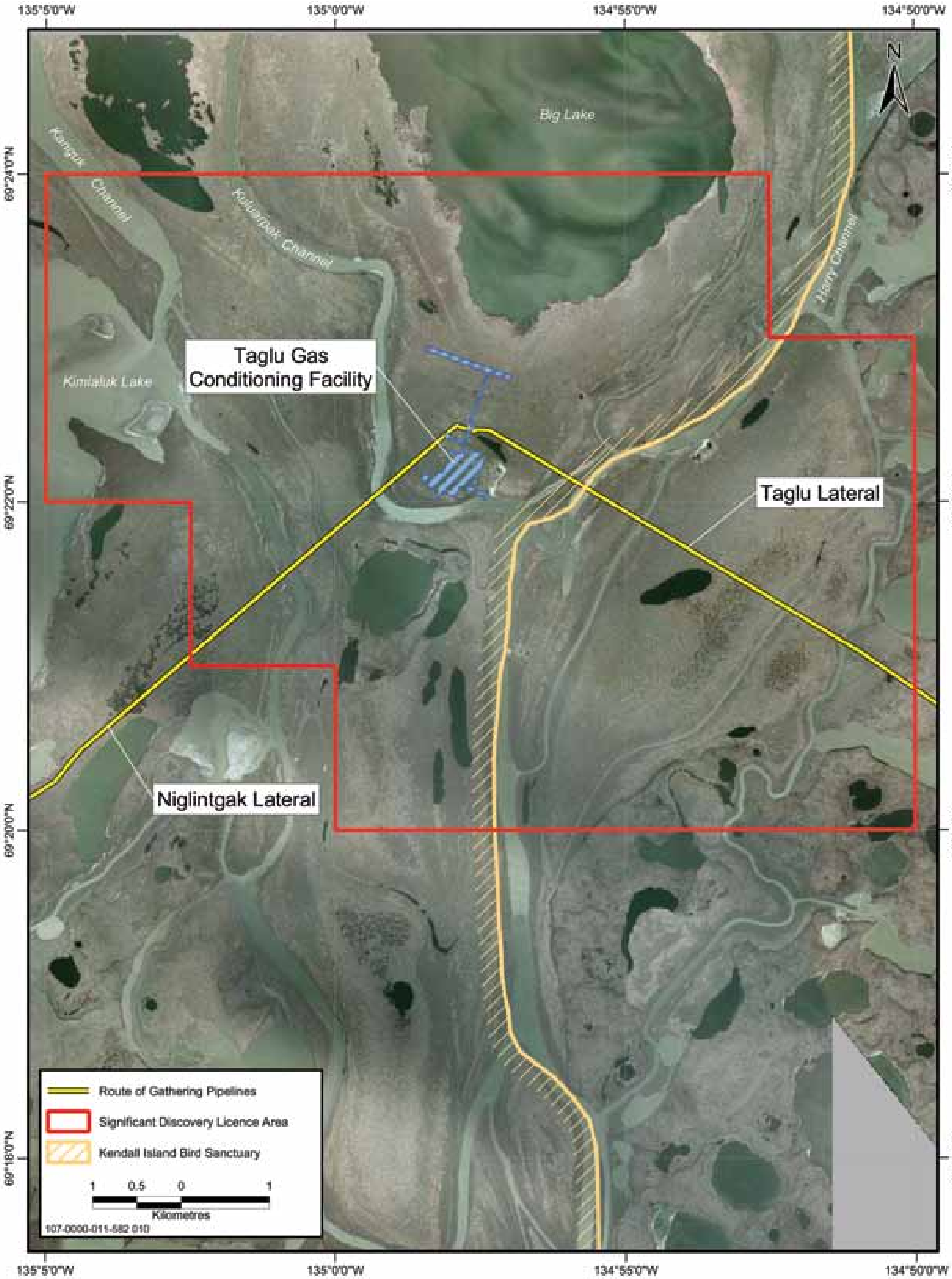
Within 8 to 10 years after start-up, additional production wells might be drilled at Taglu to maintain desired gas production rates from the reservoir. Also, new compression facilities would be needed about 5 and 10 years after start-up to maintain production.

Infrastructure

The supporting infrastructure at the Taglu site would include:

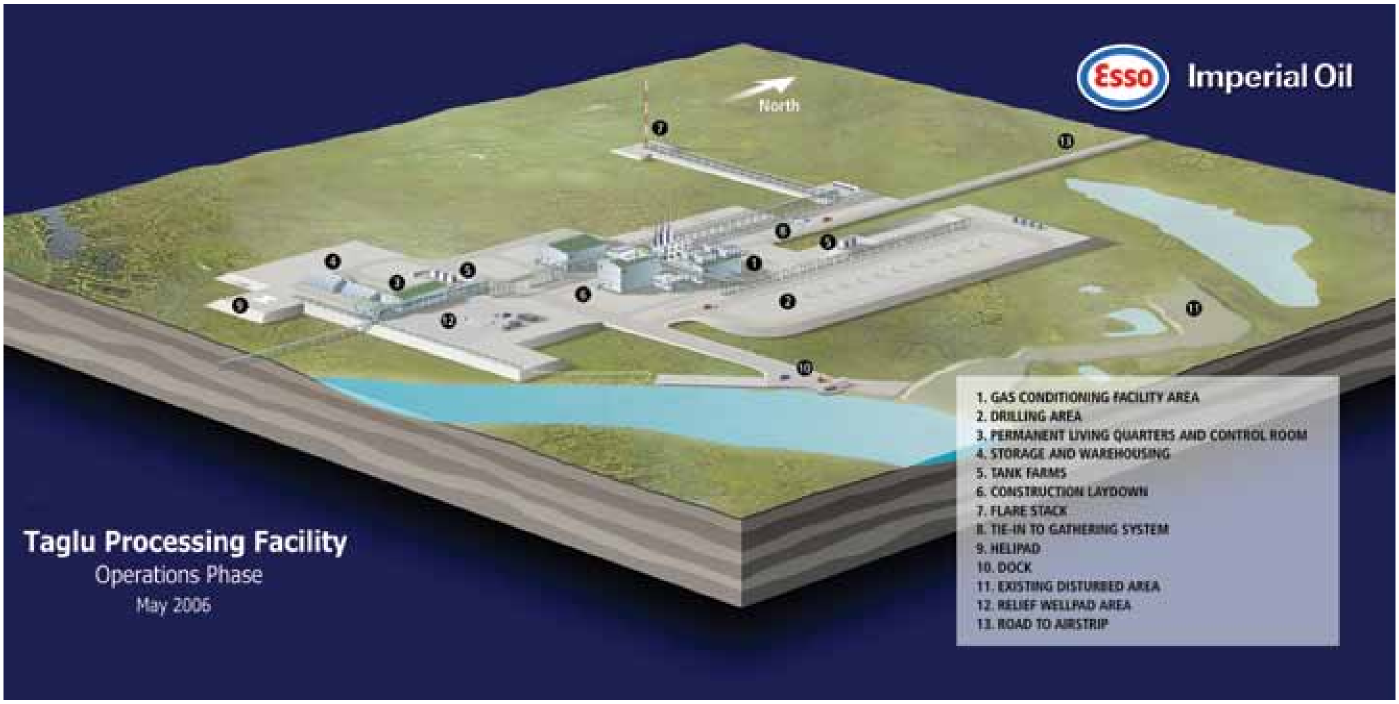
- temporary ice roads for ground transportation;
- a permanent airstrip at the site;
- a new barge landing site;
- Borrow Sites 1.008P and 1.009P at Yaya River for about 400,000 m^3 of gravel;
- temporary camps, including a 130-person drilling camp, a 200-person construction camp and a 160-person pipeline HDD camp;
- a 25-person permanent camp;
- water sourced from the Kuluarpak Channel and Big Lake;
- up to 3.4 ML of fuel storage; and
- a stockpile site.

Figure 2-9 Taglu Aerial Photograph



Source: J-IORVL-00953, Section 2, Figure 2-3

Figure 2-10 Taglu — Artist's Impression



Source: J-IORVL-00953, Section 2, Figure 2-4

Additional infrastructure would be situated on an existing disturbed area at Yaya River:

- a temporary helipad;
- a potential ice airstrip;
- a temporary barge landing site;
- a 250-person temporary camp; and
- 3 ML of new fuel storage.

Footprint

The area subject to the significant discovery licence for the Taglu field is 6,089 ha. The total area of physical surface disturbance associated with the development would be 35 ha, 30 ha of which would be permanent disturbance. The Panel understands that the area of sensory impacts would likely extend beyond this area.

PARSONS LAKE

Location

The holders of the interests in the Parsons Lake natural gas field are ConocoPhillips and ExxonMobil. The operator of the Parsons Lake field is ConocoPhillips. The field is about 70 km north of Inuvik and 55 km southwest of Tuktoyaktuk. Figure 2-11 shows the location of the Parsons Lake gas field site, and Figure 2-12 shows an artist's impression.

Production

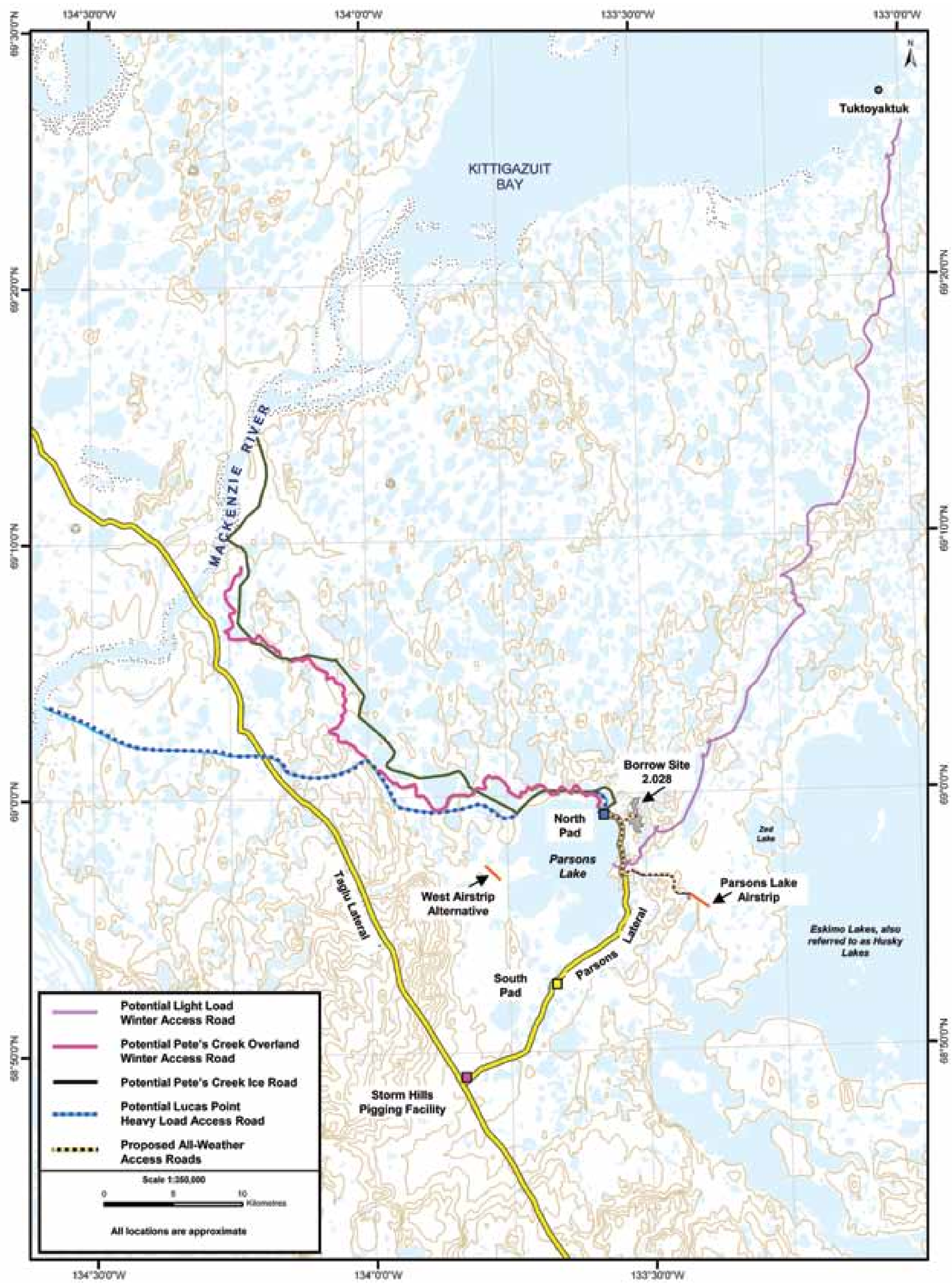
The Parsons Lake development plan is based on about 64 Gm^3 (2.3 Tcf) of raw natural gas. The Proponents estimate the production lifespan to be 25 years. The Panel understands that the daily rate of production may vary over the life of the field. The Panel also understands that production rates are considered by the NEB in the development plan approval process. Field operators are required by regulation to produce gas using good production practices to achieve the maximum recovery of gas and at the applicable rate consistent with the rate specified in the approved development plan.

Major Facilities

The Parsons Lake field development would include:

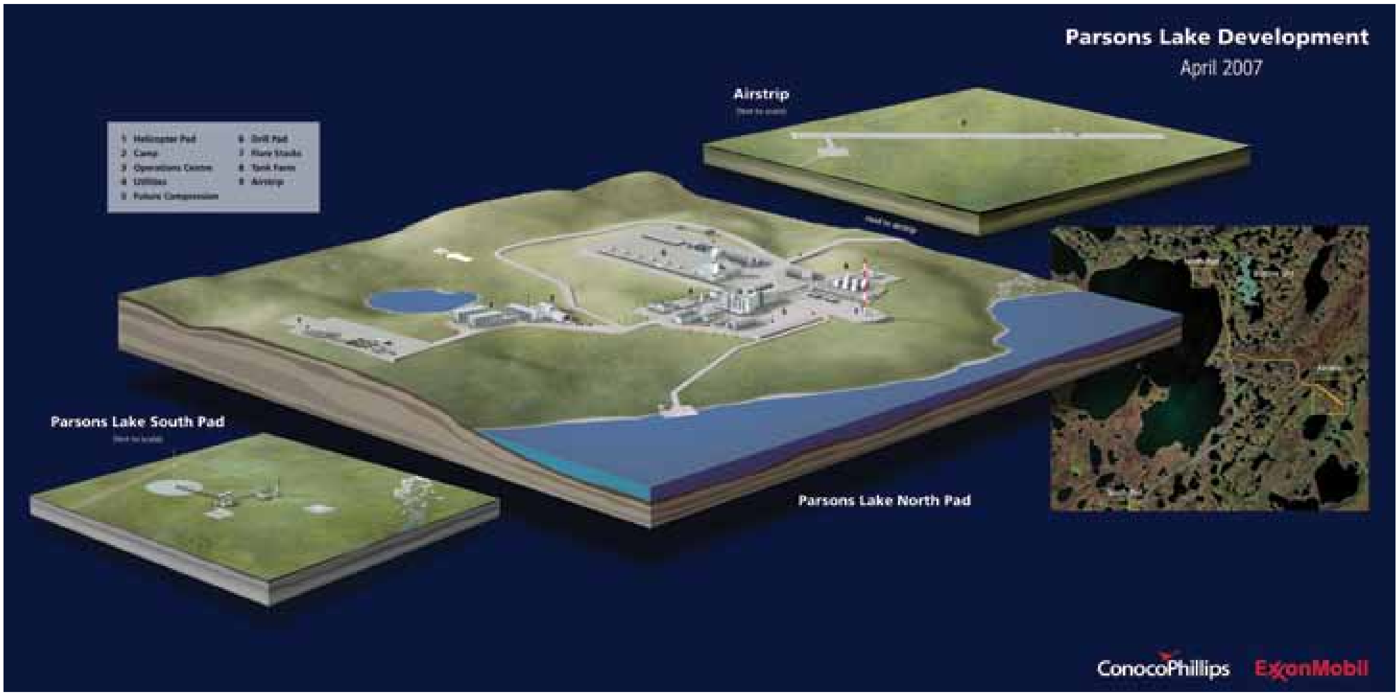
- 1 north pad, consisting of:
    - 9 to 19 production wells;
    - 2 disposal wells;
    - flow lines;
    - the gas conditioning facility; and
    - a relief well pad;
- 1 south pad, consisting of 3 to 7 production wells;

Figure 2-11 Parsons Lake Gas Field Proposed Facilities and Infrastructure Locations



Source: J-IORVL-00953, Section 2, Figure 2-6

Figure 2-12 Artist's Impression of Proposed Parsons Lake Facilities



Source: J-IORVL-00953, Section 2, Figure 2-5

- an elevated 2-phase flow line from the south pad to the north pad; and
- flare stacks and a compression facility.

Additional production wells might be required at the south pad in about six years after start-up. Construction of the Parsons Lake south pad and the south-to-north pad flow line would also occur at that time. Future compression facilities would be installed in three phases over six years, commencing about nine years after start-up.

Infrastructure

The supporting infrastructure would include:

- temporary ice roads for ground transportation;
- an all-weather road over a distance of approximately 10 km from the airstrip to the north pad;
- a new gravel airstrip capable of handling Boeing 737 aircraft and two new helipads;
- Borrow Site 2.028P for about 1.5 Mm^3 of granular materials;
- a 200-person temporary camp at Borrow Site 2.028P;
- a 300-person permanent camp at Parsons Lake;
- water sourced from Parsons Lake;
- 9.5 ML of permanent fuel storage and up to 2.1 ML of temporary fuel storage; and
- a stockpile site.

Footprint

The area subject to the significant discovery licence for the Parsons Lake field is 32,290 ha. The total area of physical disturbance associated with the development would be 415 ha, 49 ha of which would be associated with permanent facilities. The Panel understands that the area of sensory impacts would likely extend beyond this area.

2.2.2 MACKENZIE GATHERING SYSTEM

The Mackenzie Gathering System would be operated by IORVL on behalf of the Proponents (excluding the APG, whose ownership interest in the Mackenzie Gas Project is limited to the Mackenzie Valley Pipeline).

GATHERING PIPELINES

As Figure 2-1 shows, the gathering pipelines would connect the three Anchor Fields in the Mackenzie Delta (Niglintgak, Taglu and Parsons Lake) to the Inuvik Area Facility.

The gathering pipelines would consist of:

- the 14.7-km NPS 16 (nominal pipe size of 16 inches) Niglintgak lateral;
- the 80.9-km NPS 26 Taglu lateral;
- the 26.4-km NPS 18 Parsons Lake lateral; and
- the 67.2-km NPS 30 Storm Hills lateral.

These lateral pipelines would be designed for two-phase flow to carry unprocessed natural gas and associated NGL (while there is some treatment of the gas in the field at conditioning facilities, primarily to remove water, the gas upstream of the Inuvik Area Facility, including the associated NGL, is considered to be unprocessed natural gas). The lateral pipelines would be buried, with the possible exception of the Zed Creek crossing, and would normally operate year-round. The right-of-ways would be 30 to 40 m wide, with temporary workspace required for construction activities. Each gas conditioning facility, and the junction of the Taglu, Parsons Lake and Storm Hills lateral pipelines, would include pigging facilities, where a device (pig) can be inserted or removed from the pipeline. The pig is pushed through the pipeline to clean the inner surface, remove liquids or conduct inspections.

The supporting infrastructure would include:

- expansion of the existing airstrip at Swimming Point;
- a new helipad at Storm Hills;
- the existing barge site at Swimming Point;
- Borrow Site 2.061P;
- a 950-person temporary camp or about 1,100 with HDD crews at Swimming Point;
- a 250-person temporary camp at Borrow Site 2.061P;
- water sourced from the East Channel for Swimming Point;
- water trucked in from Inuvik for the Borrow Site 2.061P infrastructure site;
- existing fuel storage of 0.4 ML at Swimming Point; and
- stockpile sites at Swimming Point, Storm Hills and Lucas Point.

Aerial view of Swimming Point

Source: NGPS

INUVIK AREA FACILITY

The Inuvik Area Facility would be located approximately 26 km southeast of Inuvik and approximately 4.5 km from the Dempster Highway. The Inuvik Area Facility would separate and process the incoming gas stream from the gathering pipelines into processed natural gas (also known as sales gas) and NGL. The facility would also meter the natural gas and NGL and deliver them to the Mackenzie Valley Pipeline and the NGL pipeline, respectively. Figure 2-13 shows an artist's impression of the Inuvik Area Facility.

The facility is designed to produce 30.9 Mm^3/d of natural gas and 2,900 m^3/d of NGL in summer, and 35.2 Mm^3/d of natural gas and 3,400 m^3/d of NGL in winter.

The Inuvik Area Facility would include a pig receiver and a slug catcher to collect liquids.

The facility would be made up of four very large modules (VLMs), weighing between 3,300 t and 4,200 t, which would be transported by barge via the Beaufort Sea to a new barge landing site south of Inuvik. This would require additional dredging of certain channels in the Mackenzie River to accommodate the barges. The VLMs would be transported from the barge landing site to the site of the Inuvik Area Facility on a winter road to be built for that purpose.

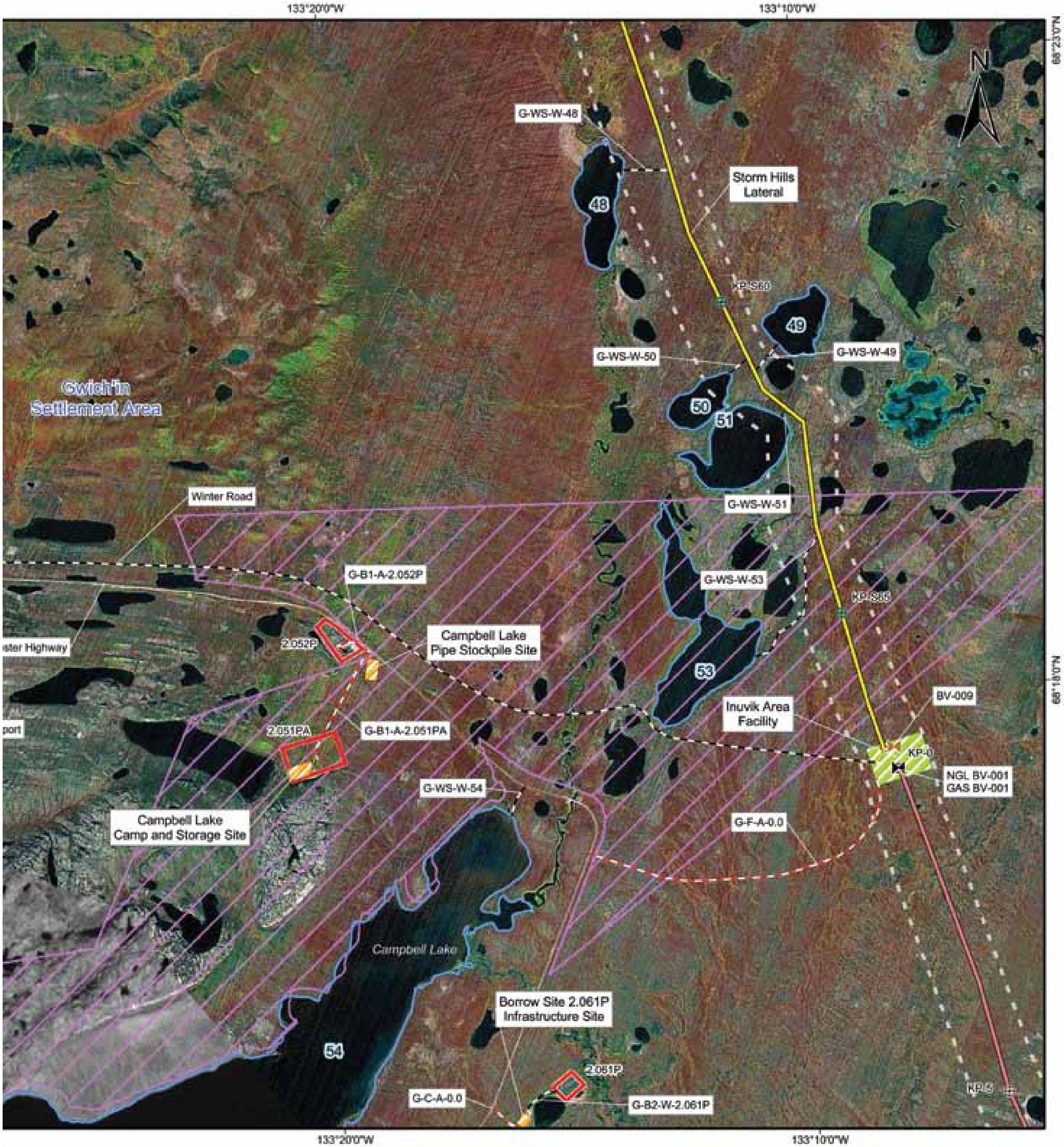
Figure 2-14 shows the proposed infrastructure needed for the Inuvik Area Facility. The supporting infrastructure would include:

- new (temporary and permanent) winter and all-weather roads;
- the existing Inuvik airport;
- the existing Inuvik barge site and a new dock and barge landing site south of Inuvik;
- a winter road from the barge landing site for the sole purpose of transporting the VLMs to the Inuvik Area Facility;
- Borrow Site 2.061P;
- a temporary 120-person camp;
- water trucked in from Inuvik;
- the existing Inuvik fuel storage site and a new 0.2 ML fuel storage site; and
- stockpile sites.

Figure 2-13 Inuvik Area Facility — Artist's Impression

Source: J-IORVL-00419, p. 13

Figure 2-14 Inuvik Area Facility Infrastructure



Source: J-IORVL-00953, Section 4, Figure 4-2

The complete map can be viewed in 4330-INAC_Book_vol_I_Figure2-14.pdf

NGL PIPELINE

As Figure 2-2 shows, a 457-km NPS 10 pipeline would transport about 3,900 m^3/d of NGL from the Inuvik Area Facility to Norman Wells, where it would connect with the existing Norman Wells Oil Pipeline.

The NGL pipeline would follow the east side of the Mackenzie Valley. The pipeline would be buried. The pipeline would share a 50-m right-of-way with the Mackenzie Valley Pipeline for about 457 km to a point near Norman Wells, where the NGL pipeline would deviate in a separate right-of-way for about 1 km to the interconnection with receiving facilities for the Norman Wells Oil Pipeline. The NGL pipeline and the Mackenzie Valley Pipeline would be constructed in separate ditches in the shared right-of-way, about 20 to 25 m apart. The supporting infrastructure would include 28 block valves.

2.2.3 MACKENZIE VALLEY PIPELINE

The Mackenzie Valley Pipeline would be operated by IORVL on behalf of the Proponents, including the APG.

GAS PIPELINE

As Figure 2-2 shows, the 1,196-km NPS 30 pipeline would transport sweet natural gas from the Inuvik Area Facility to the interconnection with the Northwest Alberta Facilities, just south of the NWT border.

Generally, the Mackenzie Valley Pipeline would follow the east side of the Mackenzie River valley. The pipeline would be buried and would share a 50-m right-of-way with the NGL pipeline for about 457 km to a point near Norman Wells. From Norman Wells to the interconnection with the Northwest Alberta Facilities, the right-of-way would be 40 m wide. The supporting infrastructure would include:

- 1,050 km of roads, including 70 km of all-weather roads and 980 km of winter roads;
- 7 existing airports, 1 existing airstrip, 2 new airstrips and up to 8 new helipads;
- 9 existing barge landing sites and 3 new sites;
- borrow sites;
- approximately 20 temporary camps with a total capacity of 12,025 persons, including HDD crews (the Panel understands that not all of these camps would be occupied to capacity at any one time);
- water sourced mostly from the Mackenzie River, nearby water bodies or towns;
- 1 existing fuel storage site and 16 new fuel storage sites with a total capacity of about 36.8 ML; and
- 20 stockpile sites.

Norman Wells

Source: JRP

GREAT BEAR RIVER COMPRESSOR STATION

The Great Bear River Compressor Station would be located 8 km southeast from the crossing of the Great Bear River, close to Tulita. Figure 2-15 shows an artist's impression of a typical compressor station.

Figure 2-16 shows the proposed infrastructure needed for the Great Bear River Compressor Station. The supporting infrastructure would include:

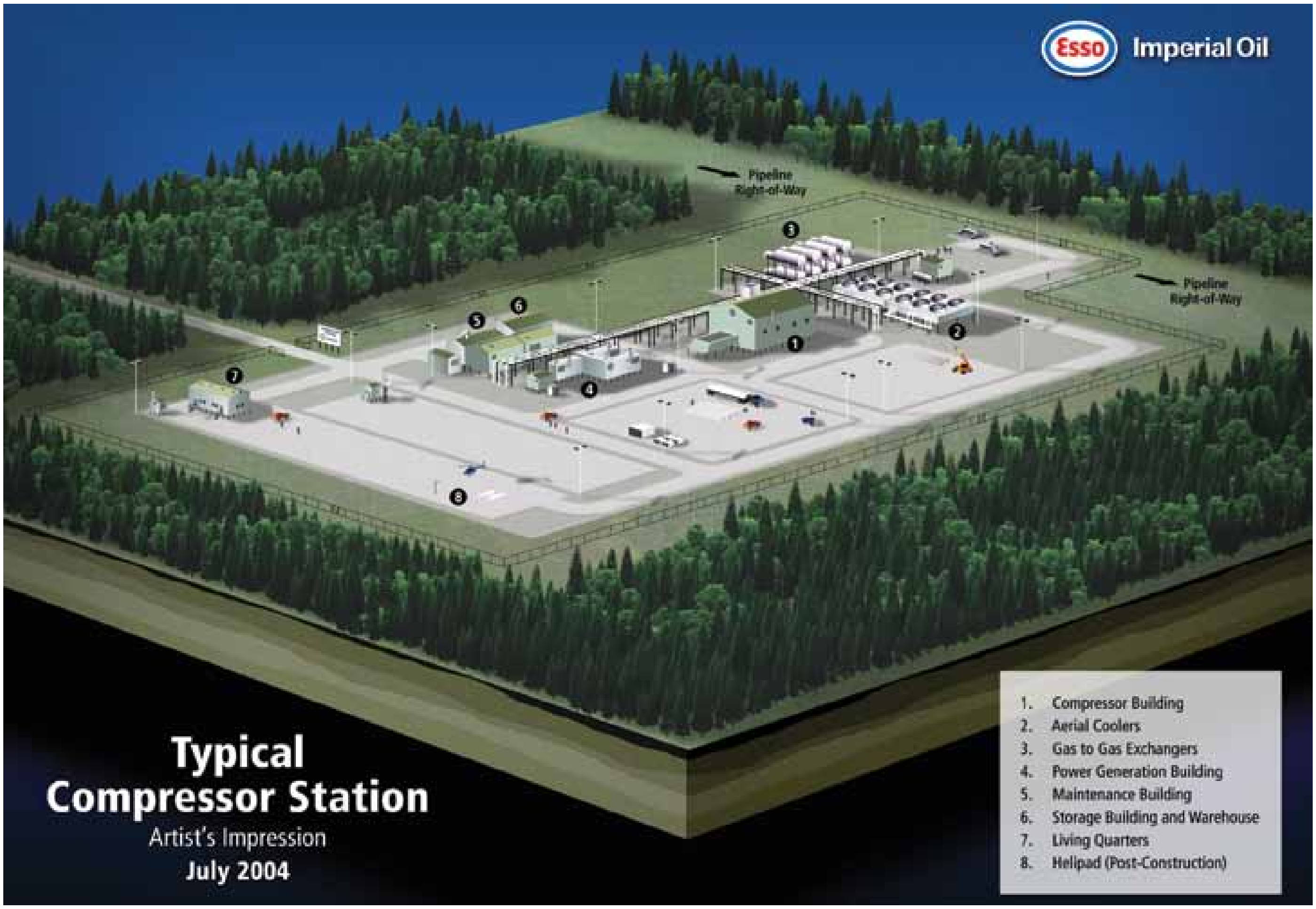
- existing roads and new winter and all-weather roads;
- the existing Tulita airstrip;
- a new helipad at the compressor station;
- existing Tulita barge sites and a new barge landing site at Tulita East;
- Borrow Sites 8.003AP, 8.003BP and 8.003CP for about 0.3 Mm^3 of granular materials;
- a temporary 120-person camp at Four Mile Creek;
- water sourced from the Mackenzie River;
- a new permanent 0.2 ML fuel storage site; and
- a stockpile site.

ADDITIONAL PIPELINE FACILITIES

The design of the Mackenzie Valley Pipeline at its initial capacity would allow the pipeline to transport a larger volume of natural gas than is currently contracted for the Anchor Fields alone. If future commitments for additional volumes of natural gas were made above those to be produced from the Anchor Fields alone, the following additional facilities would be required to bring the Mackenzie Valley Pipeline up to its full initial capacity of 1.2 Bcf/d:

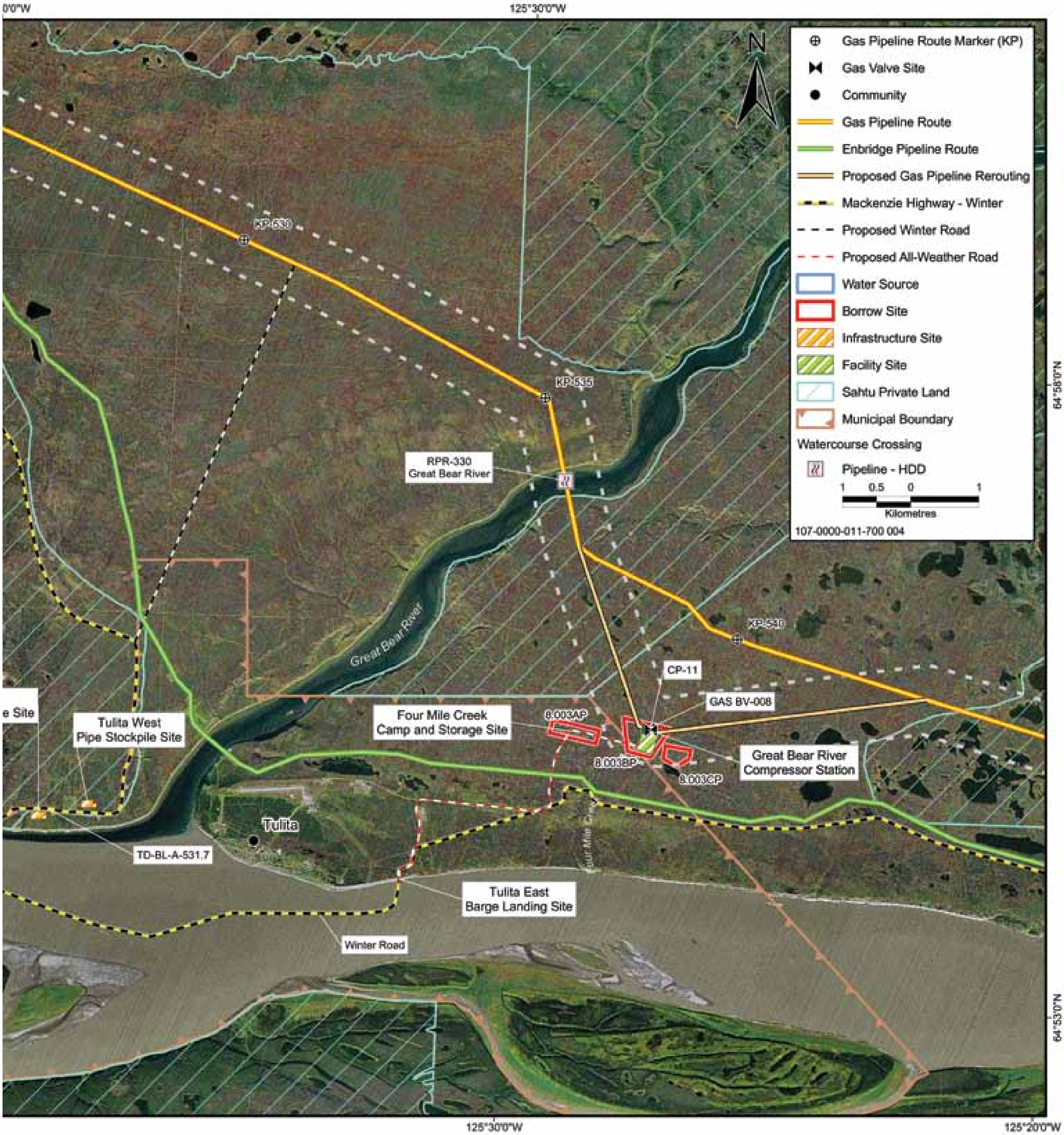
- the Loon River North Compressor Station;
- the River Between Two Mountains Compressor Station; and
- the Trout River Heater Station.

Figure 2-15 Typical Compressor Station — Artist's Impression



Source: J-IORVL-00419, p. 16

Figure 2-16 Great Bear River Compressor Station Facilities and Infrastructure



Source: J-IORVL-00953, Section 4, Figure 4-3

The complete map can be viewed in 4330-INAC_Book_vol_I_Figure2-16.pdf

These additional facilities form part of the Mackenzie Gas Project as described in this Report and are included in the Proponents' regulatory applications as currently filed with the NEB. The Proponents assume that construction of these facilities would begin three years after Project start-up. The Panel understands that this timing might be advanced depending on when additional shipping commitments were made.

The compressor stations would be similar in design, scope and infrastructure to the Great Bear River Compressor Station. The Loon River North Compressor Station would be about 40 km north of Fort Good Hope. The River Between Two Mountains Compressor Station would be about 40 km south of Wrigley.

The Trout River Heater Station would be about 100 km north of the Alberta border. The heater station would maintain the gas pipeline operating temperatures within the design requirements. The infrastructure to support construction and operations would include:

- a new permanent helipad;
- borrow sites;
- a temporary 60-person camp;
- well water;
- a new 3.0 ML fuel storage site; and
- a stockpile site.

PROVISION FOR POTENTIAL FUTURE FACILITIES

The initial installation of the Mackenzie Valley Pipeline would include 11 block valves installed at the locations of potential future compressor facilities.

2.2.4 MACKENZIE GAS PROJECT FOOTPRINT

The total land requirements for the Project would be 9,673 ha, 9,150 ha of which would be required for the Mackenzie Gathering System and the Mackenzie Valley Pipeline.

2.2.5 NORTHWEST ALBERTA FACILITIES

The Northwest Alberta Facilities are proposed to be constructed by NOVA Gas Transmission Ltd. (NGTL). NGTL is a wholly-owned subsidiary of TransCanada PipeLines Limited (TransCanada). The pipeline system owned by NGTL in Alberta is generally known by TransCanada and its customers as the "Alberta System". When constructed, the Northwest Alberta Facilities would become part of the Alberta System.

Until recently, the Alberta System was subject to the jurisdiction of the relevant Alberta regulatory authorities. Accordingly, in June 2006, NGTL applied to the Alberta Energy and Utilities Board (AEUB) for the necessary authorizations to construct the Northwest Alberta Facilities.

The Panel is aware that on April 15, 2009, the National Energy Board issued a certificate of public convenience and necessity under the *National Energy Board Act* to NGTL placing the Alberta System owned by NGTL under the jurisdiction of the NEB.

The Panel understands that as a result of these developments the Northwest Alberta Facilities would now require authorizations by the NEB, rather than Alberta regulatory authorities. As a consequence of this change in the regulatory status of the Northwest Alberta Facilities, the Panel makes a generic recommendation, in Chapter 5, "Approach and Methods", that the NEB include certain conditions in any certificate or approvals that it issues for the Northwest Alberta Facilities.

INTERCONNECT FACILITY

The Mackenzie Valley Pipeline would terminate at a pig receiver located adjacent to the interconnect facility 10 m south of the NWT–Alberta boundary. This interconnect facility would measure and heat the gas delivered from the Mackenzie Gas Project before it entered the existing NGTL system. The proposed site for the interconnect facility is about 1.3 ha.

PIPELINE

The pipeline consists of the Northwest Mainline (referred to as the Dickins Lake Section) and Northwest Mainline Loop (referred to as the Vardie River Section). The Dickins Lake Section, NPS 36, would start at the proposed interconnect facility and continue south for approximately 66 km. The Vardie River Section, NPS 36, would start at the south end of the Dickins Lake Section and continue for 37 km to the existing NGTL Thunder Creek Compressor Station.

The planned width of the construction right-of-way for the Dickins Lake Section is 31 m with temporary workspace required at specific locations. The Vardie River Section would parallel NGTL's existing Northwest Mainline for the entire length. The pipeline would cross the existing corridor at two locations. The additional right-of-way along the existing corridor would consist of 14 m for approximately 10.3 km and 17.0 m for approximately 26.9 km.

INFRASTRUCTURE

Facility components would be modular and transported to work sites by truck. The supporting infrastructure for the Northwest Alberta Facilities would include:

- existing all-weather and winter access roads;
- alternative winter access roads depending on accessibility;
- a natural gas line heater at the existing NGTL Thunder Creek Compressor Station; and
- construction camp facilities that could be located at either an existing commercial camp (Wiebe Camp) or an existing camp clearing (Wildboy Trail Camp) that could be expanded to accommodate the construction camp.

No borrow sites would be developed since there are no expected granular resource requirements. Waste would be managed according to applicable legislation.

2.2.6 PROJECT PRODUCTS

The product at the wellhead of the Anchor Fields producing facilities, and in the gathering pipeline to the Inuvik Area Facility, would be a two-phase mixture of natural gas (predominantly methane, CH_4) and natural gas liquids (NGLs) composed of heavier, less volatile hydrocarbons. In the event of a rupture, the natural gas would disperse into the atmosphere and the NGLs would be discharged as liquid droplets, some of which would evaporate, while the larger droplets would be deposited onto the ground surface.

There would be two separate products leaving the Inuvik Area Facility. The product entering the MVP would be natural gas, which, in the event of a rupture of the MVP, would disperse into the atmosphere. The product entering the NGL line to Norman Wells would be a stream of NGLs, which would be liquid while under pressure in the pipeline and which, in the event of a rupture of the pipeline, would be discharged as a mixture of gas and liquid droplets. The gas would disperse into the atmosphere, while some of the liquid droplets would initially settle onto the ground surface, but would eventually evaporate.

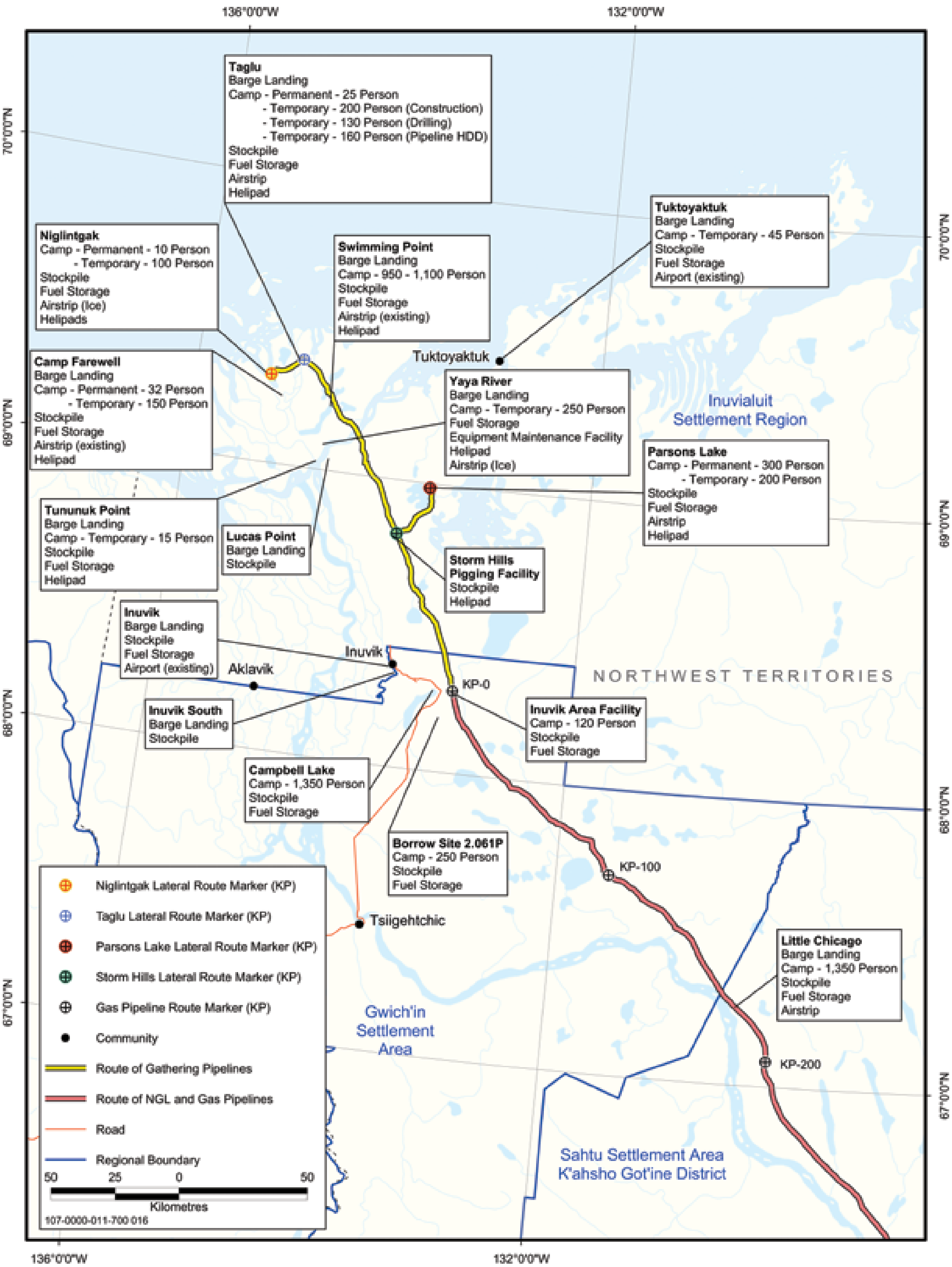
2.3 PROJECT INFRASTRUCTURE

Figure 2-17 shows the location of proposed infrastructure sites from the Mackenzie Delta south to Little Chicago.

Figure 2-18 shows the location of infrastructure sites south of Little Chicago to Wrigley.

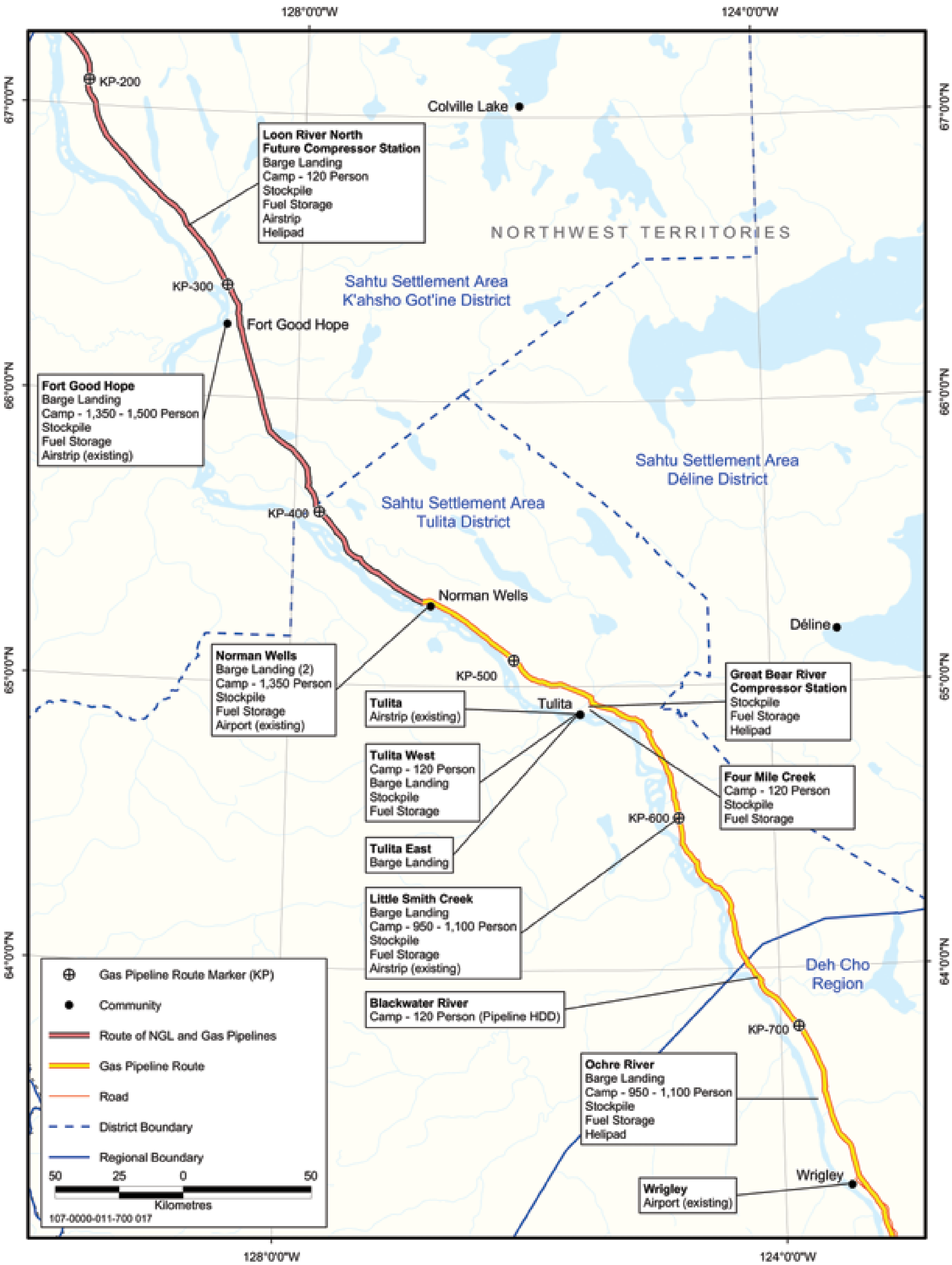
Figure 2-19 shows the location of infrastructure sites south of Wrigley to Alberta.

Figure 2-17 Infrastructure Sites From the Mackenzie Delta South to Little Chicago



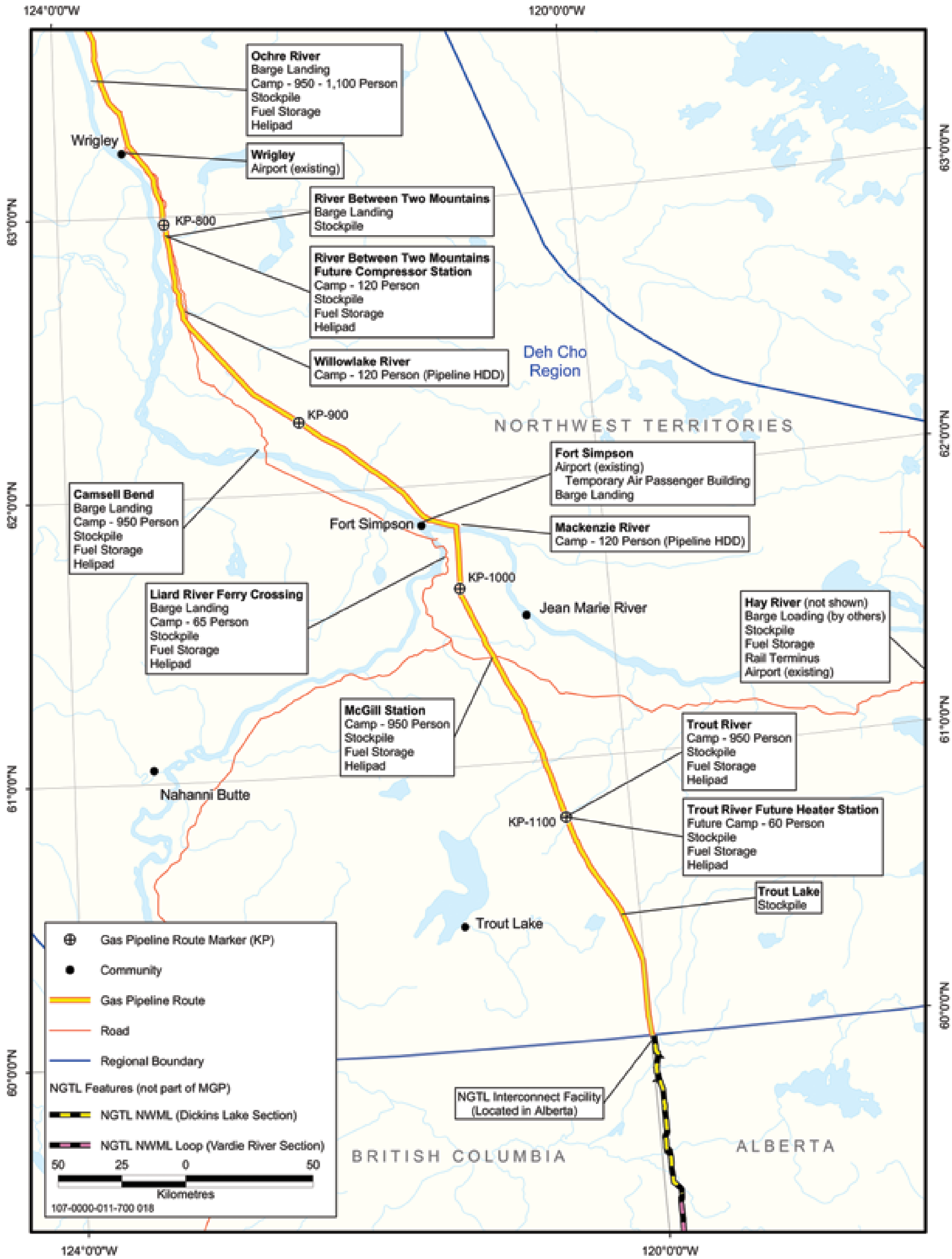
Source: J-IORVL-00953, Section 5, Part 1, Figure 5-1

Figure 2-18 Infrastructure Sites South of Little Chicago to Wrigley



Source: J-IORVL-00953, Section 5, Part 1, Figure 5-2

Figure 2-19 Infrastructure Sites South of Wrigley to Alberta



Source: J-IORVL-00953, Section 5, Part 1, Figure 5-3

2.3.1 CAMPS

The Project would use existing camps and new camps to support construction and operations of the Anchor Fields, pipelines, facilities, module assembly and drilling sites. Four camp locations would be permanent, three of which are proposed new camps. In addition, there would be 30 temporary camp locations. In some cases these locations would support HDD crews and other construction activities. Two existing camps, at Camp Farewell and Swimming Point, would be expanded. In most cases, camp components would be modular and movable. The number of overall beds that would be required for construction and operations is about 7,000. Generally, camps for pipeline construction would be located in the middle of a spread.

2.3.2 POTABLE WATER SUPPLY

The Project would source water from nearby lakes, rivers or municipal systems, with delivery to camps by trucks or temporary water pipelines. Based on peak camp capacity, each 120-person HDD camp would use 27 m^3/d of water, which represents about 225 L/d per person.

2.3.3 BARGE LANDING SITES

Barge landing sites would be used to transfer equipment, material and fuel from barges to shore. Most of the barge landing sites would be temporary summer sites, with several permanent sites to support operations. Of the 24 proposed barge landing sites, 16 would use existing facilities, and 7 would require new construction. Some existing barge landing sites would need upgrading.

2.3.4 STOCKPILE AND FUEL STORAGE SITES

The Project estimates the need for 34 stockpile sites during the construction phase to store pipe, materials and equipment. Typically, the area of a stockpile site would be about 7 ha, based on site location and storage requirements. While some sites would have existing roads, most would need new roads.

Diesel would be the primary fuel needed for camps, construction equipment and light-duty trucks, with delivery to Project sites by barges or fuel trucks. Site preparation and tank design would provide for safety and handling precautions. The Project would use existing bulk fuel storage sites in Tuktoyaktuk, Inuvik, Norman Wells and Hay River, and develop up to 23 new fuel storage sites.

2.3.5 ROADS

The Project would use existing roads and about 400 new roads to transport material, equipment and personnel to camps, storage sites, work sites and pipeline right-of-ways. An estimated 1,050 km of roads would be required, including 70 km of all-weather roads and 980 km of winter roads. Some all-weather roads would be required for the operations phase.

2.3.6 AIRSTRIPS AND HELIPADS

The Project would use approximately 11 existing airports and airstrips, 5 new airstrips and 17 new helipads.

2.3.7 BORROW SITES

Borrow sites would provide gravel, sand and crushed rock needed for the Project. The Proponents identified about 120 proposed primary and secondary borrow sites, with the final selection to be based on final construction plans.

The Project's demand for borrow materials would be about 7.6 Mm^3 placed volume, or 10 Mm^3 excavated volume. Placed volume is the engineering volume compacted in place, whereas excavated volume is that taken from the borrow site and includes allowances for bulking, ice or moisture content, and transport. Excavated volume averages 30% more than placed volume.

The proposed primary borrow sites include:

- 8 in the Inuvialuit Settlement Region;
- 11 in the Gwich'in Settlement Area;
- 14 in the Sahtu Settlement Area — K'ahsho Got'ine District;
- 15 in the Sahtu Settlement Area — Tulita District; and
- 20 in the Dehcho Region.

Table 2-2 summarizes the proposed primary borrow site requirements by use and region.

Trucks would be used almost exclusively to transport borrow materials from the borrow sites to construction sites. Transporting 10 Mm^3 of borrow materials would require about 555,556 truck loads at 18 m^3 per load. Access to borrow sites would be via winter roads, all-weather roads and pipeline right-of ways, and would require the use or crossing of public roads. About half of the primary borrow sites would require crossing or using public roads.

Table 2-2 Borrow Source Estimated Demand and Supply

Borrow Use	Region					Total Placed [1] (1,000 m³)	Total Excavated (1,000 m³)
	ISR (1,000 m³)	GSA (1,000 m³)	SSA, K'ahsho Got'ine District (1,000 m³)	SSA, Tulita District (1,000 m³)	DCR (1,000 m³)		
Anchor fields	1,700	—	—	—	—	1,700	2,550
Inuvik area facility	—	500	—	—	—	500	750
Facilities	20	—	73	370	62	525	660
Infrastructure	368	612	1,608	595	478	3,661	4,290
Pipelines	211	344	335	180	165	1,235	1,700
Demand total *	2,279	1,456	2,016	1,145	705	7,621	9,950
Total available	25,330	35,000	26,645	159,165	62,384	308,524	

Note:
1. Placed volumes are rounded to the nearest 1,000 m³.

Source: Adapted from J-IORVL-00953, Section 5, Part 2, Table 5-10

2.4 LOGISTICS AND TRANSPORTATION

2.4.1 ESTIMATED CARGO WEIGHT

The Project would require an estimated 1.2 million tonnes of cargo, including:

- pipe (442,000 t);
- fuel (384,000 t, or 460 ML);
- camp modules (45,000 t);
- facility modules (62,000 t); and
- construction and drilling equipment (155,000 t).

Estimated cargo by transportation method would include:

- 800,000 t by barge from Hay River;
- 40,000 t by barge from the Liard Ferry near Fort Simpson;
- 60,000 t through the Beaufort Sea; and
- 300,000 t by truck or air.

2.4.2 CARGO TRANSPORTATION REQUIREMENTS

The peak requirements of the Project by transportation method would include:

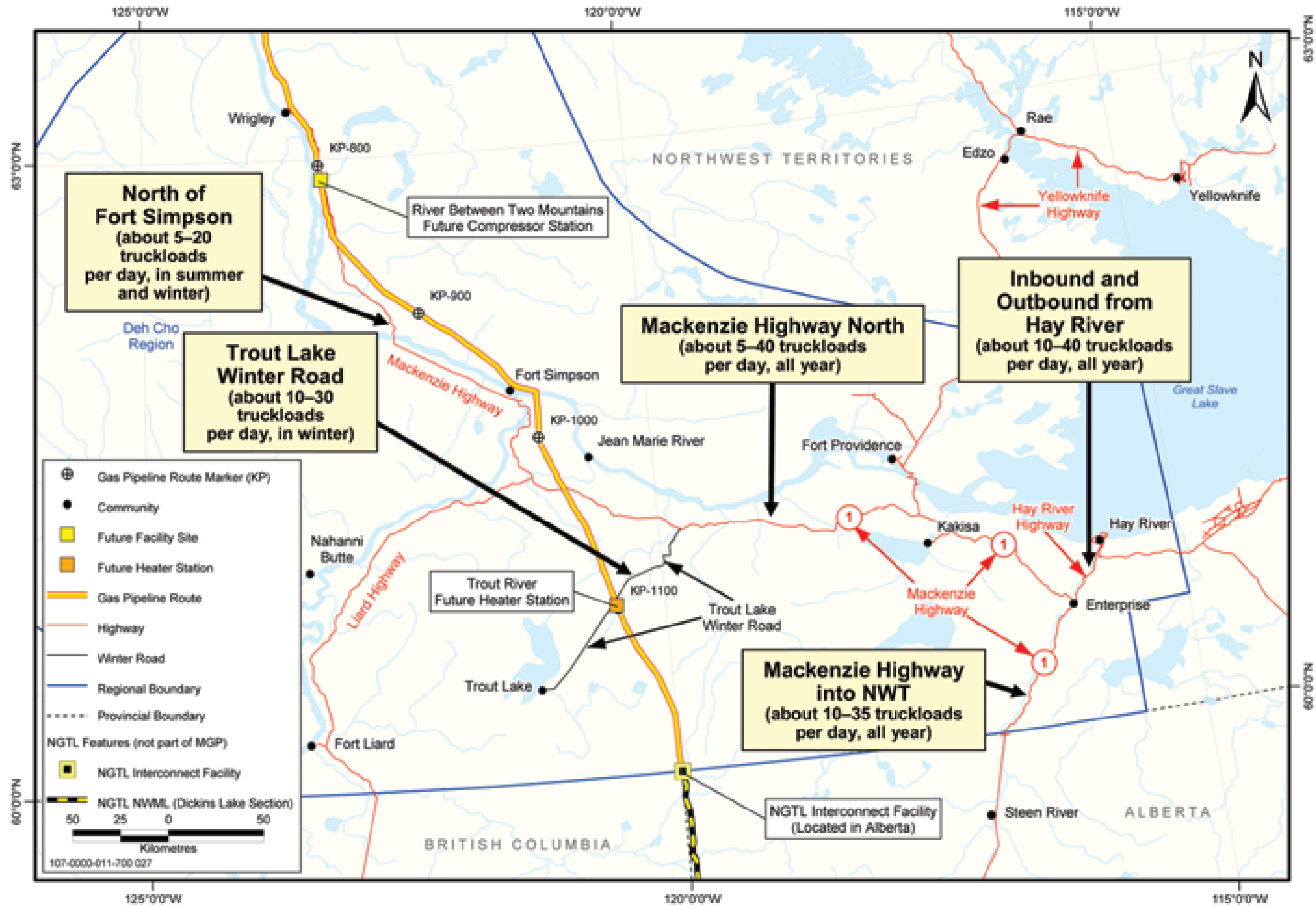
- Rail: The peak yearly railcar requirements would be about 4,900 railcars. Peak monthly deliveries would be about 600 railcars. This translates to about three to seven trains weekly into Hay River to meet delivery requirements.
- Truck: Figure 2-20 indicates estimated truckloads for the NWT, and Table 2-3 indicates estimated truckloads for the Dempster Highway.
- River barge: The weekly requirements would be about six barge trains (six barges per train) from Hay River, and two or three barge trains (four barges per train) from Liard Ferry.
- Marine transport: The requirements would include 5 to 6 heavy-lift ship and ocean barge trips, and 10 to 13 transits into the Delta.

2.4.3 WORKFORCE TRANSPORTATION REQUIREMENTS

Aircraft would transport Project workers to hubs at Inuvik, Norman Wells or Fort Simpson. The workers would take smaller aircraft or helicopters from the hubs to airstrips located near the other construction sites. From there, workers would take buses to nearby camps. The peak flight requirements for each hub would be two to three flights daily. The peak requirements for each construction airstrip would vary from three to six flights daily.

Freight and personnel would fly directly to an airstrip located at Parsons Lake aboard Boeing 737s when the airstrip became available.

Figure 2-20 Expected Peak Year Truckloads



	Mackenzie Highway into NWT	Inbound and Outbound from Hay River	Mackenzie Highway North on Highway 1	Trout Lake Winter Road	North of Fort Simpson
Peak Year	2011	2012	2012	2012	2011
Truckloads	6,900	6,600	5,500	2,000	2,800

Source: J-IORVL-00953, Section 6, Figure 6-1

Note: These dates are no longer achievable. Therefore, the Panel's review has proceeded on the assumption that the Project would generally follow the sequence and number of years from receipt of Project approvals that are reflected in this table.

Table 2-3 Estimated Project Truckloads for the Dempster Highway

Year	Niglintgak *	Taglu	Parsons Lake	Pipelines and Facilities	Total
2011	300	0	25	100	425
2012	400	0	300	100	800
2013	400	440	350	100	1,290
2014	300	200	350	50	900
Total	1,400	640	1,025	350	3,415

Note:
* Includes equipment demobilization and drilling waste fluids.

Source: Adapted from J-IORVL-00953, Section 6, Table 6-4

Note: These dates are no longer achievable. Therefore, the Panel's review has proceeded on the assumption that the Project would generally follow the sequence and number of years from receipt of Project approvals that are reflected in this table.

2.5 EXPENDITURES AND WORKFORCE

2.5.1 EXPENDITURES

CAPITAL COSTS

The Proponents estimate the total capital costs for the pre-construction and construction phases of the Project to be about $14 billion (in constant Q2 2006 Canadian dollars). This estimate includes costs for engineering design, procurement, owners' costs and construction. It does not include an allowance for funds used during construction. The estimated future capital costs to maintain production at the level of the initial capacity of the Project are approximately $2 billion. Table 2-4 shows the estimated capital costs for each phase of the Project.

NGTL estimates the capital costs for extending its Dickins Lake Section and the Vardie River Section to be about $212 million (in constant 2006 Canadian dollars).

Table 2-4 Capital Expenditures for Mackenzie Gas Project by Component and Phase

Project Component	Pre-Construction Phase (Pre-2010) ($ million) [1]	Construction Phase (2010–2014) ($ million) [1]	Operations Phase [2] (2015–2034) ($ million) [1]	Total [1] ($ million)
Anchor Fields	900	2,850	1,150	4,900
Mackenzie Gathering System	600	2,750	150	3,500
Mackenzie Valley Pipeline [3]	1,150	5,650	1,050 [4]	7,850
Total [2]	2,650	11,250	2,350	16,250

Notes:

1. Totals are rounded to the nearest $50 million and expressed in constant Q2 2006 Canadian dollars.
2. Costs include construction cleanup and demobilization in 2015.
3. Costs exclude allowance for funds used during construction.
4. Costs include estimates for future compressor stations at Loon River North, River Between Two Mountains and the Trout River Heater Station, including some initial expenditures in 2014.

Source: Adapted from J-IORVL-00953, Section 7, Tables 7-1 and 7-2

Note: These dates are no longer achievable. Therefore, the Panel's review has proceeded on the assumption that the Project would generally follow the sequence and number of years from receipt of Project approvals that are reflected in this table.

OPERATIONS COSTS

The Proponents estimate the average total operations costs (including some construction costs to be incurred after Project start-up) of the Project for the first five years of operation to be $174 million yearly. Table 2-5 summarizes the costs by Project component.

Table 2-5 Estimate of Operations Expenditures

Project Component	Annual Average 2015–2019 ($ million) [1]
Niglintgak	10
Taglu	26
Parsons Lake	25
Gathering system	55
Gas pipeline and facilities [2]	58
Total	174

Notes:
1. Costs are in constant Q2 2006 Canadian dollars.
2. Costs assume facilities required for 34.3 Mm^3/d (1.2 Bcf/d) operation start in 2018.

Source: Adapted from J-IORVL-00953, Section 7, Table 7-19

Note: These dates are no longer achievable. Therefore, the Panel's review has proceeded on the assumption that the Project would generally follow the sequence and number of years from receipt of Project approvals that are reflected in this table as filed with the Panel.

2.5.2 WORKFORCE

ESTIMATED CONSTRUCTION WORKFORCE

The Project would require a total workforce representing about 22,600 jobs, or 11,300 person years. Table 2-6 summarizes the estimated construction employment.

Table 2-6 Estimated Construction Employment

	Year (July–June)					
Component	2010–2011 (jobs/person years)	2011–2012 (jobs/person years)	2012–2013 (jobs/person years)	2013–2014 (jobs/person years)	2014–2015 (jobs/person years)	Total
Anchor Field construction	691/392	895/412	735/514	512/290	—	2,833/1,608
Anchor Field drilling	0/0	148/89	594/599	630/635	—	1,372/1,323
Pipeline and facility construction	1,325/1,047	6,196/2,558	5,253/2,360	5,419/2,384	205/65	18,398/8,414
Total	2,016/1,439	7,239/3,059	6,582/3,473	6,561/3,309	205/65	22,603/11,345

Source: Adapted from J-IORVL-00953, Section 7, Tables 7-3, 7-4, 7-5 and 7-6

Note: These dates are no longer achievable. Therefore, the Panel's review has proceeded on the assumption that the Project would generally follow the sequence and number of years from receipt of Project approvals that are reflected in this table.

ESTIMATED OPERATIONS WORKFORCE

Workforce estimates for the operations phase of the Project are 150 workers yearly. This figure includes staff to run the Loon River North and River Between Two Mountains Compressor Stations, and the Trout River Heater Station. Initially, the Anchor Fields would be staffed continuously. Table 2-7 shows the initial operations employment by Project component.

Table 2-7 Estimates for Initial Operations Employment

Project Component	Number of Personnel
Niglintgak	10
Taglu	23
Parsons Lake	19
Pipelines and facilities	98
Total	150

Source: Adapted from J-IORVL-00953, Section 7, Tables 7-20 and 7-21

The number of operations and maintenance staff would decline as operations stabilized. Some sites would be remotely monitored, with staff visiting the sites when needed. A pipeline control centre in Calgary would remotely monitor the NGL and gas pipelines. Staff at the Inuvik Area Facility would monitor the gathering pipelines and that facility. About five years after start-up, workforce estimates are between 100 and 130 people yearly.

2.6 ENVIRONMENTAL INPUTS AND OUTPUTS

2.6.1 INPUTS

WATER

The Project would require water for potable water, winter road and airstrip construction, as well as construction, drilling and operations activities. Estimated annual water requirements during construction are 3.0 Mm^3. The Project would source water mainly from the Mackenzie River. Drilling and construction activities would use nearby water bodies. Where possible, community resources would supply water for the operations phase. The Project identifies about 130 lakes and 50 locations on rivers as potential water sources.

TIMBER

The Project would require timber for construction purposes, such as erosion control, watercourse embankments and temporary bridges.

BORROW MATERIAL

Borrow sites would provide the granular materials required by the Project. The Project identifies about 68 proposed primary borrow sites and 48 proposed secondary borrow sites, with final selection to be based on final construction plans. Secondary sites are alternative locations that might be required if some primary sites are found unsuitable. Once developed, most borrow sites would be about 10 ha in size.

2.6.2 OUTPUTS

PRODUCED WATER, DRILLING AND COMPLETION WASTE

Drilling and operating the production wells would generate various solid and liquid waste products such as produced water, drilling cuttings and other drilling wastes.

FLUSH AND TEST WATER

The pipelines and selected components of the pipeline processing facilities would require hydrostatic testing before commissioning the system. The testing would require about 36,000 m^3 (7,200 m^3 per pipeline spread) of a methanol–water mixture.

The Inuvik Area Facility and compressor and heater stations would also require hydrostatic testing before commissioning, using a glycol–water mixture.

SEWAGE AND GREY WATER

Temporary construction camps and permanent pipeline facilities would produce and be equipped with facilities for the collection, treatment and disposal of domestic black water (sewage) and grey water (wastewater from showers, laundries and kitchens).

AIR EMISSIONS

The Proponents estimated the air emissions for each source during the construction and operations phases by region. Emission estimates are available for sulphur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), fine particulate matter ($PM_{2.5}$), benzene, as well as the mixture of benzene, toluene, ethylbenzene and xylenes (BTEX).

NOISE

The primary noise-generating sources would include compressors, power generation equipment and aerial coolers. All such equipment would be designed to keep the resulting sound levels below the maximum permissible sound levels of the AEUB's *Directive 038: Noise Control*.

GREENHOUSE GAS EMISSIONS

The Proponents estimated the greenhouse gas emissions for each Project-related source during the drilling, construction and operations phases by region.

OPERATIONS-RELATED FLARING

Flaring would occur at the three Anchor Fields facilities and the Inuvik Area Facility. Some flaring would be associated with well testing during the pre-operational drilling phase of the Project. Other than operations-related flaring during emergencies, upsets or some limited maintenance activities, the only continuous operations-related flaring would be associated with the flare pilot gas.

DUST

Dust would be generated by vehicle and equipment movement during the construction phase.

DOMESTIC REFUSE

The Project would generate domestic refuse and other combustible non-hazardous waste. Community landfills may be used during the pre-construction phase before the installation of incinerators, which would be located at temporary camps and permanent facilities.

The type of incinerator technology available is still under review. Incinerator technology would be selected based on the waste feedstock and expected quantities to be treated. Incinerator ash would be shipped in sealed containers to an approved third-party landfill for disposal outside of the NWT.

SOLID AND LIQUID WASTES

Hazardous materials to be used in the construction and operation of the Project would be handled in compliance with applicable federal and territorial regulatory requirements under legislation such as the *Canadian Environmental Protection Act, 1999* and the NWT *Environmental Protection Act*. For example, ethylene glycol (antifreeze), which would be used for de-icing aircraft at the Taglu and Parsons Lake airstrips and for wellhead cooling at the Anchor Fields, is a listed substance under the *Canadian Environmental Protection Act, 1999*, and its handling, storage and disposal would have to meet the requirements under the Act. The details of these requirements, as they would apply to the Project, were being discussed among the relevant federal departments and were not available to the Panel at the close of its hearings.

All hazardous wastes and non-hazardous wastes not previously discussed would be stored in approved, sealed containers and maintained in secured storage areas or buildings before being transported by truck or barge to approved disposal sites.

A comprehensive waste tracking system would track and account for waste materials from point of generation to reuse, recycling, treatment or final disposal.

2.7 OPERATIONS AND MAINTENANCE

At start-up of the Anchor Fields, operations staff would be present at the fields 24 hours a day, 7 days a week. Later in the life of the fields, operations would likely be unattended, with remote monitoring supplemented by regular site visits by operators. Regular servicing of the wells, according to industry standards, would require the use of such equipment as wireline units, coiled tubing units and fluid pumpers. Where possible, maintenance work would be conducted in winter. Summer well maintenance would be conducted as required.

The Inuvik Area Facility would be staffed on an ongoing basis, including operations and maintenance personnel. The gathering pipelines would be monitored and controlled from the Inuvik Area Facility.

Other Project facilities, including the NGL pipeline to Norman Wells, the Mackenzie Valley Pipeline and supporting facilities, would be monitored and controlled remotely from a main control centre in Calgary using a supervisory control and data acquisition (SCADA) system with backup control capability. Personnel would periodically visit the supporting facilities, including pigging facilities, meter stations, compressors and the heater station, to complete maintenance and operations activities. Temporary living quarters would be included at these sites.

The Proponents are developing an Integrity Management Plan that will include monitoring the pipeline and right-of-way and conducting periodic risk assessments of pipeline integrity and the right-of-way condition. The Integrity Management Plan will include monthly aerial inspections and will provide for field investigation to confirm monitoring data if required. Maintenance personnel familiar with the long-term right-of-way and pipeline conditions would participate in the aerial patrols. A site-specific plan would be developed after site details were known.

Helicopters and small aircraft would be used to access remote sites during operations. Maintenance activities requiring heavy equipment and material would be restricted to winter for remote sites. Emergencies or special situations might require remote locations to be accessed by ground during non-frozen conditions.

The interconnect facility in Alberta would be designed for remote, unstaffed operation and would be accessible by helicopter.

2.8 DECOMMISSIONING, RECLAMATION AND ABANDONMENT

2.8.1 INFRASTRUCTURE DECOMMISSIONING

The proposed plan for decommissioning the temporary infrastructure sites at the end of the construction phase includes:

- consulting with nearby communities and considering alternatives for abandoning the site;
- demobilizing all construction equipment and surplus materials used for pipeline construction;
- collecting all wastes generated from construction at the respective infrastructure sites and transporting the wastes from the sites to designated waste facilities;
- removing all camp buildings and modules from the site and transporting the debris from the sites to designated waste facilities;
- decommissioning, cleaning, dismantling, removing and transporting fuel tanks, fuel lines and related fuel facilities from the site to designated salvage facilities;
- removing and transporting all electrical cables from the sites to designated salvage facilities;
- removing and transporting all liners from the sites to designated disposal sites;
- reclaiming granular material that is contaminated with hydrocarbons onsite using industry standard procedures in accordance with environmental standards and regulations, and removing granular material that cannot be reclaimed to designated waste facilities;
- cutting off any pile foundations used for camp installation below ground and abandoning them in place;
- leaving granular pads in place, re-establishing pre-existing drainage patterns as required and scarifying the pads, replacing organic cover soil salvaged during construction, and seeding with indigenous species of plants as directed by land use officials or re-vegetating using natural techniques;
- removing culverts installed for the infrastructure roads and re-establishing drainage patterns, scarifying road embankments, obliterating and spreading roadbed materials along the road right-of-way, and re-spreading organic soil that was stockpiled during construction (in thaw-stable areas) over the obliterated roadbed; and
- salvaging all navigation aids, lighting systems and buried cables installed at the airstrips and helipads, disposing of materials outside of the NWT if necessary, removing airstrip and helipad culverts and re-establishing drainage patterns, scarifying embankment materials, obliterating and spreading airstrip materials along the airstrip, and re-spreading organic soil that was stockpiled during construction (in thaw-stable areas) over the airstrips and helipads.

2.8.2 FACILITIES AND EQUIPMENT DECOMMISSIONING

As the Mackenzie Gas Project approaches the end of its useful operating life, the Proponents propose to develop an abandonment and reclamation plan according to regulatory requirements in effect at the time of abandonment. The plan would include public consultation and consideration of alternative uses of the abandoned sites.

At this time, the specific regulatory requirements that might be in effect when the Project is completed are unknown. However, the Proponents expect any decommissioning plan would include the decommissioning, abandonment and reclamation of the production sites and associated pipelines and pipeline facilities as follows:

- abandoning the downhole production and disposal wells by isolating any open formation intervals using bridge plugs or cement squeezes, removing wellheads, and cutting-off casings and conductors below the surface and capping;
- removing surface pipelines and supports for reuse or recycling;
- abandoning buried pipelines in place by purging and flushing and then capping open ends;
- shutting off pipeline cathodic protection systems and removing aboveground appurtenances;
- removing hydrocarbons and other products and fluids from facilities equipment, piping, vessels and tanks, and dismantling and removing equipment, piping, vessels and tanks for reuse, recycling or disposal;
- removing or cutting off piles below ground;
- removing culverts, re-establishing drainage channels, stabilizing banks to minimize erosion and siltation, and monitoring of and taking remedial action on re-established drainage channels and banks in accordance with regulatory and corporate requirements; and
- leaving gravel pads in place and scarifying them to encourage plant growth, and considering additional measures for sensitive locations as needed.

Ice road on the East Branch of the Mackenzie Delta

Source: NGPS

The Proponents propose that all Project infrastructure and equipment be removed from the Project site during decommissioning, except for those abandoned items listed in Section 2.8, and that all abandoned equipment be rendered inert. Barges or trucks would transport all removed equipment to appropriate reuse, recycle, salvage or disposal facilities within or outside of the NWT, depending on the availability of existing facilities.

2.8.3 NORTHWEST ALBERTA FACILITIES

An abandonment and reclamation plan for the Northwest Alberta Facilities would be developed according to the regulatory requirements in effect at the time of abandonment. Development of the plan would include public consultation and consideration of alternative uses of the sites being abandoned.

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3.1 THE PROJECT AS FILED WITH THE PANEL

As described in Chapter 2, "Project Description," the Panel's review included the impacts of those components of the Mackenzie Gas Project (MGP or "Project") that were described in the Proponents' Environmental Impact Statement (EIS) and that are the subject of regulatory applications to the National Energy Board (NEB). The Panel also reviewed the impacts of the Northwest Alberta Facilities. The Project as defined by the Panel for the purposes of its review has the following components:

- three Anchor Fields;
- other components of the Mackenzie Gathering System (MGS); and
- the Mackenzie Valley Pipeline (MVP), with three compressor stations and the Trout River Heater Station.

In addition, the Panel reviewed the impacts of the Northwest Alberta Facilities.

The Project as so defined is referred to in this Report as the Project as Filed. The Project as Filed would be designed to have a **capacity** of 1.2 Bcf/d. However, until additional gas fields were developed and connected to the Project, the available gas supply of 830 Mcf/d from the Anchor Fields would provide a **throughput** on the MVP of only approximately 70 percent of that capacity. The Project as Filed does not include the development of and production from other unidentified gas fields that would be necessary to support throughput on the MVP at its capacity of 1.2 Bcf/d.

3.2 EXPANSION CAPACITY SCENARIO OF THE MACKENZIE VALLEY PIPELINE

The pipeline is being designed with the potential to expand the initial capacity of 1.2 Bcf/d to an expansion capacity of 1.8 Bcf/d. This would require the installation of 11 additional compressor stations and other facilities beyond those required for the Project as Filed. The Project, with the 11 additional compressor stations and other facilities, together with the development of additional gas fields to support throughput at 1.8 Bcf/d, is referred to as the Expansion Capacity Scenario. The Expansion Capacity Scenario could proceed only if the Project as Filed were in place. Therefore, the Panel has considered the Expansion Capacity Scenario as an extension of, not as an alternative to, the Project as Filed. Separate regulatory approvals would be required in the future to construct and operate the additional facilities to support the Expansion Capacity Scenario. The expansion would proceed only if natural gas fields additional to the Anchor Fields were discovered, developed and put into production, probably involving parties other than, or at least in addition to, any of the Proponents.

The Proponents characterized the addition of up to 11 compressor stations to the MVP as a "hypothetical" land use on the grounds that it was uncertain whether additional gas would be discovered and when that might occur. (Dr. Alan Kennedy, HT V102, p. 10101) However, the Project as Filed provides for the possibility of future expansion, as it includes, among other things, installing block valves at the locations of the 11 additional compressor stations.

The project referred for review under the *Joint Review Panel Agreement* included the additional facilities that would need to be added to the MVP by the Proponents to support the Expansion Capacity Scenario. Therefore, the Panel's Mandate has required the Panel to consider the impacts of these additional facilities. The additional 11 compressor stations are not part of any regulatory application by the Proponents. There was, therefore, insufficient information available during the Panel's review process to allow the Panel to conduct a comprehensive review of the impacts of these additional facilities at the same level as its review of the impacts of the Project as Filed. The Panel also notes that, while information about potential additional sources of gas supply for the MVP was submitted to the Panel, no information was available at the close of the Panel's record on the specific sources that would be put into production to support the Expansion Capacity Scenario. At the request of the Panel, the Proponents did, however, provide a scenario of future developments that could support the expansion of the Project to a capacity of 1.8 Bcf/d, as discussed further in Section 3.3.3.

The Panel does not accept the Proponents' characterization of the addition of the 11 compressor stations that would be required to support the Expansion Capacity Scenario as being a "hypothetical" land use. While the specific developments that would be necessary to support the Expansion Capacity Scenario cannot be identified at this time, the Proponents, by providing for expansion in the initial design of the MVP, must anticipate that the addition of further facilities in the future is more than a mere possibility. In the Panel's view, future developments to support the Expansion Capacity Scenario at a capacity of 1.8 Bcf/d are reasonably foreseeable, notwithstanding that it is not possible to identify specifically what those developments would be or, more importantly, where they might be located.

In these circumstances, the Panel has undertaken a limited review of potential cumulative impacts of possible future developments that would support the Expansion Capacity Scenario to a capacity of 1.8 Bcf/d and of the facilities that would be added to the MVP in that event.

3.3 PROPONENTS' HYPOTHETICAL EXPANSION CAPACITY SCENARIO

3.3.1 GLJ REPORT

At the request of the Panel, the Proponents developed a hypothetical scenario of natural gas developments that would support throughput on the MVP at the level of the Expansion Capacity Scenario. The scenario was based on a report prepared by Gilbert Laustsen Jung Associates Ltd. for the Proponents entitled *Mackenzie Gas Project: Gas Resource and Supply Study*, dated May 1, 2004 (referred to as the GLJ Report). The report was originally filed with the NEB to support the planned pipeline capacity of 1.2 Bcf/d. At the Panel's request, the report was also filed with the Panel.

The focus of the GLJ Report was on the gas resource and supply potential of various gas plays that could potentially be connected to the MGS and the MVP. The report did not describe any particular future developments as such. However, in addition to providing data to support the design capacity of the MVP at 1.2 Bcf/d, the report included a sensitivity forecast for a fully expanded MVP capacity of 1.8 Bcf/d.

The study area included in the GLJ Report encompasses approximately 99,700 km^2 in the following regions:

- the onshore Mackenzie Delta region, including the Anchor Fields;
- the central Mackenzie Valley region extending from the Mackenzie Delta south to latitude approximately 63 degrees, including the Colville Hills area;
- the northern portion of the Yukon Territory, including the Eagle Plain Basin; and
- portions of the offshore Mackenzie Delta region (Beaufort Sea) limited to a water depth of 30 metres.

The GLJ Report summarized a best estimate classification of marketable gas resources supply forecasts, as set out in Table 3-1.

3.3.2 OIL AND GAS MANAGEMENT DIRECTORATE

In developing their hypothetical scenario of gas production at a level to support the Expansion Capacity Scenario, the Proponents also relied on information supplied directly to the Proponents by Giles Morrell of Indian and Northern Affairs Canada's Northern Oil and Gas Branch. This information was provided in a letter from Mr. Morrell to the Proponents, which was filed with the Panel by the Proponents as part of their response to a Panel Information Request. (Indian and Northern Affairs Canada is

Table 3-1 Marketable Gas Resources Supply Forecasts: Best Estimates Classification

	Marketable Gas Resources [1]		Plateau Production Rate [2]		Plateau Rate Duration [3]	
	10^9m^3	(TCF)	$10^6m^3/d$	(BCFD)	Years	Period
Main Scenarios						
1. Contingent Onshore Resources	194	(6.8)	34	(1.2)	3	2012–2014
2. Contingent and Prospective Onshore Resources	341	(12.0)	34	(1.2)	18	2012–2029
3. Contingent and Prospective Onshore plus Offshore Resources	473	(16.7)	34	(1.2)	26	2012–2037
Sensitivity 1 — Expanded Pipeline						
1. Contingent Onshore Resources	194	(6.8)	No plateau		0	0
2. Contingent and Prospective Onshore Resources	341	(12.0)	No plateau		0	0
3. Contingent and Prospective Onshore plus Offshore Resources	476	(16.8)	51	(1.8)	15	2016–2030
Sensitivity 2 — NEB P_{50} for Anchors						
1. Contingent Onshore Resources	147	(5.2)	34	(1.2)	3	2012–2014
2. Contingent and Prospective Onshore Resources	294	(10.4)	34	(1.2)	15	2012–2026
3. Contingent and Prospective Onshore plus Offshore Resources	429	(15.1)	34	(1.2)	23	2012–2034

Notes:
1. Recoverable within a period of 50 years from January 1, 2004.
2. Plateau production rate is limited by the pipeline system capacity.
3. Years and time period when pipeline is operating at full capacity.

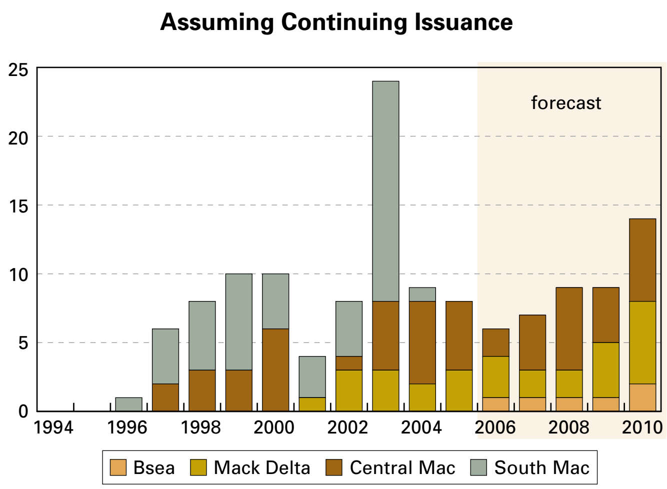
Source: J-IORVL-00349, Table 4

the federal department responsible for issuing and managing rights to explore for and produce oil and gas in the Northwest Territories [NWT] and, therefore, is in a unique position to assess possible levels of future activity. However, Mr. Morrell's letter to the Proponents emphasized that "the directorate does not publish or make available official forecasts or outlooks for drilling and seismic activities" and that what he provided to the Proponents was "a personal view, if reasonably well informed.") (J-IORVL-00318, p. 12)

Figure 3-1 shows the forecast of exploratory wells in the North, which was included in the information Mr. Morrell provided to the Proponents.

While the period covered by this table extends only to the end of 2010, it is helpful in laying a foundation for possible future development scenarios that could follow in the event these exploratory wells should lead to further gas discoveries. The Proponents stated that the exploration activity in their hypothetical scenario was consistent with Mr. Morrell's forecast.

Figure 3-1 Exploratory Wells North of 60



Source: Adapted from J-IORVL-00318, p. 17

3.3.3 PROPONENTS' SCENARIO

The Proponents' hypothetical scenario was initially presented as part of the *Mackenzie Gas Project: Additional Information Report* filed in March 2005. The scenario was based on the GLJ Report, which was prepared for the primary purpose of supporting the planned capacity of the MVP at 1.2 Bcf/d, with a sensitivity forecast for a fully expanded pipeline capacity of 1.8 Bcf/d.

Figure 3-2 and Figure 3-3 show two overview maps for the years 2016 and 2030, respectively, which were included in the *Mackenzie Gas Project: Additional Information Report*.

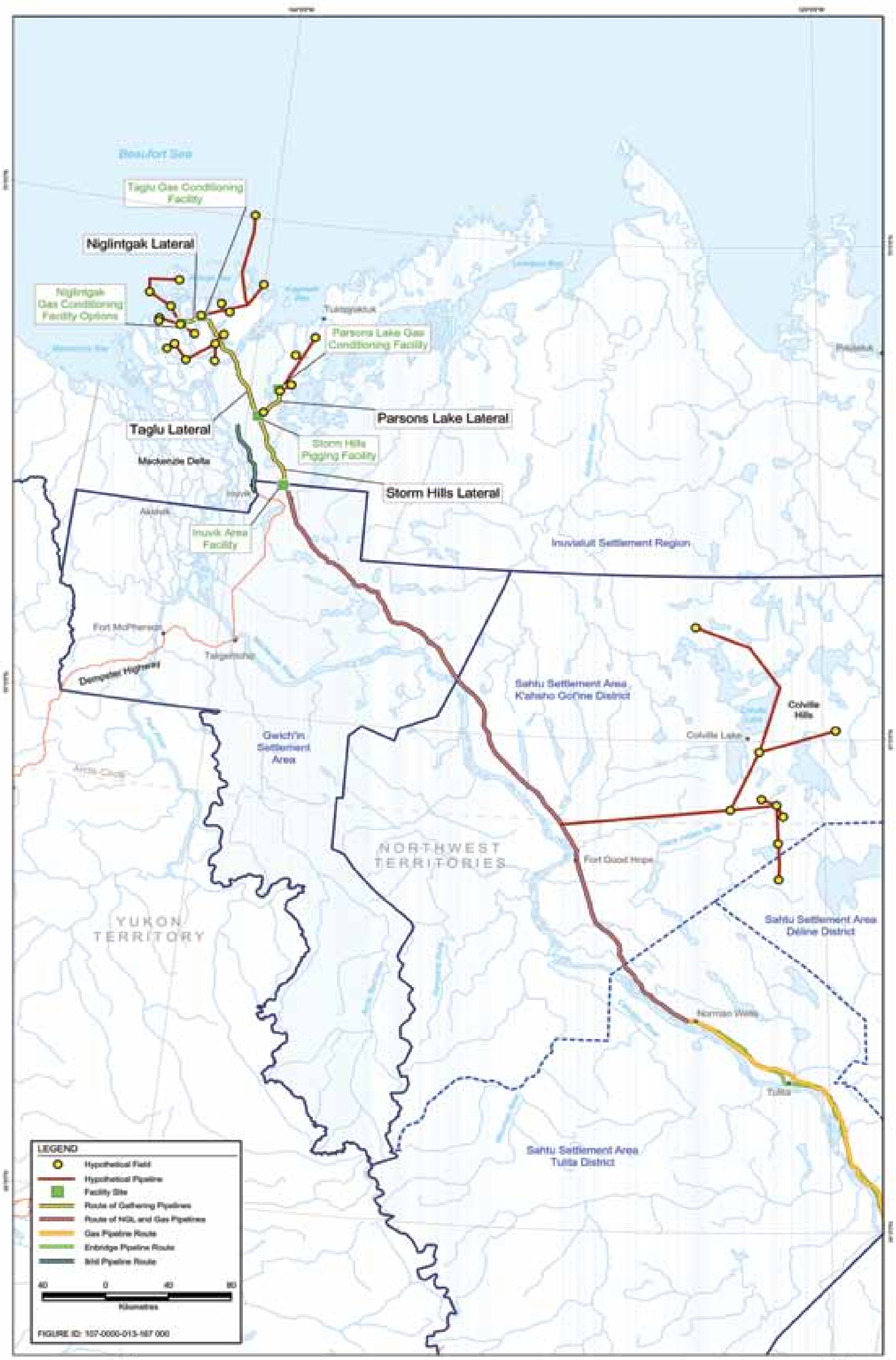
Figure 3-4 and Figure 3-5 show subsequent maps provided by the Proponents, which illustrate their hypothetical scenario for the Mackenzie Delta and Beaufort region for the years 2016 and 2030, respectively.

Figure 3-6 and Figure 3-7 show subsequent maps provided by the Proponents, which illustrate their hypothetical scenario for the Colville Hills region for the years 2016 and 2030, respectively.

Colville Lake

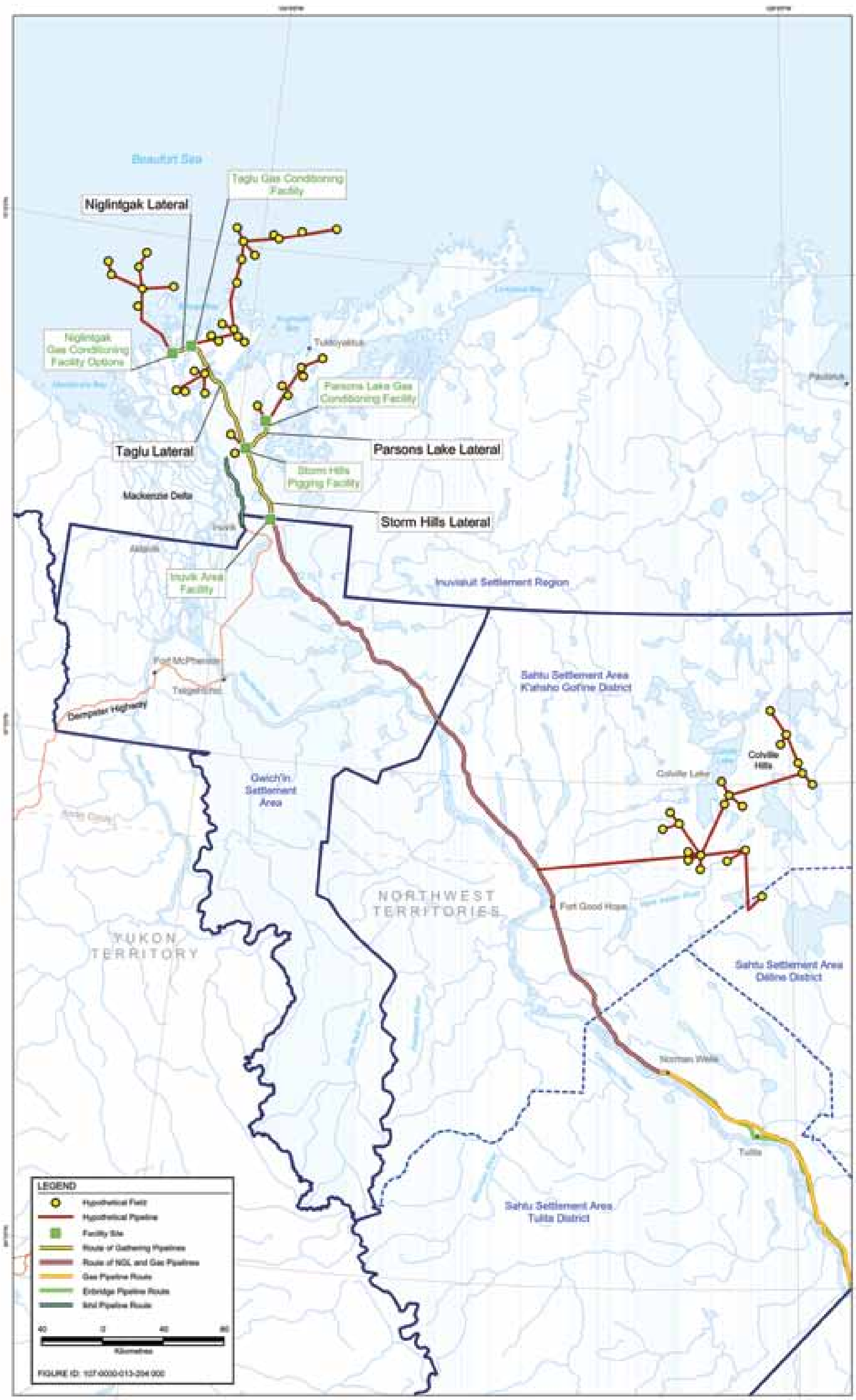
Source: NGPS

Figure 3-2 Hypothetical Development Scenario Overview: Year 2016



Source: J-IORVL-00085, Figure 11-3

Figure 3-3 Hypothetical Development Scenario Overview: Year 2030

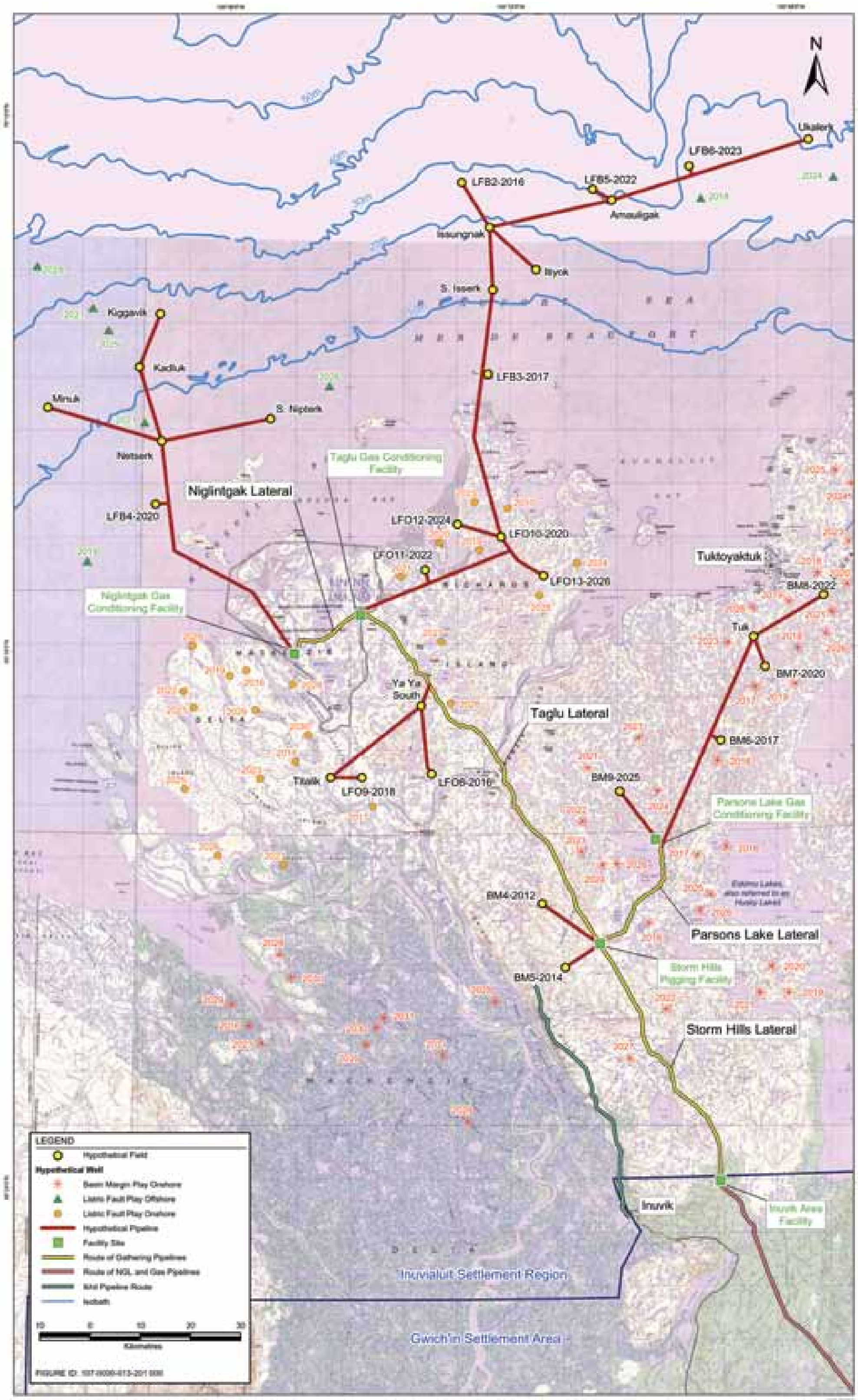


Source: J-IORVL-00085, Figure 11-4

Figure 3-4 Hypothetical Gas Development Scenario for Mackenzie Delta and Beaufort — 2016

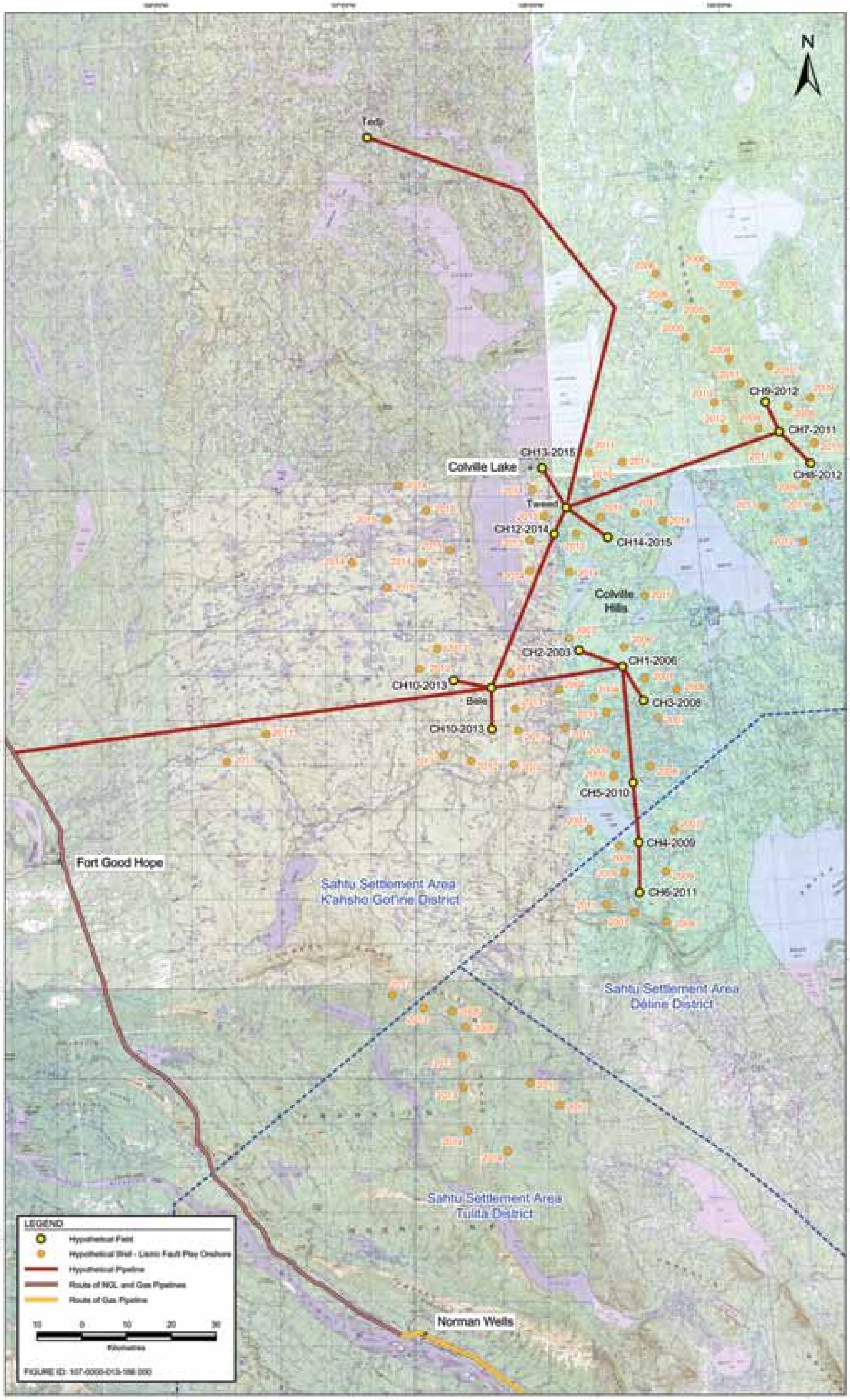
Source: J-IORVL-00331, Figure JRP 2.23-1

Figure 3-5 Hypothetical Gas Development Scenario for Mackenzie Delta and Beaufort — 2030



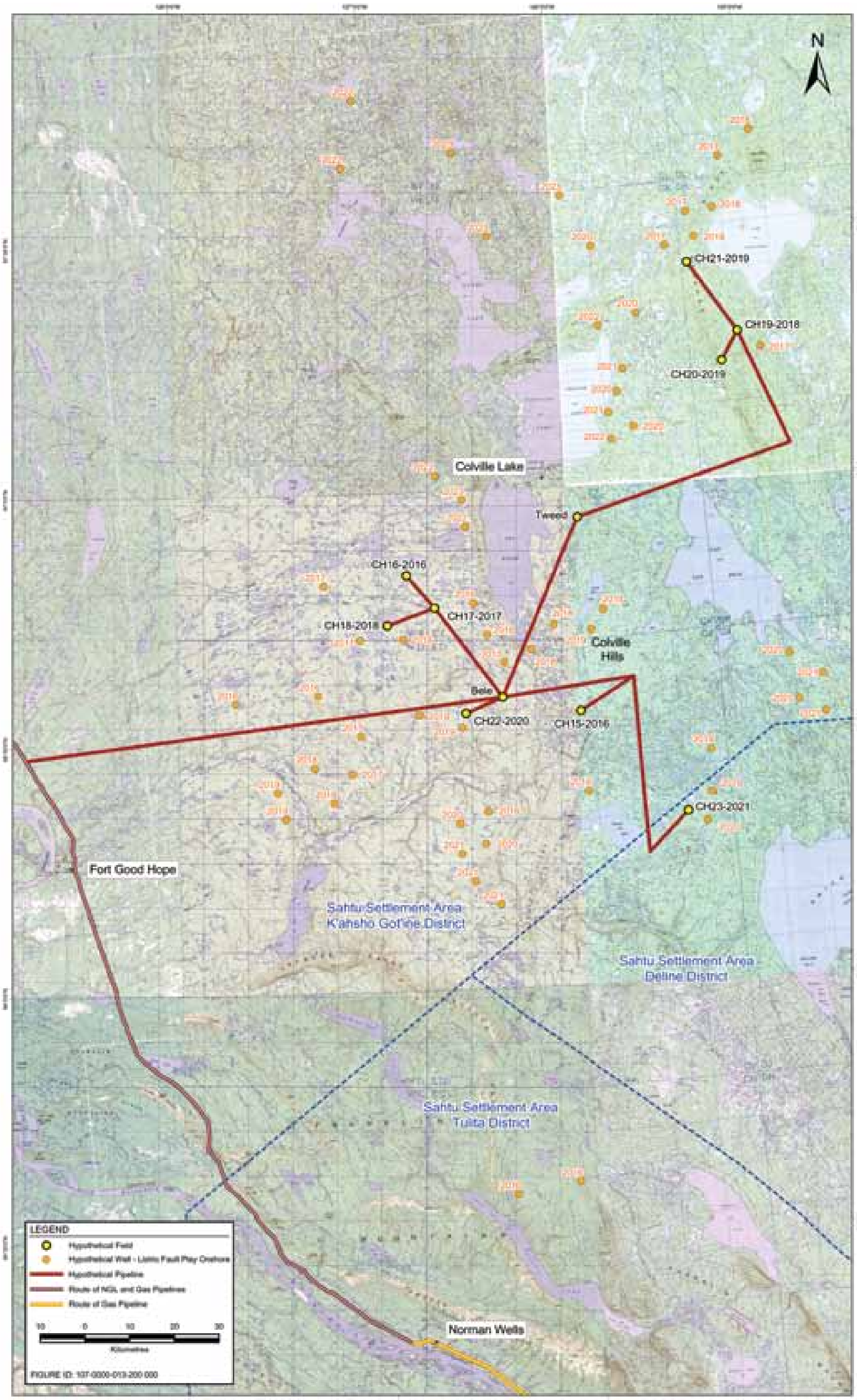
Source: J-IORVL-00332, Figure JRP 2.23-2

Figure 3-6 Hypothetical Gas Development Scenario for Colville Hills — 2016



Source: J-IORVL-00333, Figure JRP 2.23-3

Figure 3-7 Hypothetical Gas Development Scenario for Colville Hills — 2030



Source: J-IORVL-00334, Figure JRP 2.23-4

3.4 OTHER FUTURE SCENARIOS

3.4.1 CANADIAN ARCTIC RESOURCES COMMITTEE'S SUBMISSION

The Canadian Arctic Resources Committee (CARC) filed a detailed submission entitled *A Choice of Futures: Cumulative Impact Scenarios of the Mackenzie Gas Project* (referred to as the CARC Report), dated October 24, 2005. The submission incorporated the results of cumulative effects mapping that was undertaken for CARC by Cizek Environmental Services, based on data from the GLJ Report. The mapping in the CARC Report also incorporated a review and critique of various filings and data provided by the Proponents on the Project's cumulative footprint.

The CARC Report also incorporated data from a study by geological and petroleum engineering consultants Sproule Associates Limited. On June 1, 2005, a study by Sproule Associates entitled *Natural Gas Resource Assessments and Deliverability Forecasts, Beaufort-Mackenzie and Selected Northern Canadian Basins* (referred to as the Sproule Study) was filed with the NEB. The Sproule Study was commissioned by the Mackenzie Explorer Group, representing seven companies holding oil and gas exploration rights in the NWT. The Sproule Study was filed with the Panel by Kevin O'Reilly.

The assumptions and results of the CARC Report are set out in Table 3-2.

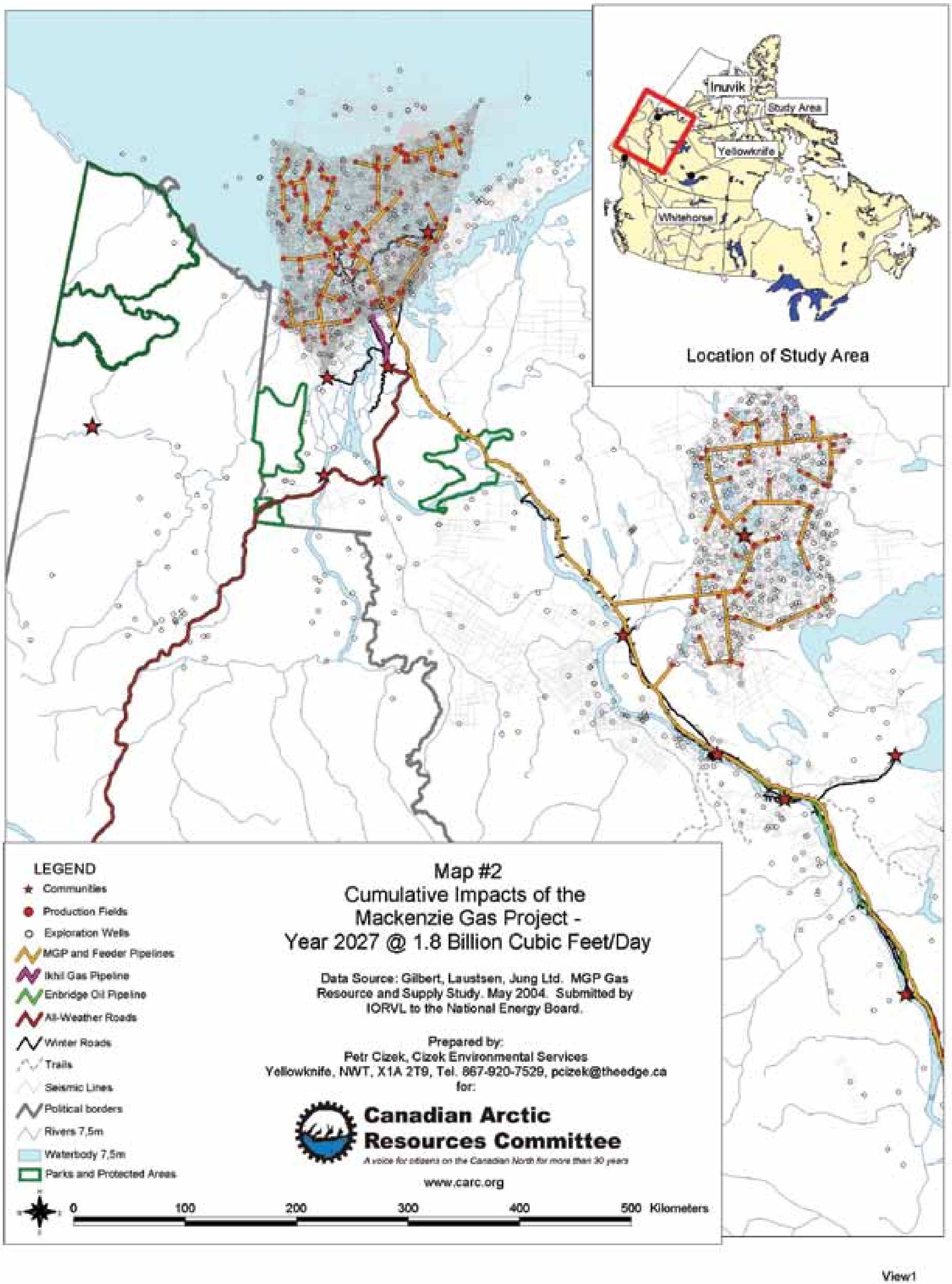
Figure 3-8 through Figure 3-11 show, for illustrative purposes only, the CARC Report's maps of potential cumulative environmental impacts of the project at 1.8 Bcf/d in 2027, at 1.8 Bcf/d in 2059, at 2.5–3.0 Bcf/d in 2059 and at 4.0 Bcf/d in 2059.

Table 3-2 Assumptions and Results of CARC's Mapping Project

	Original Data Contained in GLJ Study			Derived Data	
		Prospective Resources			
Year	**Contingent Resources (Existing Fields with Proven Gas)**	**New Production Fields**	**Total New Exploration Wells (Production Wells + Dry Wells)**	**New Seismic Lines (Linear Kilometres)**	**Cumulative Length of Trunk and Feeder Pipelines**
2027	Parsons Lake, Taglu, Niglintgak (Anchor Fields); Adgo, Yaya, Garry North, Garry South, Hansen, Kumak, Maillik, Pelly, Reindeer, Titalik, Tuk, Unak, Unipkat, Ya Ya North, and Ya Ya South (Mackenzie Delta); Bele, Tedji, Tweed (Colville Hills); Amauligak, Issungnak, Itiyok, South Isserk, Ukalerk, Kadluk, Kiggavik, Minuk, Netserk, South Nipterk (Beaufort Sea Offshore) 31 (Cumulative Total)	53 (Colville Hills) 13 (Basin Margin) 17 (Listric Fault — Onshore) 31 (Listric Fault — Offshore) 114 (Cumulative Total)	384 (Colville Hills) 108 (Basin Margin) 62 (Listric Fault — Onshore) 130 (Listric Fault — Offshore) 684 (Cumulative Total)	21,888 km (Colvile Hills) 19,656 km (Basin Margin) 19,110 km (Listric Fault — Onshore) 26,930 km (Listric Fault — Offshore) 87,584 km (Cumulative Total)	3,813 km

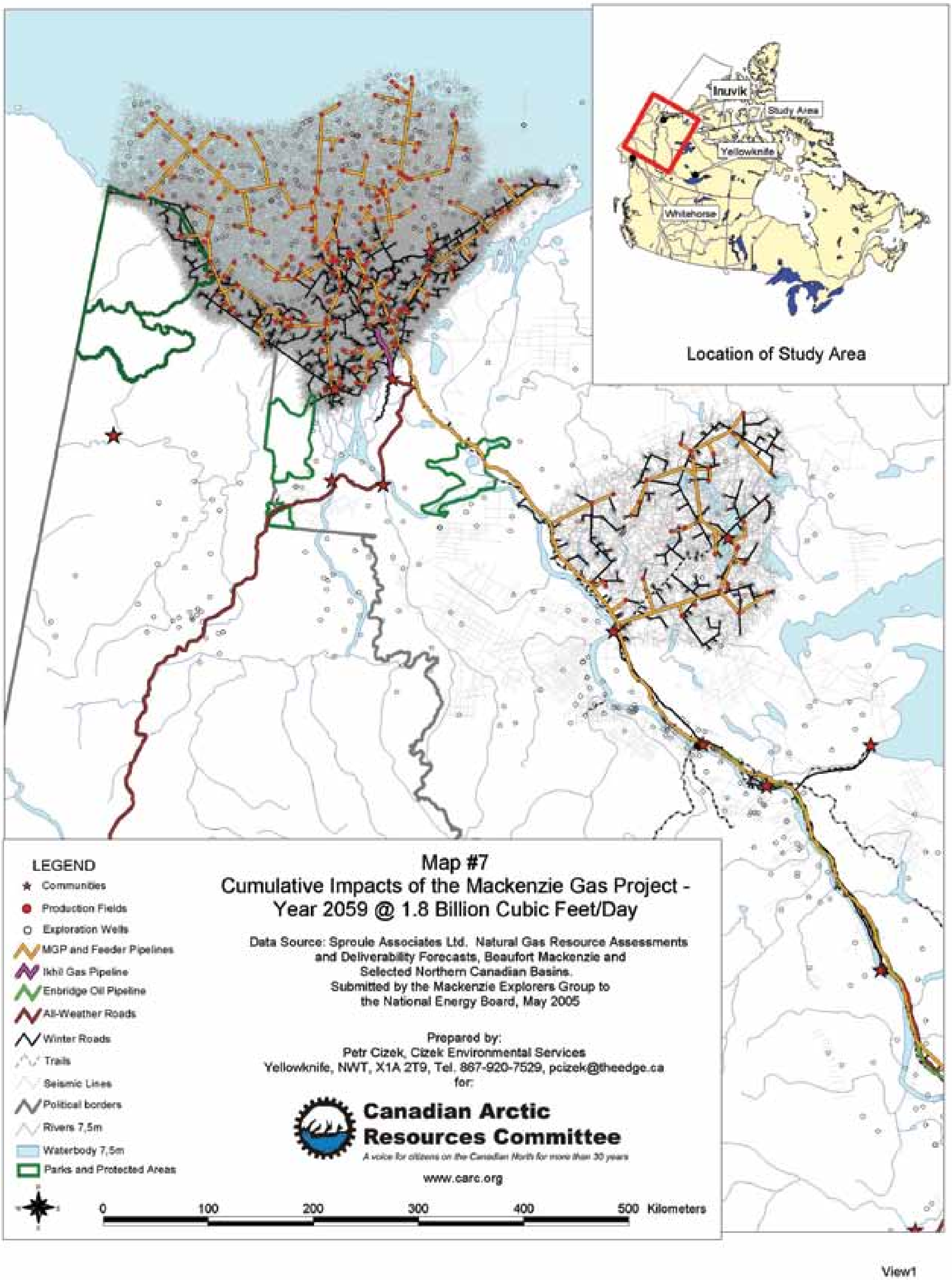
Source: Adapted from J-CARC-00021, Table 1

Figure 3-8 Cumulative Impacts of the Mackenzie Gas Project: Year 2027 @ 1.8 Billion Cubic Feet/Day



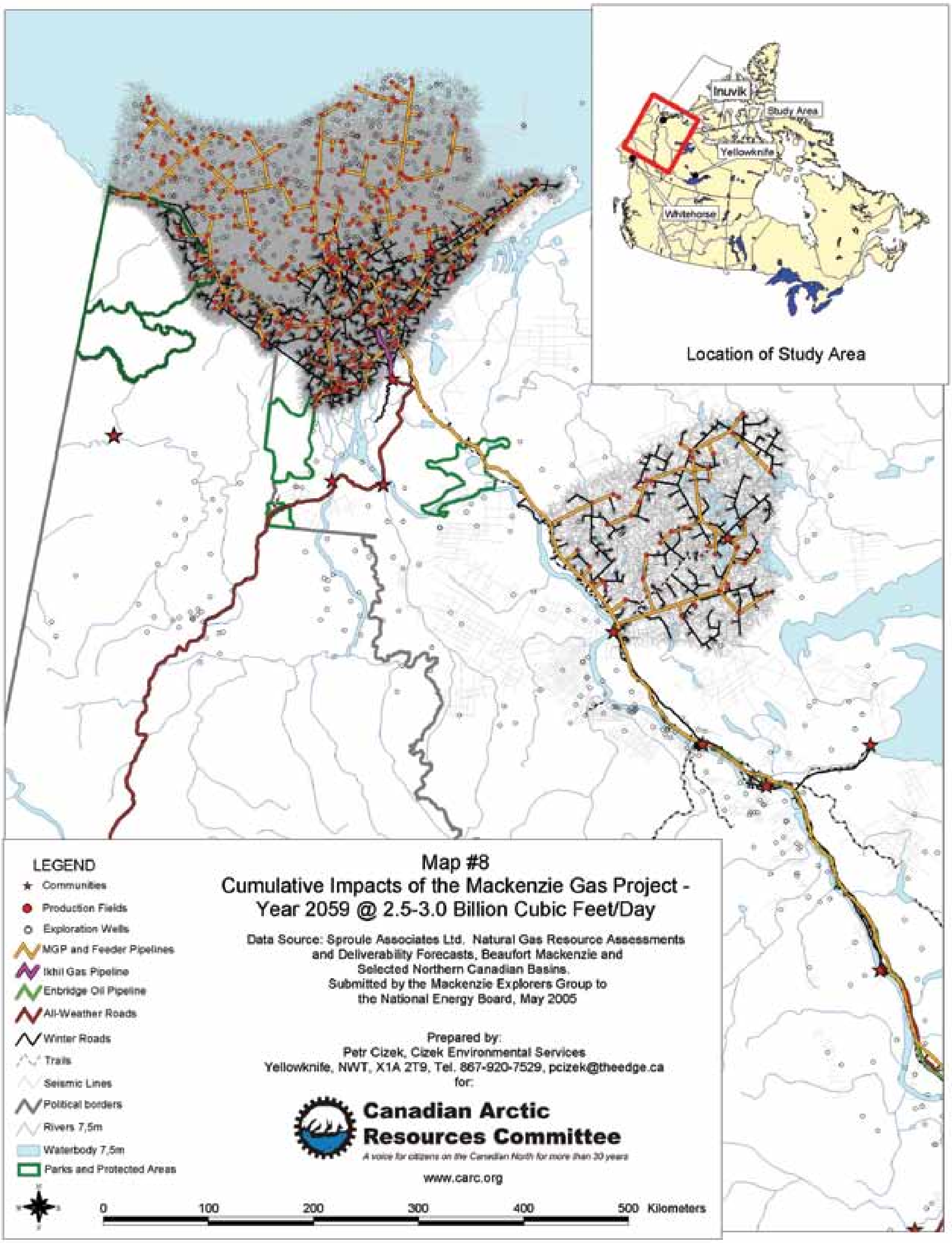
Source: J-CARC-00021, Map #2

Figure 3-9 Cumulative Impacts of the Mackenzie Gas Project: Year 2059 @ 1.8 Billion Cubic Feet/Day



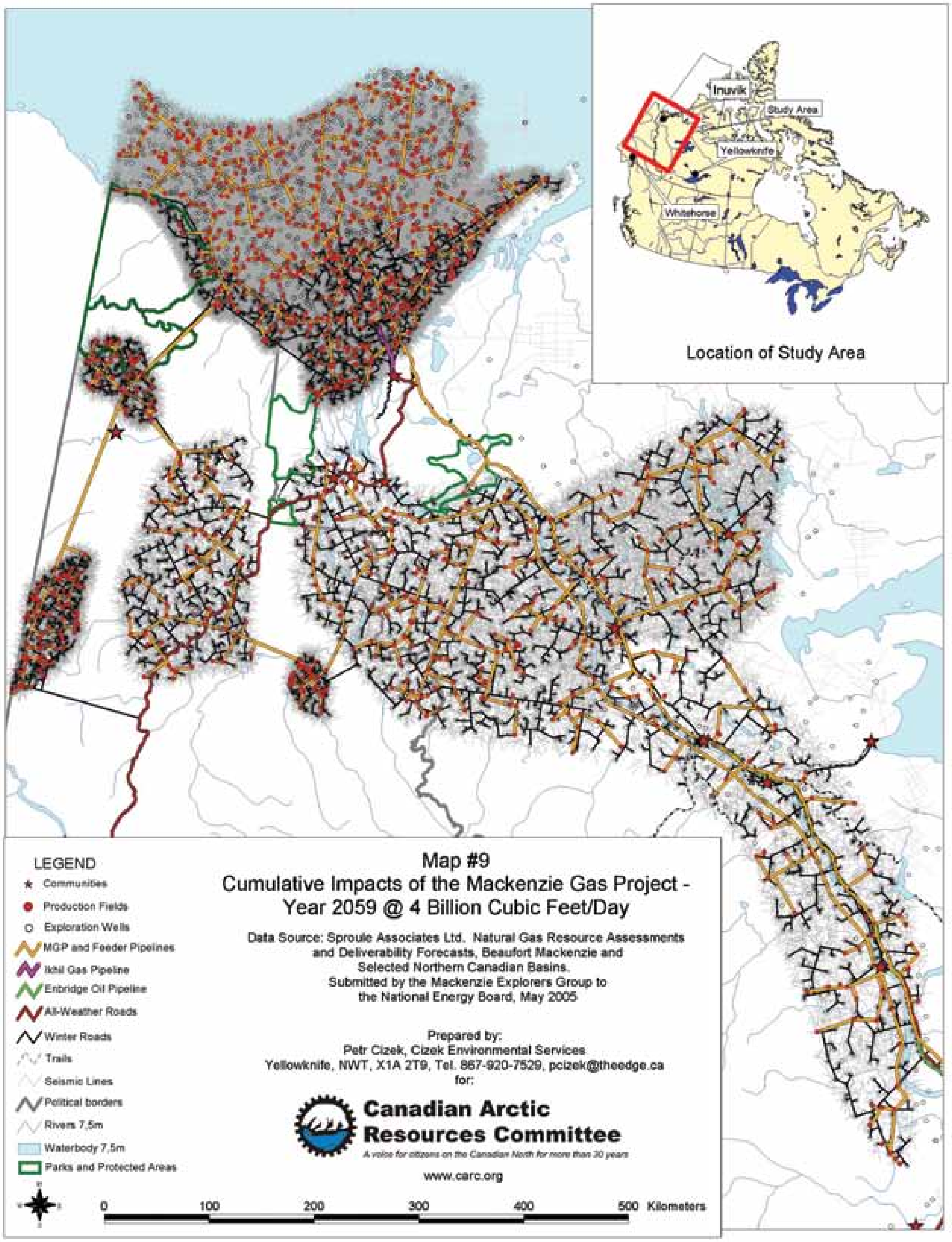
Source: J-CARC-00021, Map #7

Figure 3-10 Cumulative Impacts of the Mackenzie Gas Project: Year 2059 @ 2.5–3.0 Billion Cubic Feet/Day



Source: J-CARC-00021, Map #8

Figure 3-11 Cumulative Impacts of the Mackenzie Gas Project: Year 2059 @ 4 Billion Cubic Feet/Day



Source: J-CARC-00021, Map #9

3.4.2 OTHER VIEWS

The Panel heard a wide range of other views on potential future developments that could follow construction of the Project as Filed. Some of these developments may be highly likely, such as the development of additional gas fields to support throughput on the MVP at its capacity of 1.2 Bcf/d. However, even in this case, the individual fields and their locations were not identified, and therefore their project-specific impacts have not been reviewed by the Panel. At the other end of the range of views, some potential developments were entirely speculative. In the middle were possible developments that might be "reasonably foreseeable." It followed that the information submitted to the Panel about the cumulative impacts of potential future developments also ranged from somewhat detailed to wholly speculative.

In the Panel's view, these scenarios were generally presented as just that — views of various Interveners and other participants on possible future developments that could follow from the pipeline. The Panel expresses no view on the likelihood that any of them would come to pass. At the same time, in assessing the potential cumulative impacts of the Project and the contribution of the Project to sustainability, the Panel has had regard to what the future could look like if the Project were to proceed.

As noted, the Panel has not assessed the likelihood of any of these scenarios coming to pass. In the Panel's view, however, the preceding maps in particular suggest that exploration, development and production activities to support the Expansion Capacity Scenario would most likely occur in the Inuvialuit Settlement Region and the Sahtu Settlement Area and not in the Dehcho Region.

3.4.3 "BASIN-OPENING" PROJECT

Throughout the Panel's review process, the Mackenzie Gas Project was frequently referred to as a basin-opening project. In response to a specific question from the Panel, IORVL stated that, in its view, "basin-opening" described a "pipeline that provides the ability to sell natural gas that's been discovered and developed [and that opens] up a new region to development." (Randy Ottenbreit, HT V2, p. 139) Shell and ConocoPhillips each used the term in their opening statements to the Panel but did not expand on its meaning.

Most other parties also did not elaborate on what exactly they meant by the term. Many failed to recognize that there is more than one geologic "basin" with oil and gas potential in the NWT. However, it appeared to the Panel that most parties who used the term inferred a meaning that went beyond the narrow definition offered by IORVL. The common element seemed to be a view that the Project would lead to further developments beyond those required to support its initial capacity of 1.2 Bcf/d. For some, those further developments might encompass the full development of a natural gas exploration, development and production industry; for others, full exploitation of the oil and gas resources of the NWT, including the Beaufort Sea; and for yet others, the general industrialization of the North.

Given this range of meanings, the Panel concluded that describing the Project as a basin-opening project is of little assistance. Therefore, the Panel has not reviewed the Project as a basin-opening project as such. It has, however, considered the submissions of various parties on possible future scenarios and potential cumulative impacts that could follow the Project.

Scenarios going beyond the Expansion Capacity Scenario of the Mackenzie Valley Pipeline are generically referred to by the Panel as Other Future Scenarios. They have been considered by the Panel on the assumption that the Project would first be built to the initial capacity of the Project as Filed and would later be expanded to the Expansion Capacity Scenario. The Panel has, therefore, considered the Other Future Scenarios as extensions of, and not as alternatives to, the Project as Filed.

3.5 SUMMARY

In summary, the Panel has approached its review as follows:

(a) The Panel reviewed the Project as Filed, including the *Supplemental Information — Project Update* filed in 2007. The Project as Filed includes:

- development of and production from the three Anchor Fields at a rate of 830 Mcf/d, together with the other components of the Mackenzie Gathering System;
- the Mackenzie Valley Pipeline, with three compressor stations, one heater station and associated facilities, with a capacity of 1.2 Bcf/d; and
- the Northwest Alberta Facilities.

(The Panel recognizes that, until gas production in addition to the initial production from the Anchor Fields at the rate of 830 Mcf/d is committed to the MVP, some of the facilities included in the Project as Filed would not be built and that, therefore, the actual capacity of the MVP at start-up might be less than 1.2 Bcf/d.) The Panel has undertaken a comprehensive review of Project-specific impacts and cumulative impacts of the Project as Filed. The Panel has not reviewed the direct impacts associated with any identified exploration, development and production activities that would be required to increase throughput on the MVP from 830 Mcf/d to 1.2 Bcf/d.

(b) As required by its Mandate, the Panel then considered the Project as expanded to a capacity of 1.8 Bcf/d (the Expansion Capacity Scenario). The Expansion Capacity Scenario would include 11 more compressor stations and supporting infrastructure on the MVP, as well as associated gas exploration, and development projects and undertakings to support throughput at that capacity. The Panel concluded that the Expansion Capacity Scenario is a reasonably foreseeable development for the purpose of considering potential cumulative impacts and the Project's contributions to sustainability.

The Proponents described their hypothetical scenario of natural gas developments that would support throughput at the level of 1.8 Bcf/d as being "for illustration only [and] highly uncertain." They undertook a qualified assessment of the cumulative effects of the scenario but did not come to any conclusions on the significance of those effects "because of the uncertainties associated with the hypothetical scenario." (J-IORVL-00085, Section 11, p. 5) Therefore, with respect to the Expansion Capacity Scenario, the Panel has generally considered the impacts on the biophysical and socio-economic environment of facilities that would be added to the Project by the Proponents (mainly the additional compressor stations and supporting infrastructure) and, with the limited information available on future developments, has considered the impacts of those developments in combination with the impacts of the Project.

(c) The Panel also considered the Project in combination with other additional hydrocarbon exploration, development, production and transportation undertakings, and other activities in the region (the Other Future Scenarios). In this case, the Panel considered the comments heard during its review process on hypothetical future scenarios and the cumulative impacts that might occur in combination with the Project and their contribution to sustainability.

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CHAPTER 4
Review Process

4.1 INTRODUCTION

4.1.1 JOINT REVIEW PANEL AGREEMENT

The Joint Review Panel for the Mackenzie Gas Project (also referred to as the Panel or the JRP) was established by the *Agreement for an Environmental Impact Review of the Mackenzie Gas Project* (JRPA), between the Mackenzie Valley Environmental Impact Review Board (MVEIRB), the Inuvialuit as represented by the Inuvialuit Game Council, and the federal Minister of the Environment. The JRPA is included as Appendix 1.

The JRPA, which came into force on August 18, 2004, sets out the Mandate of the Panel. However, before describing the Panel's Mandate, it is important to understand the context in which the JRPA was agreed to.

The JRPA resulted from the *Cooperation Plan for the Environmental Impact Assessment and Regulatory Review of a Northern Gas Pipeline Project through the Northwest Territories* (Cooperation Plan), released in June 2002. The Cooperation Plan was developed by the Northern Pipeline Environmental Impact Assessment and Regulatory Chairs' Committee before the filing of any applications for the Mackenzie Gas Project (also referred to as the MGP or the Project). The Committee represented the authorities with environmental impact assessment and regulatory mandates that were expected to be triggered by any such applications and that would require a public hearing. Paragraph 3.5 of the Cooperation Plan provided:

> The EIA [environmental impact assessment] component will be undertaken by a Joint EIA Panel formed pursuant to the MVRMA [*Mackenzie Valley Resource Management Act*] (section 141) and the CEAA [*Canadian Environmental Assessment Act*] (sections 40 and 41). The Joint EIA Panel will meet the requirements of the Inuvialuit under the IFA [*Inuvialuit Final Agreement*]. The Joint EIA Panel will comprise nominees from the ISR [Inuvialuit Settlement Region], the Mackenzie Valley and other regions of Canada affected by the project, in accordance with the requirements of the relevant legislation and comprehensive land claim agreements. To facilitate linkage between the EIA process and the subsequent NEB [National Energy Board] regulatory process, a member of the NEB may be

> nominated to the Joint EIA Panel pursuant to section 15 of the NEB Act [*National Energy Board Act*]. The involvement of a section 15 member will be resolved at the time of the development of the Agreement between the EIA parties.

The "Agreement between the EIA parties" referred to in the Cooperation Plan became the JRPA.

The Cooperation Plan (and therefore the establishment of the Panel and its Mandate) was guided by a number of principles, including the desire of the relevant agencies to cooperate and the need for a "made-in-the-North" process. In the Panel's view, this need should be seen in the historical context of the evolution of the northern claims process over the past 30 years, in particular since the tabling of Volume 1 of the Report of the Mackenzie Valley Pipeline Inquiry, *Northern Frontier*, *Northern Homeland*, by Mr. Justice Thomas R. Berger, on May 9, 1977 (the Berger Report).

One of the central conclusions of the Berger Report was that native claims in the North must be settled before a Mackenzie Valley pipeline was built:

> Such a settlement will not be simply the signing of an agreement, after which pipeline construction can then immediately proceed. Intrinsic to the settlement of native land claims is the establishment of new institutions and programs that will form the basis for native self-determination...
>
> In my opinion a period of ten years will be required in the Mackenzie Valley and Western Arctic to settle native claims, and to establish the new institutions and new programs that a settlement will entail. No pipeline should be built until these things have been achieved.

Since the Berger Report, comprehensive settlement agreements have been executed covering three of the four geographic regions of the Northwest Territories (NWT) that would be traversed by the MGP:

- the IFA, covering the ISR in the Mackenzie Delta/Beaufort Sea, came into force on July 25, 1984;
- the *Gwich'in Comprehensive Land Claim Agreement* came into force on December 22, 1992; and
- the *Sahtu Dene and Metis Comprehensive Land Claim Agreement* came into force on June 23, 1994.

An agreement covering the Dehcho Region has not yet been reached. However, the Dehcho First Nations, the Government of Canada and the Government of the Northwest Territories (GNWT) have executed the *Deh Cho First Nations Framework Agreement* and the *Deh Cho First Nations Interim Measures Agreement*, both dated May 23, 2001, agreeing to negotiate "in order to set out land, resources, and governance rights to apply in the Deh Cho territory."

As anticipated in the Berger Report, the final settlement agreements listed above contain extensive provisions dealing with local decision making over matters relating to renewable resource management and environmental assessment in their respective areas, including the establishment of various institutions and programs.

The challenge for northern and other Canadian decision makers in preparing for anticipated applications for the Project was to find a means of coordinating the roles of these institutions, while maintaining and respecting the jurisdiction of each, in deference to the settlement agreements under which they had been established. Hence, the underlying principle of the Cooperation Plan reflected the need for a made-in-the-North process.

In the Panel's view, its role, while defined by the JRPA, should be seen in the broader context of the regulatory framework that has resulted from a 30-year process of working toward and achieving settlement agreements in the North, as well as the pre-existing Canadian regulatory framework that applies to the Project. Given the uniqueness of the Project and the fact that it would traverse four distinct political regions in the NWT and extend into northwest Alberta, a consolidated environmental impact assessment process, through a vehicle such as the Panel, may have been inevitable. At the same time, the Panel's origins in the history of northern settlement agreements should be recognized as essential background to understanding its Mandate and process.

The JRPA itself explicitly makes some links to its genesis. The preamble states that the three parties to the JRPA participated in the development of the Cooperation Plan, and paragraph 3 provides that the "Agreement is in furtherance of the relationship described in the Cooperation Plan." Paragraph 2 states that the purpose of the JRPA "is to establish an Environmental Impact Review that meets the requirements of the CEAA, the MVRMA [itself a product of the *Gwich'in Comprehensive Land Claim Agreement* and the *Sahtu Dene and Metis Comprehensive Land Claim Agreement*] and the IFA."

4.1.2 DOWNSTREAM REGULATORS

The Proponents' applications for approval to construct and operate the Project have already engaged the jurisdiction of several regulatory authorities. If the Project is approved, further regulatory approvals will be required for its specific elements. (The desire to provide for coordination and cooperation among the many agencies responsible for these approvals resulted in the Cooperation Plan.)

Of these agencies, the NEB has direct regulatory authority over all components of the Project, from the production of gas at the Anchor Fields, through the Mackenzie Gathering System (including the Inuvik Area Facility) and the natural gas liquids pipeline to Norman Wells, as well as the Mackenzie Valley gas pipeline from Inuvik to the interconnect with the Northwest Alberta Facilities. The Panel understands that the NEB would also have jurisdiction over the Northwest Alberta Facilities. The NEB's regulatory authority over the Project and the Northwest Alberta Facilities would continue from initial approval until after the ultimate abandonment of facilities, "from cradle to grave." Given the primary and comprehensive role of the NEB with respect to regulatory oversight of the Project, many of the Panel's recommendations are framed as proposed conditions to be included in any certificate or approvals issued by the NEB for the Mackenzie Gas Project or the Northwest Alberta Facilities.

However, the Panel, as well as the Proponents and many participants, recognized that some impacts of the Project would need to be assessed in further detail, after Project approval, during what was frequently, although imprecisely, referred to as the "regulatory phase." Generally, "regulatory phase" was used to refer to the regulatory processes that would follow after the issuance of an NEB certificate of public convenience and necessity and development plan approvals. The Panel accepts this reality, given that complete and detailed information necessary for a final assessment of all aspects of the Project was not available during its review and recognizing that much of that information should be generated during the detailed engineering phase of the Project, if it is approved and proceeds.

As a result, the Panel frequently refers to "downstream regulators" as a generic description of all authorities from which any regulatory approval would be required after initial approval by the NEB for any component or activity associated with the construction or operation of the Project and the Northwest Alberta Facilities. These would include, but would not necessarily be restricted to, the Mackenzie Valley Land and Water Board, the Gwich'in Land and Water Board, the Sahtu Land and Water Board, the Northwest Territories Water Board, Environment Canada, Fisheries and Oceans Canada, Indian and Northern Affairs Canada, and the GNWT, as well as relevant Alberta regulatory authorities.

The Cooperation Plan contemplated that "[t]he Joint EIA Panel process...will have provided the forum for consideration of all matters related to environmental impact assessment." It further states that "the Regulatory Authorities do not anticipate the need to revisit these matters during the final phases of the regulatory processes." In the Panel's view, this goal has not been achieved through the Panel's review. As noted throughout the Panel's Report, downstream regulators will play an important ongoing role in completing detailed impact assessments of certain elements of the Project when the necessary information becomes available as the Project proceeds, if it is approved.

Joint Review Panel: Barry Greenland, Percy Hardisty, Gina Dolphus, Rowland Harrison, Peter Usher, Tyson Pertschy, Robert Hornal.

Source: billbradenphoto

4.2 ESTABLISHMENT OF THE JOINT REVIEW PANEL

4.2.1 APPOINTMENT OF THE PANEL

Paragraph 4(c) of the JRPA provided that the Panel would consist of seven members: three to be selected by the MVEIRB and four by the federal Minister of the Environment. Of the four members to be selected by the Minister, two were to be nominated by the Inuvialuit Game Council in accordance with a Memorandum of Understanding between the Minister and the Inuvialuit. Paragraph 4(c)(iii) provided that the parties to the JRPA would approve the selection of the chairperson.

Pursuant to these provisions, the following seven persons were appointed as the Joint Review Panel for the Mackenzie Gas Project in August 2004, one of whom was designated as chairperson:

- Ms. Gina Dolphus, Déline, NWT;
- Mr. Barry Greenland, Inuvik, NWT;
- Mr. Percy Hardisty, Fort Simpson, NWT;
- Mr. Rowland Harrison Q.C., Calgary, Alberta;
- Mr. Robert Hornal, Chairperson, Vancouver, British Columbia;
- Mr. Tyson Pertschy, Inuvik, NWT; and
- Dr. Peter Usher, Clayton, Ontario.

Biographies of the JRP members are included as Appendix 2. The Panel first met in Yellowknife on August 30, 2004.

4.2.2 APPOINTMENT UNDER SECTION 15 OF THE *NATIONAL ENERGY BOARD ACT*

Paragraph 4(f) of the JRPA provided that the parties to the JRPA would consider appointing a member of the NEB as one of the seven members of the Panel so as to allow that member to submit to the NEB a report on environmental matters within the NEB's jurisdiction. The Cooperation Plan provided for this possibility, "[t]o facilitate linkage between the EIA process and the subsequent NEB regulatory process." Mr. Rowland Harrison, a member of the NEB, was appointed to the Panel by the federal Minister of the Environment at the same time as the other six members of the Panel were appointed in September 2004.

On October 15, 2004, the NEB issued *Authorization MO-13-2004* under section 15(1) of the *National Energy Board Act* authorizing Mr. Harrison to report and make recommendations to the NEB Panel designated to consider the applications for the Mackenzie Gas Project regarding the matters specified in the Authorization. Specifically:

> In relation to the facilities described in Annex 1 to the Schedule: Project Description [appended to the JRPA], Mr. Harrison's report and recommendations will have regard to the protection of the social, cultural and economic well-being of residents and communities and will include a consideration of the factors set out in Annex 2 to the said Schedule: Joint Review Panel Mandate.

It was further provided that "[t]he authorization allows Mr. Harrison to utilize the Joint Review Panel process to compile the evidence and information necessary for him to make his report and recommendations to the NEB Panel."

4.2.3 INDEPENDENCE OF THE JOINT REVIEW PANEL

The independence and impartiality of the Panel and the transparency of its process were assured by two key provisions of the JRPA. First, paragraph 4(d) provided that the members of the Panel "shall be unbiased [and] free from any material conflict of interest relative to the [MGP]." Second, paragraph 4.2 of the Schedule to the JRPA provided that "[a]ll information received during the conduct of the environmental impact review of the EIS [Environmental Impact Statement] will be placed on the public registry." The Panel fully complied with both requirements throughout its process, subject only to certain Confidentiality Orders that were issued by the Panel as discussed in Section 4.3.2.

4.3 MANDATE OF THE JOINT REVIEW PANEL

4.3.1 GENERAL

The overarching purpose of the Panel, as described in paragraph 1 of the JRPA, was to "conduct the Environmental Impact Review [being] the examination of the [MGP]…in accordance with the process set out in [the JRPA]." The Panel's Mandate was set out in the Schedule to the JRPA, "Joint Review Panel Mandate" (the Panel Mandate). In carrying out its review, the Panel was directed to "have regard to the protection of the environment from the significant adverse impacts of proposed developments, and to the protection of the existing and future social, cultural and economic well-being of residents and communities." The Panel was further directed under paragraph 2.0 of the Schedule to address the factors outlined in Annex 2. These factors were based on the provisions of the MVRMA and the CEAA listing the factors to be considered in undertaking environmental assessments under those Acts. Annex 2 also included requirements of the Panel with respect to the "worst-case scenario" provisions of the IFA, specific to the ISR.

The Panel Mandate was further defined by the reporting requirements set out in paragraph 4.8 of the Schedule:

> The Joint Review Panel will prepare and provide…a report including, but not limited to, the following:
>
> - a description of the public review process;
> - a summary of any comments and recommendations received from the public;
> - a rationale, conclusions and recommendations regarding the nature and significance of impacts on the environment including any mitigation measures and follow-up program; and
> - any other matter as required under the CEAA, the MVRMA and the IFA.

The Panel Mandate was clearly broader than merely undertaking a review of the *Environmental Impact Statement for the Mackenzie Gas Project* (EIS) submitted by the Proponents. Rather, the Mandate was to "conduct the Environmental Review" in accordance with the process set out in the JRPA. Part 2 of the *Environmental Impact Statement Terms of Reference for the Mackenzie Gas Project* stated: "The EIS will serve as *a basis for the Panel's review and evaluation* of the potential impacts of the Project on the environment." [emphasis added]

Accordingly, the Panel considered the submission of the EIS as a step in the conduct of the review required by the JRPA.

The Panel had no role in developing its Mandate or in scoping the project to be reviewed. The project for the purposes of defining the Panel Mandate was described in Annex 1 of the Schedule to the JRPA.

The Panel also had no involvement in developing the Terms of Reference for the EIS.

4.3.2 STEPS PRIOR TO PUBLIC HEARING PHASE

PANEL RULES OF PROCEDURE AND HEARINGS PROCEDURES

Pursuant to paragraph 4.2 of the Schedule to the JRPA, the parties to that agreement submitted to the Panel *Rules of Procedure for the Conduct of the Environmental Impact Assessment of the Mackenzie Gas Project by a Joint Review Panel* (Rules of Procedure). The Rules of Procedure, as amended by the Panel and supplemented by the Panel's *Direction on Procedures for Hearings* (Hearings Procedures), governed the Panel's procedures from the initiation of its review through to the submission of this Report.

INTERVENER STATUS AND LETTERS OF COMMENT

The Rules of Procedure provided for the Panel to grant permission to any person or body to participate fully in the Panel's review process (referred to as Interveners). The Panel issued an initial public notice inviting applications for Intervener status on November 25, 2004. The Panel granted Intervener status to 103 individuals, groups or organizations. Persons or bodies who were not Interveners were given opportunities to participate in the public hearings phase of the review at the discretion of the Panel Chair, in accordance with the Hearings Procedures.

Any individual, group or organization was invited to file written comments at any time throughout the Panel review.

INTERVENER FUNDING

The Panel had no authority to provide funding to Interveners. However, a funding program to support participation in the review process was administered by the Canadian Environmental Assessment Agency.

INITIAL REVIEW OF THE ENVIRONMENTAL IMPACT STATEMENT

Paragraph 4.4 of the Panel Mandate required the Panel to "expeditiously conduct a conformity check to determine whether the EIS contains sufficient information to proceed to the technical analysis."

The Proponents submitted the EIS to the Panel on October 7, 2004. After conducting an initial review, the Panel informed the Proponents on December 3, 2004, that additional information was required. In response, the Proponents filed two volumes of additional information, *Mackenzie Gas Project: Additional Information Report*, and a number of community reports on March 28, 2005.

INFORMATION REQUESTS

As provided for in the Rules of Procedure, the Panel initiated several rounds of Information Requests, beginning on January 13, 2005, in which the Proponents and Interveners were able to ask written questions of each other. The Panel issued its own Information Requests to the Proponents and Interveners throughout the review process.

The information request process provided an opportunity for the Proponents, Interveners and the Panel to elicit further information to expand on or supplement material already filed in the Panel's Public Registry. The process served to support the more efficient use of time in the hearing room to focus on previously filed material.

SUFFICIENCY DETERMINATION

On April 15, 2005, the Panel announced that it would host a conference to review the contents of all information filed by the Proponents. The results of the conference would be used by the Panel to determine whether there was sufficient information on the public record to proceed to the public hearings phase of its review. The conference was held in Yellowknife from June 26 to 29, 2005, and was led by a facilitator retained by the Panel. The Proponents and 21 Interveners made presentations at the conference, which was attended by members of the Panel as observers. The conference facilitator's report was issued on July 14, 2005.

On July 18, 2005, the Panel issued its Sufficiency Determination, a copy of which is included as Appendix 3. The Panel concluded that "there is sufficient information to proceed to the public hearings phase of its review, subject to certain information being filed within the time frame prescribed by the Panel." The Panel concluded that the major issues to be considered in its review had been identified and could be addressed in the hearings, which should reveal and address any new information that might affect the Panel's recommendations. The Panel also concluded that many of the deficiencies cited by Interveners who were opposed to proceeding to the hearings phase represented, in fact, differences in approach or concerns about the merits or quality of the information provided rather than the sufficiency of information to proceed to public hearings. In the Panel's view, such differences would be best addressed in the public hearings.

As part of its Sufficiency Determination, the Panel also advised of its intention to adopt a sustainability framework for its assessment of the Project, which is discussed in Chapter 5, "Approach and Methods."

TRADITIONAL KNOWLEDGE

The JRPA acknowledged "the importance of incorporating traditional knowledge in the Environmental Impact Review of the Project." Further, paragraph 3.0 of the Panel Mandate required the Panel to "make best efforts to promote and facilitate the contribution of traditional knowledge to the environmental impact review."

To support this particular mandate, the Panel issued an announcement on May 16, 2005, encouraging the submission of Traditional Knowledge during the hearings phase. The Panel heard much Traditional Knowledge directly from community members and Elders, particularly in the Community Hearings, as discussed in Section 4.4.1.

In addition, the Panel encouraged the filing of various Traditional Knowledge Study Reports that had been undertaken with specific reference to the Project. In particular, on November 3, 2005, the Panel issued a statement of *Criteria for Confidentiality Orders for Traditional Knowledge Study Reports*, which appears in Appendix 4. In accordance with these criteria, the Panel subsequently issued Confidentiality Orders with respect to portions of Traditional Knowledge Study Reports filed by Jean Marie River First Nation, Pehdzeh Ki First Nation and the Sambaa K'e Dene Band. In each of these cases, the Proponents were already privy to the contents of the relevant report. In addition, a Confidentiality Order was issued with respect to certain maps filed on behalf of the Dehcho First Nations. The Panel also received other Traditional Knowledge Study Reports that were not the subject of requests for confidentiality.

PROJECT UPDATES

During the review, the Proponents filed two updates of the proposed design and location of certain components of the Project. The first of these was submitted as *Supplemental Information — Project Update*, dated November 23, 2005, and the second as *Supplemental Information — Project Update*, dated May 15, 2007. After reviewing each of these filings, the Panel concluded, pursuant to paragraph 4.7 of the JRPA, that none of the proposed changes to the MGP required referral to the parties to the JRPA because they did not represent significant changes to the Project. However, in each case, the Panel initiated a further round of Information Requests with respect to the supplemental information provided by the Proponents. With respect to the 2007 update, the Panel also convened an additional hearing, which was held in Inuvik from July 9 to 11, 2007.

4.4 PUBLIC HEARINGS

4.4.1 PUBLIC INPUT AND ACCESSIBILITY

INPUT INTO HEARINGS SCHEDULE

Paragraph 4.2 of the Panel Mandate required the Panel to conduct its review "in a manner that will promote and facilitate public participation and ensure that the concerns of aboriginal people and the general public are taken into account in that process." Measures adopted by the Panel included:

- directing the Proponents to make the EIS available in various formats and languages to be more accessible to Northerners;
- holding information sessions in communities throughout the NWT and northern Alberta, in cooperation with the Northern Gas Project Secretariat and the NEB; and
- engaging field workers to explain the Panel's process to groups and individuals in their own communities.

In addition, Panel staff was available throughout the Panel's review to respond to individual inquiries and to assist with procedural questions.

On March 14, 2005, the Panel issued an announcement soliciting input into the types and locations of hearings that it was proposing to hold. The comments received from the Proponents and more than 40 others were considered by the Panel in determining the types and locations of public hearings, and the hearing schedule.

ACCESSIBILITY OF HEARINGS AND DOCUMENTS

All of the Panel's hearings were broadcast live by audio webcasting. Most were interpreted live into the English, Gwich'in, Inuvialuktun, North Dene and South Dene languages. All information, except for portions of certain Traditional Knowledge Study Reports that were accorded confidentiality by the Panel, was posted to a Public Registry accessible through the Internet. Hard copies of documents on the Registry were available to the public in Inuvik, Yellowknife and Calgary.

GENERAL HEARINGS

General Hearings were held in the larger centres to provide the opportunity for organizations, businesses and individuals to make presentations to the Panel on any matter within the scope of the review.

TECHNICAL HEARINGS

Technical Hearings (some characterized as Topic-Specific General Hearings) were held in some of the larger centres to provide an opportunity for the Proponents and Interveners to make presentations on specific issues, including matters related to scientific and traditional ecological knowledge.

COMMUNITY HEARINGS

Community Hearings were held in 23 communities that would be affected by the Project in the NWT and northwest Alberta. These hearings were designed to encourage the full and open participation of people living near the location of the proposed Project. Priority to present was given at these hearings to people and organizations from the particular community. Summary reports of the Community Hearings are included as Appendix 5.

4.4.2 HEARINGS SCHEDULE AND GUIDANCE

PROPONENT-REQUESTED DELAY

Subsequent to the Panel's Sufficiency Determination that it was ready to proceed to the public hearings phase of its review (discussed in Section 4.3.2), the Proponents advised the Panel on September 15, 2005, that "certain key areas remain unresolved" and that the "project proponents will advise the NEB and the JRP in November 2005 of our willingness to proceed with a public hearing." (J-IORVL-00328, p. 1) On November 23, 2005, the Proponents advised the Panel and the NEB that "the proponents of the Mackenzie Gas Project are now willing to proceed to the public hearings phase." (J-IORVL-00359, p. 1)

NOTICE OF HEARINGS

The Panel released the *Notice of Hearings and Hearing Schedule* on December 20, 2005. The schedule was developed in cooperation with the NEB to meet the intent of the Cooperation Plan so that the hearing schedules of the NEB and the Panel could proceed in parallel, without overlap. Its release was accompanied by a description of the types and purposes of the various hearings and by a detailed outline of topics for Technical and General Hearings, as discussed further in Section 4.4.1.

The Panel was required by the Rules of Procedure to give a minimum of 45 days' notice of its hearings. In accordance with the hearing schedule, the public hearings phase of the Panel's review began in Inuvik on February 14, 2006. The schedule was later revised due to various intervening circumstances. Closing remarks were heard by the Panel in Inuvik on November 28 and 29, 2007.

GUIDANCE FOR HEARINGS

The Panel's *Notice of Hearings and Hearing Schedule* was accompanied by a *Guidance Document for Hearings: Topics and Locations of Community, General and Technical Hearings* (Guidance Document). As revised from time to time during the public hearings phase, the Guidance Document described six general themes that the public hearings would address and, within the framework of those themes, outlined 16 specific topics that would be the subject of specific hearings. The Panel provided detailed guidance on the matters that it expected to be discussed under each topic.

The Guidance Document also served to develop further the sustainability framework that the Panel would use to guide its review.

In addition to the 16 topics identified in the Panel's original Guidance Document, the last two hearing sessions were devoted to recommendations and closing remarks.

FEDERAL COURT ORDER

On November 10, 2006, the Federal Court of Canada issued an Order in a court action commenced by the Dene Tha' First Nation regarding the proposed Mackenzie Gas Project. The Order had the effect of requiring the Panel to postpone several of its scheduled hearings. The Order was modified on January 30, 2007, to allow the Panel to address subject matters and complete hearings that it had previously deferred in compliance with the original Order. On July 13, 2007, the Panel released a schedule for the remaining hearings although, at that time, the Panel was still restrained by the Federal Court Order from issuing a final report. This remaining restriction on the Panel was removed by a further Federal Court Order on August 3, 2007.

RECOMMENDATIONS HEARING

The Panel's penultimate hearing session was devoted to recommendations. This innovative procedural step provided the opportunity for the Panel, Proponents and Interveners to update, clarify and finalize their own recommendations in light of the record that had developed during the course of the Panel's hearings, which had extended over nearly 22 months. Those to whom recommendations were directed were provided the opportunity to respond. All participants were provided the opportunity to comment in writing during the process leading up to the recommendations hearing.

4.4.3 HEARINGS STATISTICS

The Panel held hearings over 115 days in 26 centres and northern communities. The Panel heard directly from 558 presenters, as either individuals or as representatives of groups or organizations.

The transcript of the hearing sessions is 11,490 pages. The total number of exhibits filed with the Panel was 5,198.

4.5 RULINGS ON MOTIONS

Over the course of its review, the Panel was requested to make rulings on a number of procedural and administrative issues. The Panel's rulings on requests for Confidentiality Orders with respect to certain portions of Traditional Knowledge Study Reports have been noted in Section 4.3.2. Others, such as the Panel's ruling on a motion that it direct that a "scenario-based cumulative effects assessment be undertaken," are discussed in other chapters.

A list of the rulings made in the course of the Panel review is contained in Appendix 6.

4.6 SITE VISITS

The Panel undertook several site visits during the course of its review. These included the locations of the three Anchor Fields and overflights of most of the proposed right-of-way of the Mackenzie Valley Pipeline from Inuvik to the NWT–Alberta border. The Panel toured the Ikhil production area and flew over most of the Ikhil gas pipeline right-of-way. The Panel also flew over the Colville Lake area and parts of northwest Alberta. The Panel toured a gas processing facility (straddle plant) on the NGTL system and a compressor station on the Alliance gas pipeline in Alberta and visited a big-inch pipeline construction spread in Alberta.

4.7 TIMING OF PANEL RECOMMENDATIONS

4.7.1 GOVERNMENT RESPONSE

The timing of many of the Panel's recommendations is linked to the date of the Government Response. This refers to the response to the Panel's Report by the Government of Canada that is required under the provisions of the CEAA and for which there is provision in the MVRMA.

4.7.2 DECISION TO CONSTRUCT

The timing of some Panel Recommendations is linked to the Proponents' "Decision to Construct." For this purpose, the Panel has adopted the following definition from the Socio-Economic Agreement between the Proponents and the GNWT:

> **"Decision to Construct"** means, with respect to each portion of the Facilities, the earliest of the date on which (i) the Owners make an unconditional decision to proceed with construction of such portion; or (ii) all conditions of a decision by the Owners to proceed with construction have been satisfied or waived for such portion; or (iii) all necessary Regulatory Authorizations for the commencement of construction of such portion have been received and physical construction activities thereon have actually commenced. For purposes of this definition, physical construction activities do not include surveying activities, environmental, archaeological and geotechnical investigations, data gathering and other activities of a similar investigative nature, and preparation of staging areas. (J-GNWT-00206, p. 6)

4.7.3 LEAVE TO OPEN

The timing of some Panel Recommendations is linked to the granting of "Leave to Open" by the NEB. This refers to the date of the granting of leave by the NEB to open the MVP, as required under the provisions of the *National Energy Board Act* (or the issuance of an order by the NEB exempting the MVP from that requirement).

4.7.4 COMMENCEMENT OF CONSTRUCTION

Many Panel recommendations require the recommendation to be implemented prior to the commencement of construction. The Panel has adopted as its meaning for this phrase the definition adopted by the NEB in its February 5, 2007, letter to all Parties to the GH-1-2004 Proceeding that attached the NEB's *Proposed Conditions for the Mackenzie Valley Pipeline and Mackenzie Gathering System* which defined "commencement of construction" to include "the clearing of vegetation, ground-breaking and other forms of right of way and station site preparation that may have an effect on the environment, but does not include activities associated with normal surveying operations or data collection activities." (J-IORVL-01040, p. 1)

CHAPTER 5
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CHAPTER 5
Approach and Methods

5.1 INTRODUCTION

Public confidence in the outcome of the Panel's review will depend in part on the clarity and transparency of the methods the Panel used to make its findings and recommendations. The Panel was provided some guidance for its approach and methods in the *Joint Review Panel Agreement* (JRPA), the Environmental Impact Statement Terms of Reference for the Mackenzie Gas Project (EIS Terms of Reference), and in guidance documents issued by the Canadian Environmental Assessment Agency ("the Agency") and the Mackenzie Valley Environmental Impact Review Board (MVEIRB). The Panel also took into consideration prevailing best practices in environmental impact assessment.

These materials did not provide complete or unambiguous guidance on all issues. Participants sometimes differed on the approach to impact assessment that the Panel should take, and on the methods it should use in its assessment. These differences were particularly evident with respect to:

- the scope of the Project, particularly for the purpose of identifying cumulative impacts;
- the characterization of the receiving environment (e.g. valued components, baseline conditions);
- the identification and assessment of Project and cumulative impacts;
- the determination of the significance of Project and cumulative impacts; and
- the net contribution of the Project to sustainability of the northern environment, economy and society.

The purpose of this chapter is to describe how the Panel resolved the issues identified above, and applied them to its review. Some of these methodological issues are discussed in more detail in subsequent chapters as they apply on a topic-specific basis or with respect to particular valued components.

Early in the public hearing schedule, the Panel convened a technical session on *Approaches and Methods for Evaluating the Information in the EIS and Supplementary Submissions*. To assist the participants and the Panel itself in considering these issues, the Panel retained four specialist advisors to prepare reports addressing four areas of impact assessment methodology particularly relevant to the review:

- frameworks for sustainability-based environmental impact assessment;
- impact significance criteria and judgments;
- indicators of social, economic and cultural cumulative effects; and
- scenario-based cumulative effects assessment.

These reports were presented during the hearings with the opportunity for review and comment by participants. The reports were intended to identify and review different perspectives, approaches and methods for evaluating and assessing information about development impacts generally (positive and negative) and their significance, and to identify current best practices in environmental assessment. The advisors were directed not to address Project-specific issues or to comment specifically on the Proponents' EIS.

A further purpose of the technical session was to provide participants with an opportunity to comment on the Proponents' impact assessment methodology as it applied to any subject matter addressed by the EIS and supplementary filings by the Proponents.

Both the commissioned reports and the technical session were of great assistance to the Panel, and informed its approach to the review in important ways. This was reflected, in part, in the Hearing Guidance document that was issued and updated by the Panel during the course of its hearings. In addition to identifying the subject matter under discussion, the Hearing Guidance document also provided an indication of the Panel's expectations with respect to the treatment of key questions and issues that the Panel wanted to see addressed by the Proponents and participants. A description of the contents and role of the Hearing Guidance document is set out under Section 5.5.2.

This chapter sets out the Panel's approach but contains no recommendations with respect to the methodological issues that it addresses.

5.2 SCOPING THE PROJECT

5.2.1 PROJECT NEED AND PURPOSE

The Panel is required to consider the "need for the Project" and the "purpose of the Project." In doing so, the Panel relied on the Agency's Operational Policy Statement entitled "Addressing 'Need for,' 'Purpose of,' 'Alternatives to' and 'Alternative Means' under the *Canadian Environmental Assessment Act.*"

NEED FOR THE PROJECT

The Agency's Operational Policy Statement provides the following definition for the "need for" a project: "the problem or opportunity that the proposed project is intending to solve or satisfy. That is, 'need for' establishes the fundamental justification or rationale for the project." The Operational Policy Statement goes on to define the "purpose of" a project as "what is to be achieved by carrying out the project."

The Proponents stated in their closing remarks:

> During the JRP hearing process, Mr. Ottenbreit indicated that the demand for natural gas in North America in 2002 was in the order of 68 billion cubic feet per day, and projections call for the demand for natural gas to continually increase. That, coupled with the fact that traditional supplies of natural gas in North America are maturing, illustrates the need for the MGP.
>
> Further, Mayor Tout of Norman Wells also indicated that the MGP will provide the Town with a continued supply of natural gas and extend the life of the existing oil field production by a decade. (J-IORVL-01050, p. 23)

Some participants questioned the need for the Project, primarily in the context of the burning of the gas that would be produced and transported by the Project, and their specific concerns are addressed in subsequent sections of this chapter and in subsequent chapters of the Panel's Report.

PANEL VIEWS

At the close of the Panel's record, the Proponents affirmed that there was a demand for the gas that would be produced and transported by the Project to the North American market. The Panel is of the view that the Proponents and others have established there is a need for the Project.

PURPOSE OF THE PROJECT

The Proponents stated:

> The purpose of the MGP is to develop and produce currently stranded onshore natural gas and associated NGLs from the three Anchor Fields held by the Proponents, and to transport that natural gas and NGLs to Alberta and to consumers throughout North America. (J-IORVL-01050, p. 24)

Several participants disagreed with this characterization, primarily because in their view the purpose of the Mackenzie Valley Pipeline (MVP) was to provide fuel to the existing and planned expansions of oil sands operations of the Proponents' in northern Alberta. Elizabeth May, then Executive Director of the Sierra Club of Canada (SCC), described the MVP as a "pipeline to nowhere" in that:

> the Mackenzie Valley Pipeline includes no links to pipeline infrastructure in northern Alberta that would allow the natural gas to be shipped to market. However, TransCanada PipeLine documents make it clear that TCPL intends to ship 1.5 bcf/day of Mackenzie gas to Fort McMurray to fuel

> expansion of oil production from the Alberta tar sands from 1 million to 4–5 million barrels per day by 2030. TCPL has already negotiated a protocol agreement with the Dene Tha' First Nation of northern Alberta to facilitate construction of the so-called Northcentral Crossing Pipeline that would carry Mackenzie gas from the terminus of the Mackenzie Valley Pipeline to Fort McMurray. In its May 2004 report, the Mackenzie Valley Environmental Impact Review Board found that "the extension of the Alberta [pipeline] system to connect to the Mackenzie Gas Project is not a stand-alone development but an integral part of the Mackenzie Valley pipeline. Neither component can exist without the other." (J-SCC-00002, p. 3)

The SCC cited the proposed North Central Corridor pipeline in Alberta to demonstrate the likelihood of Mackenzie gas being used at the oil sands. The SCC also provided a map of that proposed pipeline and, just prior to the close of the Panel's hearings, filed a newspaper article indicating that TransCanada PipeLines had just filed a regulatory application to build the North Central Corridor pipeline linking the eastern and western regions of northern Alberta.

Submissions were received from a number of other groups and individuals that were based on the assumption that MGP gas was destined for the oil sands. They noted the close links between Alberta's oil sands and the MGP and raised concerns associated with those oil sands projects that, by extension, the MGP would induce, enable and perpetuate. Those concerns included:

- increased levels of greenhouse gas emissions from the oil sands themselves to 9% of Canada's total emissions in 2010 (or 12% of Canada's Kyoto target for that year);
- development of oil sands resources at a rate and scale too rapid and too extensive to enable appropriate environmental and social planning and protection to be put in place;
- increased fragmentation and destruction of large areas of the Boreal Forest; and
- increased exports of oil and gas to the United States in the absence of a Canadian Energy Strategy that focuses on "Canada's energy security needs, not just growing U.S. demand for oil and gas," that makes "current and future production, distribution and use of Canadian energy environmentally safe and sustainable" and that reinforces, rather than trumps, "international environmental, social and human rights obligations." (J-OHP-00240, p. 3)

Of these participants, several recommended that the MGP not be approved if the gas that is produced and delivered was for use in the oil sands.

In response to these assertions, the Proponents stated:

> Once in the NOVA system, Mackenzie Delta natural gas could be purchased and delivered to any of about 200 delivery points that service markets in Alberta, other provinces and the United States.
>
> While none of the Mackenzie Gas Project proponents have made any arrangements to market their Mackenzie Delta natural gas, it would be reasonable to expect that Mackenzie gas will be used to heat homes and businesses, to generate electricity, to manufacture chemicals, and to meet a variety of other industrial purposes…
>
> Production of oil in the Fort McMurray area over the past 40 years has not used natural gas from the Mackenzie Delta. Second, recent expansions of existing oil sands facilities and construction of new oil sands facilities have been completed and started up without natural gas from the Mackenzie Delta. And third, recognizing that the Mackenzie Gas Project has not been approved, future oil sands developments that have been approved or applied for are also not dependent on natural gas from the Mackenzie Delta.
>
> All of this activity is proceeding independent of what happens with Mackenzie gas. In other words, oil sands development in the Fort McMurray area is not dependent on what happens with the development of Mackenzie Delta gas.
>
> The assumption that the Mackenzie Gas Project needs or depends on oil sands demand for natural gas is also not correct.
>
> In North America, the demand for natural gas today is in the order of about 70 billion cubic feet per day, and that's expected to grow, approaching 100 billion cubic feet per day in about 25 years. Natural gas demand associated with oil sands development is only 1 to 2 percent of that total amount.
>
> And so, even if there was no growth in oil sands development, or if there was no production at all from the Alberta oil sands, there would still be a need for additional supplies of natural gas such as those anchoring the Mackenzie Gas Project.
>
> In summary, development in the Fort McMurray area is independent of whatever happens to Mackenzie gas, and conversely, we would be looking at developing the Mackenzie Gas Project even if there was no oil sands development in the Fort McMurray area. (Randy Ottenbreit, HT V83, pp. 8173–74)

Panel Views

The Panel agrees that the purpose of the MGP is to develop and produce onshore natural gas and associated NGLs from the three Anchor Fields held by the Proponents, and to transport that natural gas and NGLs to Alberta and to consumers throughout North America. The Panel notes that, as proposed, the MVP is not a "pipeline to nowhere." If constructed as proposed, the MVP would connect with NOVA Gas Transmission Ltd.'s (NGTL's) existing Alberta System immediately south of the Northwest Territories–Alberta border where gas would enter NGTL's pipeline network that gathers natural gas for use both in Alberta and for delivery to provincial border points for export to North American markets.

The Panel has no evidence that it would be necessary to use gas from the MGP for the purpose of oil sands development in northeastern Alberta. Notwithstanding that a pipeline may be built at a future point in time between the northwest Alberta facility and the oil sands, one does not currently exist and, the Panel notes, oil sands expansions are taking place in the absence of a firm commitment and authorizations that would enable the MGP to indeed be constructed.

5.2.2 ALTERNATIVES

The Panel is also required to consider "alternatives to" the Project and "alternative means of carrying out the Project that are technically and economically feasible." (JRPA, p. 12)

ALTERNATIVES TO THE PROJECT

The Agency's Operational Policy Statement defines "alternatives to" the Project as being "the functionally different ways to meet the project need and achieve the project purpose" and recommends that:

- "alternatives to" a project should be established in relation to the project need and purpose and from the perspective of the proponent; and
- analysis of "alternatives to" a project should serve to validate that the preferred alternative is a reasonable approach to meeting need and purpose and is consistent with the aims of the CEA Act.

In their closing remarks, the Proponents addressed both the null alternative and the various alternatives to transporting the gas from the Anchor Fields. The Proponents stated that they had considered a number of different alternatives to the MGP, including:

> - transporting the Mackenzie Delta natural gas as liquefied natural gas instead of by pipeline;
> - managing the NGLs in alternative ways, including transporting the NGLs by barge to Norman Wells or Alaska, or re-injecting the NGLs back into the ground; and
> - developing and transporting the Mackenzie Delta natural gas in alternative ways, such as combining the development of Mackenzie Delta natural gas with the development of Alaskan natural gas.
>
> The above alternatives either did not meet the need or satisfy the purpose of the Project, or were not feasible on an economic or technical basis.
>
> Delaying the MGP or not proceeding with the Project at all were also considered as alternatives to the proposed Project, but were rejected. Delaying the Project would reduce the likelihood of it proceeding, would reduce the likelihood of other oil and natural gas development in the North, and would reduce related Northern business opportunities and the flow of benefits. Not proceeding with the Project would mean that the purpose of the Project, and its contribution to sustainability, would remain unfulfilled.
>
> The Proponents submit that given the stated need and purpose of the MGP, as well as the benefits to be realized by the development of the Project…the JRP should endorse the Proponents' view that there are no viable alternatives to the Project as proposed. (J-IORVL-01050, pp. 24–25)

Some participants to the Panel's review recommended that the Project not proceed at all — the null alternative. Reasons for this view included:

- objection to the amount of greenhouse gases (GHG) that would be emitted by the Project itself;
- the uses to which the gas would be put;
- the lack of preparedness of northern people and institutions to manage a project of the size and scope of the Project; and
- the additional activities the Project was likely to induce.

These views are set out more fully in this Report in this chapter under "purpose" of the Project and in subsequent chapters.

Panel View

The Panel is satisfied that the Proponents have examined functionally different ways to meet the Project need and purpose. In the Panel's view, the Proponents' preferred approach for transporting gas from the Anchor Fields to market is reasonable.

ALTERNATIVE MEANS

The Agency's Operational Policy Statement defines "alternative means" as "the various technically and economically feasible ways the project can be implemented or carried out. This could include, for example, alternative locations, routes and methods of development, implementation and mitigation." The Policy Statement sets out a process to assist in the assessment of alternative means, including identification of the alternative means; the environmental effects of each of the alternative means; and the preferred means.

During the course of the Panel's proceedings, the Proponents made a number of changes to the design and location of certain components of the Project. Some of these changes were in response to input from affected participants or responsible authorities. Other changes represented refinements to the Project made by the Proponents as their assessments and design considerations advanced. Changes to the Project were conveyed to the Panel on two separate occasions, each of which included supporting information setting out the details of the proposed changes as well as their biophysical and socio-economic impacts, and the community consultation program carried out regarding those details. The details and impacts of some of these changes are described in the appropriate topic-specific chapters of this Report. The Proponents predicted that the changes proposed to the Project in their 2005 Project Update would have the same or reduced impacts as would the Project components originally assessed in the 2004 EIS. With respect to changes proposed in their 2007 Project Update, the Proponents commented that their assessment of the biophysical and socio-economic effects of these updates concluded "that these updates further mitigate potential adverse project impacts and result in enhanced project benefits." (J-IORVL-00953, p. 1)

Throughout the course of the hearings, there were instances of participants, particularly communities and individuals, who raised concerns about particular sites for Project facilities or for the pipeline right of way. These concerns were addressed by the Proponents and either resulted in a change to the Project or confirmation by the Proponents that, after consideration, their preferred option was the one they were proposing for the Project. Alternative means for carrying out specific elements of the Project that were raised as concerns by participants but not accepted by the Proponents are addressed by the Panel in other chapters of this Report.

Some participants urged the Panel to take a broader view of alternative means of carrying out the Project in light of the Panel's Mandate to consider the Project from the perspective of sustainability. These comments focused on the need for government preparedness and for the Project, as an Arctic project, to mitigate the effect global GHG emissions are having on the Arctic by purchasing carbon credits to offset the GHG emissions that would be emitted from the Project and from the burning of the gas that would be produced by the Project.

These participants recommended that the Project not proceed at this time — not so much because they opposed the Project as such, but because in their view government and other northern institutions were not ready for this development and that, in order for the people of the North to benefit, the alternative means for developing the Project had to include an institutional infrastructure capable of properly managing the Project. In its closing remarks, Alternatives North Coalition told the Panel:

> our position is that it is not in the public interest to proceed with the MGP as currently proposed…Our governments and many northerners are not ready for development of this scale and pace. We do not have in place, and cannot expect to have in place in time for the MGP, adequate and specific measures and plans to protect the environment and residents, or to ensure a fair and equitable distribution of the costs and benefits of the MGP.
>
> The Joint Review Panel has the option to recommend that the MGP proceed or not. We submit that it is your duty to recommend the MGP not proceed. Failing that, we urge you to set the bar high. If approved, this multi-billion dollar energy project will surely transform the NWT in unpredictable and undesirable ways; in ways that no order of government has adequately prepared for.
>
> If you determine that the project can proceed, we urge you to craft recommendations that:
>
> - are guided primarily by public interest and concern for net contribution to sustainability;
> - are sufficiently detailed to ensure they can be incorporated into regulatory permits and licenses to control the MGP's impacts;
> - consider the project from "cradle to grave," including proper reclamation and closure plans, as well as social and economic transition planning; and
> - call for the use of best practices in aspects of the design, construction, operation, and decommissioning of all project components of the MGP. (J-ANC-00085, p. 4)

The preferred option of the SCC was that the Panel recommend that the Project not be approved so as to allow time for government and northern institutions to improve their level of preparedness for the development and induced development, including the conduct of a scenario-based cumulative effects assessment and policies proven to reverse Canada's negative trend towards GHG emission contributions. This, suggested SCC, could be interpreted as a temporal alternative. In its view "the JRP has heard enough to conclude that under the current state of readiness, the MGP will likely lead to significant adverse environmental impacts and will not contribute to sustainability." (J-SCC-00119, p. 4) In the alternative, the SCC's second recommendation was that "should the JRP reject this SCC recommendation #1 and instead recommend approval, SCC urges the JRP to recommend that such approval not occur until after a sufficient level of readiness is attained." (J-SCC-00119, p. 20)

Under the slogan "do it right, do it green or don't do it at all," Ecology North recommended that the Panel "require that the Mackenzie Gas Project fully offset both operational and end-use greenhouse gas emissions though the purchase of certified carbon credits." (J-ECNO-00030, p. 17)

In response to the issue of being required to make the Project carbon neutral, the Proponents stated:

> Other interveners have suggested that the Proponents be bound by financially onerous conditions tied to greenhouse gas emissions, such as the requirement to be carbon neutral or to purchase offsets. For example, Ecology North has argued that the Proponents should be required to be carbon neutral by completely offsetting its greenhouse gas emissions, either through the purchase of carbon credits or by some other alternative means. The alternative means that were proposed by Ecology North in its Topic 4 presentation were to require the Project to construct 7,700 wind generators, renovate 6.4 million homes and/or

preserve 21 million acres of forest. Ecology North estimated that the cost of purchasing offsetting carbon credits for both the Project and the end use of MGP natural gas would be 19.48B$. Ecology North did not provide an estimated cost for the recommended alternative means.

The Proponents disagree with Ecology North and others' recommendation that the Project be made subject to financially onerous, Project-specific conditions, which go far beyond any requirement for any other project in Canada. As stated by Mr. Ottenbreit, the Proponents do not agree that any constraints should be placed on the MGP that are not placed on other Canadian projects with which the MGP has to compete. Notably, the Federal Government has also indicated that Ecology North's approach would do little to address Canada's contribution to overall carbon footprint in a comprehensive manner. Furthermore, giving effect to Ecology North's proposal would clearly make the Project uneconomic.

Although a project's emissions can and should be considered in a project-specific environmental assessment (as was done in this case), global/national issues relating to strategies for reductions of greenhouse gas emissions properly fall within the ambit of national interests and international obligations, and must be addressed in a fair and consistent manner by legislation and its respective regulatory bodies. The Federal Government has indicated its intent to develop industry-wide targets for greenhouse gas emissions, the timing of which is not tied to the Project. (J-IORVL-01050, pp. 141–42)

Panel Views

The Panel is of the view that the Proponents have considered alternative means of carrying out the Project and notes they have stated that they would continue to do so. Changes to location and timing of Project facilities, made in response to community concerns or Project costs or design, were generally well received by community and government authorities. The Panel is satisfied that the Proponents have adequately identified and examined alternatives to the Project and alternative means of carrying out the Project that were technically and economically feasible, and have identified the environmental impacts of each alternative means in determining their preferred alternative. These alternative means were presented by the Proponents and were considered by the Panel and the public during the course of the Panel's hearings. The changes proposed by the Proponents were accepted by the Panel as forming "the Project" that was the subject of the Panel's review.

5.3 THE RECEIVING ENVIRONMENT

5.3.1 IDENTIFICATION OF VALUED COMPONENTS

To focus their assessment of Project impacts, the Proponents selected valued components of the biophysical and human environment for study. These valued components (VCs) were selected on the basis of regulatory status, community concerns, socio-economic importance, ecological vulnerability, information availability, and as established in previous environmental assessment practice. For each of these VCs, the Proponents identified key indicators, that is, features of a VC that can be measured and used to predict impacts. The prediction of impact is based on the hypothetical pathways by which a Project activity could affect a VC. This is a well-accepted approach in impact assessment and was not disputed in principle during the Panel's proceedings.

There were some differences of views among participants with respect to the actual selection of valued components, indicators and pathways. These are for the most part considered in the topic-specific chapters, notably Chapter 10, "Wildlife." The thematic organization of topics reviewed during the course of the hearings was not substantially different from the Proponents' EIS. During the hearings, however, issues emerged that the Proponents had not originally addressed. The individual chapters in the Panel's Report are therefore organized primarily on an issue basis, rather than a sequential consideration of VC by VC.

5.3.2 TEMPORAL AND SPATIAL BOUNDARIES

TEMPORAL BOUNDARIES

Temporal boundaries encompass the period of time over which the Project is anticipated to be in existence and to give rise to impacts on the environment. The EIS Terms of Reference required that the Proponents "assess the potential impacts on the environment…for all phases of the proposed Project. Temporal boundaries should recognize the proposed lifespan of Project activities and facilities, and duration of potential impacts." (EIS Terms of Reference, p. 41)

The Proponents set out temporal boundaries that, as revised according to the 2007 Project Update, included three phases with dates estimated at that time as follows:

- Project Definition Phase (2002–2009);
- Design and Construction Phase (2009–2014, with field construction beginning in the summer of 2010); and
- Operations Phase (2014, continuing as long as there is economic gas production in the region).

The Proponents stated:

> Temporal boundaries are the time frames that were used in the assessment to consider project effects. The assessment considered the effects of the project at a number of different stages in the life-cycle of the project, because the nature of effects on the environment varies from one stage of the project to another.
>
> The EIS started with a baseline scenario that represented the biophysical and socio-economic conditions between 2002 and 2004. In the EIS, the effects likely to occur during the construction period were considered. In general, this is the period when the highest effects are expected because it will be the period of maximum disturbance, both to biophysical and socio-economic conditions. Effects were also predicted for the operational period.
>
> Effects of the activities related to project decommissioning and abandonment were also examined. (Bette Beswick, HT V6, p. 494)

A number of participants raised concerns based on their experience with other oil and gas development in the Mackenzie Beaufort Delta. Chief Charlie Furlong, a director of the Gwich'in Tribal Council and chief of the Aklavik Indian Band, told the Panel there had been impacts from oil and gas activity that took place in the 1970s and from the boom and bust "when industry pull out their stakes and left a legacy of social problems, some of which are still impacting us today." Chief Furlong also saw that there could be benefits associated with the Project that would extend beyond the life of the Project. In the context of his support for the Project, he told the Panel "We must take full advantage of this huge opportunity because we know the benefits of this project will last over many, many generations." (HT V6, p. 538)

The Panel acknowledges that adverse impacts and positive benefits can take place for periods of time extending beyond the life of the Project and has addressed the temporal nature of predicted impacts as they relate to specific valued components throughout this Report.

SPATIAL BOUNDARIES

Project Assessment Boundaries

The Proponents used several scales of "study areas" for their assessment, depending on the purpose. The biophysical study areas chosen were specific to each topic. The Proponents used two types of areas for assessing environmental impacts:

- Local Study Area (LSA): an area used to assess Project-specific effects; and
- Regional Study Area (RSA): an area used to assess Project-combined effects and cumulative effects.

The study areas selected were determined according to the expected spatial extent of the Project effects and the mobility of valued components.

The LSAs were generally a 1-km-wide corridor for pipelines and a 1-km-wide buffer around each infrastructure and facility site.

The three key RSAs for biophysical purposes were:

- Pipeline corridor study area: a 30-km-wide corridor on either side of the centre line of the right-of-way;
- Production area study area: a 40-km-wide buffer around the Project footprint plus the western half of the Tuktoyaktuk Peninsula and the winter range of the Cape Bathurst caribou herd; and
- Marine area study area: the Mackenzie Delta and estuary, and the Beaufort Sea to the 50-m depth contour.

The Proponents used a single socio-economic study area based mainly on community proximity to the Project where, in the Proponents' view, the direct or indirect effects of the Project could affect permanent residents.

Further details on the Proponents' study areas are provided in the relevant topic-specific chapters, as are participants' views on the suitability of these boundaries.

Project Review Area

The term "Project Review Area" is a generic term established by the Panel for use in this Report to describe the area that encompasses the subject matter referred to in the comments and submissions from participants in the Panel's proceedings. While the term may overlap areas covered by the "Project Area," "Project Study Area," "Regional Study Area" and "Local Study Area" — terms that were developed and used by the Proponents in their EIS — "Project Review Area" is not to be confused with these other terms. Although the focus is primarily related to the western NWT, Yukon and northwest Alberta, the subject matter considered during the Panel's review in some cases extended beyond that area. As such the Project Review Area is not a single geographic area with a fixed geographical boundary. It is a term of convenience that is context sensitive and has no legal status.

5.3.3 BASELINE INFORMATION

A sound baseline understanding of existing conditions in the Project Review Area is needed for at least two reasons. The first is to provide the review process, and in particular the Panel, confidence that the status and trends of the valued components identified by the participants are factually grounded. This is essential to evaluating whether the mitigations and enhancements proposed suit the conditions to which they will be applied, and thus the likelihood of their success, on which the determination of impact significance depends. As specified in the EIS Terms of Reference:

> The description of the environment should, when read in combination with the Project description…allow the Panel to reasonably identify and understand the selection of Valued Environmental Components (VECs) for the physical,

> biological and human environments…potential interactions, and potential impacts that may be caused by the Project. (EIS Terms of Reference, p. 23)

The second reason is to provide governments at all levels, as well as interested organizations and individuals, with an adequate base of information, should the Project proceed, on which to verify impact predictions, to monitor the effectiveness of Project mitigations and enhancements, and to modify them as necessary. This base of information should also enable others to judge how well the Proponents, governments, communities and individuals are responding to the challenges and opportunities that the Project may provide.

The Panel thus requires not only a sufficient baseline of information for its own review of the assessment of Project impacts, but also assurance that a sound baseline exists (or will exist) for the benefit of those charged with monitoring Project mitigations and outcomes. In both cases, the quality and comprehensiveness of the baseline must be sufficient to inspire confidence both in impact predictions (whether those made by the Proponents or participants) and in the measures taken to mitigate or enhance impacts.

It is first necessary to determine if the valued components have been correctly identified. These valued components should focus on what the affected population values and considers being at risk and what or who is vulnerable in relation to Project impacts. The baseline should accurately portray the status of those valued components and their trends over time. This in turn depends on selecting indicators that directly illustrate the conditions and can provide a measure of change over time. In the topic-specific chapters that follow, the Panel considers:

- whether the indicators used by participants (and particularly the Proponents) are appropriate; and
- whether the measurement (quantitative or qualitative) of those indicators provides a sound understanding of both conditions and trends with respect to any particular VC.

In the Panel's view, the requirement for adequate baseline information applies not only to the Proponents but also to those who will be responsible for monitoring impacts, testing effectiveness of mitigations and implementing follow-up programs. It is in large measure governments, organizations and communities that will need an adequate baseline. It is by no means the Proponents' exclusive responsibility to provide that baseline.

While a comprehensive and authoritative baseline does not necessarily have to emerge from the review itself, the Panel must be satisfied that adequate baseline information either does exist or can be produced for the purposes specified should the Project proceed. Is there, or would there be, a sufficient basis for predicting project impacts — both adverse and beneficial? Is there, or would there be, a sufficient basis for monitoring the impacts of the Project, and for developing programs and strategies to ensure that potential adverse impacts are avoided or potential benefits captured? Is there, or would there be, a sufficient understanding of conditions and trends without the Project, and hence what benefits or adverse impacts would result from the Project by comparison? Would this baseline enable one to attribute impacts to the Project itself (or to the cumulative impacts of the Project), rather than to other factors?

The Panel considers, in the topic-specific chapters, whether the review process actually produced a comprehensive and credible baseline, and if not, whether the needed baseline information would be produced in a timely and useful way for the purposes required of it. Specific recommendations on addressing baseline needs will be found in those chapters.

If the baseline is neither methodologically robust nor comprehensive in coverage, then the user cannot be confident of conclusions, predictions or monitoring based on it. Is this a problem? If so, for whom is it a problem, who if anyone should fix it and how, and what beneficial result would occur? These more general questions are considered in Chapter 18, "Monitoring, Follow-up and Management Plans."

5.3.4 TRADITIONAL KNOWLEDGE

The EIS Terms of Reference directed the Panel to:

> promote and facilitate the contribution of traditional knowledge to the environmental impact review process. It is recognized that approaches to traditional knowledge, customs, and protocols may differ among Aboriginal communities and persons with respect to the use, management, and protection of this knowledge. The Joint Review Panel can consider the views of communities and traditional knowledge holders during the environmental impact review process and determine which information should be kept confidential. (EIS Terms of Reference, p. 9)

The Terms of Reference also directed the Proponents to "use and incorporate traditional knowledge into the EIS" (EIS Terms of Reference, p. 11) and, in their impact analysis methodology, to "specify and reference sources for any contributions based on traditional knowledge." (EIS Terms of Reference, p. 40)

The Proponents chose to obtain Traditional Knowledge (TK) for the purposes of their EIS chiefly by organizing a program of TK studies in the Project area communities. The key components of the program included:

- reviewing existing information;
- collecting new information; and
- producing TK baseline reports.

Under their TK studies program, the Proponents initiated discussions with each community to ascertain whether it wished to undertake such a study. If so, contractual agreements for conducting the study were negotiated, with the Proponents providing all funding. Under these agreements, the TK studies were carried out under the direction of local working groups, not the Proponents or their consultants. The Proponents were authorized to use the data for Project planning and for environmental impact assessment. However, the agreements specified that TK belonged to the individuals and communities providing the information, and their organizations were "encouraged" to retain ownership of the maps and reports produced.

At the time the EIS was filed (October 2004), none of the community TK studies had been completed. The Panel therefore requested additional information on the progress and use of these studies in the review process. In March 2005, the Proponents advised that:

- only one study had been completed, several were still in progress, and some were still in the planning stage;
- while they had permission to use the TK studies, each individual community would decide whether the reports would be publicly disclosed, and
- pending completion of the TK studies, the Proponents were relying on information obtained through their public participation program and from Project-related concerns expressed by community members, and on existing published sources of TK.

The Panel issued advice by way of an announcement to all participants in May 2005 regarding the use of TK in its review. The Panel observed that most of the Proponents' TK studies had not yet been completed, that no arrangements had yet been confirmed to release any of these studies on the public record, and that this state of affairs might persist into the hearing phase of its review. The Panel therefore encouraged the submission of information based on TK independently of the submission of the Proponents-sponsored TK studies. This could be done either by informal presentations by individuals and community groups at Community and General Hearings on matters related to issues identification, baseline information and local capacity to respond to the Project or by formal submissions based on TK by participants at Technical Hearings relating to Project impacts, mitigations and follow-up monitoring.

Early in the public hearings, the Panel questioned the Proponents further on the status and availability of the TK reports, their scope, methods, quality and consistency, and on how and to what extent the Proponents would be relying on them for their assessment. The Panel understood from the responses that the TK reports, to the extent that they might become available, would supply information mainly relating to wildlife and fisheries, community use of lands and resources, and sites or areas of particular importance, but little or no information on current social and economic conditions. The studies were not themselves intended to provide significance determinations of Project impacts, but rather to provide the Proponents with a basis for making these determinations according to their own criteria.

Neither the Proponents nor their consultants exercised any control over the consistency of study content, selection of study leaders or report writers, representativeness of information provided or verification of that information. These matters were under the direction of the working groups themselves. The Proponents were provided the results of the studies, but not raw data for independent analysis.

Ultimately the Panel received five TK reports. In three cases (Sambaa K'e Dene Band, Jean Marie River First Nation and Pedzeh Ki First Nation), the communities in question applied to have certain portions of the reports (chiefly with respect to site-specific information) kept confidential, in accordance with the Panel's *Directions for Procedures for Hearings*, and its *Criteria for Confidentiality Orders for Traditional Knowledge Study Reports*. The Panel granted these applications, all of which came from the Dehcho Region where no comprehensive land claim agreement or resulting information-sharing provisions for land and resource management are in place. The Panel recognized that in these circumstances, the reports for which confidentiality orders were sought might contain information that the communities might not wish to, and were not compelled to, disclose to third parties.

Seven presentations based on TK reports were made to the Panel at community hearings; all of them in the Dehcho Region. These presentations were all placed on the public registry, with certain mapped information removed with the Panel's authorization, on the same basis of confidentiality granted to the TK reports themselves.

The Panel also received a report prepared in 1997 on the Dene Tha' First Nation traditional use area. The Dene Tha' First Nation advised the Panel that this study was not comprehensive with respect to the Project, and that they hoped to add to that information before the construction of the Northwest Alberta Facilities.

The EIS Terms of Reference defined TK for the purposes of this review. Neither the Proponents nor any participant suggested that the Panel should adopt an amended or alternative definition, and the Panel does not find it necessary or appropriate to comment any further.

Because none of the TK studies was completed, and some not even begun, when the EIS was submitted, the Panel concludes that the EIS was not informed by the TK studies program. To the extent that TK was used to inform the Proponents' assessment and their significance determinations, the Panel understands that the source of this TK was either previously published information or information obtained through the Proponents' public participation program. How the Proponents actually used this information was not disclosed in the EIS or in subsequent filings.

Because the Panel itself received only 5 of the 13 TK studies undertaken, the TK information generated by the Proponents for the purposes of the review was incomplete. However, some of the studies that were filed with the Panel provided clear and precise information about specific concerns, mainly with respect to valued components of lands and resources, local concerns about potential Project impacts and how Project routing and siting could be amended to avoid these impacts. The Panel considers that, during the course of many community and general hearings, it heard considerable TK information from participants. The Panel has relied on this information, in addition to the TK studies it received, to ensure that it has taken TK into account in accordance with the EIS Terms of Reference.

5.4 IMPACT ASSESSMENT

The impact assessment process examines the interaction of the Project with the receiving environment. It begins by identifying the potential impacts of the Project, and predicts whether residual impacts would be likely to occur after the application of the Proponents' designs, management plans and mitigations. The impact assessment process then considers the uncertainty associated with these predictions and mitigations and assigns significance to residual impacts on the basis of some stated criteria. Finally, it identifies means by which impacts (positive or negative) would be monitored and, if necessary, corrected (adaptive management). These were in essence the principles that the Proponents used in their EIS. These general principles were not disputed by participants, although there were many disagreements about how the Proponents applied them and over the conclusions the Proponents reached.

The steps identified above are in fact iterative and interconnected, although the Panel considers them in sequence for the purposes of this discussion, which also includes a consideration of cumulative impact assessment.

The Project as described in the EIS and subsequent filings was at a conceptual stage in both engineering design and project mitigation. The Panel accepts that Project design and mitigation were at a conceptual stage during its review, and that for the most part the Proponents had provided sufficient information for the Panel's review, given that stage of Project development. As a consequence, however, the Panel has necessarily applied a precautionary approach in its assessment and has sought to provide guidance to downstream regulators as they consider the Project in greater detail, should it proceed. The Panel's views on these matters are set out in further detail in subsequent chapters, particularly Chapter 6, "Project Design, Construction and Operations," and Chapter 10, "Wildlife."

The Panel observed that participants used the terms "impact" and "effect" interchangeably and without distinction. The *Canadian Environmental Assessment Act* does not use the term 'impact' yet both the *Mackenzie Valley Resource Management Act* and the JRPA use the term "impact on the environment" to include any effect on the biophysical, social or cultural environment. Consequently, in addition to being mindful of the full definition of the term "impact on the environment" in the JRPA, the Panel has used the term "impact" as opposed to "effect" throughout its Report to refer to any change the Project might cause to the biophysical, social or cultural environment including any impacts of such change and any cumulative impacts.

5.4.1 IMPACT PREDICTION

The overall approach taken by the Proponents to the identification and assessment of potential impacts was to apply sufficient mitigation to each Project-related impact to the point where significant adverse impacts would be considered not likely to occur. If significant adverse impacts were not considered likely to occur as a result of the individual Project activities, the Proponents then concluded that, in aggregate, there would also not be any significant cumulative adverse impacts. The Proponents' conclusion was dependent upon the effective application of mitigation measures, monitoring and adaptive management.

The Panel notes that, for the Proponents' significance determinations to be valid, their mitigation measures would need to be appropriate to the situation in which they were applied and be fully effective in their implementation. During the Panel's review, however, it became clear that site-specific information was not complete in terms of baseline environmental information and that appropriate mitigation measures had not been fully designed. Nevertheless, the Proponents expressed confidence that they had appropriate and effective mitigation measures available to them and that they could and would apply them.

The net effect of the Proponents' approach is that, if accepted, all other participants and the Panel would have to:

- rely on the implementation of measures and actions some of which are not yet completely known;
- assume that these incompletely described measures and actions would be entirely effective; and
- trust that the Proponents and other parties would know when those measures and actions have not been effective and take the appropriate action to remedy an unforeseen situation.

The Panel is not entirely persuaded of the merits of this approach and acknowledges the concerns that a number of participants expressed about it. In general, the Proponents' approach reinforces the need, in the Panel's view, for a precautionary approach to impact prediction. The Panel identifies its specific reservations about the Proponents' impact predictions and makes recommendations as appropriate in the topic-specific chapters.

5.4.2 PROPONENTS' COMMITMENTS, MITIGATION AND ENHANCEMENT

Notwithstanding its reservations regarding the Proponents' approach to impact predictions, the Panel notes that the Proponents proposed many detailed plans, actions and measures to avoid, reduce or otherwise minimize the potential adverse impacts of the Project, whether on the biophysical or the socio-economic environment. These were embodied in commitments that were made over the course of the Panel's review. These commitments ranged from the ones formally stated by the Proponents in their Commitment Tables filed with the Panel in March 2007 to less formal undertakings that were given orally during the hearings, not all of which were necessarily included in the Tables. In some cases, these commitments were subsequently formalized through agreements with other parties, for example, the Socio-Economic Agreement with the Government of the Northwest Territories (GNWT).

Except where otherwise noted, the Panel, and presumably participants in the Panel's review, have relied on many of the commitments made by the Proponents. The effect of these commitments as mitigation measures has been a factor in the Panel's significance determinations.

In this context, the Panel has considered the enforceability of the Proponents' commitments and has noted in this regard the following proposed condition tabled by the National Energy Board (NEB) for comment in the Mackenzie Gas Project Hearing Order GH-1-2004 proceeding that has been made for each of the Proponents of the Project:

> 1. Unless the NEB [or Chief Conservation Officer] otherwise directs, [the Proponents] shall cause the approved facilities to be designed, located, constructed, installed and operated in accordance with the specifications, standards, policies, mitigation measures, procedures, and other information referred to in [their] application or as otherwise agreed to during the GH-1-2004 Hearing. (J-IORVL-01040 pp. 4, 18, 20 and 22)

The Panel understands that the effect of this condition would be to elevate all of the Proponents' commitments to the same status as specific conditions included in the NEB authorizations and thus be enforceable by the NEB.

In order to achieve a similar result for commitments made by the Proponents during the Panel's review, the Panel recommends as follows:

RECOMMENDATION 5-1

The Panel recommends that the National Energy Board's proposed conditions tabled by the Board in the Mackenzie Gas Project Hearing Order GH-1-2004 proceeding be amended for each of the Proponents to the Mackenzie Gas Project as follows:

> *1. Unless the National Energy Board (or Chief Conservation Officer) otherwise directs, or except where the Joint Review Panel for the Mackenzie Gas Project (the Panel) has recommended otherwise, [the Proponents] shall cause the approved facilities to be designed, located, constructed, installed and operated in accordance with the specifications, standards, policies, mitigation measures, procedures, and other information referred to in their application or in the Environmental Impact Statement or other filings with the Panel or as otherwise agreed to during the GH-1-2004 Hearing or the review conducted by the Panel.*

The Panel believes that the effect of this amended version of the proposed NEB conditions would be to elevate the status of all commitments made during the Panel review to the same level as those made in the NEB proceeding.

The Panel notes that NGTL filed with the Panel in November 2007 its own Commitments Table. As noted in Chapter 2, "Project Description," the Panel is aware that, since the conclusion of its hearings, the NEB has issued a Declaratory Order that the TransCanada Alberta System (which the Panel understands is, in effect, NGTL) is under federal jurisdiction and subject to regulation by the NEB. The Panel therefore recommends that conditions similar to those recommended for inclusion in any NEB authorizations issued for the MGP should also apply to the Northwest Alberta Facilities.

RECOMMENDATION 5-2

The Panel recommends that the National Energy Board include in any certificate or approvals it might issue in relation to the Northwest Alberta Facilities those conditions the Panel has recommended for inclusion in any certificate or approvals for the Mackenzie Gas Project that could be applied to the Northwest Alberta Facilities, with such modification as the National Energy Board may determine is appropriate having regard to the location, nature and scope of those facilities.

The Proponents applied the term "mitigations" specifically to the actions they would undertake to avoid significant adverse impacts of their own activities. The Proponents also undertook to provide "enhancements" to the Project that are intended to augment its benefits and strengthen its net contribution to sustainability. The Panel acknowledges this distinction and uses it in the same sense as the Proponents.

Finally, other participants, chiefly governments, undertook to implement various actions intended to minimize adverse Project impacts or augment beneficial Project impacts. The Panel refers to these as "measures," as distinct from "mitigations," which refers solely to the Proponents' own actions with respect to their own activities.

5.4.3 UNCERTAINTY AND THE PRECAUTIONARY APPROACH

One of the principles identified in the EIS Terms of Reference to "provide context for the [Environmental Impact Review] process" was the precautionary approach. (EIS Terms of Reference, p. 7) The Terms of Reference noted that "there is not one universally agreed upon definition of the precautionary approach or principle. The term has been used in environmental decision-making to address the increasing…prevalence of scientific uncertainty" and "informs the decision-maker to err on the side of caution, especially where there is a large degree of uncertainty or high risk." (EIS Terms of Reference, p. 10)

The Proponents stated that they applied a precautionary approach by applying conservative assumptions to ensure that impacts were not under-predicted:

> [T]hroughout a conservative approach was used when considering what a potential effect might be and how it should be addressed as part of design, mitigation and residual effect categorization…For example, in cases where we weren't certain if the project would cause an adverse effect, we assumed it would. (David Kerr, HT V6, pp. 487–90)

With respect to socio-economic impacts, the Proponents indicated that the result of this approach was a tendency to understate the potential benefits and overstate the potential adverse effects of the Project and that it provides both regulators and planners with a conservative approach that addresses the difficulties of accurate effects prediction. The Proponents also identified the relative degree of uncertainty in prediction, which they considered most important for monitoring and adaptive management.

Many participants questioned the Proponents regarding their precautionary approach and suggested that the conclusions reached by the Proponents on a number of important impact predictions were not reflective of this approach.

Fisheries and Oceans Canada (DFO) identified uncertainties associated with the Project as one of its key ongoing concerns:

> We have emphasised the need for a precautionary approach when dealing with these uncertainties and want to emphasise in our closing comments where this approach will need to be fully considered in the design, construction and operation/maintenance of the project if it proceeds. (J-DFO-00103, p. 2)

Environment Canada expressed the view that the Proponents' cumulative impacts assessment had not followed a precautionary approach as it applied to many areas of Project uncertainty. Similarly, Indian and Northern Affairs Canada (INAC) expressed the view that its inability to confirm the Proponents' conclusions in a number of areas warranted a precautionary approach.

As a consequence of uncertainties with respect to the Project, the Project context and the Proponents' assessment of and conclusions about Project impacts, DFO, INAC, Environment Canada and the GNWT emphasized the need for the Proponents to take a more precautionary approach with respect to mitigation, monitoring and adaptive management. In practical terms, the government departments told the Panel this meant that the Proponents should be more proactive and anticipatory and less reactive in designing and applying measures to address uncertainty in prediction and mitigation:

> DFO has recommended to the Panel and to the proponents that a precautionary and adaptive management approach must be applied at the outset of engineering design, construction and operation phases to mitigate impacts from frost hazards such that 1) they are prevented from happening; 2) any unforeseen impacts or mitigation failures are detected early; and 3) clear commitments made that through an effective monitoring program steps are taken to rectify them forthwith. (J-DFO-00103, p. 3)

> Throughout this review, DIAND and other government agencies have been underscoring the importance of a proactive approach to avoiding and then mitigating environmental effects. And we have been concerned that, in some cases at least, the proponent seems to be relying on a more reactive approach: when problems arise, they'll solve them. Our experience suggests that prevention is better than cure and, in the North in particular, prevention is much — a much more effective way. So that is what we are talking about; a precautionary, preventative approach rather than a more reactive approach relying on solving problems as they arise. And in addition, again, we underscore the importance of ensuring that all mitigations, all best practices and improvement in best practises, and implementation of the blueprint are necessary to achieve this objective. (David Livingstone, HT V106, p. 10524)

With respect to the guidance offered in the EIS Terms of Reference, the Panel notes that a precautionary approach and the Precautionary Principle, as embodied in the Rio Declaration, have two distinct meanings and should not be conflated. The Precautionary Principle was rarely invoked and rarely applied in the Panel's proceedings. The Panel has focused on the need for a precautionary approach in the face of uncertainty and uses that term in preference to other variants used by a number of participants.

The Panel understands a precautionary approach as one that is designed to treat areas of impact uncertainty, especially when there is a threat of serious adverse or irreversible consequence. The Panel notes that the Proponents generally adopted a conservative approach to Project design and mitigation. Whether they had done so appropriately in all cases is considered in the topic-specific chapters.

The Panel observes that disagreement amongst the participants arose from uncertainties relating to:

- limited information about the nature and location of reasonably anticipated development beyond the Project as Filed;
- the reliability of predicted impacts of the Project, especially cumulative impacts;
- the effectiveness of proposed mitigation measures; and
- the adequacy of monitoring and adaptive management plans.

The Panel has approached the issue of uncertainty and the application of a precautionary approach mindful of the following considerations in determining whether the Project could result in serious or irreversible damage and in the consideration of trade-offs between positive and negative impacts:

- the novelty of Project interaction in the receiving environment, and the proven or likely effectiveness of the Proponents' designs, management plans and mitigations in that environment;
- the degree of uncertainty about potential positive and negative impacts;
- the magnitude and duration of potential impacts and the extent to which they might be irreversible; and
- the extent and scale at which potential impacts could impair biological productivity, ecosystem health, local and regional capacities and community well-being.

The Panel accepts that a precautionary approach requires that:

- uncertainty is an explicit factor in significance determination;
- the implications of uncertainties for decision making are explicitly considered; and
- greater emphasis on monitoring and adaptive management is required.

As noted above, the Panel has applied this approach in view of the largely conceptual nature of the Project at the stage in which it was reviewed.

5.4.4 MONITORING AND ADAPTIVE MANAGEMENT

The Proponents stated that management of change was integral to their business. They explained how adaptive management would be incorporated during the life of the Project and stated that it was a key attribute of environmental plans:

> Adaptive management is a process that involves changing mitigation that is not achieving the desirable effect or the predicted result. It will be used throughout each phase of the project and will be applied during inspection, where change in field conditions may be encountered during construction. (Kerr, HT V89, p. 8802)

The Proponents acknowledged the need to monitor impact predictions, listen to emerging stakeholder concerns and use adaptive management to ensure that this information was considered and adjustments made. The Proponents stated that local communities would have an opportunity to provide input on the success of mitigation measures and the need for adaptive management through their community monitors and other mechanisms. The process would follow industry standard protocols and procedures, and all adaptive management decisions would be reported and documented for use in subsequent monitoring programs.

Environment Canada and INAC both expressed concerns over the Proponents' approach to uncertainty and their approach to the exercise of precaution in impact mitigation and monitoring, and as a consequence, the implications for adaptive management, especially with regard to cumulative impacts. Environment Canada concluded that:

> significant levels of uncertainty remain with regard to the nature and extent of potential project-specific cumulative effects and that, because of this uncertainty and the lack of detail available on aspects of project-specific mitigation, monitoring and follow-up and approaches to adaptive management, Environment Canada has limited confidence that the proponent will manage these potential effects appropriately; or that the proponent's approach to monitoring and management will make an effective contribution to assessments and management of regional cumulative effects.
>
> Therefore, Environment Canada recommends that the proponent be required to demonstrate exemplary performance in all aspects of mitigation, monitoring and follow up and adaptive management, the identification, utilization and continuous improvement of best practices and through contribution to broad-based cumulative effects initiatives, such as the cumulative effects assessment and management framework and the cumulative impacts monitoring program, as outlined in our written submissions to the Joint Review Panel to date. (Chuck Brumwell, HT V104, p. 10263)

INAC stated that:

> we couldn't confirm the Proponents' conclusions, and therefore, we feel that overall in this project a precautionary approach needs to be taken in all aspects of it and that using a precautionary approach, using sound mitigation, using thorough and effective adaptive management program, the appropriate monitoring terms and conditions, and so on and so on, that a project like this can be built, but it will rely on the implementation of all those measures and recommendations that have been put forward to the Panel to date to make it so. (Livingstone, HT V104, p. 10337)

INAC emphasized during hearings that robust adaptive management is essential given the changing environment. It noted the importance of monitoring the adaptive management practices applied to the Project to determine their effectiveness. INAC recommended that the Proponents develop monitoring follow-up and adaptive management plans and programs prior to regulatory approvals. INAC noted that, in addition to adaptive management of the monitoring and project implementation, plans and programs will also need to be adjusted periodically based on new information. INAC also noted that without tiered thresholds, no monitoring program is particularly useful in an adaptive management context.

Asked to comment on the Proponents' statement that their adaptive management process would follow industry standards and protocols, DFO, Environment Canada, the GNWT and INAC responded that they were not aware of any industry-wide standards, other than ISO guidelines.

The World Wildlife Fund stated that:

> [p]erhaps the greatest fallacy that is perpetrated by proponents and governments alike, when they are eager to get on with the development, is that deficiencies in impact assessments, that is, gaps in our understanding, and deficiencies in plans to mitigate adverse effects, that is, gaps in preparedness, can be fixed sometime later through subsequent regulatory processes or adaptive management. (Dr. Robert Powell, HT V113, p. 11326)

The World Wildlife Fund further stated that:

> real programs on the ground simply do not live up to the abundance of rhetoric about adaptive management. (J-WWF-00144)

The Alternatives North Coalition stated its concerns regarding thresholds and adaptive management:

> I think one of the biggest problems here is the notion of adaptive management as the feedback loop both on the ecological environmental side and the socio-economic side. And in the absence of being able to identify clear thresholds and triggers for feedback, it's not clear that adaptive management is going to work. (Kevin O'Reilly, HT V92, p. 9216)

Several participants expressed the view that the Proponents' approach placed a heavy reliance on their proposed monitoring programs to determine the accuracy of impact predictions and the effectiveness of mitigation, when the monitoring programs themselves were ill-defined, highly conceptual and process-driven. These participants suggested that the result was to effectively defer the uncertainties associated with impact mitigation, management and monitoring to be addressed through adaptive management. The meaning and application of adaptive management, in turn, emerged as an area of disagreement as well.

The Panel understands adaptive management to be, essentially, management in the face of uncertainty. Adaptive management is meant to address the unavoidable limitations of impact assessment and mitigation/enhancement design, and to integrate means of responding to change and surprise. It is not an acceptance of trial and error or react and repair approaches to environmental responsibility. Ideally it is anticipatory and seeks to identify problems as they emerge based on well-grounded hypotheses and careful observation. Adaptive management complements best practice impact prediction, mitigation and enhancement, recognizing that avoidance of damage is typically cheaper than retroactive correction, that negative impacts may not be correctable and that lost opportunities may never be recovered. Also, effective adaptive management is not a consideration to be left to the project implementation stage. It requires considerable pre-approval preparation and is therefore necessarily a subject for attention in the Panel's review.

The Panel identifies four key elements of adaptive management:

- establishing appropriate plans, methods, thresholds, capacities and resources for impacts monitoring and adaptive response;
- using monitoring findings to inform judgments about the effectiveness of mitigation and enhancement strategies and to identify emerging problems and opportunities;
- determining what identified problems and opportunities deserve response through adjustment or repair during project implementation; and
- ensuring that appropriate responses are undertaken, that their impacts are monitored, and that needs for further response are identified and acted upon.

Uncertainties in impact assessment and project planning arise at many levels and from a diversity of sources. These include the complexity of technical and economic aspects of project selection and design, the interrelated biophysical and socio-economic systems that provide the immediate and larger context for project assessment, and the nature of future changes that may influence project implementation and the cumulative impacts to which it contributes.

In the case of the MGP, the unavoidable uncertainties and the likelihood of important surprises are especially significant. The Project as Filed involves a huge and diverse region with different ecologies and communities, and it will have impacts beyond the geographic extent of its physical footprint. Even greater complexities and uncertainties are introduced by the less well-defined characteristics of the Project at its full design and expansion capacity in combination with the larger set of associated, induced and other developments.

Adaptive management has been widely advocated as an appropriate, even necessary, response to such uncertainties in the implementation of plans and projects. Proposals for its use in the MGP have been submitted by the Proponents and many other participants in the hearings. The Panel notes, however, that the advocacy and critiques of adaptive management reflect different definitions of and approaches to adaptive management. Many of the questions about its effectiveness were dependent on how it was understood.

ADAPTIVE MANAGEMENT IN RESPONSE TO IMPACT PREDICTION UNCERTAINTIES

Some of the submissions and comments on adaptive management in the Panel hearings focused on impact prediction uncertainties and consequent needs for follow-up monitoring of Project implementation to check the accuracy of impact predictions, especially about mitigation initiatives, and to make adjustments in Project implementation as needed. This approach to adaptive management requires monitoring focused on particular predicted impacts, identification of discrepancies between predicted and actual impacts, and use of this information in determining needs for additional or adjusted mitigation efforts. For this, advocates underline the importance of specific initial predictions (against which actual impacts can be compared) and early determination of impact thresholds for determining when unexpected impact findings must trigger adaptive response. The underlying model here is that of a scientific test, though the monitoring might engage community as well as specialist monitors.

For this kind of adaptive management, the key preparatory steps include ensuring that impact predictions are specific enough to be testable (hypotheses), establishing clearly defined impact thresholds to clarify where and when adaptive responses will be necessary, and preparing contingency plans, resources and capacities for responsive action especially in areas where impact predictions may be uncertain and where predictive errors may have serious consequences.

ADAPTIVE MANAGEMENT IN RESPONSE TO ILL-DEFINED POSSIBILITIES AND SURPRISE

Some discussion of adaptive management focused on broader uncertainties and surprises arising from the complexity of ecological and socio-economic systems, changes in the regional context (especially due to the expansion capacity design inherent in the Project) and changes in the global context (e.g. due to climate change). The consequence is the possibility of unexpected impacts or impacts of unexpected significance or in unexpected locations. Because the associated concerns here are unanticipated, they may not be noticed in ordinary monitoring of predicted impacts and planned mitigation and enhancement initiatives. Broader and more comprehensive monitoring is needed to identify such emerging problems and opportunities. This monitoring could be concentrated on areas of pre-identified importance — valued ecosystem and community components — and informed by pre-identified impacts thresholds. But the significance of identified changes and the nature of the responses needed would be tested against broader objectives and progress towards desired ends. Delineating such ends could involve efforts to describe plausible and desirable future scenarios. The underlying model here is closer to iterative planning than to scientific experiment.

For adaptive management focused on broader uncertainties and surprise, the key preparatory steps centre on adaptive design and adaptive governance capacity. The Project, associated undertakings and induced development initiatives, and the planning and regulatory regime governing these activities would all need to be designed in ways that provide options for adaptive adjustment (e.g. design with an emphasis on flexibility, reversibility, fall-back options). But the desirable preparations also involve establishing and strengthening the capacity of all stakeholders — responsible government authorities and affected communities, as well as implementing companies and their contractors — to identify unexpected changes, to collaborate in analysis of their significance and to determine appropriate responses.

The Panel accepts that appropriate adaptive management preparations and plans for the MGP must be capable of addressing both of these forms of adaptive management — one focusing on predicted impacts and the other focusing on broader uncertainties — and the methodologies suitable to them. This means that adaptive management cannot be a consideration only for the Project as Filed or expanded, and it cannot be a responsibility only for the Proponents. Inevitably, the major concerns in this case are the cumulative impacts, positive and negative. These involve, in various ways, all of the participants in the review, most notably, the Proponents, the territorial and federal governments, Aboriginal authorities and organizations, and wildlife management bodies and regulators.

These matters are discussed further in Chapter 18, "Monitoring, Follow-up and Management Plans."

The Panel notes that the definition of "impact on the environment" in the Panel's Mandate includes not just the impact the Project could have on the environment but also "any change to the project that may be caused by the environment." The Proponents' prediction of changes the environment might cause on the Project as well as their proposed measures to avoid or mitigate such changes are addressed in Chapter 6, "Project Design, Construction and Operations."

5.4.5 CUMULATIVE IMPACT ASSESSMENT

Two central concerns raised by participants during the Panel hearings were the temporal and spatial scope of the Proponents' cumulative impact assessment (especially with respect to future developments that may be induced by the Project) and the application of cumulative impacts significance criteria.

In their cumulative impact assessment, the Proponents focused on identifying Project-specific cumulative impacts. This approach examined how specific types of Project impacts could combine spatially and temporally with similar impacts caused by other projects to create a cumulative effect (e.g. cumulative impacts on direct mortality, cumulative impacts on habitat). The analysis was conducted and reported at the level of direct Project effects on valued ecosystem components; estimates of such direct cumulative effects were not integrated into an overall assessment of valued component sustainability.

The Proponents considered the impacts of possible future expansion of the Project. Their expansion case considered the likely effects of increasing the throughput of gas by adding more compressor stations and other gas sources. They stated that:

> Future gas projects in the Mackenzie Delta region that might be induced by the project are also included in the cumulative effects assessment. A gas project is considered induced if its development is contingent on the development of the Mackenzie Gas Project. **A project is included in the cumulative effects assessment if a precedent agreement exists for that project to ship gas on Mackenzie Gas Project pipelines.** [emphasis added] (EIS, V1, Section 2, p. 35)

This qualifier, emphasized above, is important. The Proponents identified only the following developments as reasonably foreseeable in preparing their cumulative impacts assessment:

- the Devon Canada Corporation's Beaufort Sea exploration drilling program;
- the Deh Cho Corporation Mackenzie River bridge at Fort Providence;
- the De Beers Snap Lake diamond mine; and
- the GNWT Mackenzie River winter bridges.

In response to a Panel request, the Proponents described a future scenario of induced development which they considered hypothetical. The Proponents concluded that including the induced development in the cumulative impact assessment would not result in a Class I significance designation (i.e. potentially threatened sustainability of a valued component) for any of the cumulative effects assessed.

The Proponents stated that the list of reasonably foreseeable projects was complete and appropriate at the time. They stated that an assessment of hypothetical land uses had been performed that included the seismic and drilling activity associated with potential future exploration activity. They also noted that a conservative precautionary approach was used in conducting the assessment of the potential impacts of reasonably foreseeable projects. The Proponents therefore disagreed with statements by INAC and Environment Canada that the predicted cumulative effects had been underestimated in the assessment.

Many participants were of the view that potential cumulative effects of the MGP are of great concern and that the cumulative impact assessment done by the Proponents was insufficient, The SCC argued that by not including potential future induced development in their analysis, the Proponents had failed to meet the EIS Terms of Reference provisions, which required that they employ best practices.

Participants advocated that the Panel should recommend that a scenario-based cumulative impact assessment be done to gain insight into the implications for impacts of future induced development on the sustainability of valued components. This issue is addressed in Chapter 18, "Monitoring, Follow-up and Management Plans."

Environment Canada asserted that the Proponents had not used best practices in the cumulative impact assessment. The view of the department was that there were some likely projects that were not addressed in the cumulative impact assessment and should have been, and that the cumulative impact assessment analysis did not address all valued components that should have been included, specifically the Kendall Island Bird Sanctuary.

The Panel notes that the Proponents' focus on Project-specific cumulative effects resulted in a narrow scoping in regard to the spatial extent of the analysis and the identification of reasonably foreseeable future developments. The spatial extent of the cumulative impact assessment is the same as that employed for the EIS. An approach that focused on the conditions of valued components and the impact of the Project on those conditions would have resulted in spatial boundaries broader than those considered by the Proponents. The Proponents' criteria for identifying "reasonably foreseeable" developments likewise served to limit the scope of its cumulative impact assessment.

The Panel accepts that the Proponents' approach to considering induced developments in the cumulative impact assessment was consistent with the 1994 *Reference Guide for the Canadian Environmental Assessment Act — Addressing Cumulative Environmental Effects*, which states that in most cases induced development will not be considered as part of a cumulative impact assessment.

However, the Panel also notes that other, more recent guidance advocates the consideration of induced developments in a cumulative impact assessment, specifically the 1999 *Operational Policy Statement — Addressing Cumulative Environmental Effects under the Canadian Environmental Assessment Act*, the 1999 *Cumulative Effects Assessment Practitioners Guide*, and the guidance prepared for assessments conducted under the requirements of the *Alberta Environmental Protection and Enhancement Act* and that for the *Mackenzie Valley Resource Management Act* (MVRMA).

The 2004 *Environmental Impact Assessment Guidelines* issued by the MVEIRB for preparation of environmental impact assessments under the MVRMA indicates that "[i]dentifying reasonably foreseeable future developments involves a broad prediction for which less detail is expected than when identifying present or past human activities."

The 2004 Guidelines direct Proponents to include as reasonably foreseeable "other developments that have not been formally proposed but can be reasonably foreseen" and, in discussing an example of a proposed pipeline through a previously inaccessible area with little existing development, asserts that:

> if looking at similar cases indicated that a certain type and intensity of induced development routinely followed, then these types of induced developments should be considered reasonably foreseeable for the proposed development, even though no applications for them have been submitted. (MVEIRB EIA Guidelines, March 2004, pp. 81–82)

The EIS Terms of Reference indicate that "a degree of certainty" about a future project or activity is needed for it to be considered in the MGP cumulative impact assessment (EIS Terms of Reference, p. 62) and also that the environmental assessment, to the extent possible, "use current, accepted methods of practice in the Northwest Territories and Alberta or relevant to the Project area." (EIS Terms of Reference, p. 40)

In the Panel's view, the Proponents' focus on Project-specific cumulative effects unduly narrows the spatial and temporal scope of the assessment. This approach serves to justify the Proponents' view that future developments to support the Expansion Capacity Scenario are a "hypothetical land use." The Panel has adopted the more recent (1999) CEA Act guidance and the (2004) MVEIRB guidance in reviewing the cumulative impacts of the MGP. On this basis, and for the reasons cited in Chapter 3, "Potential Future Developments," the Expansion Capacity Scenario described in that chapter is considered to include a range of reasonably foreseeable developments and the Panel has approached the review of the Project's cumulative impacts resulting from future induced developments with this in mind.

To summarize, and as elaborated in Chapter 3, "Potential Future Developments," the Panel has approached its overall review of the Project's cumulative impacts assessment according to what it refers throughout the Report as:

- the Project as Filed;
- the Expansion Capacity Scenario (considered by the Panel to be inclusive of a range of reasonably foreseeable developments induced by the Project); and
- Other Future Scenarios (considered by the Panel to include future hypothetical developments in addition to those induced by the Project).

The Proponents used the same criteria to determine the significance of cumulative socio-economic impacts as they did for Project-specific impacts. However, the Proponents used different criteria to determine the significance of cumulative biophysical impacts than the ones they used to determine Project-specific biophysical impacts. In determining the significance of cumulative biophysical impacts, the Proponents used the following classification system:

> Class I effects represent those that are of most concern. In this class, the predicted trend in the value component could threaten its sustainability in the regional study area and should be considered a management concern. Research, monitoring and recovery initiatives should be considered under an integrated resource management framework. A Class I effect would be considered to be significant. …
>
> Class II effects are those where the predicted trend, in the valued component, will likely result in its decline to lower than baseline but stable levels or quality in the regional study area. Regional management actions, such as research, monitoring and recovery strategies might be required. …
>
> Class III effects are considered to be the least concern and would result in no change or could decline in the regional study area during the life of the Mackenzie Gas Project but should recover to baseline after decommissioning and abandonment. No immediate management initiatives other than adherence to responsible industrial practices are required. (Kerr, HT V102, pp. 10098–99)

The EIS states that these three classes are adopted from the guidance provided by MVEIRB, and the class designations were based on professional judgment.

The Proponents determined that none of the cumulative impacts would be of Class I significance (the only class that leads to a conclusion of significant effect). The Panel does not agree with this judgment and acknowledges the concerns that a number of participants expressed about it.

The Panel notes that, although the significance classification employed by the Proponents is based on the MVEIRB guidance, there is a critical difference. The significance classes recommended by the MVEIRB guidance specify levels of population decline that would be associated with each class (Class III: less than 1%, Class II: 1% to 10%, Class I: greater than 10%). The significance classes employed by the Proponents do not specify levels and are focused principally on habitat loss and not on population status and levels.

Additional discussion and recommendations on topic-specific cumulative impacts can be found in the relevant chapters of this Report. The implications and deficiencies of the Proponents' approach to cumulative impact assessment and Panel recommendations to address them are dealt with in Chapter 18, "Monitoring, Follow-up and Management Plans."

5.4.6 SIGNIFICANCE OF PROJECT IMPACTS

The concept of "significance" is central to the Mandate of the Panel. The Preamble to the JRPA recites that the Parties to the JRPA "agree that development should occur in a manner that protects the environment from **significant** adverse environmental impacts unless justified…" [emphasis added] Section 2 of the Schedule to the JRPA, setting out the Panel's Mandate, requires that the Panel's review "have regard to the protection of the environment from the **significant** adverse impacts of proposed developments…" [emphasis added] Section 4.8 requires that the Panel's Report include "a rationale, conclusions and recommendations regarding the nature and **significance** of impacts on the environment…" [emphasis added] Finally, the list of factors to be considered by the Panel includes the "significance" of impacts of the Project.

Notwithstanding the fundamental role of "significance" that follows from these provisions, neither the JRPA nor the relevant legislative framework explicitly defines the term or provides specific criteria to be applied in making individual determinations of significance. Nor is there a generally accepted meaning of the term that is helpful in coming to a finding on the significance of any specific impact.

Dr. Chris Burn, appearing before the Panel on behalf of INAC, stated:

> environmental significance is actually a question of what humans believe is environmentally significant. In other words, it's our determination of what is significant.
>
> What is environmental significance? And I think that's the question that you, as a panel, have been asked to determine. We've told you what can happen. And I think really it's the Panel's charge to determine if the things that we have identified for you are things that you can, if you like, live with or whether the risk that you've identified in association with our testimony is a risk that you [the Panel] believe requires further mitigation. (HT V34, p. 3065)

This view is helpful in emphasizing that significance is ultimately a matter of human judgment, to be made in this case by the collective judgment of the members of the Panel. However, it begs the question of **how** the Panel should go about that task and the approach it should adopt in reaching its conclusions on the significance of the impacts of the Project.

The Proponents set out four steps for systematically determining the likelihood of significant adverse environmental effects:

> ONE: Is there an "effect" in the environment that is caused by the Project? (an effect must be a change in the environment caused by the Project as defined in the TOR). If the answer to that question is "yes," proceed to Step Two; if the answer is "no," no further consideration is required.
>
> TWO: Is the effect "adverse"? If the answer is "yes," proceed to Step Three. If the answer is "no," the potential beneficial effects can be considered in respect of their overall contribution to sustainability.
>
> THREE: Is the effect, after considering all proposed mitigation measures, "significant"? If the answer is "yes" proceed to Step Four; if the answer is "no," then the effect is not significant and further analysis may only be required in the context of cumulative effects.
>
> FOUR: Is the significant effect "likely" to occur? This step requires the Panel to consider whether the predicted effect, based on the evidence before it, is likely to occur. It is important to remember that mitigation and adaptive management measures are important considerations in that they may render a potentially significant impact "not likely."
>
> In order for there to be a "likely significant adverse environmental effect" the answers to all four parts of the Four Step Test must be "yes." (J-IORVL-01050, pp. 53–54)

The characteristics of the residual effects of the Project (Step Three) were described in terms of the effect's attributes: direction, magnitude, geographic extent and duration. The Proponents defined these generally as four basic questions:

> - Is the effect good or bad? This is the direction of an effect.
> - How intense is the effect? This is the magnitude of an effect.
> - How large an area will be affected? How far will the effect reach? This is the geographic extent of an effect.
> - How long will the effect last? This is the duration of an effect. (EIS, V1, p. 26)

The Proponents considered a biophysical effect significant if the effect would be either:

> - moderate or high magnitude and extend into the far future, i.e., more than 30 years after project decommissioning; [or]
> - high magnitude and occur outside the LSA at any time. (EIS, V1, p. 31)

The Proponents considered a socio-economic effect significant if the effect would be either:

> - high magnitude, short term, and regional, beyond regional or national in extent;
> - high magnitude, long term and any geographic extent; or
> - moderate magnitude, long term and beyond regional or national in extent. (EIS, V1, p. 31)

The Proponents stated that no numerical guidelines were established for socio-economic valued components to define low, medium or high magnitude of impact. The Proponents used the following qualitative measures:

- High magnitude is a large change from existing conditions;
- Medium magnitude is a noticeable change from existing conditions; and
- Low magnitude is within normal variation.

The Proponents repeatedly stated in submissions and in hearings that they wanted to ground significance determination in the context of sustainability as an approach appropriate to the MGP. In describing their approach to significance the Proponents stated:

> The final step in describing the project effects was to make a determination of significance. As discussed earlier in the presentation, the basis for determining significance was sustainability. To help link the attributes of an effect, meaning its magnitude, geographic extent, and duration, to its significance we used decision trees that combine these attributes. The decision trees apply to both positive and adverse effects and can provide an outcome related to both significant positive effects and significant adverse effects. (Beswick, HT V6, p. 498)

The Proponents also stated that in the determination of significance, it is implicit that mitigation and management measures will be followed and monitoring programs will be conducted to test their predictions and follow the compliance required by regulators.

During the hearings and through Information Requests made to the Proponents there were numerous exchanges between participants (including DFO, INAC and GNWT) and the Proponents regarding the clarification of terms and process for determination of significance. However, no alternative methods for determining significance were presented or proposed.

A number of participants expressed a lack of confidence in the Proponents' significance judgments and the underlying assumptions that proposed mitigation measures as applied to the Project Review Area would be effective based on industry expertise and practices. For instance, Eugene Yaremko appearing on behalf of INAC stated:

> I think the position of the proponent is to say that with good engineering practices and with good construction practices, you will have a project that minimizes construction impacts and minimizes the long-term maintenance impacts of the project. And basically what this says is that they will — or you should trust them to do good engineering and good construction and there shouldn't be a problem in the long run in terms of environmental impacts. (HT V33, p. 3007)

Participants expressed concern that many proposed mitigation measures were highly conceptual and of uncertain effectiveness in northern conditions, particularly with regard to conditions of continuous and discontinuous permafrost. They expressed concerns that the Proponents' assumptions about potential impacts were not conservative enough and that there was an overreliance on contingency and emergency response plans and ongoing Project-impacts monitoring that was vague and uncertain, largely because these plans were either extremely conceptual or to be developed in the future through generally described planning processes. Others expressed concern that the Proponents' judgments regarding the significance of cumulative impacts relied heavily on the uncertain assumption that government measures for managing and monitoring cumulative impacts at a regional scale would be in place and effective.

Throughout the course of the community hearings, participants questioned and disputed the significance judgments made by the Proponents for specific impacts and valued components, as well as general concerns about unassessed or uncertain future cumulative impacts. Quite apart from the technical explanations provided by the Proponents, many participants indicated that there was something fundamentally wrong that a project of the scope and magnitude of the MGP could have no significant adverse impacts. Illustrative of these general concerns are the following comments:

> To my mind, it is the height of ignorance when a company submits an environmental assessment for a major project such as a road, a mine or a pipeline and says that no significant impact is expected. Every project has significant impacts even if sometimes the results do not show until later. Caribou, polar bears, bull trout, First Nations communities, forests, air, water, you name it; there is a news story. I've got a stack of them here. And also, stacks of scientific studies on the negative impacts that industrial development is having. Every project, as I said also, adds up to a sum that is greater than its parts. (Karley Ziegler, HT V69, p. 7040)

> On your presentation you made earlier, you said that there won't be no significant effects in the Colville Lake area because of the distance from the pipeline. I'm just wondering: How do you figure that since once you build a pipeline, you open the door to all the oil and gas companies that have interest in our land to increase exploration and then develop and then build a pipeline to tie into the existing pipeline? That's going to create a lot of effects on here. To say that there's going to be no effects in the Colville Lake region is not true. It's not only going to affect the Colville Lake region, it's going to affect the whole Sahtu as a whole. (Alvin Orlias, HT V21, p. 1976)

These and other issue-specific views are discussed at length in the relevant chapters of this Report.

To assist in developing its approach to determining significance, the Panel commissioned a report from a specialist adviser, Dr. David Lawrence, on *Significance Criteria and Determination in Sustainability-Based Environmental Impact Assessment* (the "Lawrence Report"). This report was placed on the Panel's Public Registry and was commented upon by the Proponents and Interveners at the Panel's Technical Hearing on Methodology soon after the commencement of the public hearings. Dr. Lawrence responded orally to questions from the Proponents, Interveners and the Panel.

The Lawrence Report identified certain inherent properties associated with impact significance judgments in environmental impact assessment practice. Significance determinations:

- are subjective, normative and value-dependent;
- are imprecise;
- vary among environmental impact assessment activities;
- vary for different types of effects and environments;
- are context-dependent;
- are political and often controversial;
- are not the same as magnitude of change;
- involve a process;
- are collective; and
- are complex and difficult.

The report also indicated that significance determinations are altered when sustainability is a primary consideration in environmental assessments:

- alternatives are screened for sustainability and compared for their relative contribution to sustainability;
- the focus shifts from minimizing damage (i.e. reducing the negative) to maximizing long-term gains and opportunities for multiple parties;
- time horizons are extended to consider significance for future generations;
- more attention is devoted to cumulative impacts (e.g. lasting, net environmental and human benefits), and to systems-level, collective impact significance (e.g. net contribution of social, economic, physical and ecological changes to sustainability);
- an impact from a proposed action is considered negatively significant if it inhibits sustainability; and
- sustainability can be a significance criterion (i.e. a factor for evaluating impact significance).

The Lawrence Report identified and described three approaches to and methods for determining impact significance: the technical approach, the collaborative approach and the reasoned argumentation approach. In his oral evidence before the Panel, Dr. Lawrence expressed his opinion that the Panel could apply the reasoned argumentation approach, building upon the technical approaches and the collaborative approaches through the EIS consultation and Panel hearing processes.

Neither the Proponents nor any other Party explicitly disagreed with the views expressed in the Lawrence Report, nor did any Party propose any different methodology that should be adopted by the Panel in making its significance determinations.

Panel Views

Section 4.8 of the Panel Mandate (JRPA) requires the Panel to prepare a report "including…a rationale, conclusions and recommendations regarding the nature and significance of impacts on the environment." The Report is that of the Panel and therefore it is the Panel's own conclusions on significance and its rationale on which it must report.

The JRPA does not provide explicit guidance on any particular methodology that the Panel should apply in reaching its conclusions. In the Panel's view, however, the process itself that is set in motion by the JRPA constitutes some guidance. That process provides for an EIS to be prepared by the Proponents and submitted to the Panel. The Panel is to undertake a technical analysis of the EIS. After determining that there is sufficient information to proceed, the Panel is to hold public hearings, including community hearings, "in a manner that ensures a thorough examination of matters relevant to its mandate." The hearings are to "afford an opportunity for the communities and people in the project area to present their views about the potential impacts of the Project on the environment."

The JRPA thus prescribes the means by which the Panel is to assemble the information and views on which it is to then come to its significance determinations — such determinations are to be based on the information and views as gathered and examined through the Panel process. In addition, the Panel members contribute their individual expertise, values and experience to the review of that information and assessment of the views they have heard.

The Panel has found further guidance in the requirement that its Report include a "rationale" for its conclusions on significance. This implicitly acknowledges that the Panel's conclusions will be based on judgment, rather than on a technical or mechanistic application of "rules" or the development of a consensus through collaboration. Judgment, in order to avoid arbitrariness, must be disciplined and supported by reasons — hence the requirement that the Panel not just report on its conclusions on significance but that it also provide a rationale for those conclusions.

The Panel has concluded that, for the purpose of fulfilling its Mandate, "significance" means the collective judgment of the seven members of the Panel, based fundamentally on the information and views provided to it through the process mandated by the JRPA, supported by a rationale for each significance determination. The Panel's individual significance determinations are its answers — after having completed the review process, evaluated the information collected through that process and considered the views that it heard, all shaped by the expertise and values of the Panel's individual members — to the question of whether society, as represented by the Panel, can or cannot accept, or "live with," the impacts of the Project. Essentially, both the meaning of "significance" and the method by which the Panel is to make its significance determinations are defined by the review process itself, as laid out in the JRPA and in the context of the relevant legislation. "Significance" is a convenient label to describe key conclusions that are reached by the Panel as an outcome of the review process.

This view is consistent with what the Panel understands by Dr. Lawrence's "reasoned argumentation approach" and, it believes, with the Panel's role as described by Dr. Burn. It is not a technical approach, although it takes into account approaches that might be described as technical. Nor is it a collaborative approach as such, although it does take into account, and weighs, the views of all participants and interests reflected throughout the hearing process. At the end of the day, it is the Panel's own collective judgment that prevails and not whether collaboration has produced a widespread view or even a consensus among others, although the existence of a consensus on a particular issue might be relevant in assisting the Panel in coming to its own conclusion. There may well be impacts on regions or communities that would be significant to those regions or communities but which the Panel, in its collective judgment, has concluded are not significant in the context of its overall

Mandate. There may well be impacts on individuals that, from an individual perspective, would be significant but which, again, the Panel might conclude would not be significant in the broader context.

The reasoned argumentation approach to significance determinations does not provide a single formula to be applied to each impact. Rather, each determination must be made on its own merits, supported by reasons that are articulated and clear, and grounded in the record of the Panel's review process. No single list of criteria applies. At the same time, the Panel's judgements must not be arbitrary, which means that they should generally be consistent. It is, however, inherent to the process of making judgments that not all outcomes will be seen by others as being consistent. The essential requirement is that others be able to see and understand how the Panel arrived at its conclusions, whether they agree with those conclusions or not.

The Lawrence Report identified a number of inherent properties associated with significance judgments in the context of environmental impact assessment and sustainability. The Panel does not disagree with any of these inherent properties but would note that, in the context of the task it must perform, it is particularly important to recognize that significance determinations:

- vary for different types of effects and environments;
- are context-dependent;
- are collective;
- are not the same as magnitude of change;
- devote attention to cumulative impacts and net contributions of social, economic, physical and ecological changes; and
- consider measures for minimizing damage and those, in particular, which maximize long-term gains and opportunities.

With respect to the Proponents' four elements of significance determination (direction, magnitude, geographic extent and duration of residual effects), the Panel has considered all of these in its own determinations, along with the additional attribute of reversibility.

5.4.7 THE PANEL'S SUSTAINABILITY ASSESSMENT FRAMEWORK

The Panel understands the principle of sustainability to be a fundamental basis for the assessment and review of the MGP. The grounds for this approach are found in section 2 of the Schedule to the JRPA, the "Scope of the Environmental Impact Review," and in Annex 2 to the Schedule, "Factors to be Considered During Review." They are also found in section 5.1 of the EIS Terms of Reference, which references the oft-quoted World Commission on Environment and Development's definition of sustainable development, which was subsequently included in the CEA Act as "development that meets the needs of the present, without compromising the ability of future generations to meet their own needs." This definition is consistent with the meaning of section 2 of the JRPA, although the terms "sustainable development" or "sustainability" are not used there. Sustainable development is considered in the Panel's Report to be development that does not compromise sustainability.

The EIS Terms of Reference expand on the direction for treatment of sustainability in several important ways. First, the EIS Terms of Reference suggest that the guiding goals and principles of the MVRMA and the Inuvialuit Final Agreement are consistent with the fundamentals of sustainable development. This linkage is an important one: it implies that in considering and meeting the conditions of sustainable development in the review process, progress towards the goals of the land claim agreements can also be accomplished.

Second, they state that "reconciling economic development, social equity and environmental quality is at the core of sustainable development." (EIS Terms of Reference, p. 8) This suggests to the Panel that the treatment of trade-offs between these fundamental features of sustainable development requires special attention, and that what is desirable are project design, alternatives and outcomes that deliver mutually reinforcing benefits and multiple lasting gains. The EIS Terms of Reference expand on these core features and require the review to consider the following:

- the potential impacts of the Project in relation to the social, economic, cultural and environmental goals and values of affected communities, the North and the rest of Canada;
- the capacity of natural systems to maintain their structure and functions and to support indigenous biological diversity and productivity;
- the capacity of the social and economic systems of the human environment to achieve, maintain or enhance conditions of self-reliance and diversity;
- the capacity of human environments, including local and regional institutions, to respond to and manage externally induced change;
- the attainment and distribution of lasting and equitable social and economic benefits from projects;
- the rights of future generations to the sustainable use of renewable resources; and
- protection and conservation of wildlife and the environment for present and future generations.

The Panel has assumed that the principle of achieving mutually reinforcing benefits and multiple lasting gains applies to all of these considerations taken together and integrated as attributes of sustainable development.

Third, the EIS Terms of Reference suggest a basis for the evaluation of a project's contribution to sustainability:

- the extent to which a project makes a positive overall contribution towards environmental, social, cultural and economic sustainability;
- how the planning and design of a project have considered how it affects achieving sustainable development;
- how monitoring, management and reporting systems have incorporated indicators of sustainability; and
- the views of stakeholders and participants in the environmental impact review process.

The first of these broad criteria, "the extent to which a project makes a positive overall contribution," is particularly important because it has the effect of applying a higher standard or "test" to the evaluation of project outcomes in the environmental impact review process than was typically the case in environmental assessment prior to the application of the principle of sustainability. The implied consequence is that in addition to avoiding or minimizing adverse impacts, the larger purpose is to evaluate the positive net contribution of a project and seek the reasons for confidence that the project, with whatever conditions that are recommended, at minimum, will make a positive overall contribution to sustainability, that is, a lasting positive contribution taking into account all of the key requirements for maintaining and enhancing human and ecological well-being.

The Panel's understanding of its Mandate with regard to sustainability informed its approach to adopting a sustainability framework for assessing the Project's contribution to sustainability, which is described below and in Chapter 19, "Sustainability and Net Contribution."

The general guidance provided by the EIS Terms of Reference with respect to the application of the principle of sustainability is important because it applies not just to the Proponents' EIS, but also to expectations for other participants including relevant government authorities, and to the Panel's conduct of the environmental impact review process. In its initial review of the EIS, the Panel first identified the importance that it attached to this guidance in the assessment of Project impacts in the EIS, and requested that the Proponents address these matters explicitly. The Proponents responded to this request in their Additional Information Report.

Subsequently, in the Panel's Statement of Determination on Sufficiency, the Panel announced that throughout the public hearings the Panel would evaluate the specific and overall sustainability impacts of the proposed Project and whether the proposed Project would bring lasting net gains and whether the trade-offs made to ensure these gains were acceptable in the circumstances. The Panel specifically referenced the key considerations for assessing potential contribution to sustainability listed in the EIS Terms of Reference.

The Panel's Hearing Guidance document provided a list of select questions and issues it expected the hearings to consider with respect to these matters. The Panel held an early session in the hearings to consider methodological issues including design and application of sustainability-based assessment criteria, and the Panel convened a hearing session near the end of its proceedings specifically to address the Project's overall contribution to sustainability.

Pursuant to the general guidance provided by the JRPA and the EIS Terms of Reference on the application of the principle of sustainability, the Panel commissioned a report from a specialist advisor, Dr. Robert Gibson, entitled *Sustainability-based Assessment Criteria and Associated Frameworks for Evaluation and Decisions: Theory, Practice and Implications for the Mackenzie Gas Project Review* (the "Gibson Report"). The Gibson Report described recent advances in approaches and practice of sustainability-based impact assessment. It introduced a suite of criteria, trade-off rules and procedures that could be used as a basic conceptual framework for assessing and evaluating Project impacts on sustainability. The report explained, clarified and expanded on the core conditions of sustainability and guidance outlined in the EIS Terms of Reference.

The Gibson Report recognized the need to specify the generic sustainability-based criteria for application to the particular case and context. No detailed specification was attempted, since the report was prepared before the hearings began and the nature of participants' concerns was only generally known. But the report was informed by available information from previous proposals and public discussion concerning the construction of pipelines in the Mackenzie Valley. Accordingly, the author identified the main evident considerations particular to the case and context, and integrated attention to these with the generic sustainability-based considerations to provide an initial framework for sustainability-based assessment in the MGP case. The report discussed:

- various approaches to conducting sustainability-based environmental impact assessments;
- broadly evident major sustainability issues for the MGP assessment;
- a generic framework or model for consideration in evaluating the MGP's contribution to sustainability, including a matrix of integrated evaluation criteria, which could be applied in the assessment and review of projects of this type and scale; and
- a set of "trade-off rules" to apply in weighing a project's positive and negative impacts in order to evaluate a project's overall contribution to sustainability, and to achieve mutually reinforcing gains.

No points of disagreement with respect to the Gibson Report's treatment of its subject matter were expressed by participants. Further, participants broadly agreed with the appropriateness of a sustainability-based process, although some differed on important specifics.

The Proponents stated that they embraced the principle of sustainability and that they used a sustainability framework in their assessment. The Proponents have referred particularly to:

- the MVEIRB's sustainable development goals; and
- the National Round Table on the Environment and the Economy's (NRTEE's) list of key sustainability indicators for progress towards sustainable Aboriginal communities, presented under five categories:
    - economic vitality;
    - environmental integrity;
    - social and cultural well-being;
    - equity; and
    - control over natural resources.

Moreover, the Proponents stated that they consider their views and assessment work to be at least broadly consistent with the approach set out in the Gibson Report. In particular they identified four key points of alignment:

> Number 1, basic principles: We agree with the basic principles of sustainability assessment that Dr. Gibson outlined. For example, the use of positive contribution to sustainability as a basic criterion for evaluations and decisions, giving integrated attention to core issues, focusing on identifying the best option and achieving mutually reinforced — achieving mutually reinforcing and lasting goals and avoiding lasting damage and explicitly addressing trade-offs.
>
> Point 2, sustainability assessment criteria: The Mackenzie Gas Project EIS is consistent with the basic sustainability criteria suggested by Dr. Gibson, tailoring them to the context of the project study area in the Northwest Territories and northern Alberta. Regarding socio-ecological system integrity, livelihood, sufficiency and opportunity and equity, we have paid particular attention to the key issues raised by the communities affected by our project and will continue to work with them to find common solutions.
>
> Point 3, sustainability rules: In particular, the Mackenzie Gas Project EIS focuses on seeking maximum net gains, avoiding significant adverse effects, protecting the future and using an open process.
>
> Point 4, bridging: We agree that bridging is one of the most important aspects of sustainability. The Mackenzie Gas Project is based on development of non-renewable resources; however, it can contribute positively to current sustainability goals and it can also build capacity for communities to create other opportunities for future generations. (Dr. Alan Kennedy, HT V8, pp. 671–72)

Nonetheless, over the course of the hearings, differences emerged in the interpretation and application of a number of ideas and methods discussed in the Gibson Report that are central to the evaluation of the Project's positive net contribution to sustainability. Concerns expressed by participants include the treatment of:

- Project alternatives and options, including how they should be defined, evaluated and compared;
- the temporal and spatial scope of the Project's assessment;
- the basic rules and priorities for dealing with trade-offs (where attaining one desired result seems likely to entail compromising or sacrificing another);
- particular factors and issues that are especially important in the MGP case and/or context and should be addressed in this assessment;
- the resiliency of communities and ecological systems;
- broader contributions, cumulative effects and implications of the Project and its associated and induced activities for the Mackenzie Valley region, the NWT, Canada and the world;
- the risk of "boom and bust" effects and the nature and potential adequacy of planned efforts of the Proponents and local, regional and national authorities to ensure this non-renewable resource Project serves as a bridge to more sustainable livelihoods;
- the grounds for confidence in impact prediction and significance judgments; and
- the grounds for confidence in commitments and anticipated requirements concerning Project implementation, monitoring and enforcement, adaptive management, and approaches to the review and management of future associated and/or induced activities.

Based on these differences, some participants did not accept the Proponents' conclusion that the Project would result in an overall positive contribution to sustainability. Specific differences of views are considered in other chapters of this Report.

Consistent with the EIS Terms of Reference and its intentions as stated, for example in the "Determination on Sufficiency" and its "Guidance for Hearings," the Panel has adopted and applied a sustainability-based assessment framework in its review. The Panel's approach to sustainability assessment recognizes that economic, social, ecological and cultural factors are deeply intertwined. The objective of the Panel's sustainability approach is the achievement of multiple, mutually reinforcing and lasting net gains in ways that avoid risks of significant adverse impacts, especially ones that undermine prospects for future generations. The approach also holds that any proposed trade-offs must be justified in the circumstances.

The Panel adapted the initial Gibson framework to the specifics of the Project and the receiving environment, as these emerged during the hearings.

The framework in the form of major issues tables is applied in Chapter 19, "Sustainability and Net Contribution," of this Report. Major issues are grouped under five categories:

- cumulative impacts on the biophysical environment;
- cumulative impacts on the human environment;
- equity impacts;
- legacy and bridging; and
- cumulative impacts management and preparedness.

The categories cover, but integrate, consideration of the usual economic, social, cultural and ecological "pillars" of sustainability, and emphasize attention to long- as well as short-term impacts. The issues addressed in each category are meant to capture the main broad concerns relevant to the MGP and its context.

The framework was designed and used chiefly to ensure comprehensive and integrated attention to all overall key issues and their interconnections. The framework also served to bring consistent attention to both positive and adverse impacts, enhancement and mitigation measures, remaining uncertainties and implications for net contributions and trade-offs. Recognizing the sustainability concerns inevitably raised by limited-time, non-renewable resource exploitation projects, the framework gives particular emphasis to matters of sustainable livelihoods, long-term socio-ecological system integrity, bridging and legacy impacts, uncertainties and precautionary needs.

In the Panel's review, the framework has informed the full suite of assessment deliberations including judgments about the significance of particular and cumulative impacts, the desirability of enhancement and mitigation options, the attractions and perils of future associated and induced development scenarios, the options for responding to information inadequacies, the comparative prospects for net lasting gains from various proposed and possible pipeline throughputs and associated developments, the acceptability of proposed or implicit trade-offs, and the potential adequacy of possible recommendations about approval conditions and actions. The framework described in Chapter 19, "Sustainability and Net Contribution," however, was designed particularly to provide an initial basis for comparative analysis of the cumulative impacts of the Project as Filed and of the potential cumulative impacts of possible developments under the Expansion Capacity Scenario as discussed in Chapter 3, "Potential Future Developments."

In applying this general framework, the Panel has recognized that sustainability priorities and specifics vary through the local, regional, national and global scales relevant to the Project. The Panel has also been aware that conditions, concerns and opportunities differ somewhat throughout the communities and lands potentially affected by the Project, and that contributions to sustainability may well also differ. Finally, the Panel has needed to go well beyond the broad categories and issues identified in the framework to address the many more specific considerations related to particular locations and particular aspects of the Project and Project scenarios. Throughout the review, however, the Panel has consistently focused on contribution to sustainability impacts. This focus has influenced its work in:

- identifying and evaluating potential impacts and their significance;
- considering options for enhancing positive impacts and mitigating or avoiding adverse ones;
- comparing options and alternatives at all levels (from responses to impacts to different project scenarios);
- evaluating possible trade-offs; and
- drafting and specifying recommendations.

The Panel's sustainability assessment framework was broader than the Proponents' for several reasons. First, the Proponents' application of sustainability-based criteria was focused mostly on significance judgments and on the Project as Filed (though at some points also assuming additional components and revenues to provide for benefits through the Aboriginal Pipeline Group's involvement). The EIS and other Proponents' submissions include little application of sustainability-based criteria to the implications of future scenarios, impacts beyond the life of the Project or trade-offs.

Second, the Panel's responsibility is a broader one. Unlike the Proponents, and other participants with particular focused interests or limited mandates, the Panel's Mandate requires it to consider, not only the Project as Filed, but also its surrounding context, implications for expansion and related future developments, and associated needs for capacities of and actions by government authorities and other bodies.

The Panel observes that the broad sets of indicators and goals the Proponents cited, based on principles of the NRTEE and the MVEIRB, are consistent with the Panel's approach. However, they differ from the Panel's more detailed and case-specific framework in that they give relatively little attention to the interrelations among the indicators and goals.

Some participants have expressed doubts about the consistency of the Proponents' application of their sustainability-based criteria even within their areas of most immediate concern, and have raised consequential doubts about the reliability of the Proponents' conclusions on certain matters. These are addressed on a chapter by chapter basis throughout the Report.

The Panel is satisfied that its sustainability assessment framework is consistent with the EIS Terms of Reference, suitable to the assessment of the MGP and broadly accepted by the participants to the assessment review. The framework outlined here informs the discussion of particular topics in the following chapters and the Panel's overall evaluation of the Project.

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Project Design, Construction and Operations

6.1 THE PROJECT AND THE ENVIRONMENT

The Mackenzie Gas Project would be the largest construction project to date in the Northwest Territories (NWT). It would be unprecedented in that it involves a buried non-ambient temperature gas pipeline that could thaw frozen ground and freeze unfrozen ground. All major projects must account for geohazards that may affect them, such as earthquakes and floods. However, the Project must also account for permafrost, which can both affect and be affected by a project of this nature. Adding to this dynamic environment is the prospect of accelerated climate change over the life of the Project, which could affect the Project not least by its impact on permafrost, terrain and vegetation. This chapter describes the potential impacts of the environment on the Project, as well as those of the Project on the environment.

The Proponents identified three key valued components with respect to terrain:

- ground stability;
- uncommon landforms (e.g. patterned ground); and
- soil quality.

The Proponents determined that the Project would have no significant impacts on these valued components.

The Panel did not focus on a determination of significance with respect to either the Proponents' valued components or the preservation of permafrost, which the Proponents did not select as a valued component. Instead, the focus of this chapter is to establish whether certain changes in terrain and hydrology would likely occur as a result of the Project. Each section of this chapter describes the findings with respect to specific Project activities and their possible impacts, such as thaw settlement, frost bulbs, slope failure, erosion, sedimentation, flooding or extraction-induced subsidence.

While the Panel notes that these changes might be significant from a system integrity perspective, it does not necessarily follow that they are of environmental significance. Instead, based on the findings in this chapter, the Panel considered whether these changes might have significant impacts on other valued components, such as fish, wildlife, bird habitat and populations, and their overall health and viability. These questions are considered in Chapter 9, "Fish and Marine Mammals," and Chapter 10, "Wildlife."

To the extent that changes to terrain identified in this chapter might have adverse environmental consequences, the Panel also considers whether the Proponents' design is sufficiently conservative in accounting for the uncertainties of constructing a project of this unprecedented nature in a northern environment. In the Panel's view, these circumstances demand a precautionary approach to Project design that emphasizes avoidance over mitigation.

The Panel is mindful that the Project is also being reviewed by the National Energy Board (NEB) and that, if the Project proceeds, it would be regulated by the NEB. The Panel therefore assumes that engineering matters relating primarily to system integrity would be addressed by the NEB. Although the Panel heard evidence and received recommendations relating to system integrity, the Panel does not provide an opinion on these recommendations unless they also addressed environmental impacts.

Most of the recommendations the Panel received related to the need for more baseline information, more detailed information on Project design and impacts mitigation, and on monitoring impacts on permafrost, terrain and hydrology. The Panel notes that the NEB released *Proposed Conditions for the Mackenzie Valley Pipeline and Mackenzie Gathering System* on February 5, 2007, and that some of those conditions address those recommendations. The Panel's recommendations with respect to Project design, construction and operations take the NEB's Proposed Conditions into account, which are described, for the most part, in Section 6.10.

The Panel held 13 days of hearings specifically devoted to this topic.

6.1.1 THE DISTINCTIVE NATURE OF THE PROJECT

The proposed Project is distinctive for several reasons. The first is its geographic extent. The Project would consist of three producing gas fields in the outer Mackenzie Delta connected to southern Canada by 1,386 km of pipeline right-of-way to the NWT–Alberta boundary, and an additional 66 km of right-of-way for the Northwest Alberta Facilities. These gathering and main line right-of-ways would traverse a great variety of arctic and subarctic terrain types and conditions, including hundreds of slopes and hundreds of watercourses ranging from the Mackenzie River to small streams.

Second, the Mackenzie Gathering System and the pipeline would traverse permafrost terrain. About one third of the pipeline length would be in continuous permafrost, and the remainder would be in discontinuous permafrost. The presence of permafrost is the single most important feature of the environmental setting for the Project. Over the Project Review Area, the distribution of permafrost ranges from continuous (over 90% of the ground is underlain by permafrost, and ground temperatures are generally cold) to isolated patches (less than 10% of the ground is underlain by permafrost).

Indian and Northern Affairs Canada (INAC) consultant Dr. Chris Burn noted that the practical significance of permafrost is the ice it contains, especially because the ice is near its melting point under the conditions that occur in the Project Review Area. Ground ice includes pore ice, segregated ice, massive ice near the surface and at considerable depths, and ice wedges. It is common in the Project Review Area for the near-surface permafrost (just below the active layer) to be very icy (ice-rich) so that, if the ground thaws, more water is released than can be held in the soil. The ice-rich zone is critical to the stability of terrain in the Project Review Area. This is the ground that subsides when the surface is disturbed by construction activity, as observed in many places along the Norman Wells Oil Pipeline. On hill slopes, melting of this ground commonly leads to landslides after forest fires because the water released upon thawing reduces the strength of the soil.

Third, the pipelines would involve operating temperatures below and above 0°C, with the potential for significant freezing (with associated frost heave and frost bulbs) and thawing (with associated thaw settlement and thaw weakening) along the routes.

For all these reasons, the Project poses distinctive engineering challenges to minimize adverse impacts on the environment during construction and operations. Dr. Burn submitted that the Project is unprecedented in North America as it would alter the condition of permafrost. Other participants also drew attention to the distinctive nature of the Project due to the presence of permafrost in the Project Review Area and the need to operate the pipeline in a non-ambient temperature mode.

Natural Resources Canada (NRCan) described the Project as unprecedented and noted that it "would be the first high pressure, large diameter, chilled buried gas pipeline in the discontinuous and continuous permafrost zones in North America." It further stated:

> There is little or no experience with many of the design, construction and operational aspects that will be used in the MGP. There are no widely accepted design standards that provide guidance for pipeline design to accommodate northern environmental loads such as frost heave and thaw settlement. (J-NRCAN-00090, p. 137)

6.1.2 PREVIOUS ARCTIC OIL AND GAS PROJECTS

Two pipelines have been built and operated in the Mackenzie region:

- the Norman Wells oil pipeline, from Norman Wells, NWT, to Zama, Alberta (Norman Wells Oil Pipeline); and
- the Ikhil gas pipeline, north of Inuvik.

Both are ambient temperature pipelines designed to operate at close to the local ground temperature and to not disturb the condition of the permafrost. In contrast to the Norman Wells Oil Pipeline, which was generally designed to operate at ambient temperatures with the surrounding ground, the Proponents indicated that the Project would have considerable thermal influence on its surroundings. Dr. Burn noted that, immediately downstream from a compressor station, the gas in the pipeline would be relatively warm and reach temperatures of up to about 10°C for part of the year and, on average, above 0°C year-round. Upstream from compressor stations, the gas would be relatively cold at several degrees below 0°C. Therefore, by its design, the pipe would modify permafrost by thawing it in some places and freezing unfrozen ground in others.

Dr. Burn was of the view that there is limited experience in northern pipeline engineering upon which the Proponents could draw. There are pipelines in Alaska that offer useful operating experience, but none of these traverse extensive sections of relatively warm permafrost in frost-susceptible soil, such as that found in the Niglintgak and Taglu areas of the Mackenzie Delta, and in the lacustrine and aeolian deposits of the Mackenzie Valley. Dr. Burn noted that the Ikhil gas pipeline is small and short in comparison with the proposed Mackenzie Valley Pipeline, and that the pipe is elevated at Douglas Creek, where the only significant slopes and stream crossing on the route are located. The Proponents propose to bury Project pipelines (with possible minor exceptions) throughout their entire length.

The Panel also heard from the Sierra Club of Canada's consultant Dr. Antoni Lewkowicz about the operating experience of several high-pressure gas pipelines in Siberian Russia built in the 1970s, where both frost heave and thaw settlement occurred. According to Dr. Lewkowicz, while there are some similarities between the Russian experience and that of the proposed Project, there are also important differences. Dr. Lewkowicz noted: "Rapid construction of many of the pipelines in Siberia has been regarded as shoddy, and there has been insufficient funding available for proper maintenance. In addition environmental regulations have been poorly enforced, leading, for example, to extensive terrain disturbance." (J-SCC-00055, p. 8) Dr. Lewkowicz submitted that the Siberian experience shows that construction and operation of gas pipelines on permafrost remains highly complex and that mistakes have been made, even in the recent past.

INAC noted that 20 years of experience has been obtained in operating the ambient-temperature Norman Wells Oil Pipeline in discontinuous permafrost. The pipeline was designed to have minimal thermal impact on the environment and, therefore, to minimize the impacts to permafrost and terrain stability. Nevertheless, INAC noted that the Norman Wells Oil Pipeline required remedial intervention in a number of places. Additional details relating to the Norman Wells Oil Pipeline are discussed throughout this chapter as appropriate.

The Proponents pointed out that, since the Norman Wells Oil Pipeline was designed, advances have been made in industry pipeline codes, pipe-soil geothermal analysis tools, steel making, welding, non-destructive examination technologies and in-line inspection tools. In addition, there has been worldwide experience with other strain-based designed pipelines, such as high-pressure, high-temperature offshore pipelines and pipelines in seismically active areas. The Proponents noted that they had taken advantage of this information in designing the Project's pipelines in accordance with current industry practice for strain-based design.

Further, the Proponents submitted that the Project would also benefit from other advances in pipeline technology that have been made since the construction of the Norman Wells Oil Pipeline. For example, horizontal directional drilling (HDD), which was not used on the Norman Wells Oil Pipeline, is planned for several watercourse crossings, and the Proponents submitted that this could reduce the disturbance to the stream bed and approach slopes.

6.1.3 TERRAIN AND PERMAFROST CONDITIONS IN THE PROJECT REVIEW AREA

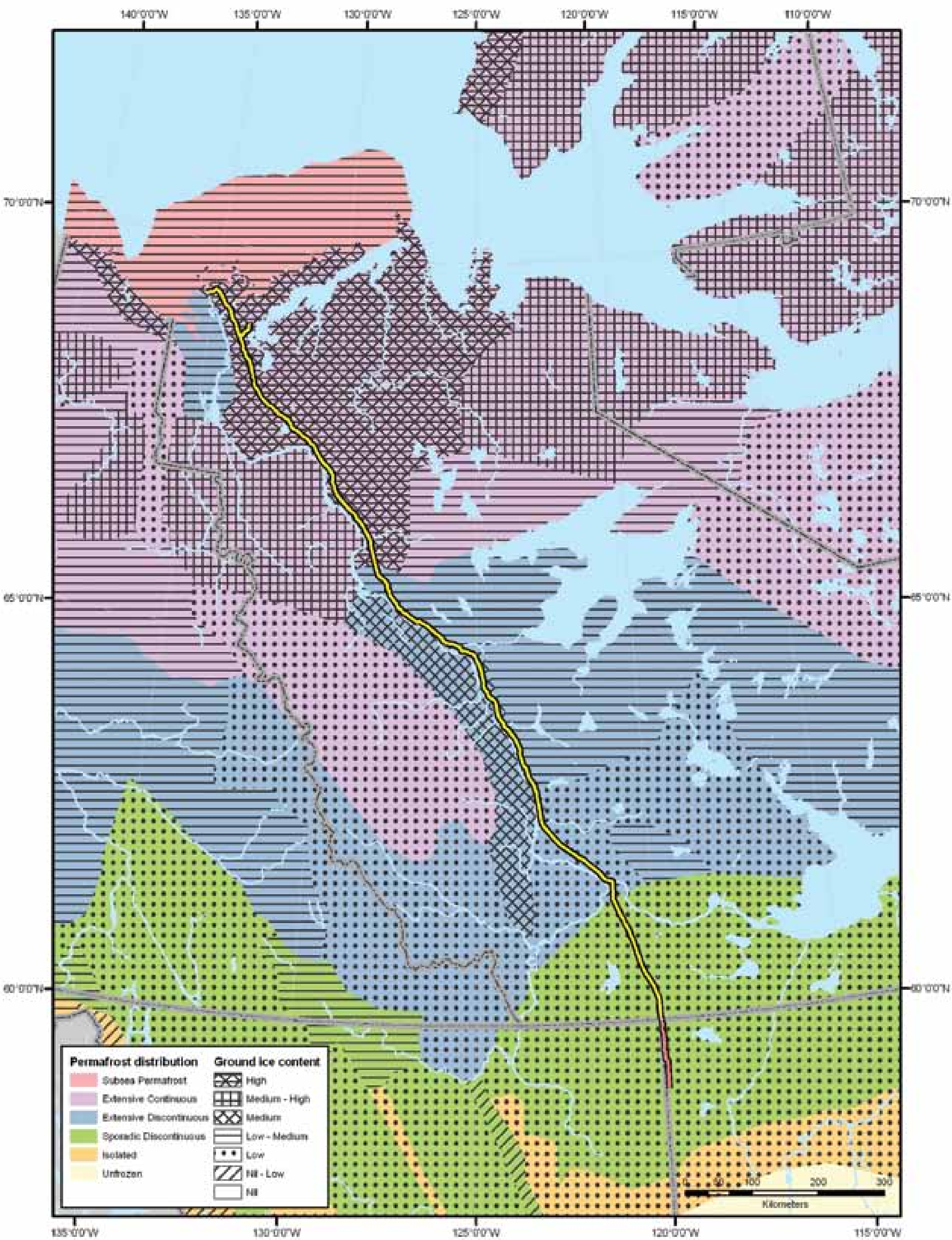
Figure 6-1 shows the distribution of permafrost conditions in the Project Review Area.

ANCHOR FIELDS AND GATHERING SYSTEM

According to the Proponents, permafrost underlies about 65% of the Mackenzie Delta. The Niglintgak and Taglu areas are within the intermediate discontinuous permafrost zone. Parts of the gathering system area south of the East Channel of the Mackenzie River, including the Parsons Lake area, are within the continuous permafrost zone. The Proponents added that they were aware of the presence of massive ice in the gathering pipeline area following specific investigations that were completed after the Environmental Impact Statement (EIS) was filed. Massive ice was detected in boreholes and geophysical surveys in the upper few metres at sites along the proposed Taglu and Parsons Lake gathering pipeline routes. Several investigations at proposed borrow sites in the Inuvialuit Settlement Region also indicated that massive ice is present in sand and gravel deposits in the gathering system area.

INAC consultant Dr. Burn asserted that the Proponents modelled the distribution of permafrost in the Mackenzie Delta on a probabilistic basis and that published field assessments indicate that permafrost in the Mackenzie Delta is ubiquitous, often containing a considerable amount of ice. The gathering system would traverse upland terrain north of the treeline that, in many places, would be underlain by massive icy beds. These icy beds are exposed in thaw slumps and are well documented in an existing database of seismic shot-hole logs for the region. Massive ice occurs both to the east of the proposed East Channel crossing and on Richards Island. Commonly, massive ice in the Project area is found several metres below the ground surface but, in places, it may be close to the base of the active

Figure 6-1 Permafrost Conditions in the Project Review Area



Source: Adapted from Heginbottom, J.A., M.A. Dubreuil and P.A. Harker (1995). Canada. "Permafrost" in: *National Atlas of Canada*, 5th edition, National Atlas Information Service, Natural Resources Canada, Mcr 4177.

layer. Dr. Burn submitted that thawing of massive ice due to construction disturbance may be difficult to stop, and slumping of the ground would likely follow, which would continue to expose additional massive ice. This could have impacts on ground stability, drainage, ecosystems, and the integrity of the gathering system and associated facilities.

PIPELINE CORRIDOR

According to the Proponents, permafrost in the pipeline corridor ranges from about 100 m thick near Inuvik to 10 m or less at the NWT–Alberta boundary. The active layer ranges from 0.5 to 1.5 m. Localized patches of isolated permafrost occur in the Fort Simpson area.

NRCan commented on NOVA Gas Transmission Ltd.'s (NGTL) characterization of permafrost and ice conditions along the proposed route of the Northwest Alberta Facilities. NRCan noted that the EIS and *Mackenzie Gas Project Environmental Impact Statement Supplemental Information: Northwestern Alberta* indicated that there are extensive organic deposits in the northern Alberta section of the pipeline corridor and that a portion, particularly peat bogs, may be frozen. A notable feature of the landscape in this region is the abundance of collapse scars in the bogs that have developed due to thawing of permafrost. NRCan noted that the Proponents' environmental alignment sheets provided no indication of the occurrence of permafrost and that an ice content value of 0% was assigned to all terrain types, including peat bogs.

NRCan also noted that information collected along the Norman Wells Oil Pipeline corridor indicates that permafrost exists in the organic terrain in the Alberta portion of that route and that 20% to 30% of the land area may be underlain by permafrost, partly due to the higher elevation of the Alberta Plateau.

Peat is defined as an organic deposit greater than 1 m thick and is differentiated from the surface organic layer (veneer) that occurs over most of the pipeline route. The Proponents noted that there are only isolated occurrences of thick peat terrain north of Norman Wells, and most of these occurrences are less than 3 m thick. South of Tulita, thick organic deposits consisting of a mix of elevated peat plateaus (palsas), which are underlain by permafrost, and unfrozen level areas with high water tables (fens), are more common along the route. Peat palsas have a relatively high potential for thaw settlement if disturbed. This mix of peat plateaus and fens immediately adjacent to each other means that there is an abrupt transition between these landscapes both in surface elevation and in subsurface permafrost conditions. The surface transition from fen to peat palsa is generally sharp, with an elevation difference of about 1 to 2 m between the palsa and the surrounding fen. The ice content of peat lands is among the highest of all terrain traversed by the Norman Wells Oil Pipeline, and these areas are subject to considerable settlement when thawed, as shown for Geological Survey of Canada study sites near the Petitot River.

Terrain and permafrost conditions could be affected by climate change throughout the Project Review Area. INAC consultant Dr. Burn noted that:

> The climate has warmed in the project area and permafrost has responded to this… In all areas the ground temperature has risen by about 1 and a half degrees. This indicates that permafrost has responded to recent climate warming… Projections, derived from internationally recognized global climate models, all suggest that climate warming will continue in the Mackenzie Valley, and so we need to know if permafrost conditions will respond to the changed climate over the life of the Project. (HT V33, pp. 2983–85)

6.1.4 PANEL VIEWS

The construction and operation of the proposed Project in a permafrost environment has no direct precedent in North America and, thus, poses distinctive engineering and environmental challenges. The presence of ground ice is the critical geophysical consideration for both the Anchor Field developments and the pipelines from the Mackenzie Delta to Alberta.

While the Norman Wells Oil Pipeline and the Ikhil gas pipeline are buried in permafrost, they provide limited experience on which to draw. The practices and impacts of right-of-way clearing, construction and maintenance would be similar for the Project. However, the Norman Wells Oil Pipeline and Ikhil gas pipeline operate at ambient temperatures (close to those of the surrounding soil), and so neither create nor degrade permafrost. The Project would do both. The Panel recognizes that the theoretical principles of engineering in permafrost are well understood. However, experience with their practical application to the construction of non-ambient temperature pipelines in the receiving environment is limited. Neither the Proponents' designs nor their mitigation strategies are yet in the realm of time-tested application and proven effectiveness.

Therefore, the Project cannot be assessed in the same way as pipeline projects of similar scope in the non-permafrost terrain of southern Canada, where there is extensive prior practice and experience to draw upon. There are risks that the Project would interact with the complex and distinctive terrain conditions to create adverse environmental impacts. Therefore, the Panel has applied caution in its findings and recommendations, and recommends that downstream regulators pay close attention to the outstanding issues that the Panel has identified, should the Project proceed.

Adequate characterization of baseline ground-ice conditions is necessary for the engineering design of the gathering system and main pipeline, in particular at watercourse crossings, slopes and where massive ice occurs, and to assess the frost heave and thaw settlement mitigation strategies presented by the Proponent. The presence of massive ice also needs to be considered in borrow source selection and in estimates of how much construction material is really available. The Panel also notes that unfrozen segments of terrain, such as are commonly found beneath river channels, are susceptible to frost heave under imposed freezing temperatures, which could result in adverse impacts to fish and fish habitat.

The Panel notes that permafrost temperatures have risen in response to recent climate warming. The Panel understands that the general effect of this trend, should it continue, would be to cause permafrost to retreat at its margins, deepen the active layer and diminish the likelihood that permafrost, once thawed by disturbance, would refreeze to its prior state.

These concerns are noted by the Panel here so that potential Project impacts on the geophysical and hydrological environment can be taken into consideration during Project design such that impacts on water quality and the habitat and populations of fish, birds and wildlife can be avoided.

6.2 PROPONENTS' APPROACH TO PROJECT DESIGN, CONSTRUCTION AND OPERATIONS

This section considers the Proponents' general strategy for avoiding or mitigating environmental impacts by means of:

- the robustness of their information base;
- their approach to Project design and construction;
- their geohazard assessment; and
- their approach to initial routing and siting.

The Proponents' more detailed strategies for addressing thermal impacts on ice-rich permafrost are considered in Section 6.3. Participants raised numerous concerns about the Proponents' general approach to Project design, construction and operations.

6.2.1 PROPONENTS' INFORMATION BASE

The main sources of information used by the Proponents for surficial geology and landforms in the Mackenzie Delta included:

- interpretation of available stereo-pair aerial photography (1:30,000);
- maps and reports in the pubic domain;
- terrain maps prepared for the Canadian Arctic Gas Pipeline project; and
- regional-scale soil maps and articles published in professional journals.

The Proponents used selected borehole sites, within about 500 m of the proposed pipelines and facilities, for permafrost delineation and characterization, as well as information from the Norman Wells Oil Pipeline ditch-wall logs and available geophysical information.

The Proponents' description of baseline conditions and assessment of terrain sensitivity in the Regional Study Areas was based largely on approximately 1,200 boreholes selected from the Geological Survey of Canada's geotechnical database, in combination with surficial geology maps and aerial photo interpretation. In some ecological zones, where a limited number or no boreholes met the Proponents' criteria for selection, the Proponents used boreholes from adjacent ecological zones to characterize the terrain properties.

The Proponents obtained data on the subsurface conditions at each Anchor Field through prior work at each site. This included exploration drilling, geophysical programs and shallow borehole investigations. The Proponents submitted that this data provided an understanding of the thickness and characteristics of permafrost for each Anchor Field.

NGTL used a combination of historical references, published Traditional Knowledge studies, field studies and aerial photography interpretation to determine baseline conditions for the proposed Northwest Alberta Facilities.

Recognizing the data limitations, the Proponents noted that their pipeline designs were being developed based on conservative assumptions. For example, all slopes were assumed to be ice-rich in the absence of site-specific data, and planning is proceeding on this basis. As site investigations proceed, some slopes would be found to be ice-poor and, therefore, more stable. In these cases, less intensive mitigation would be required. Other data collected from probe holes and test pits in a summer reconnaissance program would be used to optimize construction plans. This data would be used by contractors to refine construction progress estimates and by engineers and environmental scientists to finalize determination of mitigation measures for erosion and drainage control.

The Proponents stated their intention to review the literature on the distribution of massive ice for final route planning. They further stated that any new information on the location and occurrence of massive ice would be used to design and implement mitigation strategies to offset any potential impacts associated with the Project. The new information would be provided to regulators as it was collected and would be incorporated into appropriate environmental management plans and mitigation strategies.

The Proponents acknowledged that, in proceeding beyond the stage of conceptual design, further characterization of route conditions would be required to support a variety of work for the engineering design, construction and operations phases of the Project. For example, at individual slopes and river crossings, site-specific designs would be developed based on detailed field investigations. An integrated route database would be updated with new data throughout the detailed engineering, construction and operations phases of the Project.

During the year of clearing the pipeline right-of-way, additional geotechnical and geothermal data would be collected, including probe holes, test pits and geotechnical boreholes. The Proponents indicated that these boreholes would extend to ditch depth with spacing in the order of 100 to 200 m. The resulting data would be used to support construction and site-specific designs for slopes and river crossings, and to select among pre-established design and construction options. A Geotechnical Verification Program would be developed as part of preliminary engineering and would be finalized during detailed engineering. Given the high costs and access restrictions associated with collecting data in the North, the Proponents submitted that collecting data during the year of clearing would be the most cost-effective approach. The field program could result in changes to the routing to avoid some sites or assist in developing plans for mitigation where rerouting may not be practical. For example, the Proponents noted that they could decide to shift the route where areas of massive ice were identified through the ground-based geophysical program.

During construction, field design changes might be needed to respond to unexpected changes in route conditions. For example, different construction methods would be used for right-of-way preparation, ditching and backfilling, based on local route conditions. The design changes might have to be implemented before the end of each construction season.

INAC raised concerns about the sufficiency of the Proponents' baseline information. It noted that disturbance of the ground would occur throughout the pipeline corridor when the right-of-way was cleared and when construction occurred. However, the Proponents had not provided a detailed assessment of ground-ice conditions. The Proponents' assessment of such conditions was based on an analysis of boreholes compiled by the Geological Survey of Canada from reports of drilling in the 1970s and 1980s. INAC pointed out that this database only indirectly addresses conditions in the Regional Study Area. Data on the presence of ground-ice conditions keyed to specific terrain units had not been presented for any part of the pipeline corridor, and the Proponents had assumed that the ground-ice characteristics that would be encountered were directly comparable to the conditions represented in the database. INAC submitted that, after the right-of-way was cleared, unsuitable ground-ice conditions for pipeline construction might become apparent, and alterations to the alignment of the right-of-way might be necessary.

INAC consultant Dr. Burn noted that the EIS and the supplementary information filed by the Proponents cited little of the extensive and published knowledge on permafrost conditions in the Regional Study Area. Dr. Burn observed that the Proponents had not surveyed the distribution and character of permafrost in the field for the EIS; instead, they had modelled anticipated ground-ice conditions on a statistical basis. He further stated that, with respect to the 165 km of gathering system pipelines north of Inuvik, only about 35 boreholes, drilled in 2003, had been used to characterize ground-ice conditions.

Similarly, NRCan was of the view that the Proponents had not provided an adequate description of permafrost and terrain baseline conditions in the EIS, largely due to the rationale used by the Proponents for borehole selection and assignment of properties to terrain units in poorly represented ecological zones. Furthermore, NRCan noted that there were other sources of information that could have been consulted to provide additional information on surficial materials, permafrost distribution and ground-ice conditions.

NRCan also observed that little information had been provided in the EIS on the distribution of massive ice in the Mackenzie Delta. NRCan stated that it has documented many locations in the Mackenzie Delta where massive ice is present and indicated several occurrences in or near the proposed corridor for the gathering pipelines and Project facilities.

In the view of the Sierra Club of Canada consultant Dr. Lewkowicz, the variability in pipe temperatures along the route and through time, the impact of potential climate change, and the heterogeneity of permafrost conditions along the route in terms of temperature, ground ice and soils necessitate a detailed analysis of geotechnical conditions along the pipeline route. Dr. Lewkowicz also suggested that the variation of soil conditions in the discontinuous permafrost zone could be an order of magnitude greater than in areas with seasonally frozen ground, as in southern Canada. Dr. Lewkowicz submitted that, without more detailed geotechnical information, it is not possible to assess the environmental impact of the Project. Dr. Lewkowicz also submitted that, although the Proponents had listed a variety of possible mitigation measures, they had not demonstrated the efficacy or impacts of the various mitigation methods.

The Proponents responded that an adequate description of baseline terrain and permafrost conditions had been provided in the EIS to determine impacts associated with pipeline construction and operations in the Mackenzie Valley. They also expressed confidence in the data that had been used in the development of the EIS baseline and characterization of ground conditions for the purposes of conceptual engineering.

For the cross-country sections of the pipeline system, the Proponents submitted that it is neither necessary nor practical to map geotechnical and geothermal conditions in detail. Rather, pipelines would be designed to accommodate a wide range of route conditions and tolerate soil and terrain variations along the route.

INAC and NRCan made recommendations to the Panel regarding the need for further baseline information from the Proponents prior to trenching. The Proponents did not disagree with the substance of the information sought, only the timing of its provision and the level of detail requested.

6.2.2 PROPONENTS' DESIGN APPROACH

The Proponents stated that their general design approach:

- complies with applicable Canadian codes, regulations and standards;
- builds on experience from other northern pipelines;
- specifies pipe materials and methods to accommodate transitions from frozen to unfrozen soils and varying geotechnical conditions;
- balances frost heave and thaw settlement effects;
- uses a "tool kit" of mitigation options for environmental and pipeline concerns;
- considers specific geohazard impacts and potential climate-warming impacts to ensure pipeline integrity and reduce impacts;
- uses monitoring programs during operations and, if required, assessment and mitigation to ensure long-term pipeline integrity and right-of-way stability; and
- uses both public and Project data.

The Proponents' approach to Project design can be characterized as a designed risk management approach. In other words, their approach is to design, construct, monitor and mitigate. In this approach, the Proponents design to limit the likelihood of problems from happening, but monitor and apply mitigation if or as problems occur. The Proponents submitted that their approach would allow for the less significant geohazards to be dealt with through ongoing monitoring and maintenance activities.

The Proponents have taken a two-tiered approach in their pipeline design. "Typical" designs would be used for the major cross-country portions of the right-of-way that would be sufficiently robust to accommodate frost heave and thaw settlement, notwithstanding frozen or unfrozen transitions and varying soil types along the route. Site-specific designs would be used for areas and locations of greatest geohazard risk, such as permafrost slopes, river crossings and areas of massive ground ice. These designs would be developed during the engineering design phase of the Project. As well, the Proponents' design attempts to predict the magnitude of thaw settlement and frost heave that could result from the pipe thermal regime.

The Proponents stated that, at the time they filed their Project applications and the EIS, Project engineering was at a conceptual stage. Thus, when the Panel's Technical Hearings on Project design, construction and operations began, the Proponents were still engaged in geophysical research for detailed characterization of environmental conditions along the route and at key sites. The Proponents stated that more detailed site-specific design refinements and more refined decision criteria would be developed in the preliminary engineering phase associated with downstream regulatory review, and that more information would be provided as required.

The Proponents put forward a tool kit of mitigation options to address environmental and pipeline concerns, and identified a variety of possible mitigation measures. However, they added that "specific threshold values, detailed decision trees and associated criteria are not yet available, and they will be developed in this detailed design phase." (Rick Luckasavitch, HT V61, p. 5990)

The Proponents recognized the need for an ongoing monitoring and mitigative program for the pipeline. Aerial patrols by qualified personnel would gather data about right-of-way conditions. Indicators during such patrols would include:

- bank erosion, silt plumes and icings at watercourse crossings;
- exposed pipe, ponded water and drainage issues along the right-of-way;
- surface cracking;
- new groundwater seeps;
- surface slumping; and
- changes in vegetation and indications of thaw, such as bent trees adjacent to the right-of-way.

Off-right-of-way conditions would also be considered. Site-specific on-ground reconnaissance would be conducted where potential problems were identified.

The Proponents expect that pipeline loads due to frost heave and thaw settlement would accumulate gradually, and that several years of deformation would be required before a limit state was approached. This would allow sufficient time for monitoring and intervention. Accordingly, during operations, deformation monitoring of the entire pipeline system would be necessary. Interventions to maintain pipeline integrity at selected locations would be conducted as necessary. The Proponents submitted that the Norman Wells Oil Pipeline experience has shown that mitigative measures can be successfully applied to arctic pipeline operations.

Key issues identified by the Proponents related to facility design and operations in the Anchor Fields and the physical environment included the following:

- maintaining permafrost through design and managing thermal effects during drilling and production;
- predicting gas field subsidence;
- designing for flooding at Taglu and Niglintgak, including sea level changes, storm surges and submergence; and
- disposing of drilling discharges and process fluids.

At the Anchor Fields, the Proponents noted that key design considerations would be to ensure that wells would be drilled and completed in a safe and environmentally responsible manner. The Proponents also noted that, because operations would be continuous throughout the year, access to production facilities under all environmental conditions would be required.

INAC consultant Dr. Burn noted that the Proponents' design team expects pipe deformations and anticipates that several dozen of these would require remedial attention during operation of the Project. However, in Dr. Burn's view, the design was being undertaken in the absence of adequate field investigation of terrain materials and permafrost conditions. Dr. Burn noted that ground-ice conditions, soil frost-heave characteristics, thaw susceptibility and permafrost configuration north of Norman Wells were characterized on a statistical basis and that, along the route, the environmental loadings on the pipe were predicted by probability. Dr. Burn submitted that inherent to the probabilistic design of the pipeline is risk of failure and of significant environmental impact.

INAC noted that valuable experience gained from the Norman Wells Oil Pipeline in respect to slope design, river crossings and thaw settlement concerns in a region of discontinuous permafrost is of direct relevance to the Project. However, INAC also stated that it had sometimes been difficult to fully assess the potential environmental impacts of specific activities and the effectiveness of proposed mitigation due to the limited information provided by the Proponents to support many of their conclusions. As a result, INAC expressed concerns that the potential environmental impacts could be greater than predicted by the Proponents. INAC noted that the Proponents and regulators should adopt a precautionary approach because the Proponents do not plan to provide much of this information until the regulatory phase. INAC stated:

> We're not entirely comfortable with the just-in-time approach… We would encourage the proponent to collect the most detailed geotechnical information that it can as soon as possible… We don't want unnecessary clearing to take place, and we're particularly concerned about clearing on critical slopes not occurring prematurely. (David Livingstone, HT V34, p. 3075)

INAC stated that it was of the view that the Project could be built safely and in a way that would minimize environmental impacts. However, they stated that "among other things, this will require solid baseline information, focused monitoring programs, a sound adaptive environmental management régime and robust contingency plans." (Livingstone, HT V33, p. 3010) In response to the Proponents' questioning, INAC agreed that the Project could be designed, constructed and operated in a manner that would be safe, reliable and environmentally acceptable.

NRCan acknowledged that the design of the gathering system and associated facilities is an ongoing and iterative process and that the Proponents committed to conduct further field programs as part of their Geotechnical Verification Program. NRCan further stated that it supports the Proponents' intention to utilize all available published information and information obtained from field investigations to better characterize ground-ice conditions (including delineation of massive ice) and terrain sensitivity, and to incorporate this information into final design and environmental monitoring, management and mitigation plans.

NRCan observed that the Proponents had, for the most part, carried out the conceptual design engineering phase of the Project and had moved to the preliminary engineering design phase. NRCan submitted that it is possible that, after the detailed design is completed, some soil-pipeline interaction issues may not be satisfactorily resolved using recognized design practices. The Proponents may, in these cases, rely on mitigative measures, monitoring procedures and remedial actions to provide a level of safety or reliability similar to established design practices. NRCan stated that comprehensive pipeline integrity and environmental load monitoring programs are essential in the absence of standardized design guidelines for buried gas pipelines and return periods criteria for northern terrain-related environmental loads (such as frost heave, thaw settlement or thaw slides).

Based on its review of the pipeline design and soil-pipeline interactions, NRCan recommended that, should the Project proceed, the Proponents provide, to the appropriate regulatory agencies for their review and approval, additional data and analyses in support of their final detailed engineering design and more detailed mitigation and monitoring plans. The Proponents agreed, with variation, and noted that much of substance of these recommendations would be addressed by the NEB's Proposed Conditions.

The Sierra Club of Canada recommended that, prior to approval of the Project:

> INAC, EC, GNWT and the Proponents…undertake the detailed data collection and modelling work on permafrost-pipeline interactions for the entire length and anticipated lifetime of the MGP pipelines…and design the MGP and mitigation measures accordingly. (J-SCC-00119, p. 23)

The Proponents disagreed with the proposed timing of the recommendation and submitted that sufficient work had been completed for the EIS to allow the NEB to approve the development plans and the application for a Certificate of Public Convenience and Necessity. The Proponents noted that they had already described the design process and approach being used and that further information, as well as data collection and monitoring, would be provided as required by the NEB's Proposed Conditions.

6.2.3 DESIGNING FOR GEOHAZARDS

Geohazards are naturally occurring or Project-induced geological, geotechnical, geothermal or hydrological phenomena that could lead to pipeline or other component failure, causing adverse environmental impacts, or that could affect the right-of-way, causing environmental concerns. The Panel has already noted the critical importance of permafrost. However, permafrost is only one of several geohazards that the Proponents must account for in designing, constructing and operating the Project. The Proponents observed that there are various potential geohazards that could affect the pipeline, the pipeline ditch or the pipeline right-of-way over the 25-year design life of the pipeline.

The Proponents considered the identification and assessment of geohazards to be integral to the design, construction, monitoring and mitigation of the Project's pipeline system. They submitted that their geohazard assessment approach complies with applicable Canadian standards. The Proponents further stated that they were undertaking a detailed assessment of geohazards along the pipeline system in order to systematically characterize geohazards in terms of their spatial distribution and potential threat to pipeline integrity. Potential interactions between different geohazards, and factors contributing to geohazards either as triggering or chain-of-events mechanisms, were also being considered as possible multiple or combined loads on the pipeline.

The Proponents identified more than 30 potential geohazards and grouped them into 8 broad categories:

- freezing of unfrozen ground;
- thawing of permafrost terrain;
- landslides (including slope creep);
- tectonics and seismicity;
- watercourse hydraulics;
- erosion;
- geochemical, i.e. karst and acid-rock drainage; and
- soil structure.

The Proponents' approach to mitigation of geohazards during the preliminary (conceptual) design phase was both implicit and explicit. Implicit examples included route selections where, to the extent practical, critical cross and longitudinal slopes are avoided and stable water-crossing reaches are chosen. Explicit examples included preliminary design analyses for frost heave, thaw settlement, slope stability and watercourse crossings.

The assessment of geohazards for preliminary (conceptual) design was carried out without any detailed information on the spatial distribution or quantification of risk associated with specific geohazard occurrences. Instead, credible worst-case scenarios were used to develop conservative estimates of the impacts of geohazards on pipelines or the right-of-way, with geohazards to be subsequently verified using a more detailed assessment.

INAC consultants Wayne Savigny and Alex Baumgard advised the Panel early in the hearings that, while they were of the opinion that the proposed Project could be successfully constructed and operated, they were concerned that the Proponents had not fully identified and addressed the geohazards that might affect the Project. Thus, they added, stakeholder risks in terms of monetary and environmental costs had not been assessed. They further stated that, in their view, consideration of geohazards by the Proponents lagged behind industry standards for a large pipeline project at that stage of development. Citing U.S. data, Savigny and Baumgard noted that, although pipeline incidents resulting from geohazards are relatively low, the per-incident cost of geohazards is highest compared with other hazards. Geohazards are associated with larger releases, greater property damage, greater environmental damage and longer periods of service disruption compared with other hazards.

In the view of INAC consultants, the Mackenzie region remains a frontier area for pipeline design, construction and operations. They submitted that, in this setting, full consideration of geohazards should be based on the collective input of the best permafrost expertise available in Canada's scientific and engineering communities and supplemented by international experts. Consequently, Savigny and Baumgard recommended that the Proponents undertake a rigorous geohazard and risk assessment of the Project and incorporate the results into final right-of-way selection and design. Further, they recommended that a technical workshop be convened to:

- explore the broadest possible range of geohazards that have the potential to impact the proposed Project; and
- explore appropriate risk assessment methodologies.

As a result of this exchange of views, the Proponents, INAC and NRCan conducted a geohazard workshop in July 2006. The Proponents brought four external experts (which they characterized as their Senior Advisory Team) to review the geohazard assessment process and provide comments. The participants discussed a more formalized geohazard assessment approach for detailed design, which would provide for verification of preliminary design assumptions, and plans for obtaining information about the spatial distribution and potential impacts of various individual and combined geohazards along the pipeline route.

The Proponents noted that the results of planned geotechnical field programs, including the Geotechnical Verification Program, would be used to refine the geohazard assessment prior to completion of detailed design. During construction and the early years of operations, field conditions would be further verified during ditch excavation and later by in-line inspection and right-of-way monitoring.

The Senior Advisory Team noted that the Proponents' initial geohazard assessment placed heavy emphasis on loading impacts on the pipeline itself and on maintaining pipeline integrity and minimizing unscheduled intervention. The potential environmental impact of geohazard events, such as surface erosion and terrain disturbance linked to thaw bulb development, or silting of river channels due to slope toe erosion, needed further development. The Senior Advisory Team suggested that the Proponents make greater use of existing data sources prior to implementing its proposed Geotechnical Verification Program. However, they also noted that the Proponents' identification of geohazards was complete, that the scope of their geohazard assessment exceeded that normally done for most major projects worldwide, and that the Proponents' system for identifying and quantifying the magnitude of risk related to geohazard impact was reasonable and consistent with established methods.

6.2.4 ROUTING, SITING AND PROJECT FOOTPRINT

The Proponents' Senior Advisory Team noted that pipelines are routed based on broad consideration of a number of key factors such as topography, land use, geohazards, human settlements, transportation and available support infrastructure. It submitted that this approach allows for avoidance of the most severe hazards, but it is unrealistic to think that the Project could achieve a pipeline routing that "zigs and zags its way across the arctic and subarctic terrain successfully avoiding all frost susceptible soil deposits, ice wedges, thaw unstable permafrost, frost blisters, steep slopes, etc." (J-IORVL-00619, p. 32) Thus, at many locations, it would be necessary to accommodate unfavourable terrain through design, construction and operational mitigation techniques. The Proponents submitted that the benefit of undertaking a geohazard assessment of the route is to ensure that effective design, construction and mitigation strategies are in place to reduce the potential for pipe integrity problems and environmental impacts.

In selecting the proposed 1-km wide pipeline corridor, the Proponents sought to avoid, as much as possible, significant design and construction challenges — such as steep slopes and watercourse crossings — based on their engineers' knowledge of field conditions along the route, topographic and surface geology maps, aerial photographs, and the general database of soil borings for the region. However, a specific right-of-way had not been finalized, and this would continue to be the subject of progressively more detailed study and field investigations prior to final route approval.

In the view of the Proponents' Senior Advisory Team, the approach to pipeline routing used by the Proponents was consistent with best international practices, including the Trans Alaska Pipeline System and more recent major international projects. Except for isolated unique situations, the Team noted that detailed geotechnical investigation is not normally conducted in advance of route selection.

The Proponents described two main objectives in right-of-way design. The first is to provide adequate space for safe operation of equipment and handling of materials during construction. Construction of the Project pipelines would require a safe right-of-way that provides:

- a smooth travel surface;
- a maximum grade (longitudinal slope) of between about 8% and 10%; and
- a maximum cross slope of about 2% (an average of 1 m over a 50 m right-of-way).

A second objective is to maintain a long-term, stable right-of-way during operations by:

- stabilizing slopes, including using insulation and passive cooling for some slopes;
- controlling surface drainage and erosion using mitigation techniques such as berms, drainage/ditch plugs and grading;
- reducing ditch settlement using imported backfill in ice-rich areas;
- reclaiming the pipeline right-of-way after construction; and
- monitoring the pipeline and right-of-way during operations and applying mitigation where necessary.

In order to achieve these objectives, the Proponents stated that the required right-of-way widths would be:

- 30 to 40 m in the gathering system;
- 50 m from Inuvik to Norman Wells (to accommodate the Mackenzie Valley Pipeline and natural gas liquids line); and
- 40 m from Norman Wells to the interconnect facility at the NWT boundary.

The NGTL right-of-way would be 31 m wide.

At the Anchor Fields, the Proponents noted that key design considerations would be to minimize the footprint that would be occupied by permanent facilities. The Proponents noted that the major factors in siting the production facilities are the location and size of the reservoir and the general geology of the subsurface. These factors influence the depth, orientation and length of the wells necessary to produce the gas. This, in turn, establishes the number of wells and the number of well pads necessary to develop the field. The gas conditioning facilities would be sited as close as possible to the wells, minimizing the length of flow lines and the travel time for personnel. The environmental setting of a facility, including the surface terrain, is also considered in the siting of facilities.

Table 6-1 summarizes the physical footprint required for the development of each of the proposed Anchor Fields, which ranges from 0.6% to 2.0% of the total area of their respective Significant Discovery Licence areas.

Table 6-1 Proposed Development Footprint at Anchor Fields as a Proportion of Significant Discovery Licence Area

Anchor Field	Total Significant Discovery Licence Area (ha)	Physical Footprint (Permanent and Temporary) (ha)	Physical Footprint as % of Significant Discovery Licence Area
Niglintgak	3,665	73	1.99
Taglu	6,089	35	0.57
Parsons Lake	32,290	415	1.28

Source: Adapted from J-INAC-00177, p. 11; J-IORVL-00953, Tables 1-2, 1-3 and 1-4, pp. 22–5

INAC noted that the Norman Wells Oil Pipeline route followed existing cutlines as far as possible. Since degradation of permafrost had already occurred in places beneath these cutlines before pipeline construction, the amount of subsidence observed following construction was less than might have been expected had the Norman Wells Oil Pipeline followed an entirely new route. The Mackenzie Valley Pipeline is not expected to follow existing cutlines to the same extent. Despite its concerns, INAC noted that the corridor identified by the Proponents was by and large satisfactory, based on the level of information provided. However, establishment of the right-of-way within this corridor would require increasingly detailed information, and the centre line within that right-of-way would require even more detailed information. INAC noted that the Proponents had stated that they would be providing this information in a cascading fashion at the appropriate times.

A consultant for the World Wildlife Fund Canada, Dr. Gordon Orians, told the Panel about the experience of extensive oil and gas development on the Alaska North Slope, which began in the 1970s. Dr. Orians noted that those activities had resulted in changes in the physical, biological and human environments on the North Slope. In particular, Dr. Orians discussed the physical footprint of the development, including the extensive use of seismic lines, gravel roads, pipelines and drill pads.

Dr. Orians observed that the original expansion of the Alaska North Slope oil fields was based entirely on gravel roads, but that more recent developments made less use of gravel roads as technological advances have enabled more to be done with a smaller footprint. Based upon the Alaska experience, Dr. Orians submitted that the Proponents should use best available technology at the Anchor Fields to minimize the Project's footprint and to understand and address the impact of activities beyond the actual footprint.

6.2.5 PANEL VIEWS

BASELINE INFORMATION

The Proponents asserted that they have a general knowledge of the environment in the Project area that is sufficient for the present stage of engineering design, and that this knowledge would be augmented prior to construction. The Panel understands that the Proponents have followed a program of geotechnical verification (the Geotechnical Verification Program) and, should the Project proceed, would continue with this program at a more detailed and site-specific level.

The Panel notes that when the review process began, the Project was still in a conceptual engineering design stage. Participants with regulatory responsibilities told the Panel that they did not yet have sufficient information from the Proponents about their characterization of the environment or their designs and mitigations. These participants emphasized that they would need this information on a timely basis in order to fulfill their regulatory responsibilities and enable them to work with the Proponents to ensure appropriate environmental solutions in advance of construction, rather than leaving unexpected conditions to be encountered during actual construction when there might be less time for full consideration of environmental solutions. Some participants also expressed concerns that the Proponents did not appear to have transparent threshold criteria and decision trees by which they would determine optimum design and mitigation actions or evaluate their effectiveness.

Much of the difference expressed between Proponents and regulators focused on this question of when to provide information. There was little disagreement on the substance of the information required. The Panel acknowledges the regulators' concerns. At the same time, the Panel considers that the Proponents' submissions and their responses to questions provided sufficient information for the Panel to review the impacts of the Project.

The Panel accepts that the design of the Project is an ongoing process and that the Proponents have committed to conducting further field programs as part of their Geotechnical Verification Program, consistent with the NEB's general requirements for pipelines and, in particular, by the NEB's Proposed Conditions for the Project. The Panel expects that the Proponents would utilize all available published information as well as data obtained from their own field investigations to better characterize ground-ice conditions (including delineation of massive ice) and terrain sensitivity, and to incorporate this information in their final Project design and their environmental monitoring, management and mitigation plans.

The Panel notes that the original intent of the *Cooperation Plan for the Environmental Impact Assessment and Regulatory*

Review of a Northern Gas Pipeline Project through the Northwest Territories was that the Panel's review "will have provided the forum for consideration of all matters related to environmental impact assessment" and that the regulatory authorities would "not anticipate the need to revisit these matters during the final phases of the regulatory processes." In the Panel's view, however, the effect of conducting the Project environmental assessment at the conceptual design stage is that the effectiveness of some design mitigations could not be fully examined because further details would be forthcoming at a later stage. Therefore, the Panel's general approach is to provide guidance to those regulators by identifying the key issues that, in the Panel's view, would require further consideration in the final phases of the regulatory process. This is further discussed in Section 6.10.

DESIGN APPROACH

While the Proponents' design approach emphasizes risk management over risk avoidance, the Project has been designed to minimize environmental problems by considering options for:

- route and site selection;
- robust general design and specialized, site-specific design;
- right-of-way construction techniques; and
- operating temperature regime.

These account for generally expected conditions and for particular geohazards of low probability but of high impact.

Even with the Geotechnical Verification Program information the Proponents expect to obtain in the pre-construction period, the Panel recognizes that the Proponents may not be able to identify all of the areas especially prone to frost heave and thaw settlement in advance. The Panel accepts that the Proponents' commitment to regular integrity monitoring of the entire pipeline system should enable them to identify excessive strain as it develops, and to apply appropriate and timely remedial actions when a target pipe stress or strain limit is exceeded. The Panel accepts the view that pipe deformation would normally be slow and that there would be sufficient time for detection, analysis, planning and mobilization of materials, and that intervention would be managed and effective and would safeguard the integrity of the environment. The Panel also accepts that the Proponents' designed risk management approach anticipates that the pipeline will require remedial interventions from time to time to realign the pipe or to remedy soil conditions causing the deformation.

The Panel considers that it would be essential for the Proponents to address such circumstances in a timely and orderly way, well before conditions become acute, to avoid the need for remedial intervention (particularly the use of heavy equipment when the terrain is unfrozen).

Nonetheless, the Panel draws attention to certain aspects of the Proponents' overall design approach that warrant further attention and that suggest a need for caution.

First, it would appear that there are no methods for the prediction of frost heave or thaw settlement that are fully verified and accepted as standard engineering practice in any published code or standard issued either by a national standards body or an industry underwriting institution.

Second, while the Norman Wells Oil Pipeline provides useful experience with respect to thaw settlement, slope designs and watercourse crossing techniques, it provides little direct practical experience with respect to:

- construction and operation of production facilities in an area of continuous permafrost;
- construction of pipelines through extensive ice-rich terrain (as is found in the Mackenzie Delta);
- operation of chilled pipelines through areas of discontinuous permafrost and the associated frost heave concerns; or
- construction and operation of chilled pipelines beneath river channels in permafrost and the associated concerns with frost heave and frost bulb development in talik zones beneath such river crossings.

GEOHAZARDS

The Panel notes that the geohazards workshop referred to in Section 6.2.3 resulted in a greater level of confidence by all participants that the Proponents had taken all relevant considerations into account and had a credible plan to deal with eventualities. The Panel was reassured by statements from external reviewers that the Proponents' approach meets world standards.

To the extent that geohazards would be encountered in routing and siting, the Panel notes that the Proponents are confident that they have the "tool kit" to deal with them as encountered, even at the time of trenching and pipe laying. INAC also expressed confidence in the Proponents' ability to deal with such problems as they are encountered.

However, the Panel understands that, regardless of the amount of pre-construction information the Proponents obtain, there remains the possibility that some geohazards, including massive ice, would not be discovered until trenching and that accurate ditch-wall logging might have to occur under difficult winter conditions. The Panel accepts that this means that certain geohazards, especially massive ice, cannot be avoided. It is therefore essential that mitigation be designed in advance to minimize the need to remedy the situation afterward. This reinforces the need for caution. The Panel notes that the NEB's Proposed Condition 13 would require the Proponents to file a geohazard assessment with the NEB prior to construction.

ROUTING, SITING AND FOOTPRINT

Based on available information, the Panel considers the location of the proposed corridor to be acceptable. The Panel does not recommend any further route alterations based on geotechnical considerations raised during the review. The Panel notes that the geohazards workshop did not result in changes to the route or location of the pipelines or facilities.

The Panel also accepts the proposed width of the various sections of the right-of-way as necessary and appropriate for safe and efficient construction. The Panel also notes, however, that it heard no evidence that would justify any widening of right-of-way sections.

In the Panel's view, the likelihood that the Proponents would have to relocate the right-of-way within the corridor after tree clearing would be minimized as long as Panel Recommendation 6-1 is implemented. The Panel also notes that it is mainly in the treeless tundra north of Inuvik where massive ice is most likely to be discovered only upon trenching, and the concern about unnecessary clearing of trees does not apply in that area.

With respect to the Anchor Fields, the Panel notes that the required Project footprint for their development is substantially less than was the case when the Alaska North Slope was developed. Continued progress in minimizing the required footprint for the development of other Significant Discovery Licences will be essential should the Expansion Capacity Scenario and Other Future Scenarios proceed.

6.3 GENERAL DESIGN FOR THERMAL IMPACTS

Three elements of the Proponents' approach to designing for thermal impacts in continuous and discontinuous ice-rich permafrost apply to all aspects of the Project:

- using appropriate right-of-way and site preparation methods;
- designing an appropriate pipeline temperature operating regime; and
- accounting for climate change over the life of the Project.

The Proponents acknowledged that the construction and operation of the Project would involve thermal disturbances to the environment resulting from right-of-way construction and pipeline operating temperatures. The Proponents' general design approach to limit and manage these thermal impacts consists of:

> - limiting disturbance to the surface layer in thaw-sensitive permafrost areas;
> - limiting grading in thaw-sensitive permafrost to the area needed to safely and efficiently operate equipment;
> - reducing surface disturbance with snow-ice pads, where required;
> - reclaiming the right-of-way where disturbance is necessary for efficient construction, considering the potential thermal effects of the disturbance;
> - importing backfill to reduce ditch settlement in ice-rich areas;
> - designing the pipeline to operate at temperatures that are:
>   - colder than 0°C in continuous permafrost;
>   - above and below 0°C to balance frost heave and thaw settlement effects in discontinuous permafrost;
> - selecting a crossing method, such as horizontal directional drilling…or isolation at stream crossings where fall spawning or overwintering habitat is present;
> - using mitigation, such as deeper burial, insulation or a combination of both, to reduce the effects of pipeline operations at stream crossings;
> - conducting ground-based geophysics and geotechnical field investigations to map frozen and unfrozen areas; [and]
> - using conservative assumptions in design to offset uncertainty, or the absence, of route data. (J-IORVL-00803, pp. 3–4)

The Panel notes that there was no disagreement among participants that, in principle, these are appropriate measures for mitigating the Project's thermal impacts. Nor did any participant suggest that the Proponents had failed to consider some other measures of equal or greater effectiveness. Instead, participants' concerns focused on two main issues:

- whether the Proponents had, or would have in advance of construction, sufficient knowledge of terrain and permafrost conditions to apply these mitigative measures appropriately; and
- whether the Proponents should apply certain mitigative measures more liberally in specific situations in order to avoid with greater certainty specific environmental impacts that some participants considered problematic.

The Panel has already considered the first concern in Section 6.2. As noted in that section, the Proponents submitted that criteria to select specific mitigations were not required for the preliminary stage of engineering. Criteria would be refined and completed during detailed engineering and into the construction and operations phases, which would be subject to regulatory oversight by the NEB. The second concern is considered in greater detail in Sections 6.4 through 6.7, on thaw settlement, slope design, frost bulbs and watercourse crossings.

The Proponents noted that the climate of the Project area has been warming over the past 30 years or so and that this regional warming is expected to continue into the future under global warming scenarios. However, the Proponents concluded that increasing thaw from climate warming would be small compared with the Project's impacts and would occur over a long period. They noted that any impacts related to climate change could be managed through monitoring and mitigation measures. The potential impacts of climate change would be considered further in detailed engineering design, where required, such as for facility foundations.

All participants agreed that thermal changes due to right-of-way clearing and construction would be substantially greater than the expected impact of climate change. However, some participants questioned whether the Proponents had fully accounted and designed for potential climate change over the life of the Project. In particular, some questioned whether the Proponents had considered an appropriate range of warming scenarios that could prevail during construction and operations. Anticipation and design for climate change is considered in this section.

6.3.1 RIGHT-OF-WAY AND SITE PREPARATION AND RECLAMATION METHODS

PROPONENTS' VIEWS

The Proponents intend to use two main types of right-of-way preparation, depending on prior assessment of the susceptibility of permafrost terrain to surface disturbance impacts. For the most part, they would employ conventional winter pipeline construction techniques that require surface levelling, grading and cut and fill, similar to those used to construct the Norman Wells Oil Pipeline. The Proponents noted that disturbance and exposure of the ground surface as a result of right-of-way clearing and pipeline construction would inevitably lead to progressive thawing of permafrost due to increased exposure of the ground surface to solar radiation. This thaw would be unrelated to any thermal disturbance from pipeline operating temperatures and could result in ground settlement, pond formation, increased erosion and slope instability. Therefore, in areas of sensitive terrain, such as in the ice-rich soils and massive ice north of Inuvik, protective techniques such as preparing snow and ice pads would be used.

All work would be done in winter to minimize disturbance of vegetation and terrain. The length of the winter construction season would be determined based on contractor experience and historical weather data, using accepted indicators of sufficient frost to begin the season and of amount of thaw to end it. Right-of-way activities would not begin until the ground could support light vehicles (up to 9,000 kg). Based on historical data, probable start and stop dates and construction season duration were estimated for various points from north to south. For example, surface preparation of the right-of-way could begin in mid-November in the Inuvik area and extend to the second week of April, with corresponding dates of late November to the third week of March in the Fort Simpson area.

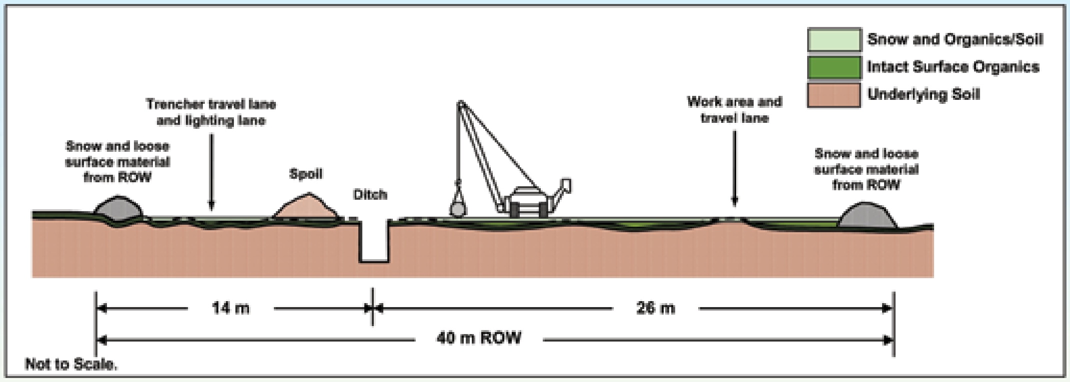
For the gathering system, snow and ice pads would be constructed by packing available snow in place and using low-ground-pressure vehicles to promote ground freezing. Heavier equipment would then be used to compact natural snowfall or to place supplemental snow and ice collected in place or hauled from other collection areas as required. Where natural snow was insufficient and transporting snow or water was not practical, available natural snow and loose surface material would be used to create a smooth surface for traffic on the temporary roads, as was the practice for the Norman Wells Oil Pipeline. Snow and ice pads would be about 10 cm thick over the highest point of the natural ground surfaces of temporary access roads. The Proponents noted that this is consistent with Government of the Northwest Territories guidelines and with current practices for winter road construction. They submitted that experience has shown that 10 cm is sufficient to reduce impacts on the underlying terrain. Right-of-way preparation would have to be completed within 40 days to allow all activities on a spread to be completed within the construction season.

For slopes with grades in excess of 10%, where it may not be feasible to construct snow and ice pads safely, conventional right-of-way preparation methods would be used, except for longitudinal slopes, which would require special slope stabilization measures, including clearing by hand or using specialized mechanical clearing equipment. Disturbed sensitive areas would be reclaimed.

Conventional arctic winter pipeline construction techniques are proposed south of Inuvik. These include, primarily, conventional surface levelling and grading. Figure 6-2 and Figure 6-3 illustrate these activities across typical cross-sections of the right-of-way south of Norman Wells, where the width is normally 40 m to accommodate the Mackenzie Valley Pipeline only. The use of snow and ice pads would be limited to approximately 30 to 50 km of thaw-sensitive terrain between the Inuvik Area Facility and Fort Good Hope. There would be approximately 90 km of surface preparation in areas of thick peat, 50 km of ice roads over watercourses and wetland fen areas, and 10 km of slopes identified for special stabilization measures. Where soil that has high ice content is identified before right-of-way preparation, snow and ice pads might be used to reduce the construction surface disturbance.

Conventional surface levelling would be used in thaw-stable and relatively level terrain (e.g. cross slopes that have grades less than 2%). High points would be graded and the material used to fill low areas, as shown in Figure 6-2. A thin layer of snow could be compacted over the travel lane to improve its suitability for traffic, depending on the snow cover on the right-of-way. Clearing and compaction of the surface would also serve to drive frost into the ground, increasing the load-bearing capacity in the travel lane portion of the right-of-way and enabling passage of heavier traffic earlier in the season.

Figure 6-2 Typical Right-of-Way with Conventional Surface Levelling

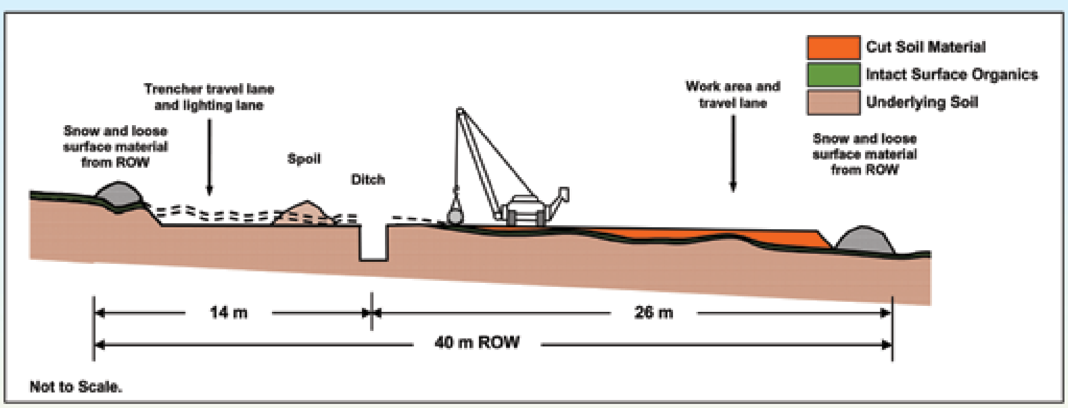


Typical overland levelling (cross slope < 2%):

- Surface levelling and trimming of some hummocks in areas with localized relief across the right-of-way
- Snow and organics/soil from surface levelling compacted in low areas and distributed across ROW to cover intact surface organics and underlying soil
- In hummocky terrain with thin surface organic veneer, levelling will expose more underlying soil than in thick surface organics or relatively smooth terrain
- Original soil surfaces shown as dashed lines
- Ditchline to be graded, as necessary, to provide stable trafficable surface for trencher

Source: Adapted from J-IORVL-00790, p. 19

Figure 6-3 Typical Right-of-Way with Conventional Grading, Cut/Fill



Typical cross slope grading/cut and fill (cross slope between 2% and 10%):

- Grading and cutting original slope and filling on downslope side of ROW using cut soil material to cover intact surface organics and underlying soil
- Some minor recontouring of cut and fill areas to reduce erosion potential following construction, and revegetating exposed mineral soil
- Original soil surfaces shown as dashed lines

Source: Adapted from J-IORVL-00790, p. 20

On cross slopes greater than 2%, a cut-and-fill technique would generally be used to create a right-of-way that is suitable for traffic, with a finished cross-slope grade of 2% or less. Cut-and-fill preparation involves removing the surface organics, followed by re-contouring the ground to reduce the steepness of slopes, as shown in Figure 6-3. This technique is expected to expose mineral soil in most cases, except in thick organic soil deposits. Following this form of construction, any available loose organic material would be redistributed and exposed mineral soil revegetated. Where cuts and fills are necessary, they would be accompanied by drainage and erosion-control measures.

According to the Proponents, experience gained from the Norman Wells Oil Pipeline demonstrates that a combination of conventional surface levelling and cut-and-fill techniques could be used successfully in most permafrost terrain between Inuvik and Alberta instead of constructing extensive protective snow and ice pads. The Proponents estimated (on a preliminary basis) the cost of right-of-way preparation using snow and ice pads to be $240,000 to $250,000 per km, compared with $80,000 to $90,000 per km for conventional construction.

The Project pipeline design and construction methods for peat plateaus would be similar to the conventional grading techniques used for the Norman Wells Oil Pipeline, as shown in Figure 6-4.

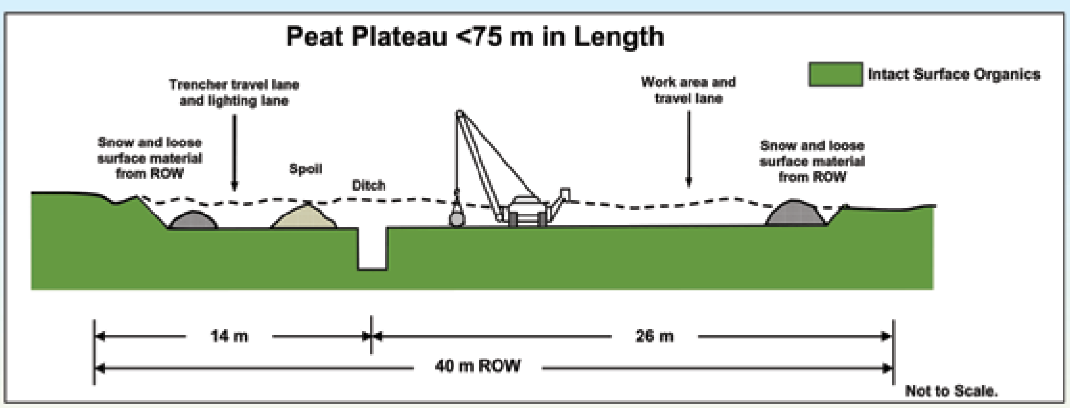
Where the right-of-way is located in thick peat (an estimated total length of about 90 km), the Proponents noted that about 90% of surface preparation is expected to involve surface levelling. The remaining 10% would involve grading at transitions and through short isolated plateaus. Fens account for about 55 km of the terrain that the pipeline would traverse. About 90% of this length is fen terrain south of Norman Wells. Ice road construction over fens might include using material such as snow, slash (debris from tree felling) and timber, whereas ice road construction over deep water bodies would primarily involve thickening the ice over the water.

Typical construction across fens would involve driving the frost deeper in order to stabilize the ground to a depth that could safely carry heavy vehicle loads. Ditching would be conducted through this frozen ground using appropriate excavation equipment. The Proponents stated that imported fill would not be used in these areas because of the unfrozen nature of the ditch and lack of lateral constraint to hold backfill in place. Instead, buoyancy control measures, such as concrete coating, concrete weights or screw anchors would be used.

Where the right-of-way crosses an elevated peat plateau, the approach would be graded to provide an acceptable transition for vehicular traffic. For short sections of peat plateau, the Proponents noted that it might be feasible to maintain a constant ditch bottom elevation from the fen through the plateau by excavating a deeper ditch.

The Proponents noted that, on the Norman Wells Oil Pipeline, the transition zone from fen to peat plateau was typically graded to a depth of over 1 m to reduce the approach grade to the

Figure 6-4 Typical Right-of-Way with Surface Preparation in Thick Peat



- Throughcut at transition zones to long peat plateaus and across short peat plateaus to reduce grade of ROW and variations in pipeline profile
- For peat plateaus >75 m in length, transition zone graded to about 5% to overcome elevation difference of up to about 2 m from surrounding low-lying peatlands
- For peat plateaus <75 m in length, deep grading (cutting) and deeper ditch may be used to reduce overbend radius in pipeline to limit potential for upheaval displacement
- Original soil surfaces shown as dashed lines
- Width of right-of-way might be reduced, as required, to reduce area affected by cut

Source: Adapted from J-IORVL-00790, p. 21

plateau. The ditch area was graded level. The depth of the ditch was adjusted to accommodate a gradual change in the bottom elevation of the ditch from the fen to slightly higher elevations across the peat plateaus.

For long stretches of peat plateau, the ditch bottom would generally be higher across the plateau than in the surrounding unfrozen terrain. This would reduce the amount of ditch excavation and imported fill required and accommodate thaw settlement of the pipeline. Differential elevation across the right-of-way resulting from local topographic highs and lows on peat plateaus would be reduced by surface levelling and grading. The ditch area would be graded level to facilitate trenchers or wheel ditchers. Imported fill and, possibly, buoyancy control would be used as required. Loose surface organics and, possibly, mulched brush and trees would be distributed across the right-of-way following construction.

Site preparation for major facilities such as the Anchor Field production facilities, the Inuvik Area Facility, and the compressor stations would consist of clearing and grading where necessary, followed by the placement of gravel pads. To reduce heat flux from buildings to the ground and maintain the integrity of the permafrost below, insulation would be incorporated in the gravel pad, or structures would be elevated on pilings, or both.

The Proponents stated that a Vegetation and Reclamation Management Plan would be submitted to regulators in advance of commencement of Project construction activity. The Vegetation and Reclamation Management Plan would contain guidelines, standards and requirements for the reclamation of lands disturbed during construction activities, including the development of borrow pits and quarries. The Proponents noted that an important aspect of post-construction right-of-way stabilization is revegetation, which would be used to help to control thawing and erosion.

In response to questioning, the Proponents stated that they planned to revegetate through a series of mechanisms, the most common being natural revegetation. Some reseeding might be required across the right-of-way in erosion-prone areas. This would involve a fast-growing crop of seeds that would allow for erosion control on those slopes and will allow the natural invasion of the native species into that area. The criteria for determining the need for reseeding would be developed during detailed design. At the time of the hearings, the Proponents had not determined the appropriate native seed mixture for reclamation. They stated they were in the process of obtaining that information in the course of construction planning and design to ensure that they would have the appropriate seed mixes at the appropriate time for construction.

In response to Panel questioning about the Proponents' use of the terms "reclamation," "rehabilitation" and "restoration," the Proponents stated that reclamation is

> the process of re-establishing a disturbed site to a former or other productive use. Reclamation includes management of a disturbed site and re-vegetation where necessary. Rehabilitation implies that the land will be returned to a form and productivity in conformity with a prior land use plan, including a stable ecological state that does not contribute substantially to environmental deterioration and is consistent with surrounding values. Restoration is a process to restore disturbed lands to conditions that existed before disturbance. (Alan Kennedy, HT V60, p. 5870)

As further discussed in Section 6.4, the Proponents have committed to undertake reclamation measures but not rehabilitation or restoration measures.

PARTICIPANTS' VIEWS AND RECOMMENDATIONS

Environment Canada was concerned about the impact of trenching on wet sedge lowlands, which is important habitat for geese and shorebirds. Environment Canada observed that sedges reproduce by propagation rather than seed and inquired whether there were any examples of wet sedge lowlands having been successfully restored to initial conditions after pipeline installation. The Proponents responded that they would rely on natural recolonization, a process they expected would take 10 to 30 years, but did not provide any specific examples of successful restoration of wet sedge vegetation.

NRCan recommended that the Proponents provide to the appropriate regulators, as part of their detailed abandonment and reclamation plans, an assessment of any post-abandonment construction, operation and abandonment related right-of-way impacts, including continuing right-of-way thaw and frost bulb degradation. The Proponents agreed, with variation, stating that their abandonment plans would be prepared in compliance with regulatory requirements at that time.

Participants raised no concerns with the Proponents' intended site preparation methods.

The environmental concerns arising from right-of-way practices and ground thawing are considered in Sections 6.4 and 6.5.

6.3.2 PIPELINE OPERATING TEMPERATURE REGIME

PROPONENTS' VIEWS

The operating temperature regime of the Mackenzie Valley Pipeline would be controlled primarily to optimize gas throughput. The variations in temperature that would occur along the pipeline are inherent to the physical properties of gas transmission under pressure. The general operating temperature regime is therefore an essential feature of Project operations in the same way that right-of-way clearing is an essential feature of Project construction. However, the Proponents plan to control operating temperatures within specified limits in order to minimize or otherwise avoid the need for mitigation of large ground movements associated with freezing (frost heave and frost bulbs) and thawing (thaw settlement and thaw weakening). The Proponents noted that the following design principles apply to frost heave of a cold pipe in initially unfrozen ground and thaw settlement of a warm pipe passing through frozen terrain:

- for frost heave, the design for pipe temperature limits would ensure that the peak strains would not exceed allowable pipe strains within the Project's life cycle; and
- for thaw settlement, the design for pipe temperature limits would ensure that:
    - peak strains would not exceed Project limits for pipe strains; and
    - thaw settlement would not be greater than the settlement that could result from right-of-way clearing and construction activities.

Accordingly, the operating temperature of the pipeline system would be regulated to adjust broadly to the range in permafrost conditions expected throughout the system. This regime would not apply to the natural gas liquids line, which is planned to operate at ambient temperatures.

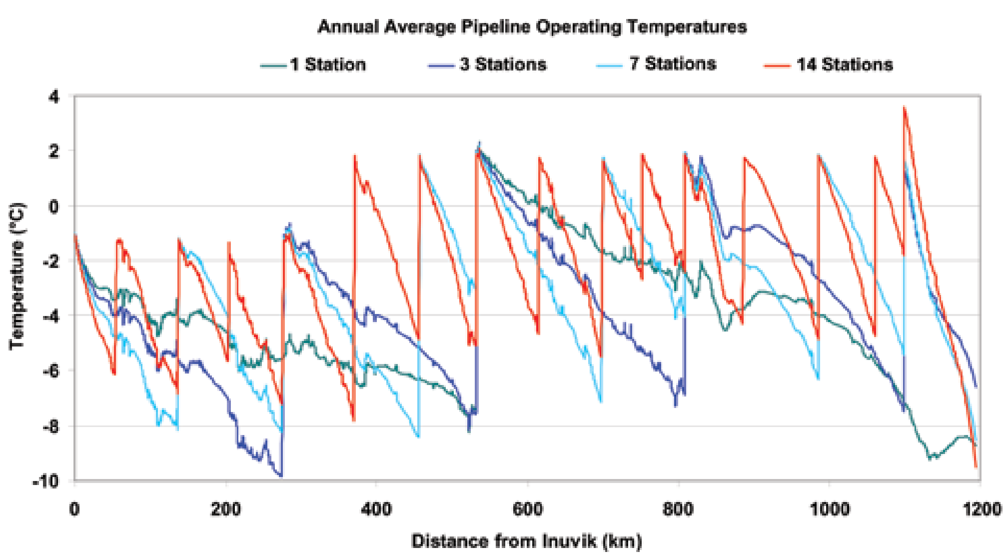
The chilled pipeline operating mode would be used north of the compressor station near Tulita and throughout the Mackenzie Delta in order to preserve the integrity of the continuous permafrost. The gathering system would be designed to operate continuously at below 0°C, and the Mackenzie Valley Pipeline between the Inuvik Area Facility and Loon River would operate at a mean annual temperature of -1°C, ranging from +6°C in summer to -8°C in winter. South of Tulita, the Proponents noted that the design of pipeline operations at temperatures above and below 0°C is intended to balance frost heave and thaw settlement impacts. The seasonal cycling of pipeline temperature is designed to minimize the number of potential locations where freezing-induced pipe strain could exceed a critical value. South of Norman Wells, where existing permafrost is expected to degrade as a result of right-of-way clearing and construction, operating the pipeline in warm mode is anticipated to produce only a minor or secondary impact on thawing.

The Proponents stated that the coldest pipeline operating temperatures and, consequently, the maximum frost heave conditions, could exist immediately upstream of compressor stations. However, due to the variability in possible flows associated with future compressor stations, the Proponents noted that the pipeline would be designed for cases when stations were bypassed under low-flow conditions. The Proponents employed a conservative approach in their assessment of frost heave and assumed that maximum frost heave might occur over the length of the pipeline.

If additional gas resources were discovered and shipped via the pipeline, more compressor stations would be required. As noted in Chapter 2, "Project Description," the Proponents have already determined the locations of these stations and the circumstances under which they would have to be added. The Proponents provided profiles of annual average pipe operating temperature along the right-of-way for four different compressor station scenarios: 1 station, 3 stations, 7 stations and 14 stations. These are shown in Figure 6-5. As a result of adding compressor stations, seasonal and mean annual operating temperatures at any point on the pipeline could change over the life of the Project.

The Proponents observed that, while they can control discharge temperatures in aid of mitigating the impacts of non-ambient temperatures over long segments of pipeline, this does not

Figure 6-5 Annual Average Temperature Profiles for Compressor Station Scenarios



Source: J-IORVL-00501, Figure J U-23-1, p. 2

constitute a site-specific solution where the pipe passes between frozen and unfrozen ground over short distances. If compressor stations were added in the future, it would be for the sole purpose of increasing throughput, not to change operating temperatures in any segment of the line as an environmental mitigation measure.

The Proponents stated that they would design the pipeline for the boundary temperature conditions that could apply at any point on the pipeline and at any time during its service life, under a range of scenarios involving the number and timing of compressor stations that might be added. River crossings would be designed for the coldest case by using a combination of pipe insulation and deeper burial depth. Thus, the Proponents would account for all possible scenarios (in effect, worst-case scenarios) for frost bulb formation and thaw impacts. Where subsequent mitigation might be required, thermosiphons could be installed, for example, where the objective would be to retain a frost bulb under warmer conditions.

In response to questioning, the Proponents noted that there is a risk that the mechanical integrity of pipe insulation may break down over the long term, especially where freeze/thaw cycling occurs. The Proponents were confident that a good insulation system is technically feasible, but they had not yet resolved its design details. Responding to questioning on the environmental impacts of future changes in the operating temperature regime, the Proponents stated they would rely on their "integrity management program, environmental monitoring program [and] change management strategies" to predict the impacts of, for example, a change from a one-compressor-station case to a three-compressor-station case. (Michelle Laplante, HT V100, p. 9910)

PARTICIPANTS' VIEWS

Several participants raised questions about the potential environmental impacts of altering the operating regime, especially where this might result in a change of state (frozen to thawed, or vice versa).

INAC consultant Dr. Burn calculated that, for the initial case of a single compressor station, the pipeline would be running at above 0°C in summer for most of the route. For a large proportion of the route running through discontinuous permafrost south of Chick Lake (approximately KP-365), the pipeline would operate at a mean annual pipe temperature above 0°C. The impact would be to thaw any frozen material surrounding the pipe.

The Proponents responded that, if the mean annual temperature of a pipe were below 0°C and the pipe were isolated from construction disturbance, the conditions around the pipe would reach equilibrium after three years. However, Dr. Burn asserted that this equilibrium should be regarded as a dynamic equilibrium because the pipe temperature would change through the year.

INAC consultant Dr. Bill Roggensack pointed out that the outlet temperatures at newly introduced compressor stations would bring the line temperature on an annual basis well above 0°C, causing ground that had initially been frozen in the single-compressor case to be thawed. Dr. Roggensack also expressed interest in the results of possible thermal modelling of temperature reversals for multiple-compressor-station scenarios, and the impact of the interval time between the initial gas flow and when multiple compressor stations are added to the system.

NRCan also raised questions about possible environmental impacts resulting from a situation where a frost bulb that had been created by cold temperature operations for a number of years were to be thawed following a temperature reversal resulting from a newly installed compressor station.

The Sierra Club of Canada consultant Dr. Lewkowicz had previously expressed his belief that an examination of the impact of changing the number of compressor stations during the Project's lifetime was needed and that each of the hypothesized temperature regimes should be examined in terms of its downstream impacts.

6.3.3 CLIMATE CHANGE

PROPONENTS' VIEWS

The Proponents stated that they had considered the possible impacts of climate warming and variability in their geothermal analyses for pipeline design. The Proponents recognized that there is uncertainty in climate conditions, including trends in mean annual values, year-to-year variability and extremes over the Project's design life. They stated that these uncertainties would be considered, as appropriate, for individual Project components, such as well pads, pipelines, facilities and the right-of-way. Other possible impacts of climate change, such as landform changes and groundwater flows, would be handled through monitoring and mitigation.

The Proponents submitted that climate change would not influence the selection of techniques and equipment for pipeline construction and maintenance activities. To the extent that climate change might reduce the weather window during which construction and maintenance activities can take place, the amount of work to be completed by a complement of construction or maintenance crews during a given winter season might need to be adjusted. This might result in multiple crews working on various shortened work fronts to complete the required work within a given season.

Overall, the Proponents submitted that their designs were sufficiently conservative to address potential climate change and variability, which they expected would have little incremental impact on thaw depth compared with clearing of the right-of-way. In addition, ongoing monitoring of the pipe, ditch and right-of-way would address thaw-related impacts, whether induced by construction, operations or potential climate change impacts. Climate change would be considered further in detailed engineering design, where required, such as for facility foundations. Uncertainty surrounding future climatic conditions would be addressed through monitoring.

The Proponents concluded that there would be no potential impacts on soils or landforms in permafrost that would be magnified by the impacts of climate change during the lifetime of the Project. They also concluded that increases in thaw depth from climate change would be expected to be small compared with Project impacts and would occur over a long period. In addition, any impacts related to climate change could be managed through monitoring and mitigation measures.

PARTICIPANTS' VIEWS

Several participants were of the view that the Proponents had not taken sufficient account of climate change over the life of the Project.

Dr. Burn noted that the climate of the Project area has warmed steadily since 1970, with the greatest change being registered in winter conditions. The warming is apparent throughout the Mackenzie Valley, and the rate of warming for the Mackenzie Delta area of 0.7°C/decade is relatively high for Canada. Dr. Burn noted that this regional climate warming is expected to continue at the present rate under an increased greenhouse effect and may accelerate in the coming decades. The *Impacts of a Warming Arctic: Arctic Climate Impact Assessment*, a product of wide-ranging international consultations, is consistent with this position. INAC noted that, in recent decades, permafrost warming had occurred at depths up to 25 m in the Mackenzie Delta area, and Dr. Burn also noted that the active layer had deepened. According to Dr. Burn, the principal impacts of the Project would be to degrade permafrost at its southern limits, deepen the active layer everywhere and, as permafrost soils warm and become more vulnerable to deformation, accelerate creep and slope movement. In Dr. Burn's view, the Proponents had not fully considered the impacts of long-term warming of shallow permafrost. However, he agreed with the Proponents that thermal change due to construction and right-of-way clearance would be greater than the impact of expected climate change.

Environment Canada noted that rising air temperatures in the Mackenzie Valley and Delta have already shortened the period of lake and river ice cover, degraded permafrost, and increased the incidence of forest fires. In Environment Canada's view, climate modelling consistently demonstrates that further changes would accelerate and exacerbate these impacts and result in decreased sea ice and snow cover, cause sea levels to rise, and alter hydrologic trends and variability. These changes could affect many of the Proponents' design assumptions for the Project. Environment Canada identified two critical issues: "1) the interpretation of past climate trends versus future climate changes; and 2) climate variability and extremes." (J-EC-00039, p. 3)

In Environment Canada's view, the Proponents' design floods on major stream crossings were extrapolated using historical data, which does not account for future hydrologic regimes that will likely be impacted by climate change and variability. Environment Canada noted that the Proponents assumed a gradual change in annual air temperature (0.05°C/a) distributed evenly throughout the proposed duration of the pipeline and that this failed to address potential impacts of future climate variability and extremes. Environment Canada submitted that the interactions of climate variability and climate change would likely be a more significant environmental stressor on Project components over the anticipated lifespan of the Project (approximately 30 years) than currently acknowledged by the Proponents. Environment Canada explained that this interaction could result in more frequent occurrence of extreme events (in relation to current climate norms), especially warmer temperatures that might occur over several successive years.

Environment Canada raised several questions about the utility, within the context of climate change, of existing baseline data the Proponents used for assessment and mitigation of river crossings. These included the reliability of stream flow predictions, designing for uncertainty in hydrological data, analysis of variance in peak and low flows, and, consequently, how a precautionary approach would be applied to minimizing adverse impacts. Environment Canada stated, therefore, that appropriate assessment, monitoring and mitigation approaches must be incorporated into the Project's design, maintenance, contingency plans and decommissioning plans.

The Proponents responded that the stream flow data they used provided a regional context for assessing the potential for perennial stream flow at a site, although local conditions might affect the stream flow at a particular site at a particular time, especially in the winter. The Proponents included methodologies for estimating peak flows in their analysis of variability in peak flows between hydrologic regions and for estimating peak flows at ungauged watersheds. They considered these estimates adequate for describing baseline conditions.

Environment Canada recommended that, prior to construction, "climate change modelling employed by the proponent…properly incorporate the upper limit temperature scenarios…to ensure that the safety margins built into the project design are adequate to cover the range of future temperature conditions including their variability and extremes." (J-EC-00178, p. 6)

The Proponents agreed, with variation, and stated that Environment Canada's requested analysis would be considered when complying with the NEB's Proposed Conditions.

Environment Canada noted that early detection of changes in key indicators, such as precipitation, temperature and lightning, would be critical for detecting potential impacts on pipeline infrastructure but drew attention to gaps in the monitoring system along the pipeline route. Environment Canada recommended that, prior to construction,

> the Proponent…conduct a thorough analysis and review of the observed climate variability and change over the project region and report its findings at regular intervals (e.g. every five years) throughout the lifetime of the project. Climate reports should include proper documentation of calibration procedures, error analyses, identification of corrections in instrumentation, and interpretation of seasonal trends and/or extreme events in the data including any identified impacts of climate change on the project. (J-EC-00178, p. 6)

Upon questioning, Environment Canada explained that it was proposing a collaborative long-term monitoring program that would involve the Proponents, although the details of this program, including who would be responsible for what, were not explained.

The Proponents did not agree with this recommendation and stated that the Project does not require climate monitoring stations. The Proponents submitted that government is responsible for monitoring and reporting on climate for the Mackenzie Delta and Mackenzie Valley. However, the Proponents would cooperate with government by allowing access to facility sites for government-installed and -operated monitoring equipment.

While NRCan agreed that climatic impacts would be smaller than Project impacts, they were not in complete agreement with the Proponents' conclusions or their assertion that they had adequately considered climate change and variability in their environmental assessment. NRCan stated that the Proponents had "said that they will deal with climate change through monitoring and mitigation." It added that the "details of those plans have not been provided, and those plans will require a definition of the thresholds and triggers that will be used to determine when mitigation is required." (Dr. Sharon Smith, HT V44, p. 4183)

NRCan also asserted that the Proponents had submitted limited analysis of the impact of climate warming on permafrost and ground thermal conditions in representative terrain types. However, NRCan acknowledged that Project design is an iterative process. It supported the Proponents' approach with respect to incorporating climate change and variability into Project design, impact assessment, and the development of monitoring and management plans to deal with issues of permafrost thaw.

NRCan recommended that

> with respect to climate change and variability, and impacts on baseline permafrost conditions and on the project,… the Proponent provide to appropriate regulators, for review and approval, final design plans that incorporate further analysis of the impacts of climate change on permafrost and terrain stability over the design life of the project and post abandonment. This analysis should be conducted for a series of typical/representative locations, conditions and terrain types and should incorporate climate variability. The results should also be incorporated into the monitoring, mitigation and adaptive management plans. (J-NRCAN-00090, p. 158)

NRCan suggested that appropriate timing for implementing this recommendation would be "prior to trenching or wellpad and facility construction." (J-NRCAN-00090, p. 158)

The Proponents agreed, with variation, again noting that they would comply with the NEB's Proposed Conditions for pipeline and right-of-way monitoring.

The Sierra Club of Canada recommended that Environment Canada and the Proponents undertake further work to assess and mitigate the impacts of climate change on the Project, prior to Project approval. The Proponents did not agree with this recommendation as, in their view, sufficient work had been completed for the EIS and in preliminary engineering.

6.3.4 PANEL VIEWS

The Panel generally accepts the Proponents' approach to right-of-way and site preparation and reclamation, except where a higher standard may be required for habitat conservation, as is further considered in Section 6.4.

The Panel considers that the Proponents have designed adequately to minimize the impacts of the range of proposed operating temperature regimes for the Project as Filed (up to three compressor stations), as well as for temporary variations due to operational requirements. Further details of these mitigation measures are provided in Sections 6.4 to 6.7. In the Panel's view, the proposed operating temperature regime would not have significant adverse environmental impacts with respect to localized thaw, heave or frost bulb formation that could not be mitigated as described by the Proponents, with the possible exception of the long-term effectiveness of pipe insulation, which is discussed in more detail in Section 6.5.

The Panel understands that the range of operating temperatures at any one point along the pipeline could change on a long-term basis by virtue of adding compressor stations at any time in the service life of the Project. In the Panel's view, the Proponents' responses to concerns raised about the environmental impacts of such changes lacked clarity. Although the long-term integrity of pipe insulation is in some question, no means of detecting its deterioration other than by adverse environmental consequences was suggested, nor was any means of remediating those consequences other than by excavation, replacement and reburial. The Panel was, therefore, not persuaded of the long-term effectiveness of the Proponents' proposed mitigations regarding the addition of compressor stations beyond those required to achieve a throughput of 1.2 Bcf/d.

The Panel was advised of the probable locations of future compressor stations but was not presented with site-specific information on the existing environment, an assessment of site-specific impacts or any detail on proposed mitigations. In the Panel's view, intervention during the operations phase in the form of pipe reburial at greater depth or with upgraded insulation would be an undesirable solution. Therefore, a conservative approach is necessary with respect to the application of pipe insulation and deep burial during construction, including the possibility of installing pipe by isolation methods at watercourse crossings and steep slopes, which is discussed in more detail in Section 6.7.

The Panel has not reviewed the impact of more than the three compressor stations identified in the Project as Filed on the operating temperature regime of the pipeline, or the environmental impacts of any operating temperature regime associated with developments other than the Project as Filed, on a site-specific or generic basis. These matters would have to be the subject of separate review if and when applications are received.

Over time, climate change may result in decreasing certainty in predicting thaw rates, soil stability, work seasons and stream flow variability, and in the resulting impacts on channel migration and morphology. However, the Panel is not persuaded that such impacts would occur so rapidly that they would fall outside the normal range of year-to-year variability in the short term. Therefore, the Panel considers that the need to account appropriately for climate change applies not to the construction period and to the activities contemplated during construction, but to Project design and the maintenance of system and environmental integrity over the duration of the operations period. These longer-term uncertainties and impacts could be of increasing importance in relation to the Expansion Capacity Scenario and Other Future Scenarios and must be considered in relation to cumulative impact assessment.

The Panel notes that the NEB's Proposed Conditions, as they apply to the consideration of climate change, relate primarily to monitoring. In the Panel's view, while the Proponents have considered climate change impacts in Project design, they should give further consideration to the concerns raised by Environment Canada and NRCan.

The Panel accepts that the Proponents considered the possible impacts of climate warming and climate variability in their design. The Panel notes that the Proponents submitted that their designs were sufficiently conservative to address potential climate changes and variability, and that they would further consider climate change during detailed engineering design and ongoing monitoring.

The Panel is satisfied that, subject to the implementation of Panel Recommendation 6-3 and the NEB's Proposed Conditions, the potential impacts of climate change on the Project would have been identified and accounted for, and that the approach proposed by the Proponents would be appropriate. The Panel therefore concludes that impacts of climate change on the Project would not likely be significant.

With respect to Environment Canada's recommendation that the Proponents conduct an ongoing analysis and review of observed climate variability and change in the region using certain prescribed standards, the Panel accepts the Proponents' response. In the Panel's view, Environment Canada is responsible for the design and implementation of ongoing climate monitoring in the region, the analysis of the data and the assessment of potential impacts. If the existing network of monitoring stations is insufficient for the purpose of monitoring climate change, then it is the Government of Canada's responsibility to ensure that the network is enhanced, sufficient resources are applied to the analysis and assessment of the data, and results are communicated to the parties that may require it. The Panel needs to be assured that the Government of Canada has the resources and capacity to fulfill those obligations. The Proponents' responsibility should be limited to providing relevant site-specific monitoring information to Environment Canada and ensuring that their operations and maintenance program takes into account any changes beyond that currently predicted.

6.4 THAW SETTLEMENT

When ice-rich soils thaw, water is liberated and, as it drains away, the ground subsides or settles. Where the ground contains excess ice, the amount of thaw settlement may be quite substantial, especially where massive ice is encountered. Ice-rich sediments are found in the Mackenzie Delta and in some parts of the Mackenzie Valley.

Ditch fill over the pipe itself may settle and subside over time, depending on pipe operating temperatures and the nature and ice content of the fill. However, thaw settlement may occur across the entire right-of-way due to clearing, which exposes the ground to more sunlight and disrupts or eliminates the natural insulating qualities of the existing vegetation and organic soil. This section considers the consequences of these impacts and their mitigation.

The Proponents considered thaw settlement to be an unavoidable impact of right-of-way clearing in permafrost terrain. They noted that if the objective were to preserve permafrost, the approach would be to ensure that the vegetation mat remained undisturbed. However, this approach would conflict with the objective of constructing a pipeline. The Proponents stated that it is not practical, in all instances, to preserve the vegetation mat and, thus, they were trying to develop an approach that balanced vegetation preservation with installation of the pipeline.

6.4.1 PROPONENTS' VIEWS

DITCH SETTLEMENT

The Proponents noted that it is common for pipelines in northern settings to experience ditch settlement, and this is expected along the pipeline right-of-way in permafrost and organic terrain.

Based on the experience of other northern pipeline projects, local settlement of the pipeline ditch immediately following construction can be greater than general right-of-way settlement.

Following construction of the Norman Wells Oil Pipeline, where no imported fill was used for backfilling during construction, it was estimated that settlement occurred along 30% of the ditch. The Proponents identified an increased potential for erosion along a sunken ditch, resulting in pipe exposure and/or displacement of the pipe.

The Proponents noted that more site-specific investigations would be required, even though borehole data is sufficient for determining the expected average amount of thaw settlement for a terrain group. Investigations would be conducted before the pipeline was installed to determine the specific extent of each section of high-ice content soil within a terrain group. In some cases, high-ice content soil might not be identified until it was exposed during construction. The Proponents stated:

> The ditch line will be graded to a width of about 4 metres, as required, to provide a stable surface for the trenching equipment. Where ice-rich soil is exposed, remedial measures such as surface insulation are available for use. As well, exposed mineral soil will be re-vegetated as required. (Luckasavtich, HT V61, p. 5993)

Potential thaw settlement along the ditch line would be reduced by using select backfill in ice-rich areas. Such areas would be identified by the Geotechnical Verification Program, to be conducted in the year of clearing and before pipeline installation. Data from the Geotechnical Verification Program would also be used to refine import fill volumes. Additional ice-rich areas might be encountered during construction and might also require import fill. Where this occurs and backfill is not available on-site during construction, ice-rich material would be put back into the ditch and would be topped up later with imported fill during pipeline construction.

Recognizing that ditch line settlement may be expected in some areas, the Proponents plan to leave a crown or roach over the ditch line as appropriate to mitigate this settlement, and, if necessary, fill would also be added to the ditch line at a later date. The Proponents would assess the condition of the right-of-way during the first thaw season after initial pipeline installation and, if necessary, regrade the centre line during the first winter after construction to repair any sunken ditch or to remove an excessively high crown.

The Proponents are considering the use of select backfill for the Project in areas where the ditch spoil would be subject to large settlement resulting from excess ice content of the soil, particularly where small streams enter the right-of-way and might be diverted along the ditch line. In the case of the Niglintgak lateral, which traverses low-lying wet-sedge tundra polygons in the Kendall Island Bird Sanctuary (KIBS), the Proponents undertook to use select backfill to provide for a slightly elevated crown above the ditch line, to allow for subsequent settlement. Should such settlement later result in a depression below grade, replacement fill would be added.

A reconnaissance of the route in the spring and summer following clearing and before construction would locate areas where drainage control measures would be needed. The drainage controls installed would be based on site-specific information.

The Proponents stated that they had designed for additional compressor stations, and, depending on timing, there might be some localized changes along the right-of-way with respect to the ditch. However, the Proponents would monitor for such changes.

RIGHT-OF-WAY SETTLEMENT

The Proponents acknowledged that progressive thawing of warm permafrost would occur in a newly cleared right-of-way due to vegetation removal and construction. They noted that such thawing would be unrelated to any thermal disturbance from pipeline operating temperatures. Disturbance of the ground surface related to right-of-way clearing and pipeline construction could lead to surface subsidence across the entire width of the right-of-way. This could result in ponding and disruption of surface drainage across the right-of-way and possible pipe buoyancy (flotation) concerns.

Thawing of permafrost terrain along the pipeline right-of-way could also lead to differential settlement of the pipe. This could result in pipe strain where differential settlement in frozen ground occurs or at interfaces of frozen and unfrozen ground. Thawing of permafrost terrain along the pipeline right-of-way could contribute to loss of pipe cover and soil strength due to thawing of ice-rich backfill. This could lead to increased potential for erosion along the sunken ditch, pipe exposure and/or upheaval displacement of the pipe.

The Proponents modelled three ground-disturbance scenarios ranging from clearing surface vegetation with minimal peat disturbance to clearing with complete removal (as described in Section 6.3). The modelling indicated that average thaw settlement would be less than 0.5 m after five years for most of the pipeline route, with average settlement generally being higher north of approximately KP-250 than south of KP-250. However, areas of thick organic terrain, such as peat plateaus and fens, could experience thaw settlement of up to about 0.7 m from clearing alone in this time frame, with additional settlement of up to about 0.5 m caused by the impacts of incremental surface disturbance.

The Proponents noted that clearing accounted for most of the predicted thaw settlement response. The incremental thaw settlement caused by disturbing the surface organic layer might be up to 35% of the thaw settlement caused by clearing. Removing the upper 0.2 m of the organic layer in thick frozen peat might induce incremental settlement of up to about 85% of that caused by clearing alone. In the extreme case, the right-of-way through thick peat plateaus would be expected to settle to the elevation of, and come to resemble, adjacent unfrozen fen landscapes.

The calculated thaw depths, from which thaw settlement was determined, were based on the thermal disturbance resulting from the clearance of the right-of-way. These thaw depths included the impacts of climate warming but did not consider the influence of pipe operating temperature. Nonetheless, the Proponents submitted that their predicted thaw settlement values were conservative.

According to the Proponents, the experience gained from constructing the Norman Wells Oil Pipeline demonstrates that a combination of conventional surface levelling and cut-and-fill techniques could be used successfully in the permafrost terrain between Norman Wells and Alberta instead of constructing extensive protective snow and ice pads. The Proponents submitted that evidence from the Norman Wells Oil Pipeline indicates that use of these techniques did not result in long-term terrain damage where the necessary rehabilitation and revegetation was carried out.

Conventional grading was also used for right-of-way construction in areas of peat plateaus for the Norman Wells Oil Pipeline. Snow or ice pads were not used. According to the Proponents, some degradation of permafrost has occurred, but the settlement is relatively uniform and vegetation has recovered. For example, observations taken south of Fort Simpson on the Norman Wells Oil Pipeline right-of-way in peat palsa terrain, show that about 1 m of settlement occurred within the first five years following construction. The Project pipeline design and construction planning for peat plateaus in the southern Dehcho Region would be similar to that used for the Norman Wells Oil Pipeline.

The Proponents noted that some erosion of the right-of-way occurred on the Norman Wells Oil Pipeline, usually where small streams entered the right-of-way and were diverted along the ditch line. For this reason, the use of select backfill is being considered for the pipeline in areas where the ditch spoil would be subject to large settlement resulting from excess ice content of the soil.

NGTL stated that it does not expect thaw settlement and thawing-related slope instability to be a significant issue on the Northwest Alberta Facilities' right-of-way. This conclusion was based on NGTL's operating experience in the area and information obtained from the initial field soil investigation program, which indicated that permafrost would be encountered on less than 10% of the right-of-way's length. The maximum mean annual gas temperature is expected to be significantly lower than other pipelines that NGTL currently operates in the same geographic area.

The Proponents stated that, where grading was necessary and where soil that has high ice content was to be exposed, special protective measures would be applied before the end of the construction season. Mitigative measures being considered include:

- surface insulation, such as a layer of stripped organics, wood chips or rigid board-stock insulation under a layer of soil, to limit seasonal thaw;
- installing berms and breakers for erosion control; and
- stabilizing the right-of-way through revegetation.

The Proponents stated that they "are committed to monitoring environmental effects along the pipeline right-of-way." They further stated that "criteria to select protection measures that might be required at any given location are not yet available, but will be developed for future environmental protection plans." (J-IORVL-00803, p. 5)

Mitigation options include:

- standard industry methods for erosion control and revegetation, modified to account for potential thermal impacts caused by the presence of permafrost;
- grading and importing fill to re-establish natural drainage;
- thermosiphons to limit thaw;
- pipeline insulation to limit heave; and
- insulated sub-drains for erosion control or groundwater flow.

While the Proponents would clean up and reclaim the right-of-way after construction, they would not rehabilitate or restore the right-of-way. The Proponents stated: "There would be no standard practice of infilling right-of-way settlement. That action would only be taken if there was an erosion problem leading to transport of soil off the right-of-way. As long as the disturbance was contained on the right-of-way, it would just settle." (Chris Heuer, HT V44, p. 4143) The Proponents submitted that no further action would be taken.

The Proponents stated that changes in overland drainage patterns would be addressed during construction and operations. Specific criteria for implementing mitigation measures for overland drainage disruption were not available at the time of the Panel's hearings, but the Proponents noted that mitigation measures had been identified. These criteria would be completed during detailed engineering.

Reconnaissance of the pipeline route in the spring and summer after clearing would be used to locate areas requiring drainage control measures. Clean-up and reclamation would be undertaken following pipeline installation. These activities would include installing sediment controls and re-contouring and re-establishing drainage. Drainage controls would be based on site-specific information in conjunction with the result of the preconstruction drainage survey. The condition of the right-of-way would be assessed during the first thaw season after pipeline installation.

6.4.2 PARTICIPANTS' VIEWS

INAC consultant Dr. Burn drew attention to factors that could compound the thawing impacts of right-of-way clearing. In his view, it was important to consider the capacity of the pipe temperature to affect thaw subsidence along the ditch line. He explained that when ice-rich permafrost thaws around the pipe, the water likely drains away. Therefore, subsidence of the ground and pipe that may occur following thawing of ground ice in summer would not necessarily be reversed in the winter. Similarly, during fall freeze-back, water liberated by thawing may migrate upward, away from the base of the pipe, again leading to continued long-term settlement rather than equilibrium. Dr. Burn concluded that thawing driven by seasonal changes in pipe temperature would contribute to right-of-way subsidence along the ditch line, especially downstream of compressor stations where operating temperatures would often be above 0°C.

INAC expressed concern that the Proponents had overlooked the far-reaching influence of the ditch in collecting groundwater from an upland-area active layer and the resulting potential for groundwater to flow to a nearby slope. Due to the convective heat associated with the groundwater, the ditch area would be the last to refreeze in the fall or early winter.

With reference to the gathering system, Dr. Burn pointed out that the terrain that would be traversed by the Niglintgak Lateral and parts of the Taglu Lateral is low-lying and within a few metres of sea level. Ice-wedge polygons are prominent in the area, and, in addition to ice wedges themselves, about 40% of the upper 2 m of permafrost in the area is ice-rich. Dr. Burn submitted that any deepening of the active layer and thawing of the ice-rich ground may lower the surface elevation closer to sea level and increase flooding along the right-of-way. The area is low-lying, flat terrain, and drainage of any depressions caused by melting of near-surface ground ice would be slow, and the depth of thaw beneath the pool would increase. Dr. Burn submitted that this impact may be mitigated by careful construction of an ice road or pad for use by equipment throughout this area.

Both NRCan and INAC commented on the experience of constructing the Norman Wells Oil Pipeline, based on the results of their joint Permafrost and Terrain Research and Monitoring Program. Temperature conditions have been monitored along the pipeline route, both on and off the right-of-way since 1985 at more than 20 sites, along with measurements of ground and pipeline subsidence.

NRCan stated that in the organic terrain south of Fort Simpson, slumping and collapse of material adjacent to the subsiding ditch has occurred, and this impact can extend to the edge of the right-of-way. Collapse and settlement are continuing 20 years after the initial disturbance. The ice-rich peat in this region can be several metres thick, and there is potential for settlement and collapse following vegetation clearance and disturbance to the organic mat that insulates the ground. Permafrost-affected peatlands in these regions are particularly sensitive to surface disturbance because the permafrost formed under colder conditions during the Little Ice Age and is now preserved under the insulating properties of the peat.

Dr. Burn stated that observations from the Norman Wells Oil Pipeline indicate that thaw subsidence at several locations reached the design value after 12 years, or after less than half the design life of the pipeline. He stated: "After 18 years of monitoring it appears that the longer-term effects caused by thaw are becoming more of a concern than the earlier erosion events. Thaw of soils at some sites has progressed at a greater rate than expected and there is evidence on sensitive slopes of a growing annulus of thaw around the pipe." (J-INAC-00074, p. 11)

NRCan pointed out that, based on the Norman Wells Oil Pipeline experience, there is potential for settlement, collapse and pond formation to extend to and beyond the edge of the right-of-way over the lifetime of the Project. NRCan stated that the Proponents may have underestimated the area that has the potential for settlement and pond formation, especially in the southern portion of the pipeline corridor. Information collected along the Norman Wells Oil Pipeline corridor through ditch logs and geophysics indicates that 20% to 30% of the land area may be underlain by permafrost. In addition, these peatlands can be ice-rich and are subject to considerable settlement when thawed.

Based on long-term thaw settlement observed along the Norman Wells Oil Pipeline right-of-way, and the similarity of the Proponents' proposed right-of-way construction techniques to those used for that pipeline, INAC concluded that thaw settlement would likely continue along the Project right-of-way for at least 20 years.

NRCan noted that the Proponents' criterion for significance of impacts was simply the proportion of the Local Study Area that would be affected (5%). NRCan criticized this approach since it did not provide any indication of the amount of settlement, erosion or depth of ponding, nor where mitigation might be most needed. Furthermore, the approach did not consider that impacts may be locally significant, such as extensive areas of thaw settlement in ice-rich terrain or ponding in sensitive peatland areas, which may have impacts on ecosystems.

In NRCan's view, it was important to estimate the amount of thaw that could occur because this would be a factor in determining the amount of erosion and gullying that could occur on sloping terrain and, therefore, the potential input of sediment to water bodies and impacts on aquatic ecosystems. NRCan submitted that the Proponents had not attempted to delineate areas where this erosion might be particularly severe and where mitigation might be required. NRCan expressed concerns that estimates of runoff and sediment transport from disturbed areas were unrealistically low because the runoff flows were based on a monthly average rainfall that was pro-rated over the entire month (or seasonal average rainfall pro-rated over the entire season). NRCan submitted that the estimates should, instead, be based on data from an extreme storm event in combination with realistic runoff periods spanning hours to several days.

NRCan pointed out that the design approach for erosion control on the Norman Wells Oil Pipeline involved detailed consideration of terrain type, slope, drainage patterns, flows, soil erodibility, thermal erosion susceptibility and topography. All mineral soils were seeded and fertilized, including level terrain and the right-of-way beyond the ditch line.

Dr. Burn pointed out that the principal direct environmental impacts of thaw subsidence would be associated with changes in the moisture regime that might follow from collection and ponding of water in depressions on the right-of-way or along the ditch. Changes in moisture conditions can lead to changes in the pre-disturbance species composition of vegetation on the right-of-way. In addition, the availability of water and disturbance of the vegetation could lead to surface erosion where mitigative measures were not taken.

Further, Dr. Burn stated that living vegetation keeps the ground cool, which is the reason permafrost is commonly preserved in peatlands in the southern portions of the discontinuous permafrost zone. Dr. Burn submitted that reseeding with grasses and other vascular plants does not re-establish the same microclimatic environment provided by the peat and, therefore, can result in reclamation challenges.

NRCan recommended that "the Proponent provide to the appropriate regulators for review and approval, the details of the mitigation measures to be implemented to control runoff and sediment in areas that will be disturbed, including the criteria for their selection." (J-NRCAN-00090, p. 158) The Proponents agreed, with variation. They noted that this recommendation is addressed by Project commitments and the development of Project decision trees, and that it would also be addressed by NEB's Proposed Conditions.

Environment Canada was concerned about the impact of trenching on wet sedge lowlands (which is important habitat for geese and shorebirds) and about the possible need to re-excavate and repair gathering system pipelines in view of the ice-rich soil conditions there. Environment Canada also stated its concern that, if settling occurs along the trench, ponding and melting could occur, and habitat recovery could take longer than 30 years. Environment Canada evaluated the costs and benefits of elevating the lateral lines within KIBS. However, it concluded that the increased disturbance arising from more frequent ground inspections would likely outweigh the benefits and, therefore, it preferred the burial option proposed by the Proponents, with qualifications.

Environment Canada called for a higher standard of gathering system pipeline construction methods across Fish Island, as shown in Figure 6-6, adjacent to KIBS, to better preserve waterfowl habitat there, for reasons further elaborated in Chapter 10, "Wildlife." Environment Canada stated that the pipeline trench there should not interfere with the microtopography of the low-centred polygons adjacent to the trench. The desired result after settling is a pipeline trench that is at grade. Slight subsidence is preferable to an above-grade trench. In Environment Canada's view, environmental damage from summer maintenance would be virtually impossible to minimize, so maintenance must occur when the ground is solidly frozen.

Environment Canada recommended that the Proponents develop, in cooperation with itself and the regulatory authorities, a Construction and Operations Plan for the Fish Island portion of the gathering system pipeline that identifies the operating standards required to protect the sedge wetlands on Fish Island. The specific objective of this recommendation was that "the pipeline trench should not interfere with the microtopography of the low-centred polygons adjacent to the trench," with the desired result being, after settling is complete, "a pipeline trench that is at grade." (J-EC-00173, p. 16)

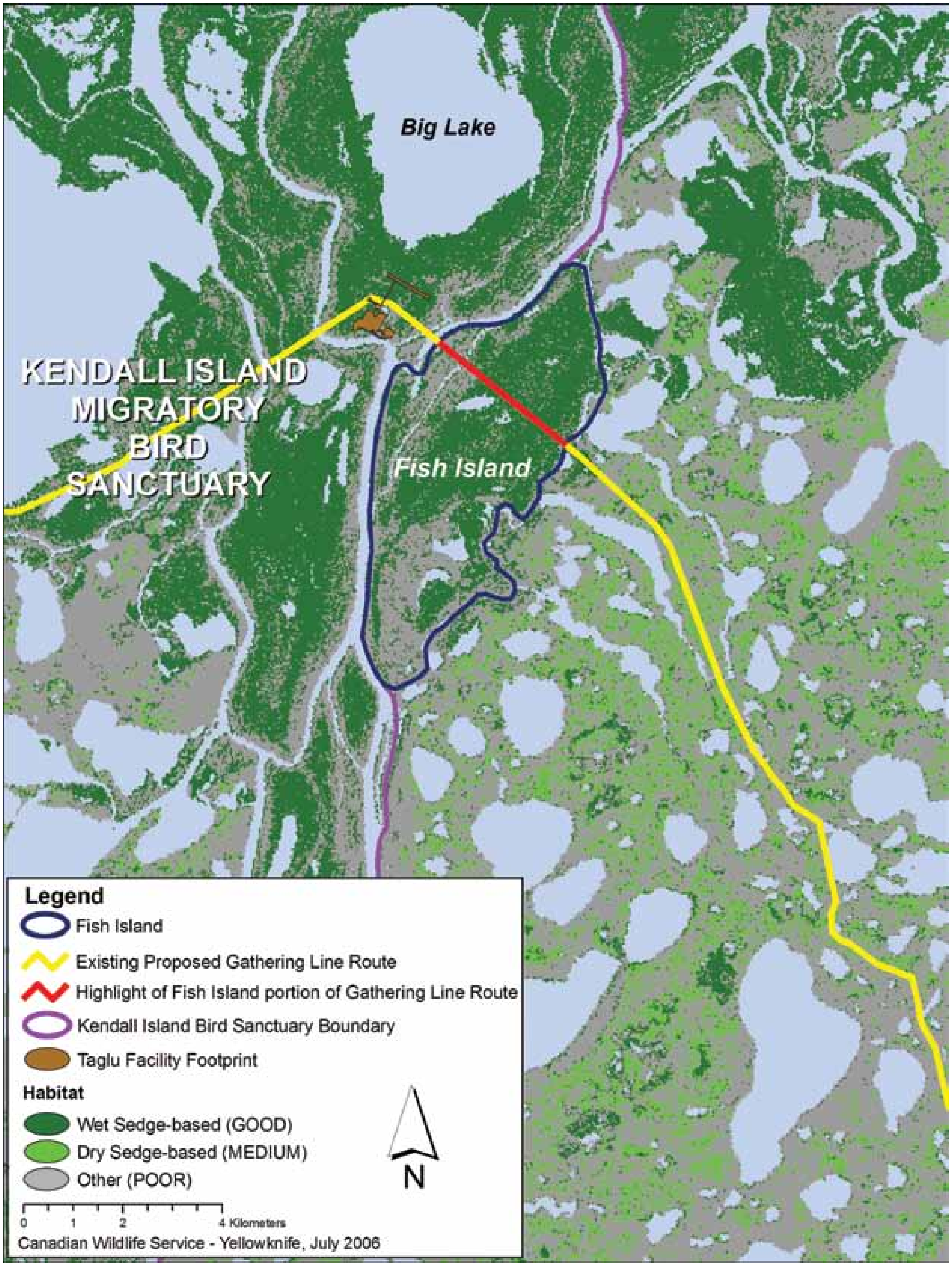
To achieve this goal, Environment Canada recommended that the Plan include, among other things, requirements that the Proponents:

- optimize the time of entry and departure onto the pipeline right-of-way by making real-time decisions based on the near-surface ground temperatures, which could be determined by shallow thermistors;
- ensure that there be absolutely no trimming, scraping or levelling of the rims of wetland sedge polygons; and
- ensure that the depth of the pad be scaled to the weight of vehicles to be used and to the existing height of the wetland sedge polygons and that weight tolerances for the ice pad be specified.

Environment Canada also recommended that the trench be backfilled in a manner that will maintain the integrity of the habitat. In addition, it said that the Proponents should consider, in consultation with Environment Canada, "the merits of segregating soils during excavation and backfilling of the pipeline trench." (J-EC-00173, p. 16) Further, "the pipeline trench should be rehabilitated in a manner which leads to the establishment of species that are present in adjacent polygon rims or centres." (J-EC-00173, p. 17)

The Proponents disagreed with these recommendations. They stated they would determine entry and departure dates by monitoring ambient temperature data and load-bearing capacities of the frozen tundra. Therefore, they do not intend to install and monitor thermistors for this purpose. The Proponents stated that some trimming, scraping or levelling of the rims of wetland sedge polygons would occur within a strip 4 to 5 m wide that straddles the ditch centreline and on steep cross and longitudinal slopes. They did not disagree with Environment Canada's objective but were reluctant to make a blanket commitment in the event that operators encounter conditions where, for safety reasons, they

Figure 6-6 Proposed Gathering Line Route Across Fish Island with Good, Medium and Poor Bird Habitat Indicated



Source: J-EC-00173, Figure 1, p. 12

might not be able to adhere to Environment Canada's standards. The Proponents stated that they would maintain a minimum thickness of 10 cm on the travel lane and work area for vehicles weighing over 9,000 kg.

The Proponents did not agree to segregate soils during the excavation of the trench, noting that experience gained from the Norman Wells Oil Pipeline and Ikhil gas pipelines confirmed that this is not required for reclamation of the trench area. The Proponents stated that commercially available native species would be used where available and, where it is necessary to stabilize erosion-prone areas, reclamation practices would encourage the re-establishment of native species.

Fisheries and Oceans Canada (DFO) stated that it was not clear what impacts a warm pipe might have on spring breakup, bank slumping, ponding and increased erosion, or what impacts on fish and fish habitat would result.

6.4.3 PANEL VIEWS

The Panel observes that the Proponents have been primarily concerned with the potential impacts of thaw settlement along the ditch to pipe deformation and to casing strain and wellhead settlement in the Anchor Fields. The Proponents' proposed monitoring programs are largely intended to determine when those developments, should they occur, would require intervention.

The Panel notes that the Norman Wells Oil Pipeline experience indicates that a combination of conventional surface levelling and cut-and-fill techniques resulted, under certain conditions, in thaw settlement of the entire width of the right-of-way. This impact persisted for years longer than originally predicted, despite efforts to revegetate and rehabilitate the affected areas. The Norman Wells Oil Pipeline right-of-way was narrower and the ditch smaller than would be the case for the Mackenzie Valley Pipeline. As well, much of the Norman Wells Oil Pipeline route followed existing cutlines where permafrost had already degraded before pipeline construction.

The Panel concludes that thaw settlement on the pipeline right-of-way would similarly occur in ice-rich areas, including palsas and peatlands, especially south of Tulita. This subsidence would likely continue over many years and exceed the depths experienced on the Norman Wells Oil Pipeline. There would be a continuing need to monitor and remediate drainage problems as they arose.

As of the close of the Panel's record, the Proponents had modelled the probability of thaw depth under various right-of-way preparation scenarios along the proposed pipeline after five years of operation, but they had not yet identified the specific locations where this might occur. The Panel understands that the Proponents do not intend to preserve the thermal qualities of the existing vegetation mat by maintaining it undisturbed. Instead, they intend to restore those qualities to the extent possible through insulation and reclamation, and minimize adverse impacts on drainage by applying erosion controls. The Proponents' approach to surface insulation is considered further in Section 6.5.

The Proponents asserted that the additional cost of right-of-way preparation using snow and ice pads is approximately $150,000/km, a solution that does not necessarily apply to peat palsas.

Consequently, it is not clear that it is either technically or economically feasible to prevent thaw settlement on all parts of the right-of-way, even with the application of more costly techniques.

The main concerns arising from thaw settlement on the right-of-way are the potential for drainage disruption and the difficulty of maintaining slope integrity. Remedies for maintaining slope integrity are discussed in Section 6.5.

In May 2006, the Panel viewed the entire Norman Wells Oil Pipeline route from the Mackenzie River crossing above Fort Simpson to the Alberta boundary by low-level helicopter flight. The terrain was at or near peak flooding, when drainage disruption would be most readily observed. Although there was much flooding on the right-of-way, as on the adjacent landscape, the Panel did not observe obvious instances of drainage diversion due to the pipeline ditch. Where the right-of-way traversed peat palsas, the terrain, although vegetated, had not returned to its original state or showed any apparent sign of doing so. Such sections, where flooded, resembled fen landscapes. The Panel concludes that where peat palsas were transected by the right-of-way, the combined impacts of right-of-way preparation and subsequent thaw settlement would likely result in the replacement of elevated peat plateau landscapes by fen landscapes.

As the Panel has determined that the impacts of changes to vegetation on wildlife due to right-of-way subsidence would not likely be significant (see Chapter 10, "Wildlife"), the Panel considers that, although subsidence along the right-of-way would occur, the Proponents' right-of-way preparation, construction and reclamation methods are generally acceptable from an environmental perspective.

However, the Panel considers that there may be situations that call for a higher standard of right-of-way preparation, construction and maintenance in order to preserve critical or otherwise important wildlife habitat. In the Panel's view, this would apply to Project facilities in KIBS and to the portion of the gathering system that crosses Fish Island. The Panel agrees with Environment Canada's objectives for those segments of the gathering system and endorses its proposal for a Construction and Operations Plan for KIBS and Fish Island portions of the right-of-way as a means of achieving those objectives, with the following exceptions.

The Panel agrees with the Proponents that the use of thermistors for determining entry and exit dates is not necessary, and that the Proponents' intended methods for determining those dates are satisfactory and would, in any event, be subject to regulatory approval. The Panel also acknowledges that, for reasons of safety, the Proponents may not always be able to construct in the manner suggested by Environment Canada but that these details should be addressed in developing the Construction and Operations Plan. The plan should include a consideration of the merits of segregating soils during excavation and backfilling of the pipeline trench.

The Panel heard no persuasive information about the effectiveness of reclamation in wet polygon environments, nor was the Panel told the reclamation practices, if any, that would encourage the re-establishment of native species. Although the Proponents stated that they would use commercially available native species, they did not provide any evidence that such species are in fact commercially available or that they could become commercially available. Therefore, in the Panel's view, the maintenance of habitat quality on Fish Island would depend on construction practices themselves rather than on post-construction reclamation or mitigation.

The Panel was not informed of any other areas along the gathering system or pipeline right-of-ways that would require a higher standard of construction (with the exception of watercourse crossings and slopes as discussed in Sections 6.5 to 6.7).

The Panel finds that the Proponents' general approach to drainage control is appropriate but should be the subject of further downstream regulatory review when site-specific designs and mitigative strategies are developed.

The Panel considers the Proponents' approach to minimizing ditch fill settlement and to remediating ditch subsidence satisfactory for most situations that would be encountered on the right-of-way. The Panel is concerned, however, that these methods may be less reliable for preventing ditch subsidence and associated drainage problems in low-lying terrain with massive ice that exist along the route of the Mackenzie Gathering System. The Panel notes the NEB's Proposed Condition 12 regarding replacement backfill specifications. However, the Panel also considers that downstream regulators should ensure that the Proponents have sufficient detailed knowledge of the right-of-way and that the Proponents should submit plans in advance of construction. The plans should describe the methods for determining the quality and quantity of imported fill that may be required to minimize the need for subsequent ditch refilling and regrading. The plans should also describe the timing and methods for hauling and stockpiling those fill requirements.

6.5 SLOPE STABILITY IN PERMAFROST

When ice-rich permafrost melts, the soil experiences a temporary increase in pore-water pressure and becomes waterlogged. Where this occurs on a slope, the slope is destabilized and becomes vulnerable to slumping or sliding (rapid downhill soil movement), and the potential increases for soil creep (gradual downhill soil movement). As thaw continues and the excess water drains away, the slope re-stabilizes, and its mechanical characteristics become similar to those of slopes in temperate regions.

6.5.1 PROPONENTS' VIEWS

The Proponents stated that their primary slope design objective was environmental protection, primarily by ensuring that any increase in pore-water pressure during thawing is not sufficient to destabilize the slope. This approach would protect watercourses from the influx of soils from slope movement or erosion because of pipeline construction and operations. Further, the Proponents would ensure that the slopes within the pipeline right-of-way remain stable throughout the life of the Project and, in doing so, reduce potential environmental impacts from erosion and slope movements.

The Mackenzie Valley is very active in terms of slope movements, and the Proponents noted that about 2,000 landslides of all forms have been identified between Inuvik and Fort Simpson. Thus, the pipeline route would traverse terrain that is susceptible to slope movements. At the same time, there are considerable lengths of the pipeline that would traverse unfrozen or ice-poor slopes. In these instances, the design for pipeline construction on slopes from a stability perspective is the same as for temperate regions, and surface erosion control would be the dominant design consideration for these slopes.

The Proponents submitted that slopes can be divided into two broad categories: cross slopes and longitudinal slopes. Cross slopes run perpendicular to the pipeline and have a slope angle greater than 2% (1.1°). Longitudinal slopes are changes in topography that generally run parallel to the pipeline and are defined as greater than 3 m in height and 3° in angle, such as might be encountered at river crossings. Longitudinal slopes are generally steeper than cross slopes and raise more significant design concerns related to potential seismic impacts and landslides of various types, including thaw plug flows, active layer detachments and creep.

The Proponents identified a total of about 70 km along the route where the pipeline would intersect a cross slope greater than 5% (3°) and about 8 km where the cross slope would be greater than about 10%. Where the angle of cross slopes on the right-of-way exceeds 2% (1.1°), the Proponents stated that the working space and trench areas would be improved to provide a safe ground surface for the pipe-laying equipment, as noted in Section 6.2.4.

The Proponents' slope designs for permafrost conditions were based on establishing a series of threshold slope angles. The threshold angle (which can vary based on soil type and thermal region) represents the angle of a slope below which no thermal mitigation is required to ensure stability, and only erosion control needs to be considered. The Proponents adopted more conservative threshold angles in the gathering system because of concerns with the potential for massive ice in some slopes and the documented creep of permafrost slopes even at low angles. Slope threshold values also take pipeline operating temperature into account. Should the operating temperature be higher than assumed, then deeper thawing could result, with the outcome that calculated threshold angles would decrease.

The Proponents identified approximately 231 longitudinal slopes that are above the preliminary threshold angles and would require some form of mitigation. In the absence of detailed site-specific data, the Proponents conservatively assumed all slopes to be ice-rich for the purposes of conceptual engineering. According to the Proponents, Project engineers would monitor and examine the slopes during clearing and construction to confirm that the information applied in the design was appropriate for the actual conditions encountered. Engineers could also modify the design as necessary. Further, the Proponents noted that they would monitor the stability of slopes at areas of concern during operations, including slope movement areas and groundwater levels.

The Proponents also acknowledged climate warming as an important factor in slope design and performance in permafrost because creep resistance would be reduced as permafrost warms. They included allowances for climate-warming scenarios in their geothermal analyses for slope design. Historical warming trends (20- to 25-year trends) were used as warming rates into the future for the life of the Project. The Proponents estimated that the effect of this climate-warming influence would be to increase the 25-year thaw by about 1 m, or 33%. As already noted in Section 6.3, the Proponents consider that climate warming would have only a secondary impact on thawing of the slopes compared with the impact of right-of-way clearing and pipeline construction. The Proponents considered that soil movement would occur slowly and could be detected by monitoring.

The Proponents noted that no slopes on the Norman Wells Oil Pipeline have experienced a stability failure, although creep on several slopes has induced progressively accumulating compressive pipe strains that eventually required mitigation. Based on experience with the Norman Wells Oil Pipeline, the Proponents stated that the number of slopes that may exhibit creep-type movement for the Project is expected to be relatively small.

The Proponents drew the following lessons from the Norman Wells Oil Pipeline:

- The slopes have performed satisfactorily in nearly all aspects. There have been no failures and only minor issues related to erosion.
- The application of a threshold angle concept that identifies slopes for thermal mitigation has been successfully and appropriately applied.
- Use of pre-existing cutlines as the pipeline right-of-way that had already experienced some thawing was beneficial from a slope stability perspective.
- The thaw rate of slopes was generally greater than predicted in design.
- Creep of slopes needs to be addressed in design. Although creep deformations have been completely manageable, the early identification of slopes susceptible to creep may be beneficial from an operations management perspective.

Because the right-of-way for the Mackenzie Valley Pipeline would typically be wider than that used for the Norman Wells Oil Pipeline, there is the potential for deeper thawing and, therefore, reduced slope stability. The Proponents' analysis indicated that a doubling of the right-of-way width used for the Norman Wells Oil Pipeline would cause only a modest reduction in slope stability, which was taken into account and combined with more conservative estimates of other factors influencing slope stability. Further, the Proponents stated that the design approach at steeper, ice-rich slopes would be to narrow the right-of-way width to 24 m south of Norman Wells. At these locations, the right-of-way would not be much wider than that of the Norman Wells Oil Pipeline.

The Proponents noted that various mitigation techniques can be applied to slopes with the aim of addressing or enhancing their long-term stability where they exceed their threshold limit. These include the manner of clearing the right-of-way, installing the pipe by directional drilling instead of by open cut (see discussion of HDD in Section 6.7.2), thermal mitigation, erosion control and monitoring.

The Proponents stated that they would adhere to the following best practices for land clearing on slopes where open cuts would be used:

- Surface disturbance of the right-of-way on slopes would be minimized. Except where required for safety and stability concerns, no grading or removal of the organic layer would be performed. Trees would be mechanically cut by hand, leaving root balls undisturbed. Cuts of steeper slopes would be conducted on a limited basis, with the side slopes protected by a surface layer of insulation or by thermosiphons to reduce disturbance-induced thawing.

- The right-of-way clearing of slopes that are thaw-sensitive would be undertaken only in the year of construction and immediately before ditching and pipeline installation. Some limited pre-clearing would be required (up to 6 m wide) to allow slope access for geotechnical investigations. Where protection of the permafrost is important, it is desirable to preserve the organic mat to the extent practical. The preferred method of slope clearing is hand clearing or use of mechanical equipment that cuts the vegetation close to the ground surface.

In their preliminary design, the Proponents proposed directional drilling on slopes at a number of watercourse crossings within the area of the gathering system and along the pipeline. Directional drilling of the slope and placement of the pipeline in the borehole at a depth below ice-rich permafrost, instead of an open-cut method, would avoid thaw from construction and from pipe operating temperatures.

The Proponents defined "thermal mitigation" as any strategy that addresses the underlying source of thaw instability on a permafrost slope, including thaw reduction or prevention and pore-water pressure control. Potential mitigation options may be applied to slopes on a case-by-case basis. (J-IORVL-00511, p. 105) Thaw reduction mitigation can take several forms, including insulation and cooling. Insulation installed on the pipe itself or around the pipeline trench acts to prevent heat transfer from a warm pipeline to the surrounding terrain. The Proponents submitted that this form of mitigation is ideal when pipeline temperatures cycle seasonally (operating above freezing for part of the year and below freezing for the remaining part of the year). The Proponents noted that, although their thermal mitigation strategy would be to rely on thermosiphons to maintain the slopes in a frozen state, additional work would be completed during final design to confirm this approach. It is also possible that surface insulation may be considered in detailed design.

The Proponents submitted that insulation placed on the ground surface would be effective in reducing the heat flux from the atmosphere to the ground. Insulation may take several forms, including synthetic materials, such as extruded polystyrene, or natural insulation, such as peat, wood chips or straw. The Proponents noted that wood chips had been used for the Norman Wells Oil Pipeline, but they also noted some technical, logistical and cost issues associated with using wood chips for the Mackenzie Gas Project. At the close of the Panel's proceedings, the Proponents were still investigating costs and effectiveness of various options for ground insulation.

The Proponents noted several cooling systems that could be used to limit thawing on slopes. Passive cooling systems, including convective cooling pipes and thermosiphons, do not require continual maintenance or energy inputs, which are not viable options for remote sites. The Proponents submitted that both systems were proven technologies and have been used in permafrost environments, although they noted that thermosiphons had not been used for the proposed application.

Convective cooling pipes typically consist of corrugated metal or plastic conduits that are installed in the sub-grade. The conduits are open in the winter and closed or sealed in the summer. On the Norman Wells Oil Pipeline, convective cooling pipes were installed on the south slope of the Ochre River to mitigate the heat generated by decaying wood chips. Thermosiphons draw heat from the ground in winter and are commonly used to maintain frost around pile foundations. They are used extensively on the Trans Alaska Pipeline System to maintain permafrost around the vertical steel support members that elevate the pipeline above ground, and they were also used to assist in stabilizing an approach slope to the Colville River crossing in Alaska.

The Proponents noted that common water erosion mechanisms that may be active on the right-of-way include sheet erosion (soil particles transported by water flow in a thin layer over a broad area), rill erosion (soil particles transported by overland water flow and concentrated in a confined path) and piping (soil particles transported through conduits created by flowing subsurface water). Processes contributing to erosion include thawing of ice-rich soils beneath the right-of-way and aufeis melting.

The Proponents stated that their design approach to erosion control was to enhance or restore the natural drainage regime along the right-of-way through prevention of erosion during construction and post-construction remediation. The Proponents noted that these methods would include the installation of ditch breakers, diversion berms and drains, as required, to control surface and subsurface water. Foam plugs were used as ditch breakers on the Norman Wells Oil Pipeline, but the Proponents noted that foam shrinkage during curing resulted in cracks and gaps between the foam and the trench wall.

For longitudinal slopes, the exposure of mineral soil could result in surface erosion, and the Proponents noted that this could be controlled in two ways. The preferred method would be to minimize the removal of the vegetative, organic and root layer from the ground surface. Even if compacted by construction traffic, moss and roots form an effective barrier to runoff and surface erosion. If the organic mat is damaged and torn, restoration activities would be required to control erosion. A second method would be to place a flexible geotextile or erosion-control mat over the exposed mineral soil. The intent of this mat would be to reduce erosion while the native vegetation becomes re-established. The erosion-control mat should be installed everywhere that exposed mineral soils are present on terrain that exceeds the threshold gradients for erosion control, which depends on soil type. The Proponents noted that products are available that have been used in harsh winter applications.

As already noted, monitoring of slope performance would be conducted during construction and operations to provide design verification and allow pipeline operators to proactively respond to a variety of developing issues.

The Proponents stated that they would develop a protocol for the timely initiation, review and approval of design changes during construction. The Proponents anticipate field changes only in the event that field conditions are found to vary significantly from those assumed in the design.

6.5.2 PARTICIPANTS' VIEWS AND RECOMMENDATIONS

INAC noted that certain slopes require special attention and that detailed geotechnical information should be obtained as early as possible. INAC stated: "Critical slopes, we would think, are more those slopes that are adjacent to the stream crossings, particularly…proposed HDD crossings, where extra care is going to be required. And we would include in that gathering of more information prior to clearing of the right-of-way…than we might on slopes of less import and certainly for the rest of the pipeline right-of-way." (Livingstone, HT V33, p. 3017) In addition, INAC said that "we don't want unnecessary clearing to take place, and we're particularly concerned about clearing on critical slopes not occurring prematurely." (Livingstone, HT V34, p. 3075)

INAC consultant Dr. Burn added that special consideration should also be given to the early identification of hill-slope ice wedges, primarily in the area of the gathering system, to minimize the thawing subsidence and erosion of these features. Dr. Burn stated: "I am concerned that under some winter field conditions, features such as these might be missed during the construction operation, if the management is solely on an as-encountered basis … these are features that are not normally recognizable in the way that the ice wedge polygons of the lowlands are recognizable." (HT V33, p. 2990, 3017).

INAC consultants Savigny and Baumgard drew attention to examples of slope instability that developed on the Norman Wells Oil Pipeline from thawing around the pipe, leading to subsurface erosion and voids, which were eventually visible at the surface. These did not result in pipe failure but required mitigation.

INAC recommended that, prior to construction, the Proponents submit to the appropriate regulators for approval, detailed mitigation designs and plans for critical slopes, especially at river crossings, and for the prevention of thaw subsidence and erosion along hill-slope ice wedges.

The Proponents did not agree with the first part of this recommendation, stating that they do not plan to complete geotechnical investigations on all significant slopes for the Project and that site-specific plans had not been developed but that these would comply with the NEB's Proposed Conditions. They agreed, with variation, to the second part, but noted that the final design would limit but not prevent thaw settlement and that these concerns would be addressed by the NEB's Proposed Conditions. Geophysical surveys are planned to identify the presence of massive ice along routing for the gathering system prior to construction. The Proponents noted that route alignment refinements would continue to attempt to avoid locations where massive ice might exist on level terrain or on hills and slopes. Lastly, detailed design strategies would be developed to reduce the impact of thaw subsidence and erosion on the integrity of the pipeline and the right-of-way, and to control surface and active-layer drainage and erosion.

NRCan observed that, although no slopes on the Norman Wells Oil Pipeline right-of-way have undergone failure of the entire slope, small portions have moved, as evidenced by localized slumps and tension cracks. These right-of-way features suggest that some slopes may be approaching an unstable condition. NRCan agreed that slopes on the Norman Wells Oil Pipeline right-of-way have generally performed well, but it noted that at a few locations the pipeline has repeatedly undergone loading to the point where the design strain has been exceeded. This loading has been attributed to a combination of thaw subsidence and gradual downhill movement (soil creep).

NRCan noted that the Proponents had presented a detailed analysis of slope stability that follows conventional limit equilibrium design. However, it submitted that examples of distress on the Norman Wells Oil Pipeline due to gradual but ongoing deformation had largely been ignored. NRCan noted that the diameter and wall thickness of the proposed pipeline would be considerably greater than those for the Norman Wells Oil Pipeline. The greater resistance that this pipeline should offer to deformation suggests that pipe wrinkles would not occur on the relatively small slopes that typify the wrinkle incidents seen to date on the Norman Wells Oil Pipeline. However, longer and steeper slopes may offer conditions that could adversely affect the larger pipe.

6.5.3 PANEL VIEWS

Thawing in ice-rich permafrost on slopes can induce instability, with impacts for both pipe integrity and the environment. This is of particular concern at steep slopes at watercourse crossings, where thaw settlement and slumping may lead to erosion and deposition in the watercourse. The adverse impacts of thaw settlement (discussed in Section 6.4) are thus exacerbated at watercourse crossing slopes.

The Panel considers that the Proponents have anticipated this problem and have designed for it, on the basis of experience with the Norman Wells Oil Pipeline, where the problem of thaw settlement induced by right-of-way clearing was, in principle, the same. Additional thaw could be induced where the pipe operating temperature is warm. Although pipe integrity concerns as experienced with the Norman Wells Oil Pipeline might be overcome by the fact that the Project's pipe would be thicker and stronger than that used for the Norman Wells Oil Pipeline, the environmental impacts might not be.

The Proponents identified several options for mitigating potential thaw impacts on slopes, noting that the combination of available mitigation tools should be effective in principle. However, the

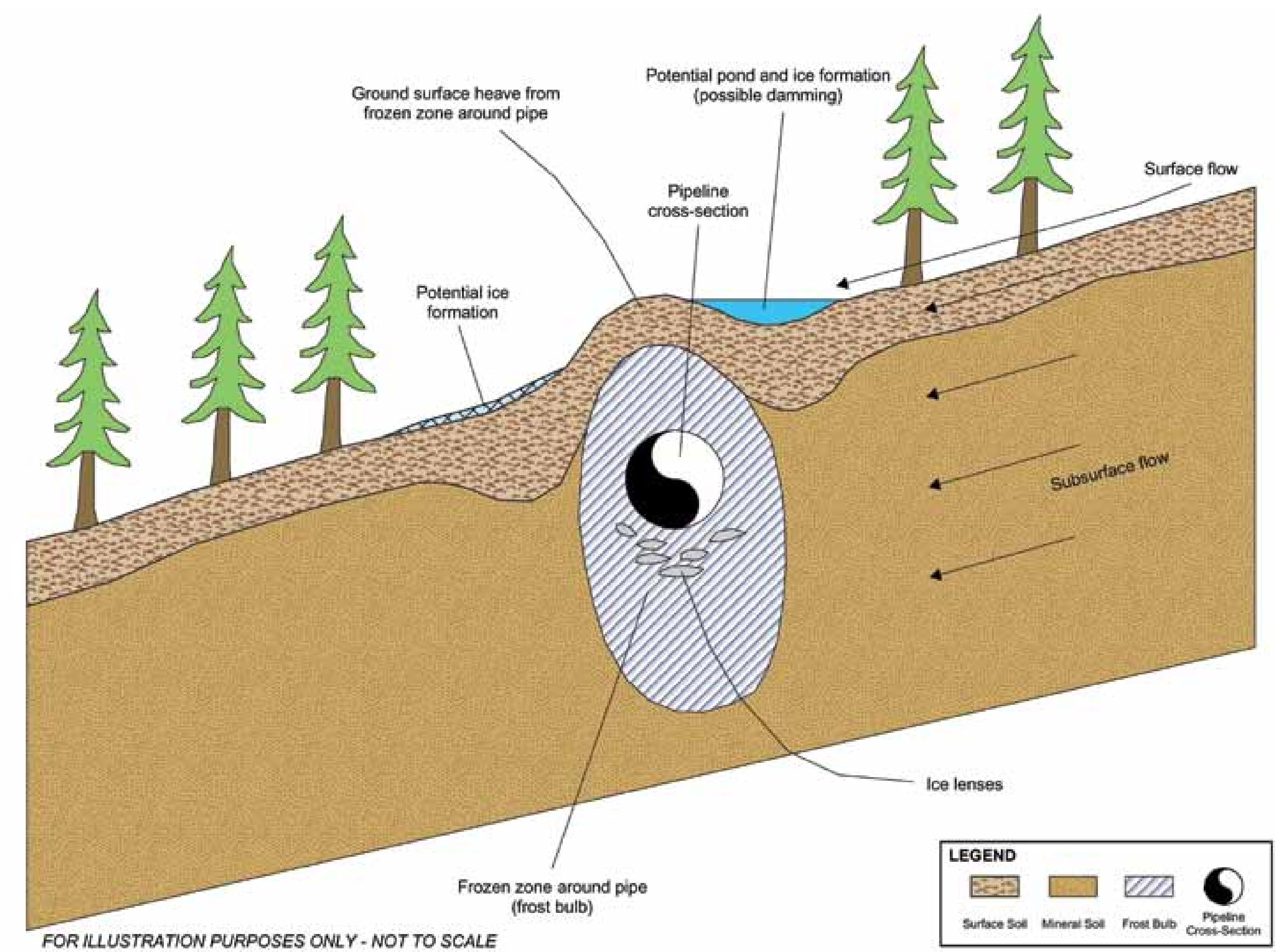
Panel notes that the materials to be used for surface insulation had not yet been selected and that the particular slopes that might be directionally drilled had not yet been fully identified. Although this introduces some uncertainty until the design has been finalized, the Panel is confident that proven techniques are available to mitigate thaw impacts on slopes and, therefore, the risk associated with this uncertainty is low. For example, the Panel notes that thermosiphons have been used to minimize heat influx for over 30 years in permafrost environments, with apparent success in a number of applications, and that they could be installed after construction to mitigate thawing on slopes where this occurs beyond design expectations.

The Panel notes that NRCan is basically satisfied with the Proponents' design approach and their understanding of lessons learned from the Norman Wells Oil Pipeline. INAC and NRCan recommended that further details with respect to design, mitigation and monitoring of critical slopes be provided prior to construction. In the Panel's view, the NEB's Proposed Conditions 16 and 17, if implemented, would address these concerns and provide the essential information.

6.6 FROST HEAVE, FROST BULBS AND GROUNDWATER FLOW

As chilled gas flows through a pipeline at temperatures below 0°C, it freezes the surrounding soil to form a frost bulb around the pipe, as shown in Figure 6-7. As long as the flowing gas is below 0°C, the bulb will gradually expand. If the temperature of the gas flowing past the bulb is raised to above 0°C, the bulb will gradually degrade. As noted in Section 6.3, gas temperatures may fluctuate above and below zero at any particular location, both seasonally and as compressor stations are added over time. Where the soil surrounding the pipe was previously unfrozen, frost bulb growth may have adverse impacts on the pipe itself and the environment.

Figure 6-7 Ground Heave and Frost Bulb Formation Schematic



Source: EIS V5B, Section 5, Figure 5-5, p. 32

Freezing of fine-grained soils increases the volume of the soil by expanding pore water and, more significantly, by drawing water to the freezing front where it freezes into lenses of more or less pure ice. Soils that undergo substantial heaving consist of alternate layers of ice-saturated soil and ice lenses. Frost heave can occur seasonally or continuously if freezing of the ground proceeds without interruption over a period of years. Very high expansion pressures can develop as the ground freezes, which displace (heave) or deform structures buried in the ground or on the surface. Stress on the pipe may develop, particularly where the pipe passes between previously frozen and unfrozen ground (e.g. in discontinuous permafrost or at stream crossings where talik exists below the stream bed).

It is also possible for a frost bulb to penetrate the water column above a stream bed, especially under conditions of low or intermittent flow, which could have the effect of displacing stream flow to the surface, where it can form thick and widespread aggregations of ice (aufeis). Similarly, groundwater flow in unfrozen soils can be disrupted and, if diverted to the surface, can result in ponding or aufeis, as shown in Figure 6-7.

6.6.1 PROPONENTS' VIEWS

FROST HEAVE

The Proponents recognized the potential for deformation loading of the pipe by frost heave associated with ground freezing along the pipeline, but they submitted that frost heave is generally difficult to predict. Therefore, the Proponents stressed that the pipeline would have to be monitored for movement over its lifetime (via an inline inspection program), and remedial measures would be taken where target strain levels were exceeded. As noted in Section 6.2, the Proponents' designed risk management approach assumes that any pipe deformation would develop slowly and that there would be sufficient time for analysis, planning and mobilization of materials. In this way, intervention would be managed and effective and would safeguard the integrity of the environment.

The Proponents recognized that the raised ground surface due to frost heave could interrupt overland drainage paths, create ponding areas and result in changes in drainage patterns. The Proponents noted that the most important impacts of the Project on groundwater would be along the pipeline where frost bulbs could form and divert groundwater to the surface. They submitted that these impacts would be localized and would occur only when the pipeline is operational. The Proponents indicated that once chilled gas is no longer flowing, any frost bulbs that have formed will melt over time.

The Proponents noted that the impacts of frost heave during pipeline operations could be alleviated by:

- using insulated pipe to reduce the rate and size of frost bulb growth;
- installing thermosiphons to reduce the rate and size of frost bulb growth; and
- excavating thawed soil in summer in areas of heave to reduce uplift resistance and pipe strain.

FROST BULBS AT WATERCOURSE CROSSINGS

The Proponents noted that frost bulb formation at watercourse crossings along the chilled gathering system and pipeline could create flow obstructions if the bulb penetrated into the stream channel. According to the Proponents, the highest risk of complete flow blockage by frost bulbs in winter is at small Active I Channels, of which there are about 70 along the pipeline's proposed route (see Section 6.7). Streams classified as Vegetated or Active II Channels were considered to be typically dry or frozen to the bed in winter and consequently were considered to have negligible or low groundwater flow. The Proponents indicated that more than 75% of the streams crossed by the Project pipelines are either Vegetated or Active II Channels. Disruption of groundwater flow for Large Channels was considered to be negligible because of the size of such watercourses and the minor contribution of groundwater to their total surface flow. The size of the frost bulb and the potential to penetrate the stream channel would depend on the surface water flow, groundwater flow, substrate particle size, pipe temperature and pipe burial depth.

The Proponents stated that freeze impacts at stream crossings would be addressed by design mitigation, such as pipe insulation, deeper installation or a combination of both. This would ensure that a thaw zone persists beneath the stream bed in Active I Channels that are susceptible to large frost bulb growth. This talik thaw zone is expected to prevent frost bulbs from penetrating the channel bottom.

Criteria to select areas requiring mitigation would be developed during detailed design and would be based, in part, on further analysis of geohazards. The Proponents' preferred mitigation is insulation, because burial by itself requires substantial depth to be effective. The Proponents noted that insulation will have the greatest beneficial effect where pipe temperatures cycle above and below freezing on a seasonal basis and will have the least effect where the temperature is continuously below freezing.

The Proponents committed to apply appropriate mitigation at all pipeline watercourse crossings where frost bulbs could affect the environment. These include watercourses where mean annual pipe temperatures would be colder than approximately -3°C and one of the following conditions applies:

- sites that have overwintering fish habitat that do not have sufficient flow to prevent excess icings; and
- sites that might freeze to the bottom but have sufficient groundwater so that large icings could form and affect downstream fish habitat.

The Proponents stated that, although they agreed that suitable mitigation measures should be applied at locations susceptible to frost bulb and thaw-related impacts on fish and fish habitat, mitigation would be required only at streams where overwintering or fall-spawning habitat is present, and where thermal and ground conditions exist such that frost bulb growth could block flow. The Proponents further noted that they were committed to working with DFO and other regulators to satisfy applicable regulatory requirements and refine mitigation measures.

However, the Proponents acknowledged that even under controlled operating temperatures, there is still the potential for significant freezing along the pipeline route. In analyzing the expected magnitudes of frost heave associated with varying geotechnical conditions along the cross-country portions of the route, the Proponents employed a desktop analysis using "characteristic" soil properties and thermal conditions derived from limited field sampling and existing databases. The Proponents noted that not all significant frost-susceptible conditions would be identified by this approach and that "frost heave in excess of the allowable design criteria will occur along the pipeline within its operating life." (J-IORVL-00337, p. 13) During operations, aerial monitoring of icings along the pipeline corridor would be used to identify potential areas requiring mitigation.

NGTL stated that it expected that frost bulb formation would be more moderate along its route than for similar types of soil along the pipeline right-of-way, chiefly because the pipe operating temperatures would be warmer and gas pressures lower. Where mitigation was necessary, they would consist of a combination of pipe insulation and deeper burial.

Overall, the Proponents submitted that changes in water levels and flow velocities because of frost bulb formation are expected to have no impact to low-magnitude impact, depending on the channel type and mitigation applied. Impacts could potentially be moderate to high magnitude in a few localized places where the redirection of groundwater leads to large icings and blockage of stream flow. For Large Channels, the Proponents submitted that there would be no impact on water levels or velocities because the frost bulb obstruction would be small compared with the flow capacity of the river.

OTHER PROJECT IMPACTS ON GROUNDWATER FLOW

The Proponents submitted that, at the Anchor Fields, low- to moderate-magnitude changes in recharge from surface water could be expected because of surface water withdrawals during construction and potential flow obstruction during construction and operations. Changes in groundwater quantity and flow patterns, in response to those changes in surface water recharge, are expected to be similar but somewhat attenuated because they would be more subdued in magnitude and potentially of longer duration. These changes are expected to be of low magnitude. Changes would occur during construction, operations and decommissioning, and impacts related to these activities would persist into the long term, i.e. for some time after the removal of surface facilities and site reclamation.

The Proponents stated that most shallow groundwater flows near the production facilities in the Mackenzie Delta occur during the summer months in the active layer above the permafrost. These areas have low gradients and are classified as having poor to very poor drainage. Therefore, most of the shallow surface water does not flow. Deeper subsurface flow might occur beneath the permafrost and in the thawed zones and discontinuities in the permafrost adjacent to lakes and rivers. However, the Proponents noted that, as the facilities and pipeline routes are remote from lakes, rivers and taliks, there is little opportunity to disrupt the flow in these areas. They submitted that existing surface flow is already poor to very poor and would not be further affected by the facilities and drilling methods proposed for these areas.

Outside the Delta areas, the permafrost is continuous and much thicker, and most of the shallow groundwater flow occurs during the summer in the active layer, which covers large areas. There is greater relief outside the Delta area, and more opportunity exists for disruption of surface flow by grading and pad construction if not properly mitigated. With the implementation of appropriate mitigation, the Proponents submitted that drilling, surface construction and operations activities would have small impacts on the surface and subsurface groundwater flow regime in the production areas.

The Proponents also stated that minor, undetectable impacts on groundwater quantity and flow patterns are expected in response to any changes in permafrost distribution as a result of the Project. Subsidence-induced changes in permafrost caused by resource extraction would persist into the far future, and related changes in groundwater quantity and flow patterns would also persist into the far future.

The Proponents submitted that all impacts on groundwater from Project-related activities are expected to be of local extent. Most impacts would be initiated by construction activities and would result in changes that would persist through, or occur during, the remainder of the Project. Some impacts would persist into the far future, specifically those related to:

- sedimentation;
- flow obstruction around the pipeline;
- changes in permafrost at Niglintgak and Taglu; and
- changes in recharge and discharge related to removing materials from the borrow sites.

However, the Proponents stated that all residual impacts are expected to cause only small adverse changes in groundwater, which are within the normal range of variation. Thus, the Proponents submitted that no significant impacts on groundwater are predicted as a result of the Project.

The Proponents noted that the presence of Project facilities in areas of discharge might disrupt groundwater discharge or result in the formation of new discharge areas. These changes could result in alterations to groundwater quantity and flow patterns, changed water table levels and changes in the distribution of wetlands frequently associated with the discharge areas.

The Proponents made several commitments with respect to protecting groundwater. These included, where practical and appropriate:

- installing sub-drains or ditch breakers in the pipeline trench, where required, to facilitate groundwater flow;
- implementing measures to maintain natural drainage patterns of subsurface and surface water flow, such as breaks in the roach (crown) at watercourse crossings, and to restore drainage where it might be blocked and where ponding occurs along the right-of-way and roads; and
- elevating or thermally separating surface facilities from the ground at Niglintgak to minimize changes in permafrost conditions.

6.6.2 PARTICIPANTS' VIEWS AND RECOMMENDATIONS

INAC observed that, in areas of discontinuous permafrost, groundwater flow is restricted to unfrozen ground. In these areas, frost bulb formation around the pipeline could block movement of groundwater across the pipeline. This could potentially concentrate surface and subsurface flow in the unfrozen portion of the right-of-way. This could lead to erosion, gullying, and perhaps subsurface piping on sloping terrain (both longitudinal and cross slopes). Also, ground disturbance during pipeline construction could create ponding or surface icings. Water in this disturbed ground could move along the pipe or parallel to it, potentially resulting in erosion or slope instability.

INAC recommended that the Proponents provide regulators with more detailed information on their plans for mitigating frost bulbs, which might impede drainage, and on the use of ditch plugs for mitigating groundwater flow along the pipeline ditch.

The Proponents agreed, with variation. They stated that in the current design phase they have acquired lidar (light detection and ranging) elevation data for most of the pipeline's proposed route. This data was used to identify cross slopes and areas where surface and shallow groundwater drainage might be affected during construction. The Proponents were also developing profiles of the operating pipeline temperatures and modelling where soils might freeze during pipeline operations. Prior to pipeline installation, a field reconnaissance of the pipeline's route would be undertaken to confirm the basis and selection of construction mitigation. The Proponents also noted that many of the industry-standard approaches to drainage and erosion control would be used. Although the Proponents did not propose alternative methods to control groundwater flow, they would define appropriate measures on construction drawings and in construction specifications. Field engineers might modify these measures during construction to apply the most suitable measure for the actual right-of-way conditions encountered.

NRCan filed recommendations relating to frost heave impacts on pipeline integrity.

DFO indicated that it was concerned that the seasonal timing and location of the impacts had not been identified and that the Proponents were proposing mitigation only at larger Active I Channels. DFO suggested that the pipeline should also be insulated at smaller watercourses, and it made a number of preliminary recommendations regarding frost bulb and aufeis formation. As discussed in Chapter 9, "Fish and Marine Mammals," DFO also noted potential impacts to fish and fish habitat as a result of pipeline temperature-induced freeze and thaw impacts at watercourse crossings.

In its closing remarks, DFO noted that frost bulbs, frost heave and aufeis formation are all possible results of design, engineering, construction and operations/maintenance decisions. Further, the consequences of these decisions would have some impact on the physical environment and the biological community that relies on that physical environment, particularly fish and fish habitat. DFO noted that it had recommended to the Panel and to the Proponents that a precautionary and adaptive management approach be applied at the outset of the design, construction and operations phases to mitigate impacts from frost hazards so that:

- they are prevented from happening;
- any unforeseen impacts or mitigation failures are detected early; and
- an effective monitoring plan is in place and any problems detected are addressed promptly.

6.6.3 PANEL VIEWS

The Panel notes that all participants acknowledged the potential for frost heave. To the extent that frost heave may affect pipeline integrity, the Panel assumes that the NEB will address the engineering details required to deal with it. However, frost heave may have environmental consequences, even where pipeline integrity itself is not at risk or can be effectively managed or remediated. Environmental consequences relate mainly to frost bulb formation in soil and streams, which can lead to blockage or diversion of surface drainage, groundwater flow or stream flow.

The Panel heard that frost bulb formation can be reduced (although not entirely eliminated) by using pipe insulation, that its impacts at stream crossings can be further reduced by deeper burial of pipe, and that possible impacts on surface and groundwater drainage could be averted by installing ditches and plugs as appropriate during construction. Because the Proponents cannot accurately predict and correct for all such occurrences in advance, they would monitor for their development on a regular basis and remediate them. The Panel understands that the Proponents are committed to using these techniques during construction as conditions require.

INAC's chief concern related to when the Proponents would provide further information to regulators regarding the locations where environmental problems might actually occur and the site-specific mitigation methods that would be proposed.

DFO's chief concern, based on the potential for adverse impacts on fish and fish habitat resulting from stream flow blockages, related to the selection criteria for applying blockage mitigations during construction. In DFO's view, the Proponents' stream classification approach might not fully account for all fish habitat that could be adversely affected. DFO recommended that the Proponents apply construction mitigations to a larger set of stream crossings than they proposed. The Panel accepts the need for identifying potential problems in advance of construction. The need for a precautionary approach to the application of mitigations in the face of uncertainty, as requested by DFO, is considered in Chapter 9, "Fish and Marine Mammals."

The Panel notes that the Proponents are committed to further refine the assessment of impacts with respect to frost heave and frost bulb formation through their geohazard assessment and as further site-specific information is collected through the Geotechnical Verification Program. This additional information would facilitate the final design and development of the mitigation plans to deal with environmental impacts of frost bulbs. However, as noted in Section 6.3.4, the Panel is not persuaded that the Proponents currently have a viable long-term mitigation plan for either the prevention of frost bulb formation at low-flow streams, or for the thawing of frost bulbs at slopes and river crossings due to changes in the operating temperature regime during operations or upon abandonment.

As further noted in Chapter 9, "Fish, and Marine Mammals," the Proponents indicated that they would identify locations where there could be a risk to fish and that they would implement appropriate mitigation measures. The detailed design phase of the Project would offer the opportunity for the Proponents and DFO to identify locations where frost bulbs and aufeis might occur and the necessary measures that could be taken in the design of the pipeline and/or implemented during construction to mitigate any potential impacts.

It is the Panel's view that the impacts of the Project on groundwater flow are not likely to be significant, provided the Proponents' commitments and Panel Recommendations to 6-2, 6-6 and 6-7 are implemented.

6.7 WATERCOURSE CROSSINGS

This section examines the Proponents' proposed design and construction of watercourse crossings, the potential impacts on shoreline and channel morphology and integrity, and the Proponents' proposed mitigations and decision criteria. The potential impacts of watercourse crossings on aquatic habitat and biota, and the need to mitigate those impacts, are considered in Chapter 9, "Fish and Marine Mammals."

6.7.1 EXISTING CONDITIONS

The Project would cross almost 700 watercourses throughout its length. A high proportion of these watercourse crossings, particularly north of Fort Simpson, are located near watershed discharge points into the Mackenzie River.

Watercourses along the proposed pipeline routes range from large rivers, such as the Mackenzie, to numerous vegetated channels that flow only during spring runoff and have no discernible banks. The Proponents classified these watercourses according to drainage area and flow characteristics, including whether the channel has year-round flow. For the purposes of preliminary design, the Proponents classified their intended watercourse crossings as follows:

- Large: a water channel that is identified by name on Government of Canada topographic maps at a scale of 1:50,000 and that has a perennial flow and a drainage area greater than 1,000 km^2;
- Active I: a water channel that has perennial flow or is partially frozen to the channel bed in winter;
- Active II: a water channel that is frozen to the bed or has no flow in winter; and
- Vegetated: an ephemeral watercourse that might be a depression or swale. This kind of watercourse experiences flow primarily only during spring runoff. It has no discernible banks or evidence of annual sediment transport.

Approximately 20 crossings were classified as Large, 70 as Active I, and 70 as Active II Channels. The remainder were Vegetated Channels, ponds or lakes. There are over 40 watercourse crossings in Alberta, with 1 classified as a Large Channel and approximately another 15 classified as Active I or Active II Channels.

6.7.2 PROPONENTS' VIEWS

The Proponents intend to bury all pipelines at river crossings in order to minimize the risk of pipeline exposure or damage to the pipeline under the design flood conditions for its service life. The Proponents have not planned for above-ground crossings (with the possible exception of Zed Creek, north of Inuvik), although they stated that further engineering and construction planning may identify the need for them.

The Proponents noted that construction activities such as ditching, pipe lowering and backfilling would disturb the channel beds and banks and result in high levels of sediment entrainment under flowing conditions. The Proponents submitted that sediment concentrations should decline with increasing distance downstream because of settling of suspended sediment. Their sedimentation modelling showed that highest deposition occurs immediately downstream of the crossing location. Sediment that remains in suspension consists of finer material that would settle out only at much greater distances downstream.

The Proponents plan to construct watercourse crossings during the winter season, when about 84% of the watercourses are expected to be dry or frozen to the bed and the flow in the remainder would be low. Reducing the amount and duration of in-stream work is an overall mitigation strategy of the Project.

The Proponents propose three types of watercourse crossing techniques: open cut, isolated and HDD. Open-cut and isolated crossing techniques involve excavation and in-stream work. HDD crossings leave the bed and banks undisturbed and, therefore, avoid adverse impacts on aquatic habitat.

Approximately 600 watercourse crossings would be constructed using open-cut techniques. This would apply particularly to Vegetated Channels and Active II Channels, which are understood to be dry or frozen to the channel bed in winter. The remainder would be isolated or HDD crossings where fish habitat exists downstream.

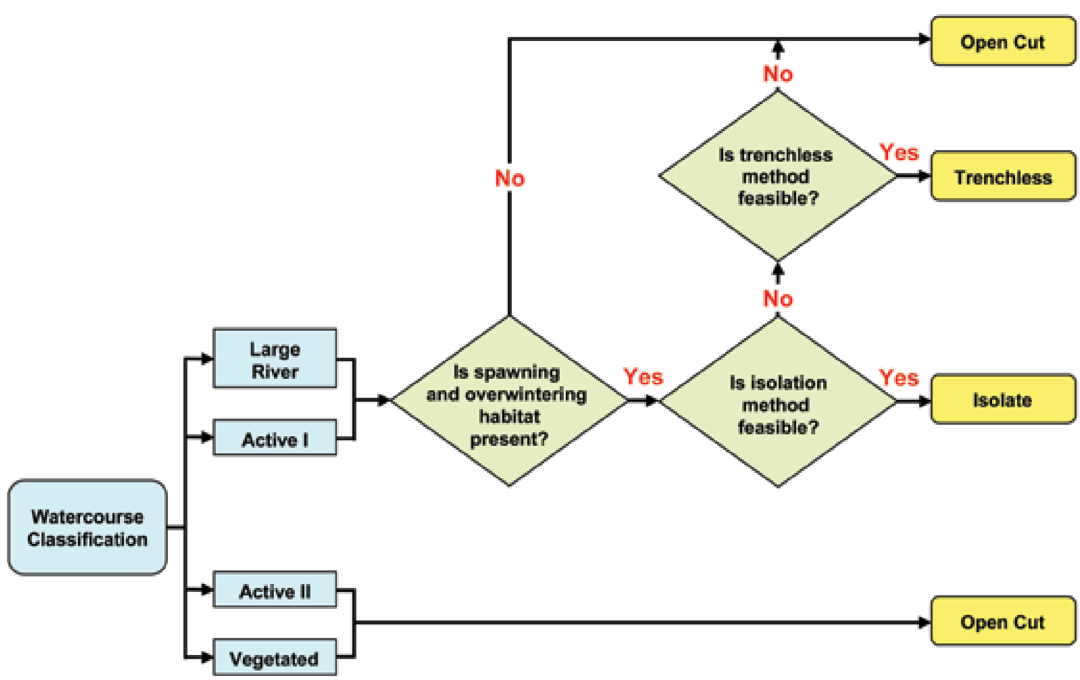
Figure 6-8 indicates how the Proponents would select the appropriate crossing methods for each watercourse.

The actual feasibility of the construction technique identified for each crossing would depend on site studies and conditions at the time of construction. Additional information from field programs would be considered during detailed engineering and would be used to refine the selection of crossing method. The Proponents noted that in-stream work would be addressed in the Project's Environmental Protection Plan.

The open-cut method of constructing a pipeline watercourse crossing involves digging a trench in the stream bed, placing the pipe in the trench and burying it with backfill. Ninety-five percent of all of the crossings using the open-cut method would be dry or frozen to the bed or would have only shallow pockets of standing water at the time of crossing construction.

The isolation method of watercourse crossings involves diverting the stream around the crossing location and excavating the trench, installing the pipe and backfilling away from flowing water. The use of flow isolation techniques requires knowledge of the flow during construction and the specific river conditions. If the construction flow and river conditions did not enable the implementation of practical flow isolation techniques, the Proponents noted that the open-cut technique could be an option, if approved by regulatory agencies. If disturbed, the

Figure 6-8 Watercourse Crossing Technique Decision Process



Source: EIS V2, Section 4, Figure 4-9, p. 66

riverbed and banks would be restored using available natural materials. The need for concrete weighting or concrete coating of the pipe to provide additional protection for the pipe would also be assessed based on the characteristics of the crossing and the likelihood of design scour.

Site-specific erosion and sediment control plans would be developed for each excavated watercourse crossing of Large or Active I Channels, and a generic plan would be developed for all Active II and Vegetated Channels. The Proponents anticipate that impacts from open-cut or isolated crossing construction would be short and limited to the actual period of crossing construction, which is generally expected to be less than seven days and even shorter for smaller streams.

HDD or isolation methods would be used for crossing watercourses that are used as overwintering habitat or spawning habitat for fall spawning species. Based on preliminary feasibility assessments, the Proponents propose to use the HDD method at 17 locations, including crossings of Delta channels, most Large Channels, some Active I Channels and one Vegetated Channel. The majority of these potential HDD sites could be reached only by ice road, limiting construction to the winter season. Major HDD crossings, such as the East Channel, could take several weeks.

The HDD method is a relatively recent development and was not used on the Norman Wells Oil Pipeline. The Proponents acknowledged there have been very few HDD installations in the far north and that permafrost poses some particular challenges. However, they noted that HDD crossings of the Colville River in Alaska were successfully drilled through a thick, high-ice-content layer, using cool freshwater mud. This technique would be incorporated in the design of the Project's HDD crossings, as appropriate. Of the HDD sites investigated by the Proponents to date in the Mackenzie Delta, none has thick ice layers.

The Proponents noted that a particular challenge for the Project is the complex subsurface thermal condition of permafrost and its potential implications for the use of HDD drill slurry. Drill slurry, or mud, is specially designed to transport cuttings from the drilled hole, stabilize the hole, provide lubrication and cool the downhole tools. In most HDD applications, the mud is a mixture of fresh water and bentonite clay. The Proponents identified two competing mud temperature issues for HDD in the North. First, in ice-rich soils, if the mud is warm and causes the permafrost to thaw, the integrity of the hole could be lost and the hole could collapse. Second, cold drill slurry could freeze in the drilled hole if mud circulation is lost for an extended period of time.

To avoid thawing of ice-rich permafrost during the drilling process for HDD crossings in the Delta, the Proponents stated that they would construct a surface pad over top of the permafrost and use drilling mud that is cooler than would be used on non-permafrost crossings. Where ice-rich and thaw-sensitive permafrost was encountered, casing would be used to isolate and protect the ground material from the actual drilling. The casing would be removed prior to pulling the pipe in.

Ideally, all drilling mud pumped downhole flows back through the drilled hole to either the entry or exit pit. The cuttings are then removed and the clean mud is reused. The thaw zone beneath a river may significantly affect drilling fluid returns if the material is fine-grained and not densely packed, making it subject to caving. The Proponents noted that, in these situations, casing may be used if the problem zone is not too remote from the drill rig.

Nonetheless, it is not unknown for mud to be lost to the surrounding strata during HDD operations. Most of the inadvertent losses occur near the entry and exit points. NGTL cited sections of a case history review of HDD in North America, which stated that drilling mud seepage is most likely to occur when highly permeable zones are present with minimal cover between the drill path and the bed of the watercourse. Potential problems are compounded for installations of large-diameter pipes and increased crossing width.

The Proponents noted that, in these cases, some mud could be recovered, but they acknowledged that a release of drilling mud would be difficult to mitigate for larger watercourses and deep water. However, the Proponents also submitted that HDD mud is more environmentally benign than exploration drilling mud because it is mostly bentonite clay. They noted that accidental release of HDD mud would not likely adversely impact water quality because it would stay bound together in a gel-like suspension when mixed with water and would eventually settle out.

The Proponents also noted that they would be preparing contingency plans to address accidental mud releases from HDD activities. Upon questioning, however, the Proponents provided no clarification as to how a contingency plan would actually provide for containment where mud was accidentally released into flowing water.

The Proponents noted that HDD drilling fluids and solids, which contain water, mud, cuttings and possibly some chemical additives, would require disposal. Disposal options being considered include distribution along the pipeline right-of-way and disposal at borrow sites.

The feasibility of HDD crossings depends on geotechnical and geological conditions under the stream bed and in the approach slopes, and on the depth and width of the river valley. Final determination would depend on the analysis of results from further geotechnical and hydrological investigations. If HDD is not suitable for certain crossings, alternative designs would be required, including an open cut or moving the crossing to a nearby site, if available. HDD crossing feasibility reports would be prepared and submitted for each HDD candidate crossing as engineering progresses.

In the event that a HDD crossing method was unsuccessful, open-cut methods would most likely be used as an alternative. Feasibility reports for HDD crossings would include the open-cut drawing and a brief description of the open-cut design. The Proponents stated that the alternative crossing construction method would likely require summer installation but that environmental impacts were predicted to be low in magnitude, localized and short term. The crossing would be excavated using a dredge, with the material removed from the ditch and side-cast to the downstream side of the open-cut crossing as much as possible. The pipeline would be coated in concrete and dragged into place in the completed ditch. The main part of the channel would not likely be backfilled and would be left to infill naturally. For a small crossing, the open cut would likely be attempted in the same construction season.

The Proponents made several key commitments to address potential impacts related to pipeline watercourse crossing construction and operations relating to:

- drainage, erosion and sediment controls;
- reducing disturbance next to the stream bed;
- reclaiming disturbed areas to stable conditions;
- using long-term erosion-control measures on slopes and stream banks, where required; and
- where practical, using clear-span bridges or culverts on all-weather roads to cross Active I watercourses.

The Proponents indicated that, when crossing a lake, a silt curtain would be used to contain suspended sediments to the work site through that portion of the lake that is not frozen to the bottom. The Proponents also stated that where pipe buoyancy could be a concern, such as in fens, they intend to use concrete weights and/or screw anchors to restrain the pipe to avoid potential exposure of the pipe and pipe flexure.

NGTL stated that it would follow Alberta's *Code of Practice for Pipelines and Telecommunications Lines Crossing a Water Body*. These requirements are consistent with crossing methods and mitigation measures described in the Project's decision trees. NGTL intends to cross one large river by HDD and possibly some additional Active I Channels.

Overall, the Proponents submitted that, taking into account the selection of crossing methods and the successful implementation of appropriate mitigation, the residual impacts of pipeline-crossing construction on sediment concentrations, channel morphology, water and sediment quality, and fish and fish habitat would not be significant.

The Proponents noted that their assessment of impacts on sediment concentrations at pipeline stream crossings was based on winter mean monthly flow estimates. The uncertainty in winter low-flow estimates is generally high even with site-specific flow data. The Proponents stated that the degree of conservatism used in their predictions of sediment concentrations compensates for the uncertainty in the winter flow estimates and increases confidence in the impact assessment. They noted that erosion control and mitigation would be implemented and monitored during construction and operations and that they would be maintained throughout the life of the Project.

With respect to cumulative impacts and sediment concentrations, the proposed watercourse crossings could act cumulatively if they were near existing crossings. The Proponents indicated that the cumulative impacts would occur only during watercourse-crossing construction during the short period when sediment was mobilized. Locations and magnitude of cumulative impacts would depend on proximity to the existing crossings and on the amount of sediment mobilized, which in the Proponents' view depends on stream size, flow during construction and the crossing method. The Proponents concluded that the Project's contribution to cumulative impacts on sediment concentration would not be significant and that overall cumulative impacts on sediment concentrations would not be significant.

6.7.3 PARTICIPANTS' VIEWS

INAC consultant Dr. Burn pointed out that river crossings in permafrost regions also pose a particular challenge because the pipe may go from frozen ground in the riverbank, continue through unfrozen ground beneath the channel, and re-enter frozen ground beyond that. Depending on the location of the crossing with respect to compressor stations, the pipe would either thaw the riverbanks or freeze the bed. River crossings may also involve negotiation of steep approach slopes. Potential environmental impacts and mitigation regarding operating temperatures and slope stability and erosion are discussed in Sections 6.5 and 6.6 of this chapter.

Dr. Burn pointed out that there is limited experience in using the HDD method in permafrost and no experience in warm, discontinuous permafrost, such as along the Mackenzie Valley where several such crossings are planned. Dr. Burn also expressed concern over the potential erosion of ice-rich permafrost by the returning drilling fluids, as these fluids would pass for several hundred metres through warm ground beneath the channel and then back through ice-rich permafrost to the entry of the drill.

INAC noted that many rivers and creeks in the Mackenzie Valley are incised into glacial lake sediments, and the pipeline would traverse ice-rich ground. It is likely that, at many minor and intermediate stream crossings, excavated trench material at stream banks would be ice-rich. The river crossings in the gathering system generally involve less relief between banks and channels compared with conditions in the Mackenzie Valley, but ice-rich permafrost occurs widely throughout the Mackenzie Delta. INAC expressed concern that, where the approach trench would be cut in ice-rich soil and backfilled using the same material, there could be sloughing into the stream as the ice melts in spring and summer following construction. Sloughing of backfill material adjacent to stream channels would affect slope stability, which in turn could lead to erosion, stream contamination and silting. Without proper mitigation, there is the potential for the uncontrolled release of sediments into streams, possibly resulting in greater environmental impacts than predicted. INAC submitted that this problem would likely develop after construction crews have left, possibly making it more difficult to implement mitigative measures and avoid environmental impacts.

INAC submitted that in such situations it may be necessary to use select backfill material. As the number of affected crossings may be substantial, material would need to be stockpiled at accessible locations on an as-required basis. In INAC's view, the Proponents would need to identify in advance the sources and quantities of thaw-stable material that might be required with respect to specific stream crossings. In addition, the means of disposal of excavated material not suitable for backfill should be identified.

INAC recommended that the Proponents submit site-specific information and detailed designs for mitigation at watercourse crossings, specifically including plans for the disposal of ice-rich material replaced by thaw-stable backfill and for the reduction of sediment release during construction. With respect to HDD crossings, INAC recommended that the Proponents provide an explanation of the impacts and contingency of having insufficient time to complete the alternative crossing method within one construction season, including the impact on the Project's overall construction schedule.

The Proponents responded that they do not plan to complete geotechnical investigations for all watercourse crossings (including Vegetated Channels) prior to construction, and that plans for the disposal of ice-rich materials would be addressed in site-specific permits where required. They also noted that, to ensure that the Project's overall schedule is not affected, the construction plan for HDD sites includes a minimum of one additional winter to allow completion of an HDD site if the initial installation cannot be completed during the first winter.

NRCan noted that the Proponents had provided only general information on streams and crossing methods. They submitted that, without site-specific data upon which to base predictions of sediment loads, the impacts of channel bed disturbance on total suspended solids without mitigative measures cannot be confidently predicted and may be underestimated in many cases. NRCan further stated that the Proponents' assessment of impacts at stream crossings was made on the basis that mitigative measures would be in place and that the specific stream-crossing methods would be selected to fit local circumstances to avoid or reduce disturbance.

NRCan also requested information on the material to be used for backfilling at watercourse crossings, as well as details of the mitigation measures to be implemented to control runoff and sediment in areas that would be disturbed, including the criteria for their selection. NRCan also asked whether the Proponents planned to restore the armoured character to channel beds to prevent scouring.

The Proponents noted they would look at each crossing individually and work with DFO to determine whether or not the excavated material should be split into near-surface and deeper materials. The Proponents do not expect significant scour at the crossing sites. However, there might be small troughs at the trench locations due more to sediment settling rather than scour. They also noted that NRCan's information requests would be addressed by the NEB's Proposed Conditions.

NRCan commented on the Proponents incorporation of potential climate change in its crossing designs and acknowledged that the Proponents had taken a conservative approach to crossing design from a hydrological perspective. Consequently, NRCan did not have any recommendations on the topic.

DFO stated that, for the purpose of environmental assessment, the Proponents' breakdown of watercourse crossings was useful but that the regulatory process would require more precision as more information becomes available. DFO indicated concerns over the number of Active II Channels that had not been adequately assessed, particularly, to DFO's knowledge, as not all watercourses categorized as Active II actually freeze to the bottom. DFO considered that the Proponents' late winter studies of Active I and Active II Channels, usually based on a single winter, were not sufficient to determine winter habitat type. The specifics of DFO's concerns are considered in more detail in Chapter 9, "Fish and Marine Mammals."

DFO recommended that the Proponents provide further baseline and design information during the regulatory phase. These recommendations and the Proponents' responses are considered in more detail in Chapter 9.

Environment Canada recommended that the Proponents provide more detailed hydrologic design information, including site-specific design flow and scour calculations, during the regulatory process. They also recommended that the Proponents' Environmental Effects Monitoring Program specifically address potential impacts of large storm events on the Project and the aquatic environment. The Proponents agreed, with variation, to these recommendations and submitted that they would be addressed by NEB's Proposed Conditions and the Proponents' own Integrity Management Plan.

6.7.4 PANEL VIEWS

The Panel acknowledges that, over time, climate change may result in increasing uncertainty when predicting stream flow variability and the resulting impacts on channel migration and morphology. However, the Panel is not persuaded that such impacts would occur so rapidly that they would fall outside the existing normal range of year-to-year variability in the short term. Therefore, the Panel understands that accounting appropriately for climate change in Project design focuses not so much on construction methods themselves but rather on the design of watercourse crossings to minimize the risks of vertical scour and channel migration over the life of the Project.

The Panel is satisfied that the Proponents have identified and considered the geohazards associated with watercourse crossings in their design and mitigations (see Section 6.2). The Panel acknowledges Environment Canada's concern that additional baseline and design information should be provided during the regulatory stage, but the Panel considers that this would be addressed by the NEB's Proposed Conditions 16 and 18.

The Panel recognizes that HDD is a relatively new method with only limited experience in permafrost environments. There are some risks in using this method, but the benefits in terms of minimizing watercourse disturbance appear to outweigh these risks. Therefore, the Panel considers HDD to be the preferred watercourse-crossing method for avoiding in-stream works wherever there is the potential for disturbance of fish habitat. The Panel notes participants' concerns regarding HDD crossings but considers these to be addressed by the NEB's Proposed Condition 15.

The Panel notes DFO's recommendations, which would require the Proponents to use HDD at more crossings than they currently propose to do. These recommendations are considered in Chapter 9, "Fish and Marine Mammals."

6.8 OTHER GEOHAZARDS

The chief geohazards not related to permafrost include seismicity, acid-rock drainage and karst topography.

6.8.1 SEISMICITY

PROPONENTS' VIEWS

The Proponents identified three types of seismic events through their geohazard assessment process:

- Pipe displacement at fault crossings: movement along existing faults could result in shear displacement or loading of the pipe, with subsequent impacts on the pipe.
- Dynamic liquefaction: a sudden loss of strength or movement of soil subjected to dynamic loading, which could contribute to lateral spreading of soil on the right-of-way, pipe uplift (buoyancy), or pipe settlement leading to flexural strain and/or exposure, leading to possible impacts on the pipe, ditch and right-of-way.
- Dynamic ground motion: ground shaking due to seismic loading, which could lead to dynamic loading of the pipe with subsequent impacts on the pipe.

The Proponents submitted that the first two events are the most significant seismic hazards for welded-steel pipelines because they produce permanent ground displacement along or across the pipeline alignment.

The Proponents submitted that the seismic hazard for the pipeline was low and warrants only limited consideration in the general area of Fort Good Hope. The level of seismicity in that area is roughly one quarter to one fifth the level of seismicity in the most active areas along the Trans Alaska Pipeline System, and it is considered unlikely to produce liquefaction of significance in relation to the Mackenzie Valley Pipeline. The Proponents considered that the Anchor Fields are in areas of moderate to very low seismicity. They propose to design the Anchor Field facilities to the seismic risk level required by the *National Building Code of Canada 2005*.

PARTICIPANTS' VIEWS AND RECOMMENDATIONS

Based on its review of the Proponents' *Seismic Hazard Assessment, Mackenzie Gas Project, Pipeline Route, Report*, NRCan concluded that the Proponents provided a thorough and comprehensive assessment of the seismic hazards from natural earthquakes to the Project and its environment, and that it substantively addressed many of NRCan's earlier concerns about the inadequacy of the seismic hazard treatment in the EIS. NRCan noted that the Proponents' iterative and phased geohazard assessment process should lead to a final route selection aimed at avoiding terrain susceptible to cross-slope movements in the vicinity of the pipeline corridor. NRCan recommended that the Proponents include earthquake response plans in their accidents and malfunctions plans, and that the earthquake design standards for the pipeline should apply to the Anchor Fields as well. The Proponents agreed, with minor variation.

6.8.2 ACID-ROCK DRAINAGE

PROPONENTS' VIEWS

Acid-rock drainage is a common environmental problem produced from the exposure of broken or blasted rock containing reactive sulphide minerals to oxygen in the presence of water. This can result in acidification of adjacent water bodies, with negative impacts on vegetation and fish. INAC noted that acid-generating materials in permafrost regions are capable of producing acid-rock drainage, as evidenced in arctic mining operations, although probably at lower rates than in warmer climates.

Quarry and pipeline excavations that expose acidic materials have the potential to induce acid drainage above background levels. The Proponents noted that, based on their analysis, no significant occurrences of sulphides are expected along the pipeline route, but testing is planned for approximately 90 km of the pipeline route where shale and limestone are within 3 m of the surface. The Proponents noted that any exposure of the upper bedrock surface during pipeline construction would be of short duration. The only Project activity likely to result in extensive bedrock disturbance would be the development of quarries for the purpose of obtaining rip-rap and trench backfill.

The Proponents committed to mitigating acid-rock drainage by site-specific assessment of the potential for acid drainage prior to quarry development, analysis of bedrock properties, including analysis of sulphide content, and remediation if required. If acid rock were encountered in the pipeline ditch, it would be used as backfill material. If there were surplus acid rock, it would need to be disposed of appropriately.

PARTICIPANTS' VIEWS AND RECOMMENDATIONS

NRCan noted that quarry and pipeline excavations across exposed pyritic siliciclastic shales and sandstones could induce acid-rock drainage above background levels. NRCan concluded that this increase should be very slight and would subside quickly to the normal background level. Acid-rock drainage could be a potential risk factor only if bedrock excavations in pipeline-related construction activities, such as quarrying, exposed a previously unknown body of sulphide mineralization. NRCan and INAC both recommended that the Proponents provide the appropriate regulators with management, mitigation and monitoring plans that include the identification of high-risk areas. The Proponents agreed with these recommendations, with minor variation.

6.8.3 KARST TOPOGRAPHY

PROPONENTS' VIEWS

Karst refers to landscape features such as sinkholes, caves and underground drainage systems that are formed from the dissolution of soluble rocks (including limestone and dolomite). The Proponents indicated that karst has the potential to expose pipe and cause spans of the pipe to be unsupported, depending on the size and depth of the collapse feature. Therefore, the Proponents avoided identifiable karst features in the proposed pipeline route and facility sites. The Proponents committed to undertake geophysical surveys along those sections of the pipeline route with potential for karst. They indicated that mitigative strategies would include additional surveys, rerouting and/or monitoring.

PARTICIPANTS' VIEWS AND RECOMMENDATIONS

NRCan stated that accurate location of karst features and the understanding of karst processes in the vicinity of the proposed pipeline are important for safe construction and operations, and the avoidance of adverse environmental impacts. NRCan noted that the Proponents had adequately documented the existence of bedrock karst and karst-susceptible bedrock along the pipeline. NRCan recommended that the Proponents provide regulators with the results of their geophysical surveys and their proposed mitigation and monitoring plans. The Proponents disagreed, noting that NRCan's recommendation would be addressed by the NEB's Proposed Conditions.

6.8.4 PANEL VIEWS

The Panel considers that the Proponents have appropriately identified the seismic and geochemical hazards that the Project may encounter (see also Panel findings in Section 6.2). Further, the Proponents have adequately accounted for these hazards in Project routing and design and will continue to refine their understanding of and mitigations for these geohazards. Participants generally agreed and were mainly concerned that the Proponents provide sufficient information on these matters to the appropriate regulators should the Project proceed. The Panel notes that the NEB's Proposed Condition 13 would require the Proponents to file a geohazard assessment for the Project, including specific measures and monitoring to address geohazards that had a reasonable probability of impacting the Project. Therefore, the Panel finds that the Proponents' consideration of these matters is appropriate to the conceptual engineering stage, which was when the Proponents provided relevant design information to the Panel.

6.9 ANCHOR FIELDS

The Anchor Fields are mostly underlain by ice-rich permafrost extending from close to the surface to depths of several hundred metres. The development and operation of the Anchor Fields requires penetration of permafrost at depth (in contrast to the pipelines that affect only the near surface of the terrain). This section considers the potential thermal impacts of Project activities in the Anchor Fields, as well as potential Project impacts in the distinctive environment of the outer Mackenzie Delta, where the Niglintgak and Taglu Anchor Fields would be situated.

The outer Mackenzie Delta consists of tidal flats, shallow waters and low-lying tundra polygons formed by massive ice wedges. As a result, both the Niglintgak and Taglu Anchor Fields are vulnerable to submergence from spring flooding and storm surges. While those are natural and frequent events, even minor changes in sea level, coupled with extraction-induced subsidence, would alter this natural regime and could permanently submerge some areas and alter the characteristics of others. Both Anchor Fields are sited in critical bird habitat that is legally protected.

6.9.1 PERMAFROST AT DEPTH

Project-induced thaw settlement would be restricted to the localized area of the production facilities themselves, but it could occur at depth from drilling and production activities and in shallow permafrost near the surface.

PROPONENTS' VIEWS

The Proponents stated that the objectives of their assessment of permafrost conditions in the Anchor Fields were to identify:

- ways to manage the impacts of drilling and production operations on deep permafrost; and
- ways to maintain the shallow permafrost when installing pads and foundations to support production facilities.

The Proponents obtained data on the subsurface conditions at the Anchor Fields through prior work at each site, including exploration drilling, geophysical programs and shallow borehole investigations. Based on this information, and their prior experience of hydrocarbon exploration and development in arctic conditions, the Proponents expressed confidence in their knowledge of permafrost conditions, at depth and near surface at each site (although less complete in the case of Parsons Lake), and their ability to ensure the maintenance of permafrost integrity during field development and operations. If permafrost conditions were not fully understood, a conservative approach would be used to ensure robust design.

The Proponents noted that deep permafrost could be affected to varying degrees by drilling and production activities. The Proponents would therefore chill the drilling mud that carries the cuttings to the surface while drilling through the permafrost to minimize thaw degradation. Soon after drilling through the permafrost, casing would be placed throughout that zone to protect it from the deeper drilling activity that would follow. The space between the casing pipes would be filled with fluid that would insulate the surrounding permafrost from the heat of the produced gas. In addition, the wells would be spaced far enough apart to accommodate the predicted thaw of the deeper permafrost during the operating life of the field. The Proponents stated that "the upper 37 metres of permafrost, including the active zone beneath the facilities, will be maintained in a fully frozen state throughout drilling and then throughout the producing life of the field." They added that "this will be achieved by using a continuously refrigerated conductor pipe." (Michael Curtin, HT V13, p. 1261)

All casing and completion design plans would be presented to the NEB for discussion and approval, as required by regulation. The Proponents also committed to developing monitoring plans for casing performance and surface displacement as engineering progresses, and they would submit these to the NEB as part of the approval process.

The Proponents stated that shallow permafrost would be kept frozen to support foundation piles and pads. Permafrost near the upper portion of the wells would be kept frozen by using some form of active refrigeration in the conductor, which is the outermost casing pipe, together with passive refrigeration, such as thermosiphons, in the well casings. Foundation piles would be augured into the permafrost and secured using a sand and water mix that would freeze them in place. Borrow material would be used in combination with insulation to protect the permafrost under fill areas such as pads. Thermosiphons might also be used under concrete floors. In some cases, buildings would be elevated on piles to prevent heat transfer to the ground.

With respect to ice wedges at Niglintgak, Shell stated, "we have seen some areas with higher ice," adding that "we have seen nothing that we can't design our facilities around and manage those foundations to accommodate it." (Paul Davies, HT V14, p. 1394) Further, Shell noted that it had considered climate change impacts in its design and, should future conditions change, designs could be adaptively managed to address those changes. For example, thermosiphons and refrigeration could be used to protect thaw-unstable permafrost as required.

At Taglu, Imperial Oil Resources Limited (IORL) submitted that a combination of gravel fill and insulation, which it intends to place on site in the winter, would permanently maintain the shallow permafrost underlying the surface facilities in a frozen condition. IORL added that appreciable amounts of ice in the upper 5 m would not be that significant, as foundation piles are intended to extend about 20 m below grade. According to IORL, some settlement of the wellheads might result from permafrost thaw near the wellbore, but this would be close to the wellhead and within the borrow material that would be used to construct the well pad. IORL also noted that it was addressing the prospect of increased moisture due to flooding in its thermal analyses. They considered the potential impacts of convective heat introduced by floodwaters into gravel foundations and determined it did not produce a material change to its designs.

At Parsons Lake, ConocoPhillips plans to use insulated gravel pads for its facilities to preserve permafrost. They noted that the main objective would be to bring the permafrost up into the gravel pad and keep it there, thereby ensuring that shallow permafrost stays frozen. For wells, the design includes insulated conductors, insulated cellars and insulated well-house floors to protect the near-surface permafrost. The design also includes thermosiphons. In addition, most of the modules would be built on pilings. Some buildings would be set on grade (such as the maintenance shop and incinerator building), but by using additional insulation and thermosiphons, ConocoPhillips submitted that the underlying shallow permafrost could be protected. During the life of the facilities, any visual subsidence would be mitigated by measures such as adding additional insulation, gravel or thermosiphons.

ConocoPhillips stated that it would install temperature-measuring equipment in each production well to monitor permafrost temperature and potential for permafrost thaw. This measuring equipment would be capable of discerning temperatures near the well and permafrost interface. ConocoPhillips would also consider installing strain-measuring devices on the shallow casing if it were determined that these devices would be useful and feasible. ConocoPhillips would also use data derived from its monitoring and other production and well data to remodel and evaluate any ongoing thaw process around the production wells.

PARTICIPANTS' VIEWS

NRCan stated that it was satisfied with the Proponents' approach and analyses to assess thaw consolidation and deformation for the well pad and casing design. NRCan made several recommendations about design and monitoring with respect to the integrity of the production facilities but did not identify any adverse environmental impacts that might result. The Proponents agreed in part, but noted that they would be submitting the relevant information to the NEB.

PANEL VIEWS

The Panel finds that the Proponents' proposed mitigations with respect to deep permafrost are appropriate. No participants disagreed and no recommendations were filed. The Panel considers that the Proponents' commitments with respect to the maintenance of shallow permafrost integrity are appropriate and recommends that they be a condition of any approvals.

6.9.2 SHALLOW GAS

PROPONENTS' VIEWS

Shallow gas refers to gas in any appreciable quantities that has the potential to result in a well-control situation while drilling a well. In the Anchor Fields, shallow gas may occur as gas hydrates, a mix of frozen gas and water under high pressure that can be destabilized by thawing. Gas seeps (underground gas that naturally releases to the atmosphere) may indicate gas hydrates at depth, but this can be verified only by exploration drilling.

The Proponents did not find evidence of significant gas hydrates based on their own drill core results or those available from the Geological Survey of Canada. Some shallow gas is anticipated at Niglintgak. At Taglu, IORL stated that the risk of encountering shallow gas before setting the surface casing is very low. At Parsons Lake, ConocoPhillips found no evidence of shallow gas at either the north or south pad.

Following questioning about the risk of shallow gas at Taglu, where gas seeps have been identified, IORL responded that a detailed shallow gas hazard assessment completed during the preliminary engineering phase did not identify any shallow gas hazards in exploration wells. Seismic results also did not indicate the presence of any shallow gas hazards. According to IORL, while gas seeps have been detected in the Project area, there are no known gas seeps that would affect the siting and design of any proposed surface facilities.

Should significant gas hydrates be encountered during drilling, the Proponents believe these could be managed through current drilling practices and casing design. The Proponents stated that shallow gas zones, if encountered, would be addressed as required by regulations through the drilling program. This would include using mandatory surface diverters, changing the weight of drilling mud, using casing to isolate zones of concern, training crews and selecting equipment.

PARTICIPANTS' VIEWS AND RECOMMENDATIONS

NRCan noted the documented presence of gas hydrates and gas seeps in the general area of the Anchor Fields and expressed the concern that thawing at depth could lead to increased discharge at the surface. This could affect safety during drilling and increase the possibility of subsidence at the surface, affecting well structures and casings. NRCan did not identify adverse impacts on valued components.

NRCan was not entirely satisfied with the Proponents' responses to its concerns regarding gas hydrates, shallow gas and gas seeps at the Anchor Fields. NRCan remained of the opinion that changes at depth associated with long-term production could lead to changes in permafrost conditions at depth, gas seeps and groundwater discharges. NRCan recommended that the Proponents provide regulators for review and approval a monitoring plan that includes verification of their prediction of negligible impacts of long-term production on gas hydrates, gas seeps, groundwater conditions and high ground-ice sediments.

The Proponents did not agree with this recommendation. They submitted that monitoring the environmental impacts of production on permafrost at Taglu and Niglintgak is not necessary because the impact of production on the permafrost would be local and occur in the area below the well pad. They did not consider that there was any environmental risk associated with trace amounts of gas that might be liberated from hydrates by permafrost thaw. Shell and IORL stated that the impact of permafrost thaw on their respective facilities would be monitored according to a plan that would be submitted to the NEB for approval. Additional data related to the presence of hydrates would be obtained during the drilling of each well within the actual area that might experience partial thaw during production. This data would be used to validate the current assessment of possible hydrate impacts at Niglintgak and Taglu. Although the gas that might be liberated from hydrates is not expected to accumulate in sufficient quantities to pose a risk to the subsurface environment, including existing gas seeps, steps would be taken, in consultation with the NEB, to develop a mitigation plan if additional data obtained during drilling warranted such action.

PANEL VIEWS

The Panel accepts the Proponents' view that the risk of encountering gas hydrates, shallow gas and gas seeps is low and that, even if encountered, the environmental impacts would be limited in extent, duration and severity (see Chapter 7, "Accidents, Malfunctions and Emergency Response"). Further, the Panel considers that the Proponents have sufficient knowledge and self-interest to ensure that these risks are properly accounted, designed and monitored for, and that the NEB will ensure that they do. The Panel notes that, while NRCan's concerns relate to safety and the integrity of production facilities rather than to environmental concerns, NRCan is not an Intervener in the NEB proceeding, nor are their concerns addressed directly by the

NEB's Proposed Conditions. No other participants commented on shallow gas, gas hydrates or gas seeps.

6.9.3 SEA-LEVEL CHANGE, STORM SURGES AND SUBMERGENCE

PROPONENTS' VIEWS

Shell and IORL carried out extensive studies and continued to gather data to establish a safe elevation that would protect facilities and personnel from flooding. Not all areas of the producing facilities would need to be protected from flooding. Some areas, such as access roads, the area under the process modules at Taglu, and the area under the well pads at Niglintgak, would be designed to accommodate temporary submergence by floodwater. For those facilities that must stay above floodwater, the following factors would be considered when establishing their height above the surrounding terrain:

- historical flood levels (breakup and storm surge);
- sea-level rise;
- climate change impacts on sea levels;
- wave heights; and
- surface impact of extraction-induced subsidence on flood depth.

In addition to these factors, the flood protection provided by the design of the facilities would be supported by monitoring flood levels, adaptive management and contingency plans to address unforeseen circumstances.

Shell reviewed trends of sea-level rise at Tuktoyaktuk and those contained in guidelines of the Intergovernmental Panel on Climate Change. For the period 2010–2040, they determined an anticipated sea-level rise of 0.1 to 0.15 m for preliminary design. Shell stated that "we felt that this was a reasonable number to use" and that "we will continue to keep abreast of that, and put the number in that's appropriate for the life of our field." (Davies, HT V14, p. 1382)

NRCan raised the issue of future changes in storm severity with changing sea-level elevations. Shell replied that "the additional effect of storminess…related to storm surges was computed as an incremental amount to the initial background calculation representative of existing conditions." It added, "those values were computed to be about .2 metres for Taglu and .3 metres for Niglintgak." (Gary Beckstead, HT V14, p. 1383) The Panel asked how likely future decreases in sea-ice cover in the Beaufort might influence storm-surge heights. Shell responded that the calculated storm-surge increase of 0.3 m for the Niglintgak development was meant to include the impact of an increased fetch in the Beaufort Sea.

Shell stated that the gas conditioning facility at Niglintgak was designed to consider the impacts of flooding, subsidence and climate change. While the current overall design elevation was considered conservative and could accommodate future changes, Shell stated that it would continue to refine the elevation inputs to ensure that "we protect our people, the integrity of our assets and the environment." Shell also stated: "Once in operation, Shell will monitor our facility, elevations and water levels. Should mitigation be required, our facility elevations can be modified. Contingency plans will be developed to react to and mitigate any short-term flooding situations." (Davies, HT V13, p. 1268)

In response to questioning by NRCan regarding installations near the shoreline of river channels and winter ice cover during breakup season, Shell responded that potential ice forces were a big consideration in choosing the location. Based on work done in the 1970s, supplemented with recent spring surveys, including 2005 videography, the ice risk at the proposed site for the gas conditioning facility is very low. Shell stated that the gas conditioning facility will be placed on an "angle to the shore… to deflect any ice that could come up as well as armouring the upstream side of the gas conditioning facility. So we believe we understand the ice forces and that we've mitigated them in our design." (Davies, HT V14, p. 1376)

In response to questioning by the Panel regarding a flood that would cover the operating surfaces, Shell responded:

> There will be a lot of reviews done in the design phase to ensure…that we make things high enough so they don't flood. In the event that…we do get a flood, that hazard is part of our hazard assessments, and we will look at our design to make sure that we aren't put into a compromised position… We would evacuate people and shut down equipment to prevent damage… One advantage…with being a remote operation is we will…be able to shut in wells and shut in equipment without having people there. (Davies, HT V13, p. 1286)

IORL stated that managing the impacts of flooding on the facilities at Taglu is a key safety and design priority. Some of the areas that did not require continuous access, such as roads, the airstrip and the barge landing, would be able to withstand temporary submergence. Other areas of the site would be set at a grade above the predicted flood levels. These include the well pad, process facilities, living quarters, and control room and storage areas.

IORL noted that springtime flooding typically occurs around the first week of June and persists from 10 to 14 days. Storm surges have been observed that range from 3 to 5 days.

IORL stated that the preliminary elevation of the flood-protected areas at Taglu was established by considering the same factors as for Niglintgak and including a 0.2 m safety factor to address uncertainty in the predictions. IORL plans to monitor flood levels to ensure that the facilities are high enough and that adequate protection is in place where needed. As an extra precaution, IORL would have the ability to increase facility elevations to accommodate higher than anticipated flood levels, and it would have a contingency plan in place in the event of unforeseen circumstances. In response to a query from the Panel regarding contingency plans for storm surges at Taglu, IORL replied, "We have not finalized our contingency plan for this particular event." (Curtin, HT V14, p. 1425)

In the event of flooding, IORL stated:

> The focus would be on ensuring that the personnel are safe… And as the water levels rise, we would have a level at which point we might swing control of the facility to the Inuvik area facility… The environmental consequences…I wouldn't envision that there would be any of significance. (Curtin, HT V13, pp. 1285–86)

PARTICIPANTS' VIEWS AND RECOMMENDATIONS

According to NRCan, while current flooding levels appeared to have been appropriately chosen, issues remained over how these levels would change in the future with changing storminess, accelerated sea-level rise and extraction-induced subsidence. NRCan submitted that climate change might affect sea-level rise and storm-surge frequency and heights, thus leading to changes in flooding in the Mackenzie Delta Project area.

In NRCan's view, the Proponents had not fully accounted for the likely sea-level rise in the region. According to NRCan, adding the ongoing sea-level rise in the region, measured by the Tuktoyaktuk tide gauge at 3.6 mm/a, to the other impacts of climate warming results in a projected 0.26 m sea-level rise between 2000 and 2030. NRCan also believed that the values for changes in storm-surge heights at Taglu and Niglintgak might be larger than calculated. NRCan recommended that the Proponents revise their estimates prior to regulatory approval.

The Proponents agreed to this recommendation, with variation, and stated that, consistent with normal engineering practices, they would continue to assess ongoing climate change data that might become available to ensure that key design parameters are refined throughout the design process. The final climate change data would be selected during detailed design. This ongoing assessment would include an analysis of climate change factors and their contribution to the design of the facilities at the Niglintgak and Taglu Anchor Fields. Flood levels would be monitored, and facility designs would include adaptive management and future mitigations, where appropriate. Pipeline design in the Mackenzie Delta would consider the possibility of flooding in low-lying areas and the potential impacts on erosion, buoyancy and upheaval displacement. Water levels considered would be consistent with the design values developed for the Niglintgak and Taglu Anchor Fields.

Similarly, Environment Canada recommended that the Proponents:

> continue discussions with appropriate government departments and regulatory agencies to finalize ongoing evaluation of flood hazards for outer delta facilities due to spring break-up, rainfall flood events in upstream tributaries, and storm surges in the Beaufort Sea…to ensure that project engineering and environmental design aspects for anchor fields and pipeline gathering system facilities have been fully and satisfactorily addressed prior to their construction. (J-EC-00178, p. 9)

The Proponents agreed with this recommendation and noted that the NEB is the appropriate regulator for these design matters.

With respect to the barge-based gas conditioning facility at Niglintgak, NRCan stated that uncontrolled shifting of the facility could result in rupture of feed or discharge pipelines that connect the barge and the shore. NRCan concurred with Shell's assessment that there would probably be little or no movement of ice during most years at the favoured locations for the barge-based facility. Observations of Little Kumak Channel ice thickness and under-ice water discharge and peak flow water level data provided in *Niglintgak Gas Conditioning Facility: Supplemental Information* suggest that water levels are not high enough to result in major ice movement in Little Kumak Channel or on the shallow shelf immediately downstream. However, there is no actual data on ice movement in Little Kumak Channel or in the immediate vicinity of the proposed barge locations.

NRCan therefore recommended that Shell "provide to the appropriate regulators for review and approval, documentation or analysis that will demonstrate the stability of the barge-based Gas Conditioning Facility against forces produced by ice movement." (J-NRCAN-00090, p. 155)

Shell Canada agreed, with variation, and noted that the NEB is the appropriate regulatory authority for this design matter.

PANEL VIEWS

The Panel considers that participants generally agreed with the Proponents' approach to mitigating the impacts of sea-level change, storm surges and submergence on their own operations, although in some cases they questioned the accuracy of the Proponents' predictions of these events. Therefore, the Panel considers that a precautionary approach is needed and understands that the Proponents accept this approach.

6.9.4 EXTRACTION-INDUCED SUBSIDENCE

Extraction-induced subsidence is a well-known phenomenon that often accompanies oil and gas production. As the resource is taken out of rocks far below the surface, these rocks may be compressed, and this subsurface compaction gradually manifests itself as subsidence of the ground surface. On the Delta coast, even a small amount of subsidence may result in flooding, thus compounding the impacts of sea-level change and storm surges considered above. This section focuses on subsidence as it may occur at Niglintgak and Taglu.

RESERVOIR COMPRESSION

The Proponents stated that the extraction of natural gas and natural gas liquids would "reduce reservoir volumes and pressures, leading to compression of the reservoir and subsequent subsidence of the overlying land." They further stated that "the total subsidence from production is estimated as 0.4 m at Niglintgak and 0.3 to 0.5 m at Taglu." (EIS, V5B, Section 4, p. 24) The amount and distribution of surface subsidence resulting from gas extraction was evaluated for each Anchor Field, and the potential for a long-term change in the elevation of the producing facilities was included in the design of the facilities. ConocoPhillips stated that it does "not expect any measurable extraction-induced subsidence at Parsons Lake" and that "the most likely subsidence from gas extraction over the 25-year field life is estimated to be less than 3.5 centimetres" at the centre of the field. (Shawn Kennedy, HT V13, p. 1274)

At the Panel's request, Shell and IORL provided maps showing the geographic extent of predicted subsidence exceeding 0.1 m around Niglintgak and Taglu, as shown in Figure 6-9 and Figure 6-10, respectively. Shapes of the subsidence bowls generally reflect the extent and depth of the gas reservoirs themselves. The land areas potentially affected by subsidence in excess of 0.1 m were calculated as 33 km^2 for Niglintgak and 67 km^2 for Taglu. According to the Proponents, more than 50% of the affected area in each location is currently open water.

The Proponents characterized these maps as "a reasonable estimate of the potential impact of extraction-induced subsidence on surface topography (without offsetting measures through natural processes, such as sedimentation)." (J-IORVL-00074, p. 119)

Shell's modelling predicted a maximum subsidence depth of about 0.45 metres at Niglintgak over the 25-year production life, with the subsidence impact centred under the Middle Channel. Shell described the rate of subsidence as "very gradual with a maximum annual subsidence rate of less than 1-½ cm per year." (Davies, HT V13, p. 1267) The depth of subsidence would decline with distance from the reservoir centre. Shell further stated: "The subsidence prediction model for the Niglintgak Field was based on conservative inputs to predict the maximum expected subsidence. The actual subsidence level is expected to be considerably less." (Curtin, HT V15, p. 1517)

IORL predicted that the amount of subsidence at Taglu would range from 0 m at the outer limits of the field to a maximum of 0.38 m in a localized area between Big Lake and the surface facilities. This subsidence was predicted to be gradual and would occur at a rate of about 1 to 1.5 cm/a over the 30-year production life of the field. IORL added that it considered its subsidence prediction for the Taglu Field "to be a reasonable upper bound, based on the data that we have." (David Haeberle, HT V14, p. 1418)

Panel advisors Dr. John Gale and Dr. Jean-Marie Konrad requested the precise specifications of the models used to derive these estimates and the data inputs so that they could replicate the Proponents' estimates. However, the Proponents declined to provide this, chiefly on the grounds that it was proprietary information.

Therefore, the Panel commissioned Dr. Gale and Dr. Konrad to assess the evidence the Proponents had actually placed on the public record. In their report (referred to as the Fracflow Report), they suggested that, in the case of Taglu, IORL's own information could lead to a subsidence estimate of up to 0.8 m, or double that put forward by IORL. They stated that "we are concerned that the Proponent's maximum subsidence values at each gas field, but especially at the Taglu field, do not represent the maximum value and may not be as conservative a value as stated in the EIS." They further stated that they are "also unable to comment on the confidence levels of the predicted subsidence at the anchor fields as the Proponents have not provided this information." (J-JRP-00457, p. 10)

The Fracflow Report concluded:

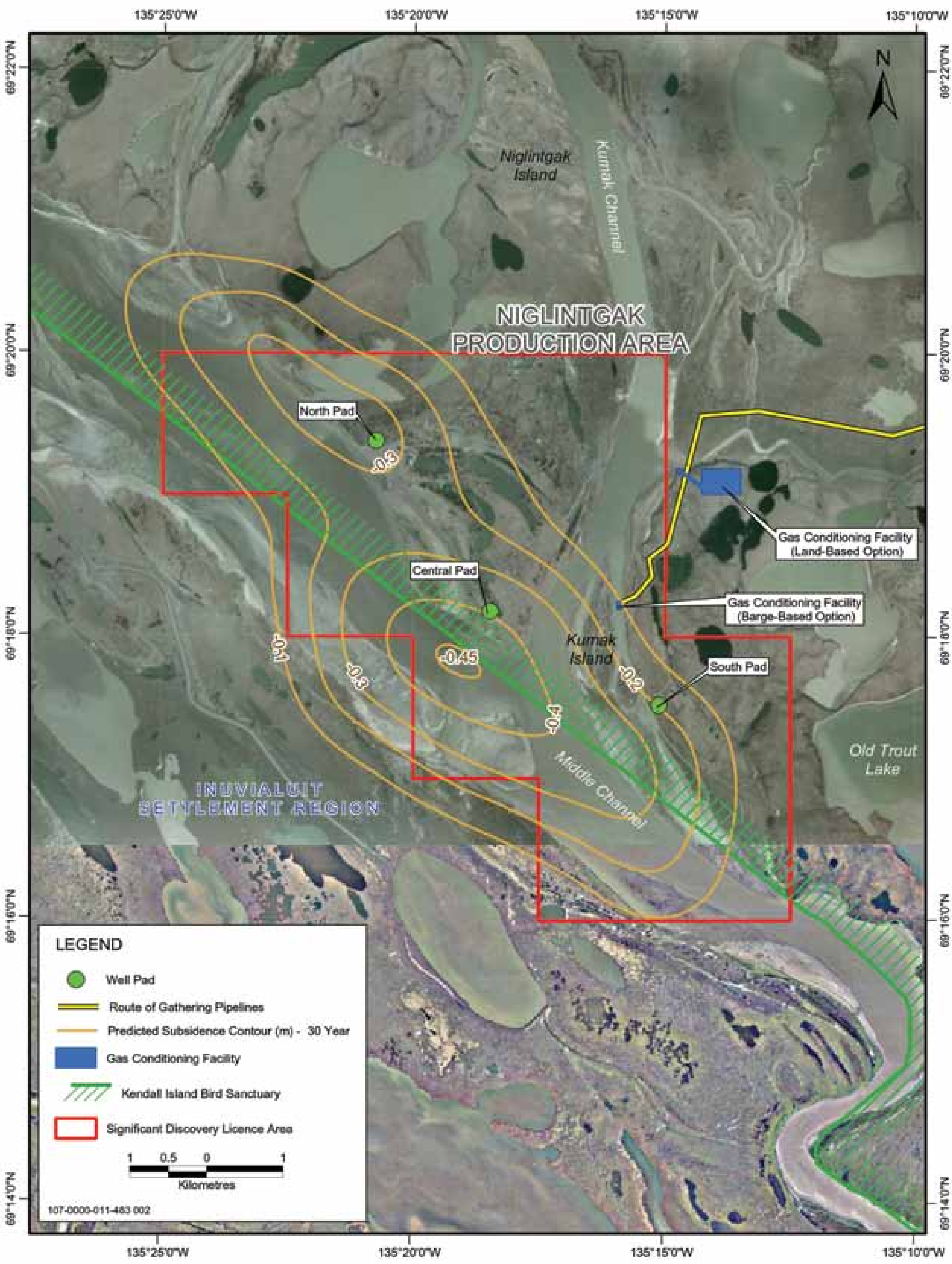
> Based on information filed to date by the Proponent of the Taglu field, we believe that the prediction of reservoir compaction and surface subsidence due to gas extraction is associated with a high degree of uncertainty. This also leads to uncertainty in predicting the severity of the environmental impact, especially as it may affect the Kendall Island Bird Sanctuary. (J-JRP-00457, p. 13)

Further, Dr. Gale and Dr. Konrad did not agree with NRCan's original submission on this matter, which considered the Proponents' subsidence estimates to be reasonable, assuming that the reservoir mechanical properties used in their calculations were accurate.

In response to the Fracflow Report, NRCan subsequently clarified that its assessment was made using data supplied by the Proponents. NRCan agreed with the reservations in the Fracflow Report regarding the subsidence analyses provided by the Proponents. NRCan also agreed with the Fracflow Report's conclusion that the determination of compressibility is difficult and the values used by the Proponents could have considerable uncertainty. On this basis, NRCan acknowledged that it could have underestimated the values it had previously provided for subsidence for the Taglu and Niglintgak Anchor Fields by up to a factor of two.

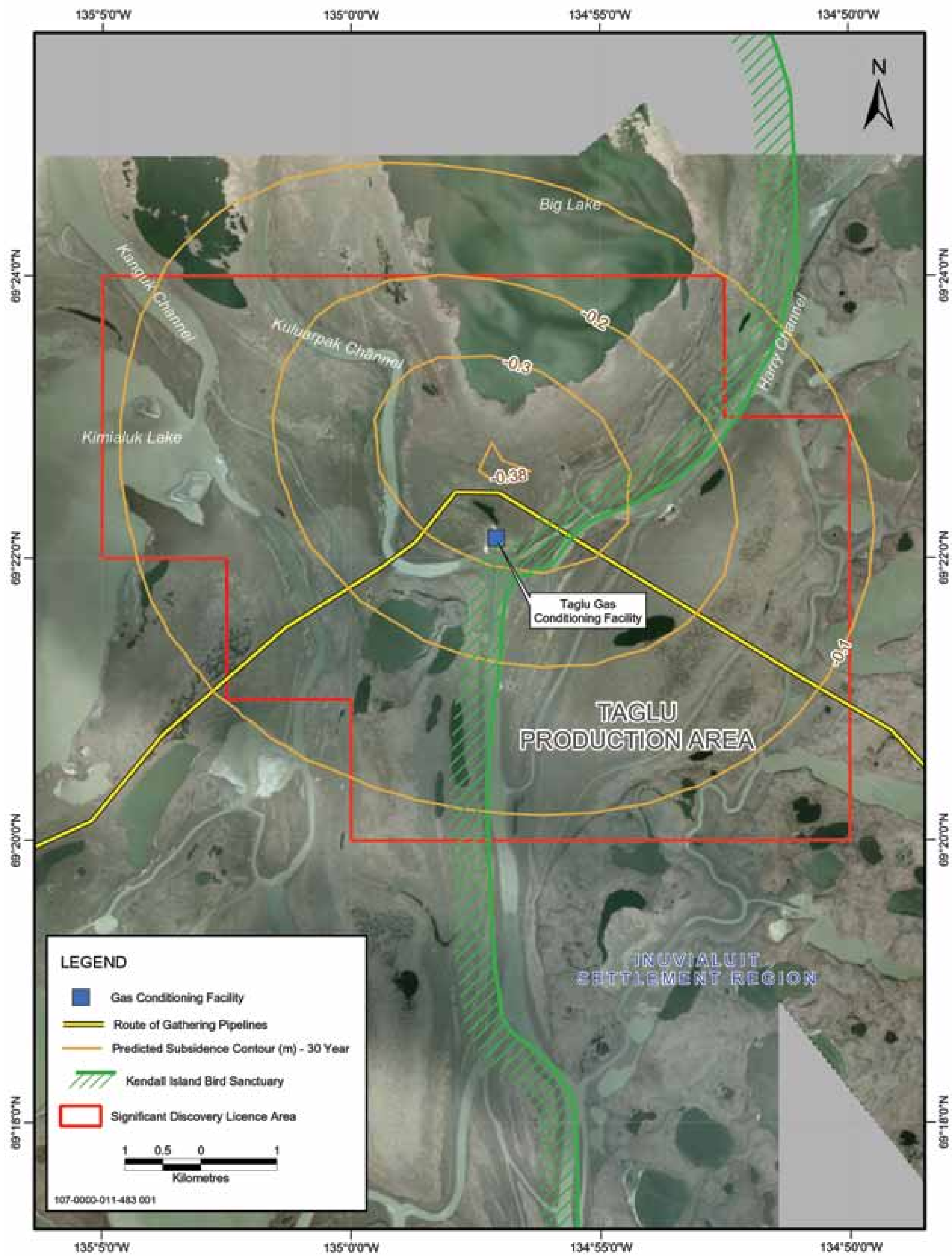
According to Dr. Gale and Dr. Konrad, the prediction of surface subsidence is a function of reservoir compaction far below the surface and the material properties (arching resistance) of the intervening overburden. Depending on the extent of arching phenomena in the overburden rock, surface subsidence will be lower than reservoir compaction. Uncertainties arise in predicting surface subsidence associated with uncertainty in reservoir

Figure 6-9 Predicted 30-Year Subsidence (Niglintgak Area Map)



Source: J-IORVL-00074, Figure JRP 1.25-1, p. 123

Figure 6-10 Predicted 30-Year Subsidence (Taglu Area Map)



Source: J-IORVL-00074, Figure JRP 1.25-2, p. 124

compaction prediction and uncertainty in determining the amount of arching in the overburden rock.

Specifically, uncertainty in reservoir compaction prediction arises from several factors, including:

- The thickness of reservoir rocks affected by gas depletion: This refers to the identification of those layers within the reservoir that will be affected by gas extraction (pay zones) and how thick these are across the reservoir. The rock formations in the Mackenzie Delta consist of interbedded sand and shale layers. Gas is generally produced from the sandstone or sand units. Uncertainty in choosing a representative reservoir thickness might arise from the fact that gas extraction over a 30-year period would also affect, at least partially, the shale formations.
- Reservoir compressibility: This refers to the degree to which the rocks in each pay zone and the interbedded strata would be compressed when gas is extracted from them, which is based on their characteristics and the degree to which they may have already been compressed and decompressed in earlier geological periods. Compressibility is, by far, one of the most difficult parameters to determine, particularly on the rock mass scale, and the degree of uncertainty will be higher when the number of samples are small and are restricted to a few zones of the reservoir.
- Gas-pressure depletion values: This refers to the drop in reservoir pressure as gas is extracted. For the Niglintgak and Parsons Lake Anchor Fields, the maximum pressure depletion would be almost equal to the initial reservoir gas pressure. The predicted gas-pressure depletion values given for Taglu were generally much lower and might be underestimated.
- Creep: This refers to the process by which subsidence continues for some period of time even after gas extraction ceases and the extent of that continued subsidence. Failure to include creep in any reservoir compaction prediction model will underestimate the level of reservoir compaction during the gas depletion phase and for some time after active gas depletion has ceased.
- Arching: This refers to the competence or stiffness of the rock layers above the reservoirs that has the effect of moderating the potential compaction of the reservoir rocks.

The first four parameters indicate the potential for compaction of rock strata within the reservoirs from which gas would be extracted; the fifth indicates how this theoretical potential would be moderated by the arching effect of the strata above the reservoirs.

In their responses to the Fracflow Report, Shell and IORL did not dispute these basic principles. They asserted only that their specific modelling was based on these principles and that they had used conservative estimating procedures with respect to pre-consolidation, aquifer support, gas-pressure depletion and intra-bedded shale depletion. They reiterated that the maximum subsidence was expected to be less than predicted. Shell stated that it “remains confident in the subsidence evaluation it has undertaken.” (J-SCL-00032, p. 3)

In response to questioning by the Sierra Club of Canada, IORL acknowledged that its estimate for subsidence at Taglu was not a maximum upper bound but could, in fact, be exceeded. IORL stated that what is “important to recognize is that our objective is to find the balance between depleting the natural resource and the environmental effects that may result from the activity.” It added that “we feel that through the use of conservative assumptions in our inputs…that we have established a reasonabl[e] upperbound for our estimates.” (Curtin, HT V62, p. 6156)

Subsequently, IORL characterized its estimate as “a reasonable maximum case for determination of subsidence and, therefore, subsidence effects,” and declined to characterize them as maximum estimates or worst-case scenarios. (Bruce Parent, HT V67, p. 6738)

SURFACE EXPRESSION OF SUBSIDENCE

The Niglintgak and Taglu Anchor Fields lie wholly or mostly beneath KIBS. Since the land areas of the outer Mackenzie Delta are only slightly above water levels in adjacent lakes and channels, the Proponents noted that a small decrease in land elevation could result in inundation of some low-lying areas. Further, inundation over larger areas and for long durations could, in turn, promote thaw settlement of shallow permafrost and enhanced subsidence impacts. The Proponents rated the impact of land subsidence at both Niglintgak and Taglu as moderate.

The Proponents pointed out that the area that is predicted to subside at Taglu and Niglintgak is exposed to the natural processes of flooding, stream bank erosion and frost heave. The Taglu and Niglintgak areas are already flood-prone, and the additional depth of flooding caused by surface subsidence would be a small part of the total flood depth. Because of the slow rate of change, the Proponents expect that these natural processes would mask the impacts of subsidence on the landscape. They stated that “the effect of land subsidence on the lake morphology is unlikely to be very different from those historical changes resulting from natural processes, and is therefore rated as low to moderate.” (EIS, V5B, Section 5, p. 152)

IORL asserted that it would not be possible to separate subsidence impacts from the natural variability in the depth of flooding or the natural impact of the flooding itself on the landscape.

NRCan stated that the evidence presented did not adequately support the Proponents’ contention that the estimated changes in the landscape are expected to be indistinguishable from natural variability, such as flooding. Based on the Proponents’ response to Information Requests, there remained a lack of clarity regarding the areas at the Niglintgak and Taglu fields that could become permanently inundated or affected by early-season flooding as a result of hydrocarbon extraction subsidence. NRCan also noted that Shell did not address the question of what portion of the Niglintgak area may be permanently inundated at normal water levels or during waterfowl nesting seasons. The frequency and timing of flooding of the area would also likely change as a result of changing land surface elevation due to subsidence.

Dr. Gale and Dr. Konrad observed that “owing to the relatively flat topography in the Taglu area, typical of the outer Mackenzie delta, doubling the depth of the subsidence does not result in a two-fold increase in inundated area.” They further observed that “our desktop analysis showed that a doubling of subsidence depth at Taglu (from 0.4 m to 0.8 m) could result in approximately a ten-fold increase in the inundated area within KIBS.” (J-JRP-00457, pp. 11–12)

Based on NRCan’s observations and the data provided by IORL, NRCan considered that permanent inundation and more frequent early-season flooding in the subsided area south of the present shoreline of Big Lake is possible. NRCan also calculated the rate of expansion of Big Lake as a result of production-induced subsidence over the 30-year lifetime of the Project, which could be more than double the natural historical rate of change.

Using the subsidence predictions quoted by the Proponents, Environment Canada estimated the area of subsidence-induced flooding to be 617.8 ha at Taglu and 140.2 ha at Niglintgak, for a total area of KIBS affected by subsidence of approximately 758 ha. However, based on preliminary analysis of a doubling of the subsidence estimate for Taglu and Niglintgak, NRCan determined that the areas of inundation at each location as estimated by Environment Canada would increase by three and five times, respectively, and that additional complications could arise at Taglu from overtopping of levees along river channels.

In September 2007, Environment Canada conducted a workshop to explore the development of a monitoring and research program to determine the areal extent of subsidence-induced flooding from proposed gas extraction in KIBS. The workshop was attended by representatives from Shell Canada and IORL and by government scientists from Environment Canada, NRCan and INAC.

Rather than generating alternative predictions of subsidence, the parties agreed that the Proponents’ modelled predictions would serve as an operational starting point for the monitoring program. The results of the monitoring program would be used to:

- validate predictions of gas-extraction-induced subsidence flooding in the vicinity of the two Anchor Fields;
- identify whether observed changes were due to natural process or anthropogenic impacts;
- provide a defensible basis for adjusting (either up or down) the size of established habitat offsets (see Chapter 10, “Wildlife”); and
- assist with future subsidence impact prediction and evaluation of potential future developments.

NRCan confirmed to the Panel that substantial progress had been made in reaching a common understanding of what should be monitored and how to monitor it. However, it added that, while subsidence has been measured in many locations around the world, it had not been measured in a river delta affected by permafrost. NRCan stated, “while there may be other locations which we can use to help us understand certain aspects of the impacts, I think we really are alone in some respects…in trying to understand it in a permafrost-affected delta.” (Steve Solomon, HT V112, p. 11121)

Shell noted that subsidence might be offset by sediment deposition in the Middle Channel and the Kumak Channel in the vicinity of Niglintgak. In response to questioning from NRCan, Shell observed that “there are a lot of things happening in the Delta” and that subsidence could be up to 1.5 cm per year. It further stated that sediment rates are 1 to 9 cm per year and that it would be very difficult to predict the net impact of these opposing forces with confidence. (Davies, HT V14, p. 1379)

In response, NRCan noted that “[while] our knowledge of that area certainly suggests that there is some potential for aggradation,” it “would be very surprised if any area is aggrading over the long term at the rate of 9 centimetres per year.” It added, “in the 1970s, Environment Canada did some work on sedimentation rates in the outer Delta area…and I don’t recall seeing sedimentation rates of that magnitude in those areas.” (Solomon, HT V15, p. 1532)

MITIGATION

In response to a question from Environment Canada regarding the mitigation of surface subsidence by water injection, IORL replied that

> if we were to attempt to mitigate the reservoir compaction associated with gas production, which subsequently affects the surface by this gradual lowering,…it would severely reduce the amount of gas that we would recover from the reservoir. As a result, we don’t feel that mitigation of the subsidence effect is practical, nor do we feel that it is necessary. (Curtin, HT V13, p. 1311)

Shell stated that, in addition to being counter-productive to the objective of optimizing gas production,

> a large volume of water would be required along with water treatment facilities and a significant number of additional injector wells, all of which would significantly increase both environmental impacts and project costs. (J-SCL-00032, p. 6)

Dr. Gale and Dr. Konrad suggested that, in view of

> the Proponent's high level of confidence in their predictions regarding gas field subsidence at Taglu and Niglintgak, we would advocate [that] gas production…continue to the time of gas field depletion or until the maximum predicted surface subsidence is reached, whichever comes first. (J-JRP-00457, pp. 12–13)

In response, the Proponents submitted that

> The maximum subsidence numbers for each of the anchor fields are not directly linked to potential environmental effects. Reservoir compaction is a physical change in the environment that will result in surface subsidence and may or may not result in adverse environmental effects. (Curtin, HT V62, p. 6131)

The Proponents went on to state that their goal had been to accurately and conservatively predict the potential Anchor Field subsidence. They asserted that, based on maximum predicted subsidence values, "no likely significant adverse impacts on birds or bird habitat are expected as a result of this subsidence" (J-IORVL-01050, p. 107) (the Panel considers this conclusion in Chapter 10, "Wildlife"). Consequently, in the Proponents' view, there is no environmental justification for stopping or limiting production at Niglintgak or Taglu prior to depletion, and doing so would threaten the viability of those Anchor Fields. The Proponents also noted that they had committed to and were already working with the appropriate regulators to establish environmental effects monitoring and management programs that include addressing the potential impacts of subsidence.

PARTICIPANTS' VIEWS AND RECOMMENDATIONS

NRCan submitted that it would be essential to have refined estimates of flooding and the associated key input parameters, especially for habitat management purposes. Consequently, it would be essential to develop and implement an effective and thorough monitoring program to determine and track the extent of the area flooded, and obtain the data required to separate Project-induced changes from natural changes in the rate and extent of flooding.

NRCan submitted that subsidence of the ground surface in low-lying parts of the Mackenzie Delta due to hydrocarbon extraction would affect habitat and foundation conditions for facilities constructed for gas production, treatment and transport. NRCan considered that the Proponents' "most likely" subsidence estimates are reasonable and provide a basis for impact assessment, assuming that the reservoir mechanical properties used in their subsidence calculations are accurate. Discussions between the Proponents and Environment Canada regarding the impacts of subsidence within KIBS were supported with technical expertise from NRCan during the course of the hearings. As a result of those discussions, NRCan noted that most of their initial comments had been or were being addressed. However, NRCan recommended that, in order to verify predictions of flooding impacts as a result of hydrocarbon extraction-induced subsidence and to mitigate against these impacts:

> the Proponent provide to the appropriate regulators for review and approval, prior to anchor field construction/production, a program to monitor subsidence and flooding related to hydrocarbon extraction generated reservoir consolidation. The monitoring program, developed in collaboration with the appropriate regulators, should include a description of the monitoring techniques that will be used to monitor the ground and water level surfaces and movements, the current accuracy of each monitoring technique, the frequency with which each monitoring technique will be applied, and details on periodic reporting on the monitoring to the appropriate regulators. (J-NRCAN-00090, p. 155)

The Proponents agreed to this recommendation, with variation, noting that the Niglintgak and Taglu Anchor Field Proponents were currently working with the appropriate regulators and NRCan to develop a practical program to monitor the impacts of extraction-induced subsidence. Monitoring techniques, program parameters, reporting and other responsibilities would be consistent with those established by this program.

NRCan noted that vertical datums in the Mackenzie Delta region are not well documented and, because the land elevations are not very far above sea level, errors or discrepancies of several decimetres can have a considerable impact on engineering design as well as the environmental impact assessment. NRCan stated that, although the Proponents provided documentation to clarify use of terms related to elevations and depths, and explanations of the vertical datums, there were some outstanding issues. With respect to vertical datums and design elevations in the Anchor Fields, NRCan recommended that the Proponents provide to the appropriate regulators:

- a statement about the potential inaccuracies and uncertainties in the measured and derived elevations; and
- an estimate of the range of errors, taking this into account as engineering design and the development of mitigative measures proceed.

The Proponents did not agree with this recommendation and noted that information describing how the Proponents had determined preliminary design elevations for the Taglu and Niglintgak facilities had already been provided. The Proponents submitted that quantifying uncertainties and estimating the range of potential errors is not necessary because:

- the inherent conservatism in each elevation factor is added to establish the top elevation for each facility, which compensates for potential inaccuracies or errors in the current estimate of ground elevations;
- the preliminary designs are adequate for assessing the environmental impacts. These designs will be refined as engineering progresses, including considering these potential inaccuracies and the use of more precise survey methods; and

- the understanding of potential inaccuracies in surveyed elevations will improve as survey data and gravity measurements from more locations become available. Flood protection provided by the facilities' design will be supported by monitoring flood levels and by adaptive management, where necessary, to maintain protection, and by contingency plans to address unforeseen circumstances.

PANEL VIEWS

The Panel understands that Shell's and IORL's predictions of the extent of subsidence at Niglintgak and Taglu, as shown in Figure 6-9 and Figure 6-10, respectively, are based on modelling of what happens in the rock layers far below the surface as gas is extracted. These predictions thus represent the extent of subsidence at the earth's surface, in response to 30 years of gas extraction, as if the earth's surface were flat, uniform and stable. Consequently, the maps do not (and were not intended to) portray the possible extent of subsidence on the actual landscape.

The Proponents insisted on the reasonableness of their predictions on the grounds that they had applied conservative assumptions and values in their modelling. However, the Proponents did not provide the precise basis of these calculations or any error estimates or confidence limits for them. Under further examination, IORL acknowledged that its subsidence estimate was not an upper bound and could be exceeded.

The Panel understood from this exchange of views that, in principle, it is possible to provide an estimate for each of the five parameters involved in subsidence, with error bounds at a specified confidence limit. As the individual terms are combined in the calculation method, the total error would propagate based upon the uncertainty associated with each term. However, the Panel understood that Shell and IORL instead made conservative assumptions or estimates for each parameter and, without employing a formal error analysis, arrived at, in their view, reasonable estimates of the maximum possible subsidence.

In their closing remarks, the Proponents asserted that they had "responded to each of the Fracflow alleged deficiencies and those responses have not been challenged." (J-IORVL-01050, p. 109) While strictly speaking this may be correct, in the Panel's view the Proponents did not adequately address the uncertainty of their estimates. The Panel notes that Environment Canada and NRCan accepted the Proponents' subsidence estimates as a reasonable basis for developing monitoring and mitigation programs in relation to habitat offsets (discussed in Chapter 10, "Wildlife"). However, Environment Canada and NRCan did not agree that the Proponents' estimates could not be exceeded or that all uncertainties had been resolved.

In the final analysis, the Panel remains unconvinced that the Proponents' estimates of maximum surface subsidence could not be exceeded. Thus, the Panel concludes that extraction-induced subsidence at both Niglintgak and Taglu could exceed the Proponents' estimates, although by how much, with what probability, and with what impact cannot be stated with certainty based on the information available to the Panel. There was, nonetheless, general agreement among participants that the areal extent of submergence would be substantially greater than the physical footprint of the Project.

The Panel appreciates that the outer Delta is an environment where natural processes of deposition, erosion and flooding could exacerbate or possibly offset subsurface subsidence in ways that are difficult to predict. Yet even minor changes in water levels in the area of Niglintgak and Taglu due to subsidence could lead to inundation, greater incidence and extent of flooding, and changes in the balance between fresh and brackish waters. The impacts of these potential changes in vegetation and habitat are considered in Chapter 10, "Wildlife." The Panel considers it essential to use caution when considering the potential impacts of subsidence.

The Panel accepts the Proponents' contention that there is no feasible mitigation of potential subsidence on their part that is consistent with the full exploitation of Niglintgak and Taglu, and to limit production for that reason would jeopardize the viability of those Anchor Fields.

However, in light of the existing uncertainties and the need for a precautionary approach, the Panel considers that, in addition to the requirements of the NEB's Proposed Condition 7 for the Niglintgak and Taglu Fields, a cooperative monitoring program of the scope proposed by NRCan would be required as a basis for determining the extent of extraction-induced subsidence.

The Panel's recommendations on mitigating extraction-induced impacts on bird habitat are discussed in Chapter 10, "Wildlife."

6.10 OVERALL PANEL VIEWS AND RECOMMENDATIONS

In view of the limited experience of constructing and operating a non-ambient-temperature pipeline in a northern environment, the Panel considers that there is a need for conservatism in Project design and construction methods, caution in impacts prediction and mitigation, and well-designed and effectively implemented monitoring programs. Until site-specific conditions along the right-of-way are more fully identified and the appropriate mitigations are applied, there is an increased element of risk associated with the prediction of Project-related environmental impacts.

The Panel is largely confident in the Proponents' understanding of the engineering challenges related to the Project and their design approach to addressing these challenges. The Panel notes that, even if there were to be an accident or malfunction such as a pipeline rupture or well blow-out, the environmental impacts would likely be localized and short-lived (see Chapter 7, "Accidents, Malfunctions and Emergency Response"). The Panel draws further assurance from the fact that the NEB will also assess the Proponents' general design approach and would have continuing regulatory authority over the Project.

However, the Panel notes that some design and mitigation considerations (as discussed in Sections 6.4 through 6.9) were not entirely resolved during the hearings, and the Panel was unable to determine whether the Proponents' proposed mitigations would sufficiently address them. These matters, to which downstream regulators should pay particular attention, include:

- The need for a higher standard of right-of-way preparation, construction and reclamation in particular circumstances. The Panel accepts the Proponents' general approach to right-of-way preparation, construction and reclamation methods, even though these methods may result in thaw settlement along substantial portions of the right-of-way. However, where significant adverse impacts are identified for valued components, the Panel considers that higher standards would be required.
- The impacts of additional compressor installation over time. There is insufficient clarity on how the pipeline would be designed to minimize the impacts of change-of-state (frozen/thawed) at any particular location and the effectiveness of the proposed mitigations.
- The effectiveness of pipe insulation as a long-term mitigation for reducing frost bulb formation under stream crossings or for frost heave. There is insufficient clarity on the long-term effectiveness of pipe insulation as a primary mitigation, how declining effectiveness of this mitigation over time might be remediated, and what other effective mitigations might be available.

The Panel notes that flooding and submergence would increase in the outer Delta as a result of extraction-induced subsidence and that there is no practical means of preventing this. Mitigation must therefore be addressed by habitat replacement, as discussed in Chapter 10, "Wildlife."

The Panel notes that more detailed baseline information and designs will be required for downstream regulators, who will be responsible for determining the adequacy of site-specific design and mitigation. The Panel is satisfied that the Proponents intend to provide the necessary baseline information. However, for greater certainty, the Panel recommends the following:

RECOMMENDATION 6-1

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to provide prior to the commencement of trenching:

- *an updated inventory and assessment of baseline permafrost, ground-ice and terrain conditions along the Project corridor;*
- *an updated delineation of massive ground ice along the Mackenzie Gathering System and at associated facilities, based on all available data sources and any additional field data collected as part of the Geotechnical Verification Program; and*
- *information on the stratigraphy, locations and extent of ice-rich soils at stream crossings.*

The information filed in accordance with this National Energy Board condition should also be provided to other appropriate regulators for review.

The Panel is satisfied that the Proponents intend to provide further information on their designs and mitigations with respect to ground ice, thawing and freezing. The Panel also notes that the NEB's Proposed Conditions 13, 14, 16g and 18d would require some of this information. However, for greater certainty, the Panel recommends the following:

RECOMMENDATION 6-2

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, for approval, six months prior to the commencement of trenching:

- *final designs that incorporate updated characterization of ground-ice conditions, including delineation of massive ground-ice occurrence at the gathering system facilities and along the gathering system route, fully utilizing published data as well as any additional field data collected by the Proponents prior to or post-right-of-way clearing;*
- *an update of their ground stability and drainage impact assessments and of their environmental management and mitigation plans based on this additional baseline information on ground-ice conditions, including massive ice;*
- *identification of areas where impacts related to permafrost thaw and frost bulb formation along the right-of-way could be most severe (e.g. settlement, heave, ponding, erosion and drainage alteration) and where pre-burial or early mitigation might be required. This assessment should incorporate updated baseline information and thermal modelling. The assessment should examine a range of pipe temperatures along the route over the Project's life, including scenarios of adding compressor stations with various configuration durations, and the potential for associated impacts on right-of-way and pipe integrity, including those sections of the route where a period of freezing (and frost bulb formation) is followed by a reversal to thawing;*
- *an effects monitoring plan that includes, in addition to pipeline integrity monitoring, monitoring of permafrost, terrain and geotechnical parameters (such as ground temperatures, thaw bulb size, frost bulb size, ground movements and drainage and erosion changes) relevant to thaw bulb and frost bulb impact assessment;*
- *environmental management and mitigation plans based on the updated baseline information and geohazard assessment; and*
- *a mitigation "tool kit" that includes the thresholds for monitored permafrost, terrain and geotechnical parameters (e.g. ground*

temperatures, thaw depth and ground movement) that, once reached, will trigger the need for mitigation, as well as the criteria for selecting the most appropriate mitigation technique.

The information filed in accordance with this National Energy Board condition should be provided to other appropriate regulators and agencies in sufficient time for them to review and provide input to the National Energy Board.

The Panel is generally satisfied that the Proponents have taken adequate account of the potential impacts of climate change on the Project. However, for greater certainty, the Panel recommends the following:

RECOMMENDATION 6-3

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, for approval, prior to the commencement of trenching or well pad and facility construction, final design plans that incorporate further analysis of the impacts of climate change on permafrost and terrain stability over the design life of the Project and post-abandonment. This analysis should be conducted for a series of representative locations, conditions and terrain types and should incorporate climate variability and, in particular, upper limit temperature scenarios to account for the range of future temperature conditions, including their variability and extremes, and the impact of this variability on stream flow regimes. The results should also be incorporated into the monitoring, mitigation and adaptive management plans.

The information filed in accordance with this National Energy Board condition should be provided to other appropriate regulators in sufficient time for them to review and provide input to the National Energy Board.

The Panel considers that, for reasons further discussed in Chapter 10, "Wildlife," pipeline construction procedures in KIBS and on Fish Island would require higher standards of practice than those the Panel finds acceptable elsewhere. Therefore, the Panel recommends the following:

RECOMMENDATION 6-4

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, for approval, six months prior to the commencement of construction, a construction and operations plan for the Project facilities in Kendall Island Bird Sanctuary and for the Fish Island segments of the Mackenzie Gathering System that has been developed in consultation with, and to the satisfaction of, Environment Canada and that includes:

- *the goals of the plan;*
- *the manner in which the Proponents will address the recommendations of Environment Canada with respect to construction and operations of the Kendall Island Bird Sanctuary and the Fish Island segment of the Mackenzie Gathering System;*
- *measures to avoid, prevent or mitigate adverse impacts to migratory birds, their nests, eggs or habitat in Kendall Island Bird Sanctuary and on Fish Island;*
- *plans for monitoring compliance and impacts during construction and operations, as well as proposed responses to address unanticipated impacts; and*
- *reporting frequency and content.*

The plan must also include details on how it will be implemented. When implemented, the Proponents must file copies of their monitoring reports with Environment Canada.

Although the Panel considers the Proponents' plans for avoiding and remediating ditch fill settlement satisfactory for most terrain likely to be encountered, concerns remain about their effectiveness in areas of massive ice, such as low-lying tundra polygon terrain along the Mackenzie Gathering System. For greater certainty, therefore, the Panel recommends the following:

RECOMMENDATION 6-5

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, for approval, six months prior to the commencement of construction, plans that describe, with respect to the entire right-of-way, including watercourse crossings:

- *the methods for determining the quality and quantity of imported fill that may be required to minimize the need for subsequent refilling and regrading;*
- *the timing and methods for hauling and stockpiling those fill requirements;*
- *the methods for monitoring for and remediating ditch subsidence in the first year after construction and as required during operations; and*
- *the methods for disposal of excavated material not required for backfill.*

The information filed in accordance with this National Energy Board condition should be provided to other appropriate regulators and land managers in sufficient time for them to review and provide input to the National Energy Board.

In the Panel's view, priority must be placed on avoiding the creation of frost bulbs and aufeis through effective design and mitigation. To this end, the Panel recommends the following:

RECOMMENDATION 6-6

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals that it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, for approval, six months prior to the commencement of construction, their plans for identifying the potential for and preventing or mitigating any impacts to stream flow or diversion from frost bulb and aufeis creation as a result of the Project. The plans should be developed in consultation with, and to the satisfaction of, Fisheries and Oceans Canada. The plans should include:

- *field procedures to be utilized in determining the potential locations where a frost bulb may impede drainage;*
- *proposed design and construction methods for frost bulb and aufeis prevention and mitigation and the criteria for their selection;*
- *selection of pipe insulation materials and methods of application and installation, including the rationale for same, and the estimated longevity of their effectiveness; and*
- *proposed mitigations for reduced effectiveness of pipe insulation, should it occur, and the criteria for initiating those mitigations.*

The crossing designs and criteria for frost bulb and aufeis mitigation should also address changes in the thermal regime of the pipe associated with the installation of any additional compressor stations required to enable the throughput of the Mackenzie Valley Pipeline to be increased above 1.2 Bcf/d.

The Panel is generally satisfied that the Proponents have adequately addressed potential impacts of the Project on groundwater flow. However, for greater certainty, the Panel recommends the following:

RECOMMENDATION 6-7

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, for approval, six months prior to the commencement of construction, detailed descriptions of:

- *installation procedures and limitations of using ditch plugs to mitigate groundwater flow along the pipeline ditch and horizontal directional drilling pathways;*
- *alternative methods for the control of groundwater infiltration and flow along the ditch and horizontal directional drilling pathways and evaluation of the methods' effectiveness in northern conditions; and*
- *how monitoring will be implemented to ensure the effectiveness of these mitigations.*

The information filed in accordance with this National Energy Board condition should be provided to other appropriate regulators in sufficient time for them to review and provide input to the National Energy Board.

The Panel is generally satisfied that the Proponents have addressed, or would address prior to construction, participants' concerns about the design and construction of watercourse crossings. The Panel also notes the NEB's Proposed Conditions 15 and 18 regarding hazard analysis for HDDs and inventory, final designs, and frost bulb analysis for watercourse crossings. However, for greater certainty with respect to control of sedimentation, the Panel recommends the following:

RECOMMENDATION 6-8

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, for approval, six months prior to the commencement of construction, detailed mitigation plans to reduce the release of sediments at stream crossings during construction and in the post-construction phase.

The plans filed in accordance with this National Energy Board condition should be provided to other appropriate regulators in sufficient time for them to review and provide input to the National Energy Board.

The Panel is generally satisfied with the Proponents' commitments regarding acid-rock drainage. However, for greater certainty, the Panel recommends the following:

RECOMMENDATION 6-9

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, for approval, prior to the commencement of quarrying or trenching:

- *the results of acid rock drainage surveys and/or analyses performed to identify Project activity areas with potential for acid rock drainage;*
- *detailed mitigation and management plans for acid rock drainage prevention or disposal of potentially acid-generating materials, in the event that either expected or unexpected sulphide-rich bedrock is exposed during construction; and*
- *an outline of a monitoring program that would be implemented during operations to assess the effectiveness of mitigation measures.*

The information filed in accordance with this National Energy Board condition should be provided to the other appropriate regulators in sufficient time for them to review and provide input to the National Energy Board.

The Panel accepts that extraction-induced subsidence cannot be prevented. In order to implement the Panel's recommendations on habitat offsets to address the impacts of subsidence (see Chapter 10, "Wildlife," and Chapter 11, "Conservation Management and Protected Areas"), there must be a monitoring program to identify the extent and impacts of subsidence. Therefore, the Panel recommends the following:

RECOMMENDATION 6-10

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, for approval, prior to the commencement of construction of the facilities at the Taglu or Niglintgak Anchor Fields, a program to monitor subsidence and flooding related to hydrocarbon extraction generated reservoir consolidation for the purpose of verifying predictions of flooding impacts. The monitoring program, developed in collaboration with the appropriate regulators, should include a description of the monitoring techniques that will be used to monitor the ground and water level surfaces and movements, the current accuracy of each monitoring technique, the frequency with which each monitoring technique will be applied, and details on periodic reporting on the monitoring to the appropriate regulators.

NRCan made several recommendations on design and monitoring regarding soil–pipeline interaction, Project and Norman Wells Oil

Pipeline proximity and crossings, pipeline materials technology, and production facility safety and integrity. The Panel considers that these recommendations primarily address matters of pipeline or system integrity rather than environmental impacts, and may be addressed in whole or in part by the NEB's Proposed Conditions. Mindful that NRCan is not an Intervener in the NEB proceeding, the Panel refers these recommendations to the NEB without further comment.

NRCan also recommended that, should the Project proceed, collaborative permafrost and terrain research and follow-up programs be established, that these programs be modelled on the joint INAC-NRCan Permafrost and Terrain Research and Monitoring Programme or the Norman Wells Oil Pipeline, and that government agencies that have relevant scientific expertise be engaged in them. The Panel agrees with NRCan and makes the following recommendation:

RECOMMENDATION 6-11

The Panel recommends that, as part of the follow-up program for the Mackenzie Gas Project, the Government of Canada establish, prior to the commencement of construction, a multi-year permafrost and terrain research and monitoring program for collaborative government–industry monitoring that engages government agencies with relevant scientific expertise in the development of and participation in the follow-up monitoring program. This program should continue into the post-abandonment phase of the Mackenzie Gas Project.

The Panel notes that several of the NEB's Proposed Conditions address, in whole or in part, the concerns identified by the Panel. These include:

- for the Mackenzie Valley Pipeline and Mackenzie Gathering System prior to construction: Proposed Conditions 10, 11, 12, 13, 14, 15, 16, 17 and 18;
- for the Mackenzie Valley Pipeline and Mackenzie Gathering System during construction: Proposed Conditions 39, 40, 41, 42 and 43; and
- for Shell's and IORL's development plans for the Niglintgak and Taglu Anchor Fields: Proposed Condition 7.

The Panel recommends that the NEB retain these Proposed Conditions at a minimum as final conditions of the Proponents' certificate, if granted. In the Panel's view, if the NEB's Proposed Conditions identified above and if the Panel's recommendations, including the Panel's recommendations on offsets as a mitigation for the impacts of subsidence as found in Chapter 10, "Wildlife," are implemented, then the adverse environmental impacts of construction and operations of the Project as Filed would not likely be significant. Therefore, the Panel recommends the following:

RECOMMENDATION 6-12

The Panel recommends that, in addition to the foregoing Panel recommendations, the National Energy Board adopt its Proposed Conditions 10, 11, 12, 13, 14, 15, 16, 17, 18, 39, 40, 41, 42 and 43 as set out in the Proposed Conditions for the Mackenzie Valley Pipeline and Mackenzie Gathering System, and Proposed Condition 7 as set out for the Proposed Conditions for Shell Canada Limited (Shell) Development Plan for the Niglintgak Field and for Imperial Oil Resources Limited (IORL) Development Plan for the Taglu Field, amended to apply to the relevant proponent and component of the Mackenzie Gas Project and the Northwest Alberta Facilities, as final conditions in any certificate or approvals it might issue in relation to the Project or the Northwest Alberta Facilities.

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Accidents, Malfunctions and Emergency Response

7.1 INTRODUCTION

As with any industrial undertaking, there is the potential for accidents and malfunctions to occur in conjunction with the Project and related undertakings. The potential for accidents and malfunctions necessitates appropriate emergency preparedness and response (EPR) planning.

The previous chapter considered the Proponents' design approach to avoid or minimize the frequency and magnitude of accidents and malfunctions as a result of construction and operations, especially with respect to geohazards, as these could affect pipelines and production facilities during operations.

This chapter focuses on how the Proponents intend to minimize the consequences of accidents and malfunctions — chiefly by minimizing their duration and extent — during construction and operations, through rapid and effective emergency response, and clean-up and restoration after the event.

The Proponents' approach is to prepare and implement a series of emergency response and management plans. Most of these plans are required by regulatory agencies and must be approved in advance of construction or operations. The Proponents provided the Panel with summaries or sample tables of contents of these plans during the course of the Panel's review proceedings.

The Panel has considered the likely effectiveness of the emergency response and management plans the Proponents would develop — either as part of their commitments or under current regulatory requirements to minimize the magnitude, extent and duration of impacts should an accident or malfunction occur — and the respective response roles of the Proponents and regulatory agencies. The Panel is concerned not only with the effectiveness of the Proponents' plans and preparedness, but also with the existing government response framework and its effectiveness, including, for example, how well organized and prepared the relevant government agencies are to respond to an accident or malfunction.

Many participants raised concerns regarding potential accidents, malfunctions, spills and leaks resulting from the Project and related activities, and the Proponents' response to such events. The Panel heard about these concerns at most of its Community Hearings and at many of its Technical Hearings.

The Proponents provided scenarios on potential accidents and malfunctions, potential impacts and mitigation, and emergency response and recovery. The Panel has chosen to discuss some of the evidence related to accidents, malfunctions and EPR in the context of the following four broad categories as they relate to the Project:

- proposed Anchor Field development, including wells, gas processing facilities and the Inuvik Area Facility;
- proposed pipeline development, including the Mackenzie Valley Pipeline and gathering pipelines;
- transportation-related activities; and
- hazardous materials management.

The Panel notes that accidents, malfunctions and EPR pertaining to transportation are unique to the Project due to the magnitude of its transportation requirements and the unique characteristics of the logistics and planning associated with transportation in the North. Thus, the Panel has chosen to address this topic in some detail.

The Panel also notes that this chapter is limited to accidents, malfunctions and EPR as they relate to the Project as Filed and the additional compressor stations associated with the Expansion Capacity Scenario. The Panel does not have sufficient evidence before it to assess accidents, malfunctions and EPR as they relate to gas field development in the Expansion Capacity Scenario and Other Future Scenarios. However, the Panel notes that it is likely that much of the following discussion would be relevant to those activities since they would likely occur within a similar regulatory environment as the Project as Filed and the additional compressor stations associated with the Expansion Capacity Scenario.

7.2 EXISTING CONDITIONS

In the Northwest Territories (NWT) there is a complex system of regulatory controls and management plans designed to prevent and respond to accidents and malfunctions. A number of government agencies are involved, and they have jointly prepared response plans to be implemented in case of an accident or malfunction.

7.2.1 NATIONAL ENERGY BOARD

The National Energy Board (NEB) regulates all oil and gas exploration and drilling and related pipelines north of the 60th parallel. It also regulates interprovincial and international pipelines in southern Canada. The *Onshore Pipeline Regulations, 1999*, promulgated under the *National Energy Board Act*, contain various planning and operational requirements for pipelines under the NEB's jurisdiction that are relevant to accidents, malfunctions and EPR. The primary requirements include an EPR program (hazard assessment and emergency response training), a Pipeline Security Management Program and a Pipeline Integrity Management Program.

Within their EPR programs and security management programs, companies are required to consider all hazards, including threats from terrorism and criminal activities. Further, companies are required to undertake regular audits and inspections of their programs. NEB staff also review these programs.

The *Canada Oil and Gas Operations Act* and related regulations also contain various plans, programs and requirements for operations, contingency, safety and environmental protection for well drilling and production activities. Examples include requirements for a Safety Plan and an Environmental Protection Plan.

The NEB typically attaches conditions to certificates or approvals that it may issue for projects.

7.2.2 GOVERNMENT OF THE NORTHWEST TERRITORIES

The Government of the Northwest Territories' (GNWT's) responsibilities for emergency response are coordinated by its Emergency Measures Organization. Within this organization, the Territorial Emergency Response Committee has the lead role in coordinating interdepartmental and intergovernmental cooperation when emergencies occur. The GNWT has also developed the *Northwest Territories Emergency Plan* to provide a prompt and coordinated response by the GNWT, other governments and non-governmental agencies to territorial emergencies that affect all or part of the NWT.

The GNWT stated that the initial response to any accident or incident related to the Project would be the responsibility of the Proponents and their employees. Larger incidents might also involve the GNWT in its role as emergency coordinator under various acts and arrangements, upon request of the municipal authority, or as a responder in certain instances. The largest-scale incidents might require the involvement of Canada's emergency response under various Acts and arrangements, upon request of the GNWT, or as a responder in certain instances (e.g. air search and rescues by the Canadian Coast Guard).

The GNWT's Pipeline Readiness Team also noted that emergency planning is the responsibility of community governments and that those plans would need to be reviewed prior to the construction of the Project. The GNWT stated that it was in the process of obtaining new staff to work with community governments to review emergency plans. Provisions were also included in the *Mackenzie Gas Project Socio-Economic Agreement* to include the Proponents' consultations with community governments and the Pipeline Readiness Team in the preparation of these plans.

Regarding hazardous material spills, the GNWT made reference to the NWT's *Spill Contingency Planning and Reporting Regulations and the Northwest Territories/Nunavut Spills Working Agreement*, as discussed further in this chapter.

The GNWT also stated that it works under the principle that the polluter bears the responsibility for spill response and clean-up actions. This responsibility includes providing all personnel, equipment, clean-up, disposal and site restoration. Territorial and federal government agencies are responsible for initiating an investigation and/or evaluation of the spill event and monitoring the clean-up activities to ensure protection of people, property and the environment.

The *Spill Contingency Planning and Reporting Regulations* require that spill quantities of refined petroleum products in excess of 100 L be reported to the NWT 24-Hour Spill Report Line.

7.2.3 ENVIRONMENT CANADA

Environment Canada stated that it provides leadership and guidance to other federal departments and agencies, as well as provinces, territories and industry, in the development of contingency plans for environmental emergencies, including reporting and response systems at the national, regional and local levels. Environment Canada noted that the goal of its enforcement program is to ensure compliance with all Acts that it is responsible for, such as the *Canadian Environmental Protection Act, 1999*, the pollution prevention provisions of the *Fisheries Act*, and the *Migratory Birds Convention Act, 1994*. In cases where Environment Canada responds to an environmental emergency, it may inspect the site to verify compliance or to investigate suspected violations.

Environment Canada also filed information regarding its responsibilities in the event of a spill on the Mackenzie River and noted that its responsibilities are also outlined in the *Northwest Territories/Nunavut Spills Working Agreement*.

Environment Canada has environmental enforcement officers and environmental emergency officials designated under the *Canadian Environmental Protection Act, 1999* and inspectors and/or fishery officers designated under the *Fisheries Act* who ensure compliance with the Acts and corresponding regulations.

7.2.4 INDIAN AND NORTHERN AFFAIRS CANADA

Indian and Northern Affairs Canada issues land use permits in the Inuvialuit Settlement Region and enforces land and water permits and licences issued by the Land and Water Boards throughout the NWT.

Indian and Northern Affairs Canada noted that it has responsibilities with respect to the protection of land and water in the NWT and Nunavut under such legislation as the *Northwest Territories Waters Act*, the *Territorial Lands Act*, the *Arctic Waters Pollution Prevention Act* and the *Mackenzie Valley Resource Management Act*. Under the *INAC Spill Reporting Protocol for Upstream Oil and Gas Operations*, all harmful substances, regardless of quantity, are immediately reportable where the release is near or into a water body. Indian and Northern Affairs Canada further stated that the occurrence of spills and subsequent response and follow-up were of particular concern and that it had been party to the *Northwest Territories/Nunavut Spills Working Agreement* since its inception in 1979. When Indian and Northern Affairs Canada is the designated lead agency, its inspectors at regional offices throughout the NWT and Nunavut perform the required spill response duties.

7.2.5 TRANSPORT CANADA

Transport Canada stated that the legislative and regulatory framework that governs its operations integrates, in many instances, specific environmental requirements. These include:

- ballast water management regulations;
- oil-handling facilities standards;
- stringent requirements for containment, marking and transportation of dangerous goods; and
- a program to detect and prosecute marine polluters.

Transport Canada also has programs to enhance the safe operation of aircraft, trains, ships and barges, as well as a program to ensure that works built in, on, over, under, through or across any navigable waterways do not interfere with the public right to navigate. Transport Canada submitted that these programs contribute to an environmentally responsible transportation system by preventing accidents that can result in spills and ultimately harm the environment.

7.2.6 LAND AND WATER BOARDS

Land and Water Boards in the NWT require Emergency Response Plans as part of their permitting process and involve other parties in the review of these plans.

7.2.7 THE *NORTHWEST TERRITORIES/ NUNAVUT SPILLS WORKING AGREEMENT*

The *Northwest Territories/Nunavut Spills Working Agreement* outlines responsibilities for various government departments and agencies in the event of a spill in the NWT or Nunavut on land or in Arctic or inland waters. It states that the party that caused the spill bears primary responsibility for cleaning it up, restoring the area impacted, and otherwise undertaking an effective operational response. The purpose of the agreement is to formalize procedures for coordinating spill investigation and monitoring. The signatories to the agreement are:

- Indian and Northern Affairs Canada;
- the Canadian Coast Guard;
- the National Energy Board;
- Environment Canada;
- the Government of the Northwest Territories;
- the Government of Nunavut; and
- the Inuvialuit Land Administration.

The agreement documents the requirements for use of the NWT 24-Hour Spill Report Line and sets out which agency is to take the lead in various spill situations, depending on jurisdiction. The lead agency is responsible for ensuring that the spill is investigated and that adequate follow-up and monitoring takes place by the polluter. The agreement enables each agency to fulfill its own responsibilities and ensures timely coordination and integration of each agency's actions. The framework and procedures outlined in the agreement emphasize the role of the appropriate regulatory agency to monitor and investigate spills.

7.2.8 AQUATIC SPILLS

As noted in the preceding section, the *Northwest Territories/Nunavut Spills Working Agreement* applies to land-based and aquatic spills. Discussion about the regulatory responsibilities of various agencies in the North in the event of accidents and their potential impacts on water resources occurred primarily during the Panel's hearings on fisheries, water, monitoring and follow-up programs.

Fisheries and Oceans Canada noted that it had been meeting with Environment Canada, Transport Canada and the Canadian Coast Guard to discuss spills on water, both ship-based and non-ship-based. Transport Canada is the lead regulator for ship-based pollution, including the transfer of oil from ship to shore, and it develops and implements the regulations that apply to shippers. The Canadian Coast Guard is the lead agency in the NWT for response to spills on water from an unknown source, or where the polluter is unwilling to clean up the spill, or where the polluter is willing but not fully able to respond.

On behalf of Fisheries and Oceans Canada and Transport Canada, Environment Canada submitted details on the responsibilities of the Canadian Coast Guard, Transport Canada and Environment Canada related to barge traffic, fuel handling and spill response on the Mackenzie River. Responsibilities include controlling and limiting the amount of barge traffic on the Mackenzie River, marine emergency preparedness and incident reporting, and emergency response in the event of a spill.

Environment Canada also noted that, in the event of a major environmental emergency on the River, it may activate its Arctic Regional Environmental Emergency Team. This team is not a response organization but a scientific and technical advisory group that provides response and clean-up advice to the lead responder or the clean-up contractor. At the time of the Panel's hearings, team members were located in Yellowknife, but Environment Canada noted that they could be stationed anywhere in the Northwest Territories, Nunavut or the Yukon.

Transport Canada stated that its regulations require a Ship Oil Pollution Emergency Plan for barges and ships and an Oil Pollution Emergency Plan for oil-handling facilities. It also noted that companies currently shipping on the Mackenzie River have a Ship Oil Pollution Emergency Plan that conforms to international standards. These plans are reviewed annually during inspection of vessels by marine safety inspectors. Part of the inspectors' review is to check the plans' contents to see whether they have been updated on a timely basis, whether changes have been made, and whether training exercises or other requirements of the plans are in place. Transport Canada also noted that there may be additional provisions and mitigation regarding spills and their prevention that are not required as part of a Ship Oil Pollution Emergency Plan. However, additional provisions may be contained in other plans and documents, such as a company's operating procedures. Transport Canada also filed a copy of the *Arctic Waters Oil Transfer Guidelines*, which are intended to prevent cargo and fuel oil spills during transfer in Arctic waters between any two vessels or between a vessel and shore terminal or storage depot.

Fisheries and Oceans Canada provided information on the Canadian Coast Guard's National Exercise Program, which includes management and operational exercises. Fisheries and Oceans Canada referred to several Canadian Coast Guard–sponsored exercises and operational training that has occurred within the NWT since 1997. Individual exercises range from informal drills to multi-organizational events, with desktop simulations and on-water deployments. All exercises, irrespective of location, contribute to the state of the Coast Guard's operational readiness since the equipment and systems used are not based on specific geography but on the pollutant and a range of environmental factors. Fisheries and Oceans Canada submitted that the Arctic, specifically the Mackenzie River and Delta, poses difficult but not entirely unique challenges in terms of accessibility, limited infrastructure and limited human resources. It noted that these issues were being, and would continue to be, addressed in the preparation of area-specific annexes to the National Exercise Program and the Coast Guard's overall preparedness. It also noted that exercises are one part of overall preparedness capacity and that other important factors include planning and client networking, training (including operational deployments), equipment life-cycle management, and infrastructure support.

Fisheries and Oceans Canada stated that spill exercises are not exclusively the responsibility of the Canadian Coast Guard or related solely to marine shipping. The Coast Guard works in partnership with the NEB, Indian and Northern Affairs Canada, Environment Canada, and the GNWT to collect and disseminate pollution reports to the appropriate agencies. Each of these entities either regulates or monitors exercises conducted by various private sector companies that engage in transportation, storage and distribution of potential pollutants. In particular, companies such as Enbridge Pipelines (NW) Inc., Imperial Oil Limited and Devon Energy Corporation conduct exercises for land and marine situations in support of their business. Other government departments also have responsibility to ensure that companies have an appropriate state of readiness.

Regarding future exercises, the Canadian Coast Guard stated that it remained committed to facilitating and participating in desktop and operational exercises, individually and in partnership with other agencies, and at a frequency that can be regionally sustained. It noted that it supported and encouraged all entities engaged in transportation and storage of hydrocarbons to also conduct exercises. It further stated that, during the Project's construction phase and beyond, increased vessel traffic would heighten the Coast Guard's awareness of such traffic but would not significantly change its capacity to respond. Fisheries and Oceans Canada had no plans to conduct field exercises specifically in anticipation of the Project, but it noted that it would continue to undertake operational and desktop exercises in the region, which would ultimately increase its preparedness. Fisheries and Oceans Canada stated that future Coast Guard exercises for the Arctic, including the Mackenzie River, would involve the deployment of personnel in command and control roles and deployment of spill response equipment. The Coast Guard schedules exercises in consultation with partners and as opportunities arise.

Since compliance with regulatory requirements is an element of avoiding and minimizing ship-source spills, there was discussion during hearings of the relevant legislative framework, related government surveillance program, and enforcement and prosecution with respect to spills that have occurred. In response to questioning, Transport Canada indicated the following: "When ship-source pollution is detected through aerial surveillance or other means, Transport Canada investigates in close cooperation with Environment Canada and the Canadian Coast Guard. Whenever there is sufficient evidence, and pictorial evidence has been sufficient in previous court cases, Transport Canada will prosecute marine polluters under the *Canada Shipping Act* or the *Arctic Waters Pollution Prevention Act*, depending on the location of the incident." (Craig Miller, HT V54, p. 5228)

To clarify the ship-source pollution deterrent provided by the *Canada Shipping Act, 2001*, the *Arctic Waters Pollution Prevention Act* and the *Fisheries Act*, the Panel requested information on the number of spills detected, charges laid and successful prosecutions over the past 10 years on Canada's three coasts, the Great Lakes and major rivers that have ship traffic.

In response, Transport Canada advised the Panel that there were no ship-source spills reported through aerial surveillance in the Arctic over the past 10 years since it had initiated dedicated surveillance only in summer 2005. However, it also noted there were more than 20 successful prosecutions taken against vessels that were observed polluting in other areas of the Atlantic and Pacific by its National Aerial Surveillance Program aircraft, other aircraft contracted to it, and other government surveillance programs reporting to Transport Canada from April 1, 1992, to March 31, 2006. It also noted that, as far as it was aware, there were no stays of proceedings directed by the Attorney General under the *Canada Shipping Act, 2001* or the *Arctic Waters Pollution Prevention Act.*

The Panel asked the same question of Environment Canada. In response, it stated that Transport Canada is the lead federal regulatory agency responsible for spills from ships. It also noted that roles and responsibilities related to inspection and investigations of ships and ship-source pollution incidents had been clearly defined through a 2006 Memorandum of Understanding between Environment Canada and Transport Canada. One of Environment Canada's functions during its ice reconnaissance flights is aerial observation of oil transport. All observations of spills are reported to Transport Canada as the lead agency and, as appropriate, to Environment Canada for follow-up. Environment Canada also noted that satellites can be employed to track vessels and look for oil anomalies on the ocean surface, including Arctic waters. These initiatives aim to deter mariners in the Arctic from intentional discharges and assist in response, clean-up and enforcement in the event of a pollution incident. On June 28, 2005, amendments to the *Migratory Birds Convention Act, 1994* and the *Canadian Environmental Protection Act, 1999* resulted in Environment Canada having a greater opportunity to enforce ship-source marine pollution laws and regulations. To support this greater role, it has created a national enforcement team to deal with the investigation of larger ship-source pollution incidents. With respect to ship-source spills, Environment Canada noted that it had limited previous involvement because Transport Canada is the lead federal agency, but it did provide one example of successful prosecution.

Answering the same question from the Panel, Fisheries and Oceans Canada noted that the Canadian Coast Guard does not routinely conduct pollution surveillance flights. However, when tasked for other purposes, Coast Guard aircraft have agreed to report pollution sightings. The Coast Guard presented the total number of pollution incidents reported since 2001 by region (the national database captures data only since this time). The Coast Guard noted that it does not lay charges under the *Canada Shipping Act, 2001*, the *Arctic Waters Pollution Prevention Act* or the *Fisheries Act*. Designated pollution prevention officers within the Canadian Coast Guard may collect and provide evidence to

Transport Canada, which in turn would decide whether or not to investigate the offence and prosecute.

Transport Canada also submitted a copy of the Memorandum of Understanding between Environment Canada and Transport Canada, *To Outline the Co-Operation of Both Parties in Enforcing Pollution Prevention and Wildlife Legislation for the Protection of the Marine Environment from Ship Source Pollution*. This agreement outlines the basis of cooperation to protect the marine environment in waters under Canadian jurisdiction and in meeting Canada's obligations in accordance with international agreements with respect to subjects such as ship-source pollution. There are various legislative and regulatory authorities governing this agreement. Environment Canada has responsibility for inspections to verify that ships are in compliance with the *Canadian Environmental Protection Act, 1999*, the *Fisheries Act*, the *Migratory Birds Convention Act, 1994* and the *Species at Risk Act*.

7.2.9 TRANSPORTATION OF DANGEROUS GOODS

The *Transportation of Dangerous Goods Act, 1992* and associated regulations manage the transportation of dangerous goods by air, marine, rail and road within Canada. The regulations, which have been adopted by all provinces and territories, establish safety requirements such as packaging standards, incident reporting and Emergency Response Assistance Plans for the transportation of dangerous goods. The Act defines dangerous goods, which include products such as explosives, gases, flammable liquids and solids, and poisonous and radioactive materials. The requirement for an Emergency Response Assistance Plan depends on the nature and volume of the product being transported.

7.3 PROPONENTS' VIEWS

7.3.1 KEY PLANNING DOCUMENTS

The Proponents stated that the Project falls under a comprehensive regulatory regime governed by Acts such as the *National Energy Board Act*, the *Canada Oil and Gas Operations Act*, the *Fisheries Act*, the *Migratory Birds Convention Act, 1994* and the *Mackenzie Valley Resource Management Act*. They stated that they would prepare a number of Environmental Management Plans that would ensure that Project commitments and regulatory requirements were met. These plans would include mitigation, monitoring and reporting measures required by regulators or other authorities that make recommendations to regulators. The Proponents noted that plans may also be prepared that are not directly covered by legislation but are nevertheless an integral part of Project planning and management.

The Proponents provided profiles of Environmental Management Plans that they expected to be required by regulation or conditions attached to Project authorizations for construction or operations for the Anchor Fields, the gathering lines and the Mackenzie Valley Pipeline. The information provided was broad and conceptual, but the Proponents stated that prior to construction and drilling they would prepare detailed, functional plans that would incorporate feedback obtained through the regulatory review process. Similarly, leading up to production facilities and pipeline commissioning and start-up, detailed operations plans would be prepared and submitted. Each Project operator would have its own set of Environmental Management Plans.

NOVA Gas Transmission Ltd. also presented a summary of its Environmental Management Plan and noted that regulatory oversight of the plan would be from the Alberta Energy and Utilities Board (now the Energy Resources Conservation Board), the Government of Alberta's Department of Sustainable Resource Development, Alberta Environment, and Fisheries and Oceans Canada. It stated that its plan would ensure that environmental objectives, mitigation measures and communications protocols are implemented for all construction activities.

The following sections describe the key plans and programs related to accidents, malfunctions and EPR that the Proponents noted they would prepare. Numerous regulators and agencies would be involved in preparing and approving these plans.

EMERGENCY PREPAREDNESS AND RESPONSE PLAN

The Proponents stated that their overall Emergency Response Plan would meet the requirements of the NEB and Land and Water Boards in the NWT, would include spill response and contingency planning, and would apply to the pipeline, Anchor Fields, and all their phases and components. The plan would outline procedures for preparing for and dealing with emergencies, as required by the NEB. The Proponents noted that the plan's prime objective is to provide an effective way to protect employees, contractors and the public, and that it expected that the NEB would seek input from other agencies that have emergency response expertise, such as Environment Canada. The Proponents also noted that they would develop separate Emergency Response Plans for each mode of transportation.

The Proponents' Emergency Response Plans would provide information on spill response procedures and protocols. Each facility and operator would have its own plan tailored to specific needs. The Proponents stated that the objective of the Spill Response Plan contained within the overall Emergency Response Plan is to reduce impacts on public health and safety, the environment and traditional harvesting. The Spill Response Plan would address fuel and chemical spills and waste or other products used or generated by the Project. Examples of mitigation measures that would be included in the Spill Response Plan include:

- identifying and preventing potential incidents through formal risk and hazard assessments;
- establishing a Spill Response Organization and developing training drills and exercises; and
- identifying sensitive areas and times of year.

The Proponents' procedures and regulatory requirements would provide the basis for implementing these mitigation measures. Monitoring would involve periodically reviewing the risks during Project design, construction and operations and regularly conducting hazard assessments. The effectiveness of training and response would also be evaluated and reported.

The Proponents elaborated on the contingency and response measures that would be used to mitigate the potential impacts of accidents and malfunctions on the environment and human health. These included potable water supply, harvesting, and social and cultural elements during each phase of the Project. Contingency and response measures would include oil and hazardous materials spill contingency plans, fire-fighting plans and other emergency response plans. The Proponents noted that the Project's Spill Contingency Plan would include mock spill drills and a summary of restoration measures to be undertaken in spill-affected areas to ensure that the spill does not continue to be a potential source of contamination. The Proponents also described specific Emergency Response Plans and procedures for accidents and malfunctions and explained their due diligence standards regarding oil and hazardous material spill prevention, preparedness, response, and restoration, and identified contacts in the event of incidents. The Proponents stated that planning for Project-related accidents and malfunctions would specifically consider biophysical and social components of particular value, such as harvesting, traditional land use areas and natural sites of particular value.

The Proponents outlined their accident, malfunctions and EPR planning for a variety of scenarios and noted that these plans would be prepared by adapting documents from existing plans. Planning would be based on the NEB's expectations as outlined in its letter to all oil and gas companies under its jurisdiction, File 172-A000-73, Security and Emergency Preparedness Response Programs (April 24, 2002); the *CAN/CSA-Z731-03 Emergency Preparedness and Response* standard; and the ISO 14001 Environmental Management Systems standard.

The Proponents stated that Project Emergency Response Plans would be unique to specific activities and functional areas, and would vary with Project requirements. However, all plans would have common elements, including a response organization, identification of first responders and emergency-specific response procedures.

The Proponents also noted that their accident, malfunction and EPR planning would incorporate unique circumstances associated with operating under northern conditions.

HAZARDOUS MATERIALS MANAGEMENT PLAN

The Proponents noted that all Project phases would involve handling, storing and transporting a variety of hazardous materials. The Proponents committed to preparing a Hazardous Materials Management Plan that would include proactive measures to prevent releases. These measures would include handling and containment procedures, plans, policies, and training and documentation requirements. The Proponents submitted that information in the plan would assist users in planning and implementing hazardous materials management activities according to the requirements of federal and territorial regulations, land use permits and industry best practices. The Proponents noted that the plan's requirements and procedures might need to be updated throughout the Project's life to reflect changes in its design and requirements.

The Hazardous Materials Management Plan would provide guidelines, standards and requirements for classifying, handling, storing and transporting hazardous materials, including a variety of controlled substances, such as flammable, poisonous or corrosive materials, identified in the Workplace Hazardous Materials Information System under the federal *Controlled Products Regulations*.

Additional hazardous materials, such as explosives, pesticides and radioactive material covered by relevant federal legislation, would be included within the scope of the plan.

PIPELINE INTEGRITY MANAGEMENT PLAN

The Pipeline Integrity Management Plan would include provisions for monitoring the pipeline and right-of-way and conducting periodic risk assessments of the pipeline's integrity and the right-of-way's condition. The plan would apply to the Mackenzie Valley Pipeline and the gathering lines. Monitoring frequency and intervention decisions made during operations would be based on the results of these assessments. Assessment methods would include aerial patrols, ground inspections and the use of in-line inspection tools. The Proponents also noted that the pipeline would be designed in accordance with *CSA Z662-07, Oil and Gas Pipeline Systems* and Annex C of that standard, which would address pipeline loads that may occur, such as loads from thaw settlement and frost heave.

The Proponents stated in response to questioning that, in general, surveillance is more visual in nature (e.g. aerial patrols), whereas monitoring involves the use of instrumentation and taking measurements, although some monitoring can also be visual. Monitoring typically refers more directly to the type of activity associated with impacts monitoring, compliance monitoring where there are monitoring plans in place, and parameters that are being checked and measured against. The Proponents further stated that surveillance and monitoring should not be considered as mutually exclusive and that both may apply at any one time. The Proponents also noted that monitoring and surveillance activities may be undertaken off the right-of-way if required.

The Proponents noted that the Pipeline Integrity Management Plan would ensure the safety of employees and the public, reduce environmental impacts, protect the installed pipelines and facilities, and maintain reliability.

ADDITIONAL PLANS

The Proponents have also committed to prepare, or would be required to prepare, the following plans, which have a bearing on accidents, malfunctions and EPR.

Environmental Protection Plan

The Environmental Protection Plan, which is a requirement of the NEB, would address environmental impacts identified in the Environmental Impact Statement (EIS), including environmental management and mitigation measures to be used throughout the construction and operations phase of the Project.

Waste Management Plan

Construction, drilling and operations activities would generate various types of liquid, solid and semi-solid waste, which would be governed by a Waste Management Plan. The plan would address waste generation, storage, transportation and disposal.

The Proponents noted that the guiding principles they would use in developing the Waste Management Plan include meeting all existing regulatory standards regarding waste management, consulting with northern communities, understanding community views on waste management issues related to the Project, and implementing best management practices in waste management.

Chemicals and Fuel Handling Plan

The Chemicals and Fuel Handling Plan would address the transportation, storage and containment for chemicals and fuel.

Emergency Response Plans under the *Mackenzie Gas Project Socio-Economic Agreement*

The Proponents are also committed to the relevant clauses within Section 5.5 (5.5.1, 5.5.2 and 5.5.3) of the *Mackenzie Gas Project Socio-Economic Agreement* on emergency measures. Specifically, the Proponents, through those clauses, have committed to develop detailed Emergency Response Plans and procedures to deal with emergencies, malfunctions and incidents that may occur during the Project's various phases. They have also committed to collaborate with the GNWT and local governments to develop and maintain emergency planning and response arrangements and to locate emergency response units along road and highway systems during construction.

7.3.2 ACCIDENT AND MALFUNCTION SCENARIOS

Many participants were concerned about the potential for oil spills resulting from the Project. The Panel observes that there were some misperceptions about the nature of the product in the proposed pipeline. The product passing through it would be a gas and would disperse into the air if the pipe were ruptured. The product passing through the natural gas liquids (NGL) line would be a liquid that, in the case of a rupture, would expand and release a gas phase and a liquid phase. Some of the liquid may fall to the ground, where in time it would evaporate. The Project would not involve an oil pipeline but rather the construction and operation of natural gas and NGL pipelines. The potential environmental and socio-economic impacts associated with releases and leaks from natural gas and NGL are substantially different from those of an oil pipeline. However, there is the potential for spills or leaks of oil and refined petroleum products from transportation and storage activities associated with the Project, which are discussed throughout this chapter. The Panel notes that the Project would not involve the production or transport of sour gas, so the risks associated with such activities would not arise.

The Proponents submitted that accidents and malfunctions can result from numerous causes, including pipeline and equipment failure, human error and natural perils, and that the resulting potential emergencies or incidents could include fuel spills, pipeline rupture, fires and explosions, and traffic and health incidents. The Proponents subsequently provided an additional assessment of their responses to specific scenarios, including a major hydrocarbon spill into the Mackenzie River, well blow-outs and pipeline failure beneath a watercourse.

The Proponents identified their accident and malfunction scenarios in the context of their Project risk assessment framework, which in turn was based on regulatory expectations of the NEB, the Canadian Standards Association and the GNWT. The Proponents outlined potential environmental and socio-economic impacts associated with the various scenarios, including a gas pipeline rupture, a barge spill of diesel fuel into the Mackenzie River, a spill of diesel fuel onto snow, and the collision of a fuel truck with another vehicle.

In the case of a gas pipeline rupture as a result of damage by equipment operated by an independent contractor, the Proponents identified the following potential impacts:

- death of the equipment operator;
- short-term air quality impacts from smoke and emissions from the fire;
- a short-term increase in noise levels from the fire and explosion;
- impacts on soil, ground stability and permafrost due to the heat of the fire;

- plants burned near the rupture and in any associated wildfire; and
- impacts on traditional harvesting and land use due to limited access and wildfire impacts.

In the case of a barge spill of 160,000 L of diesel fuel into the Mackenzie River as a result of a collision with the proposed bridge at Fort Providence, the Proponents identified the following potential impacts:

- short-term water quality impacts until the plume has dispersed;
- stress to and possible mortality of fish trapped within oil collection booms;
- impacts on aquatic mammals and shoreline habitat;
- contamination of localized shoreline with subsequent remediation being required;
- delayed bridge construction due to response and recovery activities; and
- disrupted access to harvesting areas, specifically along the shoreline.

Notwithstanding identifying these accident and malfunction scenarios as required for the Panel's review, the Proponents stated that Project planning and mitigation would reduce the likelihood of such incidents occurring. They outlined various mitigation measures to prevent accidents and malfunctions and the potential emergency response measures and recovery plans that would be implemented following assessment of damage, should accidents and malfunctions occur.

WORST-CASE SCENARIOS

The EIS's Terms of Reference repeated the Proponents' obligations under the *Inuvialuit Final Agreement* to provide an assessment of worst-case scenarios within the Inuvialuit Settlement Region. The Panel is obliged through the *Joint Review Panel Agreement* to recommend terms and conditions relating to mitigation measures to minimize impact on wildlife harvesting and an estimate of the potential liability of the Proponents in relation to those worst-case scenarios. This section sets out the worst-case scenarios identified in the Panel's review, but the actual assessment is discussed in Chapter 12, "Harvesting."

To assist the Panel, the Inuvialuit Game Council and the Proponents jointly developed five worst-case scenarios and submitted them to the Panel. Five cases were chosen because each of the three Anchor Fields has a different owner, and two cases were necessary to describe the worst case for the gathering system (one case captures a spill into water, and the other captures a spill onto land). Table 7-1 lists the five worst-case scenarios and the respective Proponents.

Well Blow-Out Scenarios

In the event of a well blow-out, the Proponents noted that the sweet natural gas released would dissipate into the atmosphere or ignite. A continuous release of NGL during a well blow-out and subsequent spill response, clean-up and reclamation was considered to have the highest potential to affect wildlife, wildlife harvesting and habitat.

Taglu

The Taglu worst-case scenario well blow-out is predicted to occur if "well control had been lost after drilling through the reservoir to expose all of the sands in a relatively low-angle well." (J-IORVL-00008, p. 14) The predicted flow rates at this well are 8.4 Mm^3/d (0.3 Bcf/d) of gas and 420 m^3/d of NGL.

The results of dispersion modelling of the Taglu case in winter meteorological conditions, assuming the gas does not burn and a maximum of 40 days to cap the well blow-out is required,

Table 7-1 Five Worst-Case Scenarios and Associated Proponents

Worst-Case Scenario	Proponent
Well Blow-Out of Gas and Natural Gas Liquids at an Anchor Field	
Taglu Anchor Field	Imperial Oil Resources Limited
Parsons Lake Anchor Field (north)	ConocoPhillips Canada (North) Limited (75%) and ExxonMobil Canada Properties (25%)
Niglintgak Anchor Field	Shell Canada Limited
Rupture of a Gathering System Pipeline and Release of Gas and Natural Gas Liquids	
Taglu Lateral rupture (just north of the East Channel of the Mackenzie River; represents a spill into water)	Imperial Oil Resources Ventures Limited
Storm Hills Lateral rupture (between the Storm Hills Pigging Facility and the Inuvik Area Facility; represents a spill onto land)	Imperial Oil Resources Ventures Limited

Source: Adapted from J-IORVL-00008, p. 7

predict that the total liquid deposition would be about 10,500 t, or 8,400 m^3, of NGL. The estimated maximum concentration of NGL on the ground is shown in Table 7-2.

Table 7-2 Winter Ground Concentrations of Natural Gas Liquid Compared with Distance from Release Point

Proximity to Blow-Out	Dispersion (L/m^2)
Immediately adjacent	26.0
At 1 km	1.0
At 2 km	0.1
At 5 km	0.01
From 10 to 15 km	0.001

Source: Adapted from J-IORVL-00176, pp. 4–5

Based on summer meteorological conditions and a 40-day maximum period to cap the well blow-out, estimates predict total liquid deposition at 3,400 t, or 2,700 m^3, of NGL. The estimated maximum concentration of NGL on the ground is shown in Table 7-3. The concentration of NGL on the ground in summer is much lower than in winter because the higher temperatures would result in much of the NGL evaporating before it reaches the ground.

Table 7-3 Summer Ground Concentrations of Natural Gas Liquid Compared with Distance from Release Point

Proximity to Blow-Out	Dispersion (L/m^2)
Immediately adjacent	Highest concentrations
At 1 km	0.1
From 3 to 4 km	0.001

Source: Adapted from J-IORVL-00176, p. 5

Parsons Lake

The Parsons Lake worst-case scenario well blow-out is predicted to occur "if well control had been lost after drilling through all expected producing intervals in the Kamik reservoir, at or near the bottom of each well." (J-IORVL-00008, p. 15) The predicted flow rates at the proposed Parsons Lake J-19 well (predicted to be the most prolific) are 6.9 Mm^3/d (0.2 Bcf/d) of gas and 400 m^3/d of NGL. The Parsons Lake J-19 well is located on the north drilling pad. Dispersion modelling for the Parsons Lake well blow-out scenario was not filed with the Panel. However, ConocoPhillips confirmed that the Taglu dispersion modelling represented a bigger deposition area than the results of the dispersion modelling undertaken by ConocoPhillips and that they accepted this larger area as the Parsons Lake area of influence.

Niglintgak

The Niglintgak worst-case scenario well blow-out is predicted to be "a blowout from the lower section in the planned P-4L well" as "it would encounter the only interval with the potential to release NGLs and minor amounts of heavier hydrocarbon components." (J-IORVL-00008, p. 13) The predicted flow rates at this well are 3.2 Mm^3/d (0.1 Bcf/d) of gas and 65 m^3/d of NGL. Dispersion modelling for the Niglintgak well blow-out scenario was not filed with the Panel. However, Shell confirmed that the Taglu dispersion modelling represented a bigger deposition area than the results of the dispersion modelling undertaken by Shell and that Shell accepted this larger area as the Niglintgak area of influence.

Pipeline Rupture Scenarios

The Proponents noted that typical causes of a pipeline rupture include internal and external corrosion, third-party damage, and earth movement.

A pipeline rupture could result in an explosion and subsequent fire with severe consequences to persons, vegetation and wildlife in the immediate area. If a pipeline ruptured, the natural gas or NGL released would dissipate into the atmosphere or, more likely, ignite. The Proponents submitted that a leak or rupture of the pipeline would thus not be expected to have any impact on the quality of local groundwater sources.

As the worst-case scenarios were being developed, a potential release of NGL to the atmosphere as opposed to a release of natural gas was considered to have the greatest impact on wildlife harvesting. Release volumes for each pipeline rupture scenario were calculated to be the total volume of NGL contained within that pipeline segment. It was assumed that the total volume contained in each segment would be drained in a rupture event.

For each pipeline rupture scenario, dispersion of NGL could be expected to create a surface disruption of the ground cover immediately adjacent to the rupture. Further, this disruption could measure up to 30 m long by 10 m wide by 5 m deep. In addition, based on extrapolation from the well blow-out case, the areal extent would likely be within 1 km or less of the event location, depending on wind conditions at the time.

Taglu Lateral

In the Taglu Lateral worst-case scenario, the rupture location is assumed to be upstream of the Mackenzie River East Channel automated block valve. In addition, this scenario assumes that the NGL would migrate to the Mackenzie River East Channel. Further, some quantities of NGL could be released into the channel and move downstream to Kugmallit Bay. In a rupture event, the NGL release volume (based on average liquid concentration of 2%) would be 250 m^3.

Storm Hills Lateral

In a rupture event, the NGL release volume (based on average liquid concentration of 2%) would be 430 m^3. The Storm Hills Lateral worst-case scenario assumes the rupture to be between the Storm Hills Pigging Facility and the Inuvik Area Facility. In addition, this scenario assumes that the NGLs would be released to the land at the rupture location.

Potential Release Impacts

According to the Proponents, the predicted impacts of an NGL release include the following:

- vegetation within a radius of 1 to 2 km would show symptoms of phytotoxicity, depending on the degree of exposure, which could result in mortality of some plants, particularly lichen;
- birds in the immediate vicinity of the blowout would be disturbed by the noise and leave the area, resulting in potential loss of young if the release occurred during the breeding and nesting season;
- birds at a further distance from the blowout could remain at their nesting sites and become covered with a thin layer of NGLs, thereby affecting their feathers and resulting in a loss of insulation and subsequent potential mortality of the adults, the eggs or the chicks;
- larger terrestrial animals would move out of the blowout area and not be directly affected, although some portion of their habitat or forage vegetation could be affected;
- aquatic species would not be affected, because of the rapid dilution and low solubility of NGL in water, unless NGLs became concentrated in a shallow or confined body of water over a long period of time. (J-IORVL-00176, pp. 5–6)

The Proponents further predicted the following:

> During a summer blowout, NGLs moved by water currents into the Beaufort Sea from either the Taglu or Niglintgak locations would appear as an iridescent sheen on the water, and would eventually disperse as a result of wave and wind action. There is no recorded evidence in case histories of NGL tainting or affecting the taste of aquatic species consumed for food. (J-IORVL-00176, p. 6)

Timing of Event

The Proponents told the Panel that the well blow-out scenarios could occur during any season that drilling operations are conducted and that the pipeline rupture scenarios could occur during any season.

Areal Extent

The results of dispersion modelling for the Taglu worst-case scenario in winter meteorological conditions and a maximum 40-day capping period indicate a potential ground cover of up to 15 km from the blow-out location.

Regarding the pipeline rupture scenarios, "the areal extent would likely be within 1 km or less of the event location, depending on wind conditions at the time." In the Taglu Lateral scenario, "some quantities of NGL could be released into the channel and move downstream to Kugmallit Bay." (J-IORVL-00176, p. 8)

Duration of Event

In the event of a well blow-out worst-case scenario, a maximum of 40 days would be required to cap the well.

In the pipeline rupture scenario, automated block valves would close due to a pressure reduction. The contents between block valves would be released in a period of minutes.

7.3.3 PROPONENTS' MITIGATION MEASURES AND COMMITMENTS

ANCHOR FIELDS

The Proponents made the following commitments:

- The Proponents noted that the hydrostatic pressure exerted by drilling fluid would provide primary well control for development drilling operations. The well control equipment, such as blow-out preventers and drilling fluid pumping and circulation systems, would provide secondary well control. In addition to these preventive measures, the potential for a blow-out would be reduced by other measures including detailed well planning, extensive safety management systems, regular training for well control and blow-out prevention drills.
- The Proponents stated that, "if a blowout occurred at one of the anchor fields, well-capping operations would start immediately to control the blowout." (J-IORVL-00008, p. 12) In addition, "well blowouts are most often terminated by well-capping operations than by relief wells," and "capping is done by specialists with experience in firefighting, removing debris and using specialized well-capping equipment." (J-IORVL-00008, p. 13)

PIPELINES

The Proponents submitted that in-line inspection tools detect potential pipeline problems (e.g. strain anomalies) several years before measures need to be taken to deal with the potential problem. The Proponents discussed their preliminary monitoring program and noted that they would supplement all forms of monitoring with field investigations and develop and implement an action plan to deal with any potential problems. They also noted that monitoring methods being considered represent technologies currently used in the pipeline industry. The Proponents' monitoring program, which would be described in their Pipeline Integrity Management Plan, would include their plan to conduct periodic risk assessments of pipeline integrity and the condition of the right-of-way.

In response to enquiries regarding remediation techniques, the Proponents stated that strategies for remediation would be developed on a site-specific basis, considering potential impacts of the spill or leak on environmental receptors, and the potential impacts that implementation of the remedial measures would have on environmental receptors. The Proponents said that a precautionary approach would be applied when uncertainties existed about the potential impacts to environmental receptors.

Regarding the application of remediation technologies in Arctic environments, the Proponents noted that they intend to use existing reference resources (such as those provided by the U.S. Army's Cold Regions Research and Engineering Laboratory) if they require additional expertise to address any information gaps in appropriate remediation technologies or undertakings. They further noted that, where there are information gaps in suitable and appropriate remediation techniques, they would resolve such gaps in consultation with local regulators and with support from oil and gas industry research organizations.

The Proponents made the following commitments:

- All pipelines, including the main pipeline and those in the Anchor Fields, would be designed for no loss of product for the design contingency earthquake.
- Automated block valves would be installed at appropriate locations to limit the release of natural gas and associated NGLs in the event of pipeline rupture.
- Management practices, contingency plans, and mitigation and Emergency Response Plans would be implemented to prevent and address leaks and spills.
- If a spill occurred, established emergency spill procedures would be used to limit the extent of contamination. Clean-up and remediation techniques would be used to eliminate the potential for human health impacts through ingestion of traditional foods from the spill area.

TRANSPORTATION

Rail Transportation

The Proponents noted that CN Rail routinely moves diesel and other fuel products by rail from the Edmonton area to Hay River year-round to supply communities and industries in the NWT. Currently, CN Rail's fuel volume exceeds 300 ML/a, of which more than 200 ML/a supports the diamond mines. By comparison, the Project's estimated fuel delivery by rail to Hay River of 460 ML would be spread over 5 years, with approximately 150 ML delivered in the peak year.

The Proponents noted that in the course of transporting fuel to the North, the rail carrier is responsible for meeting all applicable regulations, and it has existing contacts with adjacent communities, regulators and others in the event of a train derailment along the Edmonton–Hay River track. The carrier's Emergency Response Plans include mutual aid agreements, an incident command structure, and coordination procedures with provincial, NWT and federal regulators. The Proponents submitted that this would ensure efficient and quick response and management of any incident.

The Proponents further stated that the rail carrier would have primary responsibility for issues involving the transport of Project-related materials, including custody of fuel shipments, between Edmonton and Hay River and for responding to any accidents or spills of product. The Proponents would assist the rail carrier with any response as appropriate and as requested by the carrier.

The Proponents outlined their response to a scenario where a shipment of Project materials, including diesel fuel, derails just south of Enterprise, NWT. The Proponents reiterated that although emergency response is the primary responsibility of the rail carrier, Project personnel from Hay River would assist with the response as appropriate and as required. The carrier would notify NWT emergency response organizations, local Transport Canada offices and Project personnel of the incident. The Proponents stated that they expected the rail crew would:

- ensure that the site is safe and secure;
- control access to the site by non-essential personnel;
- provide information to the rail company to support the mobilization of equipment and response personnel; and
- make decisions on the need to involve local environmental and construction contractors for clean-up, recovery and remediation.

The Proponents further noted that CN Rail's established Emergency Response Plan includes measures such as containment and recovery of the spilled product, remediation of the area, and clean-up of spills resulting from derailments or other accidents.

The Proponents asserted that the primary responsibilities regarding accidents, malfunctions and EPR lie with the rail carrier. Nonetheless, the Proponents noted that they would ensure that rail carriers understand and comply with generally accepted principles for accidents, malfunctions and emergency response. Further, the Proponents would carry out due diligence and risk assessment reviews with all its transportation contractors, including CN Rail, to ensure that they meet the Proponents' requirements for safe and efficient operations and have the capability to respond to emergency events.

Additional issues pertaining to rail transportation, including safety concerns, are discussed in Chapter 14, "Physical Infrastructure and Housing."

Road Transportation

The Proponents confirmed that provisions for highway rescue vehicles and ambulance services would be included in detailed Emergency Response Plans to be developed before construction starts. The Proponents noted that specific emergency equipment had not yet been selected but that transport equipment, such as ambulances, would be provided at each camp. This equipment would be used for Project-related emergency response if required.

The Proponents discussed a potential scenario involving a diesel fuel spill onto snow from a truck travelling on the Mackenzie Highway (as noted in Section 7.3.2) and outlined their proposed response measures, which would be similar to a spill event on ice and which are described in the Proponents' *Mackenzie Gas Project Accident and Malfunction Scenarios*.

Barging and Shipping

In response to public concerns regarding the potential for spills of hazardous material into the Mackenzie River, the Proponents stated that such a situation was considered in its preliminary Emergency Response Plans and scenarios for incidents or accidents that may occur from barging. Further, they have proposed mitigation measures for the containment of fuel and have made commitments to supply fresh water to communities in instances of contamination. The Proponents also noted that Northern Transportation Company Limited (NTCL), a potential barging contractor for the Proponents, maintains spill equipment on its barges, has trained personnel, and obtains Transport Canada review and approval of its Spill Response Plans. Regardless of the barging company contracted, the Proponents noted that they would develop an Emergency Response Plan together with the barging contractor and agree on its contents. The contractor, however, would have the first line of responsibility for response. The Proponents also noted that they would cooperate with the contractor on emergency response training, drills and exercises to understand each other's capabilities. The barge company would be responsible for ensuring that a spill was cleaned up and that conditions reverted back to normal or baseline. Discussions on monitoring requirements would be part of the negotiations associated with the contract for shipping and barging between the Proponents and the contractor.

In the event of a spill of a dangerous substance, the Proponents noted that a Communications Plan would be included in its Emergency Response Plan and that they would inform downstream water users, such as those living on the land during the summer. The Proponents further stated that the Communications Plan would include documentation of cabins and fishing camps in the area and, in the event of an incident, members of the spill response team would visit those cabins and camps to inform people that there had been a spill.

The Proponents stated that during the Project construction phase, increased volumes of diesel fuel would be transported from Hay River to locations along the Mackenzie River by accredited and experienced marine carriers. About 85 ML of fuel are currently transported annually by barge on the Mackenzie River. The Project's estimated peak annual requirement for fuel transported by barge would double the current volume. The Proponents noted that barge companies currently operating on the Mackenzie River have existing Emergency Response Plans for moving fuel to communities. Because Project fuel requirements would be delivered using the same approved equipment and the same procedures, the Proponents submitted that existing Emergency Response Plans are expected to be adequate for the Project. However, the Proponents would also work with the barge companies to ensure that these plans would be adequate for handling the increased volume of fuel shipped during the Project's construction period.

The Proponents made the following commitments:

- Implement plans to prevent and address leaks and spills.
- In the event that NTCL is the carrier, follow existing NTCL cleaning procedures if any barges require tank-cleaning (for ballasting or any other reason), and ensure that any River water put into the tanks after they have been cleaned is safe to discharge back into` the environment.
- Monitor and report the following to applicable communities and authorities if a diesel spill into the Mackenzie River occurred:
    - the spill's movement downstream from the point of release;
    - the extent of contact with the shoreline;
    - the physical dispersion and evaporation rate;
    - the potential for fish mortality; and
    - the taste and tainting of fish and other harvestable food.
- Consult with the community of Fort Providence, Fisheries and Oceans Canada, and barge operators in assessing the impacts of increased barge size and barge traffic to determine appropriate mitigation, including barge scheduling, emergency response and waste management, and potential monitoring.

Air Transportation

The Proponents noted that they recognize the importance of safety in the selection and use of airline services in support of Project activities and that airline company safety practices and statistics, including emergency response capability, would be screened during the selection process. In addition to using the coordinated efforts of the airline companies and the Proponents' own programs, the Proponents stated that they would also consult with Transport Canada when finalizing accidents and malfunctions prevention and response planning for the Project. The Proponents noted that they were consulting with the GNWT and the communities of Fort Simpson, Norman Wells and Inuvik about emergency response capability and services at their respective airports.

The Proponents noted that airplane service providers would transport a variety of Project personnel and materials. The Proponents would use existing NWT airports and facilities and would also construct several temporary airports and facilities to support fixed-wing or helicopter transfer of personnel and equipment where local services were not available. These temporary airports and facilities would be constructed according to Transport Canada requirements and would be operated by local contractors who were approved by the Proponents' aviation department. Project aviation service suppliers would have the necessary licences and operating certificates issued by the Canadian Transportation Agency and Transport Canada and adhere to the requirements of the Canadian aviation regulations issued by Transport Canada. The Proponents also noted that, generally, aircraft used for crew transfer would have twin turbine engines and instrument flight rules capability (i.e. be able to be navigated using only the aircraft's instrument panel). Further, all NWT and Project airport facilities and runways would have emergency response programs in place that followed the *Planning Guide for Community Officials* (April 2002) of the GNWT's Emergency Measures Organization. The response plan would be registered with the local Emergency Measures Organization.

HAZARDOUS MATERIALS MANAGEMENT

The Proponents stated that hazardous materials associated with the Project, such as fuel, oils, solvents and paints, are common for gas field development and pipeline projects and that their transportation, handling and storage would be managed according to the governments' transportation of the dangerous goods regime.

Substances that are potentially hazardous to human health that could be released into the Mackenzie River if an accident occurred are regulated by the *Transportation of Dangerous Goods Regulations*. The Proponents stated that barge carriers on the Mackenzie River are familiar with these regulations and comply with them. The Proponents submitted that risks to human health are considered by strictly adhering to the regulations to prevent hazardous substances from being released into the environment. Actions to be taken in the event that a hazardous substance is spilled include notifying any downstream water users and preventing substances from entering drinking water intakes.

The Proponents noted that their strategy for planning and developing Emergency Preparedness and Response Plans was provided in the *Environmental Impact Statement Additional Information Report*. It stated that industry-proven emergency response experience has demonstrated the importance of understanding how hazardous materials might behave under possible spill conditions. It also stated that a variety of planning tools might be used, including modelling possible spill events and assessing the potential reaction of response equipment under a range of weather and geographic conditions. The selection of these planning tools would be refined as Project planning proceeds and as site-specific details are determined.

The Proponents confirmed that they would not store or dispose of any Project hazardous waste in community solid waste sites located in the NWT. In accordance with the *Guidelines for the Planning, Design, Operations and Maintenance of Modified Solid Waste Sites in the Northwest Territories*, existing community solid waste facilities do not accept hazardous waste for disposal. The Proponents confirmed that all hazardous waste generated by the Project would be segregated, stored and transferred for treatment, recycling or disposal at an approved facility, expected to be located outside of the NWT. A waste tracking system would be developed under the Waste Management Plan to manage and account for all waste from point of generation to final disposal.

The Proponents noted that types and quantities of explosives had not been determined and that requirements for explosives would be defined as construction planning progressed. The Proponents also noted that:

- storage and use of explosives would comply with applicable regulations;
- a magazine licence for storage would be required;
- the manufacture of explosives would not be required;
- liquid explosives would likely not be used; and
- unused explosives would be returned to the supplier.

The Proponents also stated that evaluation of potential accidents and malfunctions related to explosives use would be considered when site-specific Emergency Response Plans were developed. Manufacturers' data sheets and technical bulletins would also be used as references and supporting documentation once the specific types and manufacturers of explosives were identified.

7.4 PARTICIPANTS' VIEWS AND RECOMMENDATIONS

7.4.1 ANCHOR FIELDS AND PIPELINES

Many parties noted concerns regarding accidents, malfunctions and EPR at the Anchor Fields and along the pipeline right-of-way. The Gwich'in Tribal Council had specific questions regarding how the Proponents would detect and clean up pipeline spills, and the Panel heard concerns regarding pipeline-related accidents, malfunctions and EPR from residents of many communities during its Community Hearings.

Environment Canada requested that the Proponents provide additional information on their response to a scenario of a pipeline rupture or failure beneath a watercourse. The Proponents responded that their basic response principles were outlined in the *Mackenzie Gas Project Accident and Malfunction Scenarios* and in the *Worst-Case Scenarios in the Inuvialuit Settlement Region*. These principles would be applied to a scenario of a pipeline rupture or failure beneath a watercourse and subsequent release of NGL.

As groundwater is used as a potable water supply for the community of Wrigley, the GNWT asked the Proponents to discuss their plans for contingency and emergency response in the event of a pipeline leak or rupture. The Proponents submitted that a leak or rupture of the pipeline would not be expected to have any impact on the quality of local groundwater sources near Wrigley because natural gas is lighter than air and dissipates into the atmosphere upon release. Therefore, no specific emergency response or groundwater monitoring plans were developed for the area.

7.4.2 TRANSPORTATION

RAIL TRANSPORTATION

During its Community Hearings in Hay River and on the Hay River Reserve, the Panel heard concerns from the Katlodeeche First Nation and others regarding potential train-related accidents and malfunctions and the Proponents' response to such a scenario. The Town of Hay River also expressed concerns as to how rail and truck traffic would be coordinated so that it does not interfere with emergency services.

ROAD TRANSPORTATION

The Panel heard concerns regarding the potential for road-related accidents, malfunctions and the Proponents' Emergency Response Plans from residents in the Hamlet of Fort Providence, from the Fort Providence Resource Management Board, from the Katlodeeche First Nation on the Hay River Reserve, from the Ka'a'gee Tu First Nation in Kakisa, from residents in the Village of Fort Simpson, and from the Pehdzeh Ki First Nation in Wrigley.

Despite existing initiatives such as the *Northwest Territories/ Nunavut Spills Working Agreement*, the Fort Providence Resource Management Board expressed concern about the lack of clarity about which organization to contact in the event of an accident or malfunction. It described a situation where a truck had broken through the ice on the Mackenzie River; it was not clear to various agencies and departments who had jurisdiction to deal with the situation, and the Panel heard that it took some time to determine that the initial response was the responsibility of the GNWT's Department of Transportation.

The Pehdzeh Ki First Nation and the Samba K'e Dene Band expressed concerns regarding the capacity of local community emergency response services and questioned the Proponents on their provision of emergency services for road-related accidents. The Proponents noted that their camps would be self-sufficient and that emergency response would be available from those camps. They also noted that they would consult with the GNWT and affected communities with respect to supporting emergency response but that it is the Proponents' intention to be self-sufficient.

Enterprise also expressed concerns regarding its emergency services capacity and suggested that it develop an Emergency Response Plan with the GNWT's Department of Transportation and Department of Municipal and Community Affairs, as those departments contribute substantially to the development of local fire and emergency response capacity. The community was seeking a commitment from the GNWT toward building emergency response capacity within the community.

Additional issues pertaining to increased traffic and resultant safety concerns are discussed in Chapter 14, "Physical Infrastructure and Housing."

BARGING AND SHIPPING

Residents of Fort Providence and area were particularly concerned about potential barge-related impacts of the Project. These concerns were expressed by the East Deh Cho Alliance, the Deh Gah Got'ie Dene Council, the Hamlet of Fort Providence and the Fort Providence Metis Council. The Panel also heard from individuals concerned about the potential for fuel spills from barges and corresponding emergency response measures. The Ka'a'gee Tu First Nation noted barge-related accidents, malfunctions and EPR issues. Residents of Fort Simpson and representatives of the Pehdzeh Ki First Nation expressed similar concerns. The Joint Secretariat noted that the quantity and quality of water is critical for all flora and fauna and for the Inuvialuit. It submitted that there were no physical resources or trained personnel within the region to deal with a major spill of any kind in the Beaufort Sea and that, should a spill ever happen, it would threaten water quality and have major impacts on marine resources.

The East Deh Cho Alliance, including the Deh Gah Got'ie Dene Council, stated that it had concerns regarding the increased volume of barge traffic on the Mackenzie River. Its interviews with residents, particularly those in Fort Providence, highlighted the potential for spills of hazardous materials into the River as one of the community's primary concerns. Water quality would be seriously impacted in the event of a spill of, for example, diesel or gasoline from a barge or at barge landing sites. The East Deh Cho Alliance highlighted the fact that the community of Fort Providence obtains its drinking water from the River and asked if the Proponents had considered the consequences of an accident or spill on this community's drinking water supply. The Proponents responded that they had proposed mitigation measures for the containment of fuel and that they had made commitments to supply fresh water to communities in instances of contamination.

The Deh Gah Got'ie Dene Council also questioned Environment Canada as to its capacity to respond to a barge spill if required to do so and asked it to comment on extra resources that may be required to deal with potential spills. Environment Canada responded that it was well equipped to respond to a spill and provide advice, with three environmental emergencies officers in the Prairie and Northern Region and a complement of enforcement officers who have a similar level of expertise, some stationed in Yellowknife. Environment Canada also noted that there are approximately 20 to 25 environmental emergencies officers nationwide who could be called upon to assist in a response. It also has technical experts available at its

Environmental Science and Technology Centre, a research and development facility.

Fisheries and Oceans Canada commented on its response capacity and stated that the Canadian Coast Guard's response would depend on the location of the spill. It would take an average of 12 hours to transport clean-up equipment from Hay River to an area such as Inuvik, depending on aircraft availability. To respond to a spill in Fort Providence, response time would be approximately one hour. The Coast Guard also described some of its communications and clean-up equipment. Lastly, Fisheries and Oceans Canada noted that it had at least 17 Coast Guard staff in its Environmental Response Division in the NWT who could be called upon if necessary.

The Deh Gah Got'ie Dene Council retained Emergency Response Management Consulting to provide guidance on emergency planning. The consultant reviewed NTCL's Emergency Response Plans, including its Ship Oil Pollution Emergency Plan, and noted that the plans were essentially good, but that several important elements were missing. The Proponents responded that if NTCL were contracted by the Proponents to provide barge transportation, as part of the contractual arrangement, the Proponents would ensure that all necessary spill plans and equipment required by regulation were in place and operational. The role of the barge company, the Proponents and the regulatory agencies, as well as any other operators and Spill Response Organizations with whom the Proponents had mutual aid agreements, would be clearly defined in advance of shipping to ensure a rapid and coordinated response in the event of a spill. Transport Canada also commented that the review of NTCL's Emergency Response Plans conducted by Emergency Response Management Consulting had been based on some information that exceeded the current regulatory requirements and that Transport Canada found the plans to be compliant with the *Canada Shipping Act, 2001* and the *Oil Pollution Prevention Regulations*.

At the request of the Deh Gah Got'ie Dene Council, the Proponents requested NTCL to provide a copy of is Emergency Response Plan to the community of Fort Providence. NTCL replied that it is required to have a separate Emergency Response Plan for each vessel (tug) in the NTCL fleet and that each plan has been reviewed and approved by federal authorities. NTCL noted that these plans contain proprietary information and, therefore, cannot be made public. However, it also stated that it could meet with the community of Fort Providence to review current and historical operations, review their Emergency Response Plans, and answer questions.

The East Deh Cho Alliance questioned the GNWT on its plans to review the Emergency Response Plans of barging companies operating on the Mackenzie River. The GNWT noted that it would have discussions with Transport Canada to ensure that the GNWT can review the plans and comment on them.

The Deh Gah Got'ie Dene Council asked the Proponents to identify and discuss the potential training opportunities for First Nations people as emergency first responders. The Proponents stated that they do not intend to specifically train community members to become first responders or provide them with the equipment necessary to respond to an emergency, as first responder responsibilities are best managed by personnel who have been effectively trained in emergency response and the use of associated equipment.

The Deh Gah Got'ie Dene Council and the East Deh Cho Alliance filed the following recommendations with the Panel: "Emergency spill response must be more thoroughly addressed. In case of a spill in the river, local emergency spill response teams must be available in order to expedite clean up efforts." (J-DGGDC-00060, p. 2)

The East Deh Cho Alliance also submitted that the remoteness of Fort Providence means that it might be several hours before a response team and equipment could be called in from another area and that a spill could spread far downstream and have widespread impacts.

The Proponents agreed with the premise of this recommendation but clarified that the barge operators transporting Project materials and equipment would be responsible for being the first responder to an emergency and would maintain spill response capability. The Proponents reiterated their commitment to work with the barge companies to ensure that adequate and detailed Emergency Response Plans were in place and that these response plans would be discussed with the community of Fort Providence.

The East Deh Cho Alliance recommended that:

> the Proponent and NTCL work with community members of Fort Providence to establish a local spill response plan and develop local capability (equipment and trained personnel), so that there can be an immediate community response to any contaminant leakage or spillage, either on the river or along the highway. (J-DGGDC-00060, p. 1)

The Proponents did not agree with this recommendation and stated that local community members were not expected to be involved in immediate emergency response but that they would be notified of the response and kept informed of the situation. The Proponents reiterated that the first responder to spills or leaks during transport would be the carrier.

The East Deh Cho Alliance also recommended that efficient protocols be established for the immediate reporting of and response to all incidents and that a multi-agency spills response plan be implemented with funding from the Proponents.

The Proponents did not agree with this recommendation and submitted that collaboration with government agencies in developing mutual aid agreements is addressed by Project commitments, as described in the Section 5.5 of the *Mackenzie Gas Project Socio-Economic Agreement*.

Both the Katlodeeche First Nation and the West Point First Nation recommended that a multi-agency Spill Response Plan be developed and that locally trained spill response teams be created in their communities. These recommendations were filed in the context of barging on the Mackenzie River.

In response, the Proponents noted that they do not plan to specifically fund and train locally based spill response teams and that the carriers of products are responsible as first responders in an emergency. Indian and Northern Affairs Canada, on behalf of the Government of Canada, noted that the participants' recommendation is consistent with recommendations made by departments that the Proponents develop a Spill Response Plan that includes input from appropriate regulatory agencies involved in spill response.

As discussed in Chapter 8, "Air and Water Quality," the GNWT conducted an assessment of Project impacts on community drinking water. It identified initial concerns regarding leaks or spills from tugs or barges and the release of contaminants through bilge and wastewater discharges. However, in its final recommendations filed with the Panel, the GNWT stated that the Proponents had responded positively to many of its concerns and, throughout the Panel's proceedings, the Proponents committed to apply and implement appropriate solutions in their Project plans. The GNWT also made reference to the Proponents' commitment to developing Environmental Management Plans as a means of managing the Project's environmental impacts. The GNWT did not file any recommendations with the Panel regarding marine-related accidents, malfunctions and EPR.

Fisheries and Oceans Canada filed a recommendation with the Panel that included a component on EPR and accidents and malfunctions, i.e. in order to ensure responsible management of Project-related vessel traffic, the Proponents should develop and implement in consultation with Aboriginal groups, responsible authorities and Fisheries and Oceans Canada a plan that addresses increased marine and river barge traffic and its potential impacts to the biophysical environment, access to fisheries and other harvest activities, emergency response procedures for accidents and malfunctions, and includes a communications strategy to notify relevant communities and stakeholders of Project vessel traffic. The plan should take into consideration the *Vessel Traffic Marine Safety Advisory — Mackenzie River* and existing shipping regulations and guidelines.

The Proponents agreed with this recommendation with variation. They stated that, although the issues described in this recommendation would be managed, a specific plan for all of the aspects would not be required. With reference to the emergency response procedures for accidents and malfunctions, the Proponents noted that the barge operator would be responsible for Emergency Response Plans to handle spills and other types of incidents associated with barge activities. The Proponents would work with the barge companies to ensure that these detailed Emergency Response Plans were adequate for the volumes and types of materials transported during Project construction. These plans fall under Transport Canada's jurisdiction.

Parks Canada recommended that, prior to construction, Ivvavik National Park of Canada, the Kittigazuit Archaeological Sites (National Historic Site), Pingo Canadian Landmark and the Nagwichoonjik National Historic Site be added to the list of sites of particular value when planning for accidents and malfunctions that involve marine vessels and when developing a Ballast Water Management Plan. The Proponents agreed with this recommendation.

Regarding shipping throughout the Beaufort Sea, Randal Pokiak of Tuktoyaktuk recommended that:

- shipping lanes or routes should be identified for the Alaska–Yukon border and the Northwest Passage to the Beaufort Sea, seaports and the Mackenzie Delta;
- marine protected areas should be clearly identified and mapped out before any approval is given to the Project; and
- fully equipped emergency response depots should be in place along the Beaufort coastline.

In support of his recommendation, Mr. Pokiak stated that harvesters depend on marine life, which is essential to the physical and mental health and well-being of all Inuvialuit. He further stated that Arctic conditions are unpredictable and that every precaution must be taken to respond to a disaster.

The Proponents agreed with this recommendation with variation. They noted that information on proposed shipping routes in the Beaufort Sea for use by the Project was described in several Panel documents and that proposed Marine Protected Areas had been defined and mapped by Fisheries and Oceans Canada. The Proponents also noted that an emergency response Canadian Coast Guard depot is located at Tuktoyaktuk and is fully equipped to respond to emergencies in the western Beaufort Sea region.

In response to Mr. Pokiak's recommendation, Fisheries and Oceans Canada stated that the Proponents should provide information on proposed shipping routes in advance of shipping activities, develop a response plan based on existing depots and capacity, and identify any additional requirements necessary to mitigate potential impacts. Transport Canada also noted that vessels currently transit the Arctic following historically recommended routes, with adjustments for ice conditions as required, and that the proposed increase in vessel traffic would not warrant any changes to this system.

Transport Canada's closing remarks and recommendations regarding its marine risk analysis and barge traffic management are discussed in Chapter 14, "Physical Infrastructure and Housing."

7.4.3 HAZARDOUS MATERIALS MANAGEMENT

The Northwest Territories Literacy Council requested that the Proponents provide a risk assessment for each of the controlled or hazardous materials that the Project may use and that they outline the roles and responsibilities of the Proponents and different levels of government for emergency response to accidents. The Proponents submitted that because they plan to prepare a Hazardous Materials Management Plan to ensure that all applicable regulations are met, a specific risk assessment of each material was not required. The Proponents stated that, to deal with risks associated with accidents and malfunctions, Emergency Response Plans for all components of the Project would be in place prior to construction and operations.

7.4.4 GENERAL CONCERNS

Indian and Northern Affairs Canada, on behalf of federal government departments participating in the Panel's review, noted that some participants had made recommendations about potential impacts to wildlife and fish harvesting activities and about the adequacy of Spill Response Plans related to increased barge and marine traffic associated with the Project. Some participants also noted barge traffic monitoring and community involvement in emergency response measures.

Indian and Northern Affairs Canada stated that safety and oversight responsibilities, including compliance monitoring and enforcement activities related to pollution incidents, are administered under the existing regulatory framework. It referred to filings with the Panel that outline the spill response responsibilities of Fisheries and Oceans Canada, the Canadian Coast Guard, Environment Canada, and Transport Canada. It also noted that the Proponents made commitments to include community consultation as part of barge traffic management, including consultation on community monitoring, during construction of the Project. Barge traffic would be expected to return to near current levels post-construction. Other Proponents' commitments made throughout the Panel's review process would also be captured and implemented through terms and conditions in permits, licences and/or Environmental Protection Plans.

Indian and Northern Affairs Canada further noted that federal departments had made recommendations to the Panel on plans for emergency response and spills containment, and that such plans are common and necessary features of regulatory issuances. Indian and Northern Affairs Canada stated that there is a well-established spills working group in the NWT, which supports appropriate notification to affected communities, and that the Proponents had also committed to a Spill Response Plan. The final contents of those plans and protocols would be informed by the recommendations put forward by the Panel and would be dealt with during the regulatory phase of the Project.

The GNWT noted that a project such as the pipeline requires good contingency planning. Part of that planning is ensuring that, if the response capability of the primary party (i.e. the polluter) is exceeded, then there must be mutual aid agreements in place where others would come to the assistance of that party.

The GNWT filed recommendations with the Panel to clarify some outstanding issues and, in discussion of its recommendations, noted the following:

- the limited capacity in the NWT, including contractors and equipment, to respond to spill incidents that may result from Project-based activities;
- the limited NWT-based regulatory instruments to address regional contingency planning for a large-scale, multi-jurisdictional industrial project;
- the fact that the *Transportation of Dangerous Goods Act, 1992* and related regulations (NWT) do not define refined petroleum products as dangerous goods that require spill contingency plans;
- the proposed Umbrella Spill Contingency Plan is not intended to replace other agreements and regulatory requirements but rather to bridge all plans, ensure that there are no gaps, and ensure cradle-to-grave contingency for all materials to be transported, used, stored and disposed of in support of the Project;
- the limited ability to assess the cumulative impacts of frequent minor spills that may occur in high-traffic work areas;
- the benefits of consolidated secondary reporting of cumulative spills that fall below specified spill size, combined with major spill data;
- concerns regarding regulatory certainty for the storage, loading or transportation of refined petroleum products, hazardous materials and dangerous goods on federal lands;
- concerns regarding the planned storage of bulk fuel or other dangerous goods in or on ice or in or upon water and support for the storage of these products in land-based facilities engineered to meet national and territorial standards for human safety, fire prevention and environmental protection;
- concerns that the Proponents' commitments do not ensure a consistent and acceptable level of environmental protection regarding the storage of bulk fuel and other dangerous goods in barges; and
- the need for all reporting to reflect consistency with Project scheduling to be publicly available, be developed in consultation with the GNWT, and be consistent with the NEB's Proposed Conditions as stated in its letter dated February 5, 2007.

To address its outstanding concerns, the GNWT filed several recommendations with the Panel and asked that these be incorporated as components of the NEB-required Environmental Protection Plan.

The GNWT recommended that the Proponents develop, in consultation with the GNWT, an Umbrella Spill Contingency Plan for the pre-construction and construction phases of the Project. The plan should include, but not be limited to:

- submission of updated transportation logistics schedules and individual contingency plans to account for all activities to the GNWT;
- cradle-to-grave coverage of spills of hazardous materials and of dangerous materials; and
- assurance that geographical and regional considerations have been assessed.

The Proponents did not agree with this recommendation and submitted that the issues described would be managed through existing regulatory requirements and the Proponents' management systems and programs. Each operator, whether with a company or contractor, would have a specific Spill Contingency Plan for its activities and operations. Mutual aid agreements would link these plans. Therefore, the Proponents submitted that a specific Umbrella Spill Contingency Plan is not required.

The GNWT recommended that the Proponents develop and submit a Consolidated Spills Report within 30 days after the conclusion of each work season and for each of the Project's pre-construction and construction phases. This report would consolidate information on all spills that are required to be reported or recorded, summarize any problems encountered, and recommend actions to ensure adaptive management during future operations.

The Proponents did not agree with this recommendation and submitted that the issues described would be managed through existing regulatory requirements and the Proponents' management systems and programs. They stated that there is no need to provide a Consolidated Spills Report; in the unlikely event of a spill, it would be reported to the appropriate regulator, and reports on individual spills would be publicly available on request. The Proponents noted that they would systematically review all spill incidents to identify causes and take corrective action.

The GNWT recommended that the Proponents incorporate several best management practices into management planning for refined petroleum products, hazardous materials and dangerous goods. These practices included "no planned storage" of these products on or near ice or in or upon water. (J-GNWT-00314, p. 22) Practices also included designing equipment appropriately for the environmental conditions to be encountered and to the standard set out in the most recent national codes.

The Proponents agreed with the premise of this recommendation but with variations. They noted that they would incorporate best management practices into the management planning for refined petroleum products, hazardous materials and dangerous goods, as appropriate for the northern and remote conditions of the Project. Relevant standards and best management practices would be adopted in consultation with the appropriate regulatory authorities. Fuel would not be stored in single-hull barges over the winter. However, ConocoPhillips plans to store some fuel in tanks equipped with secondary containment on the decks of barges frozen in near Pete's Creek on the Mackenzie River. Once an ice ramp was constructed from the shore to a barge, the fuel would be moved to an onshore storage area on land away from the Mackenzie River, and additional fuel would be supplied via the Mackenzie River ice road. ConocoPhillips indicated that it has consulted with, and will continue to consult with, appropriate regulators before developing a detailed plan for this activity.

Further to the issue of over-winter storage of fuel in barges, the Dehcho First Nations also recommended to the Panel that fuel should not be stored in this manner. In response, Transport Canada noted that storage of fuel in barges moored in areas where land-fast ice forms (i.e. not subject to dynamic ice pressures) is not in violation of regulations under the *Canada Shipping Act, 2001* or the *Arctic Waters Pollution Prevention Act*. The Joint Secretariat also expressed concern over potential over-winter fuel storage in barges.

Environment Canada concluded that:

> One, the proponent has not identified risks in a comprehensive manner nor provided substantive details regarding environmental emergency response planning.
>
> Two, the proponent has not demonstrated through evidence filed with the [Panel] that it meets or exceeds best available standards for practice of the emergency prevention, preparedness and response.
>
> Three, the proponent has not demonstrated through evidence filed with the [Panel] its ability to manage major spills, accidents or malfunctions during the pre-construction, construction or operational phases of the project. (David Noseworthy, HT V94, p. 9495)

Environment Canada stated that these issues were of great concern and require remedy. Therefore, it filed several recommendations with the Panel that were directed to the Proponents and dealt with the content and scope of the Proponents' Environmental Emergency Plans and the need for these plans to be consistent with industry standards and be reviewed, approved and evaluated.

The Proponents agreed with the recommendations but clarified that Emergency Response Plans developed for the Project would be filed with the NEB and other appropriate regulatory authorities. They also noted that communities are not expected to be involved in an emergency response, but they would be notified of the situation and kept informed of the response. The Proponents submitted that it is not necessary for the Panel to respond to the recommendation regarding the evaluation of the effectiveness of the Emergency Response Plans because the NEB's emergency response requirements would address the intent of this recommendation. The Proponents stated that they would comply with the NEB requirements.

In its closing remarks, Environment Canada reiterated its concerns and noted that the Project would transport, store and use significant amounts of hydrocarbon-based fuels (e.g. diesel) and hazardous natural gas, which can pose substantial risks to safety and the environment through the release of toxic substances. It submitted that the Proponents had not clearly demonstrated that they were fully prepared to prevent and, where prevention was unsuccessful, respond to environmental emergencies, and to avoid and/or reduce the environmental impacts of such emergencies. It also pointed out the importance of and need for all Project-related plans for spill contingency, emergency response and environmental management to be available for review during the regulatory process prior to commencement of construction.

Natural Resources Canada filed a recommendation with the Panel that stated that the Proponent should "provide to the appropriate regulators, for review and approval, prior to commencement of operation, an accident and malfunction plan that includes response activities for earthquakes." (J-NRCAN-00090, p. 23)

The Proponents agreed with this recommendation with variation and noted that they would comply with the NEB's proposed conditions for the Anchor Fields, the Mackenzie Gathering System and pipeline to provide Emergency Response Plans. The plans would include activities for general emergency responses, including but not specific to earthquakes.

The Ka'a'gee Tu First Nation recommended that the Proponents contribute to the funding of a community-based spill response team and the development of a local Spill Response Plan. The Proponents responded that they would develop Emergency Response Plans related to the construction and operation of the pipeline. Barge carriers would be responsible for responding to emergencies associated with barging activities. With these points in mind, the Proponents stated that they did not plan to specifically fund or train a community-based spill response team.

The Liidlii Kue First Nation recommended to the Panel that the Proponents and Indian and Northern Affairs Canada create an emergency environmental clean-up fund to deal with problems as they arise and appoint an environmental monitor to supervise the clean-up. The Proponents partially agreed with this recommendation. They submitted that an environmental clean-up fund is not required but agreed that an environmental monitor from the local community would participate during clean-up activities.

The Pedzeh Ki First Nation recommended that further consultation is needed on an Emergency Response Plan and said that its community has not been consulted with on how emergencies in its area would be dealt with and how reclamation procedures would be implemented and paid for. It further stated that the Pedzeh Ki First Nation needs to know how emergencies would be dealt with and how local services can be improved and be of service to the Proponents. In addition, it recommended that the Project not proceed before and without the provision of a full-time nurse in Wrigley.

The Proponents agreed with this recommendation with variation and noted that Emergency Response Plans were discussed during the Project's extensive public consultation activities and that the Pehdzeh Ki First Nation would be kept informed as emergency response planning continued. The Proponents did not agree that the Project should not proceed until a full-time nurse had been provided in Wrigley.

In reference to this recommendation, the Government of Canada noted that federal departments had provided recommendations to the Panel on Emergency Response Plans in general.

7.5 PANEL VIEWS AND RECOMMENDATIONS

The evidence before the Panel indicates that there is a regulatory regime at a variety of levels regarding accidents, malfunctions and EPR for all activities associated with the Project, including the Anchor Fields, pipelines, and the transportation and management of hazardous materials. Regulatory requirements under federal and territorial legislation are often aimed first at preventing the occurrence of accidents and malfunctions. There are also several regulatory requirements for EPR programs and plans to be in place to deal with accidents and malfunctions in the event that they occur.

The Proponents have provided the Panel with sufficient information and commitments to indicate the proposed contents of the Proponents' accident, malfunction and EPR plans and programs. The Panel also notes that numerous regulators and agencies would be involved in preparing and approving these plans and programs and in ongoing monitoring and oversight during construction and operations. The Panel is of the view that it is incumbent upon these government departments and agencies to make adequate preparations in the form of staff and resources to allow them to fulfill these roles, as discussed in Chapter 18, "Monitoring, Follow-Up and Management Plans." The Proponents have also committed to working with their barge and rail carriers to ensure that their EPR plans and programs are sufficient and meet the Proponents' requirements and commitments.

The Panel notes that the Proponents committed to ensure that "trained personnel" would monitor the movement of Project-related controlled and hazardous materials to ensure compliance with regulations and land use permit requirements. (J-IORVL-00174, p. 19)

The GNWT expressed concerns regarding the adequacy of the existing regulatory regime as it related to preventing or responding to accidents and malfunctions. Some federal departments, such as Environment Canada and Fisheries and Oceans Canada, expressed concern regarding the level of information filed by the Proponents and recommended to the Panel that outstanding issues regarding accidents, malfunctions and EPR be adequately captured during the regulatory review phase of the Project. Federal and territorial government departments and agencies also described to the Panel how they would work together in the event of an emergency and how these roles and responsibilities were outlined through instruments such as cooperative working agreements and mutual aid agreements.

The Panel notes that no dissenting or contrary opinions were offered by any participants regarding any of the worst-case scenarios presented by the Proponents and the Inuvialuit Game Council. The Panel therefore accepts these scenarios as presented.

Despite the apparently comprehensive nature of the current regulatory regime, the Panel also heard concerns regarding implementation of this regime. In particular, the Panel heard that, despite legislated requirements and the establishment of working agreements and mutual aid agreements, it is not always clear to individuals working in the field or to local residents which organization they should call in the event of an emergency, accident or spill. It appears to the Panel that there is room for improvement in how government departments and agencies communicate their roles and responsibilities to staff and the general public, and the Panel is of the view that they should increase their efforts in this area. Further, the Panel heard concerns regarding the capacity and response times for emergency response within the NWT. The Panel is of the view that these issues should be closely examined by the Proponents, transportation providers (such as barging and shipping contractors), and the relevant government departments and agencies as Project planning proceeds, to ensure appropriate emergency response time and capacity.

As part of their response to participants' recommendations, the Proponents filed with the Panel the proposed certificate conditions that the NEB may attach to any Project approval. The Panel notes that proposed Conditions 5 and 34 address the preparation and filing with the NEB of an Emergency Preparedness and Response Plan and an Emergency Procedures Manual. Condition 35 requires the Proponents to conduct an emergency response exercise. The Panel supports these conditions.

7.5.1 SPILL REPORTING

The Panel is not persuaded that there is a plan for the detection or remediation of spills in Arctic waters, or for the prosecution of the party responsible.

RECOMMENDATION 7-1

The Panel recommends that, within one year of the date of the Government Response to the Panel's Report, the Government of Canada publish a plan that demonstrates that Transport Canada has adequate capacity in place to ensure that spills and accidents in the Arctic marine environment are appropriately prevented, detected and remediated, and that contraventions of existing legislation will be prosecuted.

7.5.2 SPILL CONTINGENCY PLANNING

Considering the Proponents' accident, malfunction and EPR commitments, which include meeting regulatory requirements and continued consultation with relevant government departments and agencies, the Panel does not have sufficient evidence before it to endorse the GNWT's recommendations regarding spill contingency planning and consolidated spills reporting, as worded. The Panel also notes that Section 5.5 of the *Mackenzie Gas Project Socio-Economic Agreement* between the Proponents and the GNWT describes the Proponents' accident, malfunction and EPR obligations. However, the Panel recognizes the GNWT's outstanding concerns in the areas of spill contingency planning and consolidated spill reporting and makes the following recommendation.

RECOMMENDATION 7-2

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, prior to the commencement of construction and in conjunction with their Environmental Management Plans, the results of their discussions with the Government of the Northwest Territories regarding spill contingency planning and consolidated spills reporting and how the Proponents have addressed the concerns of the Government of the Northwest Territories in these areas.

The GNWT also commented that legislation concerning the transportation of dangerous goods does not require spill contingency plans for the bulk transport of refined petroleum products on roadways within the NWT. The Panel notes that these plans are referred to as Emergency Response Assistance Plans within legislation for the transportation of dangerous goods and that such plans are not required for the road transport of diesel and gasoline. Considering the large volumes of diesel and gas proposed to be transported during Project activities, the absence of such a requirement is of concern to the Panel.

RECOMMENDATION 7-3

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, prior to the commencement of construction and as part of their Environmental Management Plans, adequate mitigation measures for spill response for any bulk carriage of diesel or gasoline on roads within the Northwest Territories. At minimum, such mitigation should include the carriage of appropriate spill response kits on all trucks transporting diesel or gasoline and the development of a Spill Contingency Plan to be implemented in the event of a spill.

Further, these mitigation measures should receive endorsement from the Government of the Northwest Territories prior to being filed with the National Energy Board.

7.5.3 TRANSPORT AND STORAGE OF DANGEROUS GOODS

While the Proponents indicated that they had plans for trained personnel to monitor the movement of controlled and hazardous goods, and to ensure compliance with regulations and land use permit requirements, the Proponents did not provide any details as to how this would be implemented.

RECOMMENDATION 7-4

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, prior to the commencement of construction and as part of their Environmental Management Plans, the qualifications of the trained personnel monitoring the movement of controlled and hazardous goods and their plan for ensuring compliance with regulations and land use permits.

The Panel shares the concerns of the GNWT regarding management of refined petroleum products and dangerous goods. The evidence before the Panel indicates that there may be regulatory gaps in this area, and the Panel is of the view that such products should be managed to a high standard to reduce the potential for accidents and malfunctions to occur and to mitigate any impacts from any accidents and malfunctions that might occur. In particular, the Panel notes the absence of regulations governing the storage of bulk fuel or dangerous goods in or on ice or water. Considering the potential impacts to the aquatic environment in the event of a spill or leak of these substances, the Panel is of the view that Transport Canada and other relevant regulatory authorities should develop regulatory requirements for storage of bulk fuel or dangerous goods in or on ice or water or, alternatively, take steps to eliminate the practice altogether.

RECOMMENDATION 7-5

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, prohibit the Proponents from storing Project-related bulk fuel or dangerous goods in or on ice or in or upon water without the prior approval of Transport Canada.

The Panel further recommends that Transport Canada, when considering whether to grant an approval for storage of Project-related bulk fuel or dangerous goods in or on ice or in or upon water, have regard to whether there are logistically or economically practical alternatives to such storage. Where such storage is permitted, the Panel recommends that such storage not be allowed to occur in single-hulled barges and that the following mitigation is in place:

- *appropriate secondary containment;*
- *an appropriate spill response kit; and*
- *a minimum of weekly monitoring for any spills or leaks.*

7.5.4 HAZARDOUS MATERIALS AND DANGEROUS GOODS MANAGEMENT PLANNING

In order to minimize the opportunities for accident and malfunctions during the handling of petroleum products, hazardous materials and dangerous goods, the Panel recommends the following.

RECOMMENDATION 7-6

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents, prior to the commencement of construction, to incorporate the following best management practices into management planning for refined petroleum products, hazardous materials and dangerous goods:

- *new bulk fuel storage facilities and any newly placed storage tanks meet the requirements of:*
  - *the most recent version of the* National Fire Code of Canada*;*
  - *the* Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products, *Canadian Council of Ministers of the Environment, 2003 (including but not limited to Sections 3, 4, 8 and 9);*
- *equipment used for the purpose of refined petroleum product transfer and storage, including, but not limited to, fittings, valves, couplings and hoses, be designed for the environmental conditions under which it is to be used; and*
- *the* Arctic Waters Oil Transfer Guidelines, *April 1997, Transport Canada, be used for Arctic and inland waters operations.*

In the absence of federal or territorial regulations for the management of refined petroleum products, hazardous materials or dangerous goods, the Panel recommends that the Proponents adopt a relevant standard or best management practice in consultation with the appropriate regulatory authority. Where a best management practice requires a more stringent requirement than a regulation or standard, the best management practice must be followed.

7.5.5 ENVIRONMENTAL EMERGENCY PLANS

With the exception of Environment Canada's recommendation that the Panel recommend evaluation of the effectiveness of the Proponents' Emergency Response Plans, the Panel notes that the Proponents agreed with Environment Canada's recommendations. The Proponents also noted that Emergency Response Plans developed for the Project would be filed with the NEB and other appropriate regulatory authorities.

Regarding Environment Canada's recommendation that the Panel recommend evaluation of the effectiveness of the Proponents' Emergency Response Plans, the Proponents submitted that it is not necessary for the Panel to respond to this recommendation because the NEB's emergency response requirements would address the intent of the recommendation, and the Proponents would comply with the NEB requirements. They also noted that, although communities are not expected to be involved in an actual emergency response, they would be notified of the situation and be kept informed of the response. The Panel is not clear on the intent of the Proponents' assertion that it is not necessary for the Panel to respond to this recommendation and notes that the NEB does expect companies to conduct some form of simulated emergency response exercise annually. Nonetheless, the Panel agrees that, although it is important to notify and involve communities to the extent possible, it is not appropriate for community members at large to be involved in an actual emergency response or emergency response exercise without sufficient training. However, it may be appropriate for a select number of community members to be involved as observers, and the Panel is of the view that the Proponents should investigate this possibility further.

RECOMMENDATION 7-7

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, prior to the commencement of construction, their Environmental Emergency Plans to the appropriate regulatory authorities for review and approval. These plans should:

- *include:*
  - *an inventory of petroleum products, chemicals and other hazardous substances that will be transported, stored and/or used during pre-construction, construction and operational phases;*
  - *storage facilities and locations of inventoried products;*
  - *identification of resources (equipment and staff) to be on-site and/or available to respond to environmental emergencies;*
  - *procedures for responding to spills and releases, including an incident reporting and notification system;*
  - *a list of response contractors and their respective roles;*
  - *clean-up and disposal procedures for generated wastes;*
  - *identification of sensitive areas such as groundwater sites and sensitive habitat;*
  - *a commitment to design and implement, as appropriate, pre- and post-development monitoring to enable the Proponents to readily identify, respond to and rehabilitate spills and/or chronic contamination should such events occur;*
- *address:*
  - *the types of emergencies that might reasonably be expected to occur, including potential on-site and off-site consequences;*
  - *prevention (evaluation of risks), preparedness (resources and training), response (notification and mobilization of resources) and recovery (assessment of damages and restoration of environment);*
  - *involvement of communities and stakeholders who may be impacted by an environmental emergency or involved in an emergency response; and*
- *be consistent with industry standard publications such as* CAN/CSA-Z731-03 Emergency Preparedness and Response *and the requirements of all federal and territorial government departments and agencies.*

The Panel further recommends that the effectiveness of these Environmental Emergency Plans be evaluated by the National Energy Board and the appropriate regulatory authorities through exercises conducted each year in which Project-related construction takes place and every three years during operations. Local and territorial emergency authorities should be involved in these exercises as appropriate, and communities should be involved in these exercises to the extent possible considering logistical and safety concerns.

7.5.6 RESPONSE AND DESIGN FOR EARTHQUAKES

The Panel supports Natural Resources Canada's recommendation regarding earthquake preparedness and notes the Proponents' willingness to accept this recommendation.

RECOMMENDATION 7-8

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to provide to the appropriate regulators for review and approval, in advance of the National Energy Board granting the Proponents Leave to Open, the Proponents' accident and malfunction plans that include response activities for earthquakes.

7.5.7 EMERGENCY PREPAREDNESS AND RESPONSE PLAN

With reference to the Pehdzeh Ki First Nation's concerns regarding emergency response planning, the Panel notes the Proponents' commitments to comply with regulatory requirements and to consult with relevant government departments and agencies during preparation of their accident, malfunction and EPR plans and programs. The Panel is of the view that the Proponents should continue to consult with potentially affected communities and keep them informed as emergency response planning continues.

The Panel notes that the NEB expects companies to include in their EPR programs a continuing education program for members of the public who live adjacent to a pipeline to inform them of the location of the facilities, potential emergency situations and emergency procedures to be followed. Further, the Panel notes that the *Northwest Territories/Nunavut Spills Working Agreement* also includes a provision for the lead agency to inform parties that may be directly affected by a spill. Notwithstanding these requirements and the Proponents' commitment to develop EPR plans for the various transportation modes associated with the Project, it is not clear to the Panel the extent to which the Proponents intend to include a continuing education program within their EPR plans for transportation activities. This is of concern to the Panel since many communities expressed their desire to be better informed of accidents, malfunctions and EPR planning and responsibilities.

RECOMMENDATION 7-9

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to provide to the appropriate regulators for review and approval, prior to the commencement of construction, an Emergency Preparedness and Response Plan for all forms of transportation associated with the Mackenzie Gas Project that includes a continuing education program for the public who might be affected by a transportation-related accident, malfunction or spill associated with the Project. At minimum, the continuing education program should outline how the Proponents and their transportation providers will inform the public of actions to be taken in the event of an emergency and how those potentially affected by an accident or malfunction would be informed of such an event.

7.5.8 LOCAL SPILL RESPONSE CAPACITY

Several participants, including the Deh Gah Got'ie Dene Council, the East Deh Cho Alliance, the Fort Providence Resource Management Board, Katlodeeche First Nation, West Point First Nation and Ka'a'gee Tu First Nation, recommended that the Proponents, and sometimes NTCL, establish, train and fund local spill response teams. The Panel is of the view that participants' general concerns in these areas should be directed to the relevant government agencies and departments, and the Panel encourages these participants to bring their concerns regarding local spill response capacity forward to these agencies and departments. However, the Panel is also of the view that the Proponents could play an increased role in addressing this issue and that they should work with communities and other government agencies and departments to investigate any potential opportunities in this regard. In the case of barging on the Mackenzie River, the Panel notes NTCL's responsibilities for spill response and is of the view that NTCL and other barging operators on the Mackenzie River and in the Beaufort Sea should investigate the potential for involvement of local residents in spill response activities.

RECOMMENDATION 7-10

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to provide, prior to the commencement of construction, as part of the Emergency Preparedness and Response Plan referred to in Panel Recommendation 7-9, their assessment of the potential for establishment of local, community-based spill response teams, their commitments to build community spill response capacity, and a discussion of opportunities and constraints in establishing local spill response teams.

7.5.9 GOVERNMENT PREPAREDNESS

In response to community concerns about governments' ability to identify an accident or spill, respond to it promptly, and advise local residents of the event and its significance, the Panel recommends the following.

RECOMMENDATION 7-11

The Panel recommends that, within one year of the date of the Government Response to the Panel's Report, the parties to the Northwest Territories/Nunavut Spills Working Agreement review, update and publish their plans to manage a Project-related accident or spill along the Mackenzie River or in the Mackenzie Delta. The update of these plans should address the specific measures to be taken to notify the public of any spills, the actions to be taken to notify the front-line members of the lead agency that has responsibilities flowing from the agreement, and a method to keep the plans up-to-date. The Panel also recommends that the parties conduct a mock exercise to test these plans. This exercise should be repeated each year that construction is under way and every three years during operations.

In the Panel's view, it is critical that, first, measures are put in place to avoid an accident or malfunction from occurring, and second, should an accident or malfunction occur, that there are appropriate measures to respond to and follow up on any such occurrences. The Panel heard evidence that both of these requirements would be in place in relation to the proposed Project and related activities. In the Panel's view, the existing regulatory regime, the Proponents' commitments, the Proponents' proposed design and ongoing integrity evaluation, the implementation of the NEB proposed Conditions 5, 34 and 35, and the implementation of the Panel's recommendations would be sufficient to lessen the potential for accidents or malfunctions to occur and, in the event that they do occur, would mitigate any significant impacts. Engineering and design of the pipeline for safe and efficient operation are discussed in further detail in Chapter 6, "Project Design, Construction and Operations."

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Air and Water Quality

8.1 INTRODUCTION

Air and drinking water in the Project Review Area are of high natural quality, particularly compared with many parts of southern Canada. Residents of the Northwest Territories (NWT) place a high value on the existing quality of their air and drinking water and do not wish to see it diminished by the Project. Government regulators emphasized the need to "keep clean areas clean."

The first two sections of this chapter consider air emissions from construction and operations and from waste incineration. These are Project-specific effects and would be regional or local in nature.

The third section considers greenhouse gas (GHG) emissions. These emissions are considered at a different scale because, although their local effects are negligible, they would contribute to atmospheric concentrations of GHG on a global scale. Although that contribution would be small, Canada has international obligations with respect to GHG emissions by virtue of being a signatory to the *Kyoto Protocol*. Because of those obligations, some participants called on the Panel to consider not only Project-specific emissions of GHG, but also GHG emissions resulting from the end use of the gas produced and shipped.

The fourth section considers the impacts of the Project on water quality with particular emphasis on drinking water. Project-induced sedimentation (chiefly through construction activities or design failures) is considered separately in Chapter 6, "Project Design, Construction and Operations" and Chapter 9, "Fish and Marine Mammals."

The Panel held three days of hearings specifically devoted to air and water quality.

8.2 AIR QUALITY

8.2.1 EXISTING CONDITIONS

Compounds likely to be generated by the Project either directly or indirectly as by-products include:

- sulphur dioxide;
- oxides of nitrogen;

- nitrogen dioxide;
- ozone;
- carbon monoxide;
- volatile organic compounds;
- respirable particulate matter smaller than 2.5 micrometres (μm) in diameter, referred to as $PM_{2.5}$; and
- compounds that include sulphates and nitrates, collectively referred to as potential acid input.

Certain compounds — carbon dioxide (CO_2), methane and nitrogen dioxide — have the potential to collect in the atmosphere and influence global temperatures. These are referred to as greenhouse gases (GHGs).

Air emissions from the Project would affect the airsheds in three ways:

- Concentrations of certain compounds in the air would be increased through the deposition of airborne dust caused by Project activities and the deposition of acid formed through chemical reactions in the air.
- During the construction phase, air emissions would be generated by facility and pipeline construction activities, the operation of construction camps, and the movement of construction vehicles and aircraft.
- During operations, emissions would be generated from facility operations, well test flaring, process venting, fugitive emissions and vehicle movements. Some emissions would also result from the incineration of wastes.

The Proponents provided baseline information on climatic conditions and ambient air quality for three areas:

- a northern airshed that included the Anchor Fields, the gathering pipelines and the Inuvik Area Facility;
- a central airshed that included the pipeline right-of-way and compressor stations from Little Chicago to Tulita; and
- a southern airshed that included the pipeline right-of-way, compressor stations, the Trout River Heater Station, and the Northwest Alberta Facilities from Blackwater River to Petitot River.

The Proponents' baseline information was based on historical data and the results of air quality monitoring carried out over one year near the communities of Inuvik and Norman Wells, and periodically at the Parsons Lake and Taglu gas fields. The Proponents also developed an inventory of existing community and industrial air emissions within a 50-km corridor around proposed Project facilities.

The Proponents' monitoring data and other sources indicated that background concentrations of air quality contaminants are generally low (below detection levels or well below applicable guidelines). Carbon monoxide and $PM_{2.5}$ were not measured but were assumed to be effectively zero because there were no anthropogenic fuel-burning sources in the vicinity of the proposed Project facilities. The one exception is ozone: monitoring indicated relatively high background levels (exceeding federal guidelines) in Inuvik and Norman Wells. The Proponents indicated that elevated ozone levels at high latitudes in the northern hemisphere are thought to result from the intrusion of stratospheric ozone. Existing emissions were calculated as tonnes/day (t/d) by activity (aviation, marine, communities, power and industrial), using published emission factors, population data and fuel information.

In the NWT it is difficult for governments to manage air emissions on federal land because territorial and municipal regulations or regulatory permits generally do not apply to activities on federal and Aboriginal lands.

8.2.2 PROPONENTS' VIEWS

PROJECT IMPACTS DURING CONSTRUCTION

The Proponents did not quantify or assess air emissions during the construction phase in the Environmental Impact Statement (EIS) because they believed that emissions would be minor when compared with emissions during peak operations, would be localized, and would occur over a short time frame. Emissions during construction would include:

- dust generated from borrow sites, pipeline construction and vehicle movements along unpaved roadways; and
- localized air emissions from space heating and waste incinerators at construction camps.

Emissions would also occur during the construction phase through intermittent flaring during well testing at the three Anchor Fields. In the EIS, the Proponents provided estimates of the rate at which sulphur dioxide and oxides of nitrogen would be emitted during flaring. Emissions during flaring were not included in the overall impact modelling or in the cumulative assessment of air impacts.

The Proponents provided estimates of air emissions for each year during the construction phase and provided further details in the May 2007 *Supplemental Information — Project Update.* The Proponents maintained that the revised estimates of air emissions did not change the fundamental conclusion of the EIS that the impacts of construction would be relatively short-lived and less than during peak operations.

The Proponents also provided further details regarding dust emissions and their impacts. Most of the dust particles generated by vehicle movements and construction activities are expected to be too large to be inhaled by humans or wildlife. The Proponents predicted that 60 to 90% of dust particles would not be transported through the atmosphere but would fall down to the ground.

The impacts of dust would be mitigated through:

- presence of snow and ice cover during winter months;
- application of water from tank trucks; and
- application of a calcium and water mixture.

Construction activities would result in increased traffic and heavy machinery in and around communities. Adverse impacts are expected to be temporary and associated with seasonal atmospheric phenomena, such as temperature inversions. Because traffic would not be stationary but would be travelling along roads, the Proponents considered it highly unlikely that emissions from traffic would have any measurable impact on ambient air quality.

In the assessment of the Project's impacts on individual, family and community wellness, the Proponents addressed the potential impacts of diesel exhaust. The Proponents do not expect diesel particulate matter to be emitted over sustained periods of time and expected that such particulate matter would be at lower concentrations than typically occur in occupational exposures. As 80 to 90% of diesel particulate matter would comprise organic carbon and elemental carbon, these exhaust components would readily become part of the natural soil matrix over time. Diesel exhaust would also include small amounts of polycyclic aromatic hydrocarbons and metals, which are potentially dangerous. However, the Proponents concluded that such hydrocarbons and metals would not present a substantial threat to vegetation, animals or humans. They asserted that it would likely be almost impossible to observe any cause and effect linkage between diesel particulate matter exposure from the Project and specific symptoms or illnesses because of compounding issues, such as the effects of smoking.

The Proponents proposed to mitigate the impacts of diesel exhaust by:

- encouraging the use of late-model diesel-powered vehicles;
- avoiding idling vehicles close to camps and communities except under extreme cold conditions;
- using railroad and barge transportation to the extent possible;
- using bypass routes through and around communities where available; and
- using low-sulphur diesel fuel.

The Proponents assessed the emissions associated with the proposed Norman Wells construction camp, one of the larger camps, during the construction phase. The Proponents' modelling used conservative assumptions that all camp generators and the waste incinerator would operate 24 hours a day and that the maximum of 1,350 workers would be on site continuously. The modelling focused on $PM_{2.5}$ and nitrogen dioxide, which would result from the emissions of oxides of nitrogen. The results indicated that appropriate air quality objectives would not be exceeded.

PROJECT IMPACTS DURING OPERATIONS

The Proponents stated that, during operations, the proposed Project would result in air emissions in four categories: toxic air pollutants, criteria air contaminants (air pollutants that cause smog, acid rain and other health hazards), acid deposition and GHGs. Table 8-1 shows the scale of assessment according to type of emission. Section 8.4 specifically discusses GHGs.

The Mackenzie Valley is particularly sensitive to acid deposition because ecosystems are subjected to a harsh climate and a short growing season.

During operations there would be continuous emissions associated primarily with the combustion of natural gas as fuel. The largest source would be the compressor turbines, with additional emissions released from power generation equipment and heaters. Fugitive emissions would include:

- methane leaks from valves, seals and fittings;
- blow-down emissions (vented methane releases) at compressor stations; and
- emergency flaring at the Inuvik Area Facility and Anchor Fields.

Table 8-1 Scale of Assessment for Specific Air Emissions

	Scale of Assessment			
	Local	Local and Regional		National and Global
Categories of Emissions	Toxic Air Pollutants	Criteria Air Contaminants	Acid Deposition	GHGs
Examples	• mercury • polycyclic aromatic hydrocarbons • dioxins • furans	• nitrous oxides • particulate matter • sulphur dioxide • carbon monoxide • volatile organic compounds	• nitric acid • sulphuric acid	• CO_2 • methane • nitrous oxides

Source: Adapted from EIS Vol. 3, Section 2, pp.15–26; J-IORVL-00115, p. 215

In order to predict ground-level concentrations, the Proponents modelled continuous emissions sources from facilities. The modelling involved calculating emission rates and using these calculations as inputs to the dispersion models. The Proponents indicated that the modelling used conservative assumptions, including guidelines from the Canadian Council of Ministers of the Environment (CCME) for stationary combustion turbines, maximum operating conditions (i.e. equipment running at full capacity, 24 hours a day, 365 days a year), and worst-case meteorological conditions. For the Anchor Fields, estimates of sulphur dioxide emissions assumed the presence of a nominal 4 parts per million of sulphur compounds, even though all the Anchor Fields would produce sweet gas with a lower sulphur concentration.

Predicted concentrations were compared with the NWT's ambient air quality standards where available or, when not available, federal criteria or criteria from other Canadian or North American jurisdictions. Predictions were made for:

- the three regional airsheds;
- local study areas around Project facilities;
- 19 communities;
- other locations of importance to communities, such as hunting and fishing camps; and
- potentially sensitive lakes near Project facilities.

The Proponents stated that all ground-level concentrations of compounds released by the Project during operations at the Anchor Fields, the Inuvik Area Facility, and compressor and heater stations sites would increase, but that these would be below applicable federal and territorial guidelines at all locations in the production area and along the pipeline corridor.

The predicted magnitude of impacts on air quality for main Project facilities during the operations phase would be low to moderate. Moderate magnitude was assigned where predicted maximum concentrations were between 5 and 100% of the applicable objectives and standards. Potential acid input, the key indicator of increased acid deposition, was always found to be of low magnitude. All area potential acid input predictions were lower than the critical or monitoring load values identified by Alberta's Clean Air Strategic Alliance (a multi-stakeholder partnership that recommends strategies to assess and improve air quality in Alberta) for sensitive ecosystems. Each of the compressor stations had a small area (less than 25 ha) around them where the potential acid input would exceed the monitoring load value identified by the Clean Air Strategic Alliance. For all air quality parameters and facilities, the area affected was deemed to be local in extent, and the impacts would be long-term over the life of the Project.

The Proponents acknowledged that facilities would need to relieve pressure occasionally by releasing gas to the atmosphere. The Proponents considered controlled venting to be safe and reliable because gas from the Anchor Fields is sweet and therefore does not contain hydrogen sulphide. Fugitive releases of small volumes of gas could also be expected from valves and fittings.

The Proponents indicated that the availability of wildlife habitat in a few locations could be affected because air emissions and dust might affect the health, vigour, growth or abundance of plant species used by wildlife for forage. During construction, dust deposition could adversely affect lichen health and consequently affect caribou winter-foraging habitat. Vegetation health could also be affected by emissions of oxides of nitrogen, CO_2, carbon monoxide and $PM_{2.5}$. The subsequent impact would depend on each species' food requirements. As an example, nitrogen deposition could increase the growth of grasses and shrubs that are the preferred food of barren ground grizzly bears and some birds in the arctic tundra, but this increased growth could also shade out more sensitive plant species such as lichens, thus affecting barren ground caribou. However, for all species of wildlife, the impacts of altered vegetation health due to air emissions was assessed as being low and local, although potentially lasting for several decades.

The Proponents commissioned a qualitative risk assessment of the different pathways that might affect country foods, which concluded that fuel combustion would not result in an appreciable increase in chemical concentrations in the environment or accumulation in plant or animal tissues. This was because natural gas is a clean-burning fuel, and diesel fuel would be used primarily during construction and during the winter period, when snow cover would prevent direct deposition on plants and soil. Flare emissions would emit negligible amounts of metals and polycyclic aromatic hydrocarbons. Because solid waste incineration would meet Canada-wide standards for mercury, dioxins and furans, concentrations would not be measurable. Therefore, the Proponents concluded that there was no requirement to carry out any further assessment of the impacts of air emissions on country foods.

The Proponents did not quantify the potential impacts on air quality of accidents and malfunctions. In response to an Information Request, the Proponents described the possible impacts on air quality of a fire or an explosion resulting in a fire. The impacts of a fire were expected to be short-term and similar to the impacts of a naturally caused wildfire regularly experienced along the pipeline right-of-way. The impacts of a spill or loss involving hazardous material would depend on the quantity. Air quality could be negatively affected, especially if a vapour cloud formed, but the cloud would be expected to dissipate within hours. Accidents and malfunctions are discussed more fully in Chapter 7, "Accidents, Malfunctions and Emergency Response."

Air quality predictions in the EIS were based on a throughput of 1.2 Bcf/d. The Proponents stated that they would require detailed characteristics of equipment and operating conditions in order to model emissions associated with additional pipeline capacity. However, the Proponents also noted that any additional facilities would not contribute to significant air quality impacts because they would be designed to meet regulatory guidelines. Also, new compressor stations would be located sufficiently far apart to make cumulative impacts unlikely.

The Proponents committed to:

- where regulations do not exist in the NWT, ensure that equipment would comply with CCME guidelines or those from other jurisdictions, such as Alberta;
- consider efficiency in equipment selection using a "balanced approach," not necessarily focusing on an individual pollutant;
- avoid vehicle idling except in essential situations;
- implement the Canadian Association of Petroleum Producers' best management practice, *Management of Fugitive Emissions at Upstream Oil and Gas Facilities*, as defined and updated through *Directive 060* of the Alberta Energy Utilities Board (EUB; now the Energy Resources Conservation Board);
- apply site management practices for dust suppression; and
- develop an emissions management plan in consultation with Environment Canada and the Government of the Northwest Territories (GNWT).

The Proponents proposed to carry out compliance monitoring as required by regulations and undertake passive monitoring for nitrogen dioxide at Project facilities. The Proponents did not provide information on specific issues to be addressed through impacts monitoring programs but did indicate that the programs would be designed in consultation with communities and regulators. The objectives of the impacts monitoring would be to:

- confirm effectiveness of mitigation;
- verify accuracy of predictions; and
- identify any impacts not predicted through environmental assessment.

8.2.3 PARTICIPANTS' VIEWS

BASELINE DATA

Environment Canada agreed with the Proponents that existing air quality in the proposed Project area is good. Environment Canada, the GNWT and Health Canada indicated to the Panel that the Project should therefore adhere to the principle of Keeping Clean Areas Clean (KCAC). The KCAC principle does not preclude new industrial development but requires that it be "planned, constructed and operated in a manner that minimizes the degradation of air quality in these areas." (J-EC-00102, p. 4) The principle plays a key role in the CCME's *Canada-Wide Standards for Particulate Matter (PM) and Ozone* and the *Canada-Wide Acid Rain Strategy for Post-2000* of the Federal/Provincial/Territorial Ministers of Energy and Environment. There are no numerical standards associated with the KCAC principle.

PROJECT IMPACTS DURING CONSTRUCTION

Health Canada criticized the decision not to assess air emissions during the construction phase on the grounds that short-term and highly localized air emissions could still have health impacts because construction activities may be in close proximity to communities, and short-term exceedances of air quality standards could occur.

At the hearings, Health Canada stated that a portion of road dust — particulate matter less than or equal to 10 μm in diameter (PM_{10}) — could be inhaled into the lungs. Particulate matter has been associated with irritated eyes, itchy nose, throat irritation, respiratory diseases, lung inflammation and some cardiovascular effects.

Environment Canada and the GNWT told the Panel that road dust is a concern from several perspectives. In communities, high levels of road dust can lead to health concerns, visibility issues, and soiling of buildings and clothes. Road dust along highways can cause reduced visibility, which has safety implications, and impacts on adjacent ecosystems, such as suppression of photosynthesis, alteration of water chemistry, introduction of contaminants into watersheds, and changes in the timing of snowmelt.

Environment Canada indicated that vehicle idling in communities generates significant quantities of toxic pollutants that can affect populated areas. In addition, most idling usually takes place on very cold winter days when dispersion of pollutants may be limited under thermal inversions. However, some vehicle idling is necessary in the coldest weather for operator comfort and safety and to ensure that vehicles run. Therefore, Environment Canada and the GNWT recommended that the Proponents develop appropriate dust management strategies in collaboration with local stakeholders and develop a management plan to avoid unnecessary vehicle idling.

PROJECT IMPACTS DURING OPERATIONS

Environment Canada and the GNWT expect the Proponents to meet all federal and territorial ambient air quality and emissions standards. However, because air quality in the NWT is generally considered to be pristine, the Proponents "should make every reasonable effort to minimize emissions [by] the application of best available technology, best management practices and optimizing systems for energy efficiency." (David Fox, HT V58, p. 5691) Environment Canada and the GNWT stated that permitting levels of pollutants to rise to the maximum allowable limit would not be acceptable.

Environment Canada focused its recommendations on pollution prevention and the use of best available technology and best management practices to minimize the degradation of air quality. Emissions that remain after the application of best available technology and best management practices must be adequately dispersed so as not to pose a risk to the health of humans or ecosystems.

Environment Canada and the GNWT made several comments on the Proponents' approach to predicting emissions for the operations phase. It was noted that not all sources were quantified, examples being mobile sources such as cars, trucks, off-road machinery, barge transport and aircraft. However, it was recognized that these sources would be relatively small. The Proponents also did not quantify emissions of volatile organic compounds other than benzene and BTEX (benzene, toluene, ethylbenzene and xylene). Environment Canada and the GNWT also noted that the EIS did not address increased air emissions caused by:

- Project-related activities in communities;
- development of further natural gas or oil resources induced by the Project; and
- pipeline capacity expansion.

Environment Canada and the GNWT concluded that representing existing sources of emissions in modelling by adding a small background concentration was an acceptable approach, especially for smaller diffuse sources. This may, however, underestimate the contributions of large point sources, especially under worst-case scenarios.

Because the modelling did not include upset conditions (e.g. emergency flaring) at any of the facilities, Environment Canada and the GNWT recommended that the Proponents carry out air quality monitoring at various locations to determine actual impacts during operations.

Environment Canada indicated that oxides of nitrogen (NO_x), which is the sum of nitric oxide and nitrogen dioxide, is a pollutant of concern because nitric oxide may affect human health and NO_x may affect vegetation. NO_x is also a precursor to ozone and particulate formation and contributes to acid deposition. NO_x is emitted mainly through combustion, and the Project's largest sources of this gas would be natural-gas-fired turbines and reciprocating engines used for compression and power generation.

There was discussion between Environment Canada and the Proponents regarding the appropriate benchmarks to assess nitric oxide impacts. The Proponents used the "maximum acceptable level" for nitrogen dioxide from the federal *National Ambient Air Quality Objectives* from the *Clean Air Act* (1981). Environment Canada argued that the "maximum desirable level", 40% lower than the maximum acceptable level, should be used because it "provides a basis for an anti-degradation policy for the unpolluted parts of the country." (J-EC-00102, p. 13)

Because federal guidelines for nitrogen deposition are intended to protect human health rather than vegetation, the Proponents also provided modelling based on estimates by the World Health Organization and the United Nations Environment Programme that would constitute a critical annual load of nitrogen per hectare for sensitive vegetation species and ecosystems. This modelling showed that nitrogen deposition would exceed these critical loads over an area of 12 ha around the Great Bear River Compressor Station. The Proponents asserted that overall, despite that prediction, impacts on vegetation health were still predicted to be low. Environment Canada agreed that the Project should comply with the *National Ambient Air Quality Objectives*, but it also indicated that adaptive management may require more stringent measures on a site-specific basis. Environment Canada also called for the use of best available technology to minimize NO_x emissions and passive monitoring of NO_x around Project facilities.

Environment Canada and the GNWT indicated that $PM_{2.5}$, emitted by combustion sources, is a pollutant of concern because of potential cardio-respiratory health impacts and regional visibility degradation. Larger particulates associated with road dust can cause soiling problems in communities, vegetation damage and accelerated spring snowmelt. Environment Canada and the GNWT disagreed with the Proponents' assumed background concentration of zero for $PM_{2.5}$. Existing monitoring information from Norman Wells and Inuvik indicated that typical daily concentrations of $PM_{2.5}$ ranged from 1 to 10 $\mu g/m^3$, excluding extreme pollution episodes from forest fire smoke. Even remote areas are expected to have background $PM_{2.5}$ levels of a few $\mu g/m^3$. Therefore, Environment Canada and the GNWT indicated that total $PM_{2.5}$ concentrations (background plus Project impacts) would be greater than predicted in the EIS.

With respect to overall air quality monitoring, Environment Canada recommended that the Proponents design and implement appropriate monitoring programs with its help. Its preferred regulatory instruments would include monitoring to support the requirements of the National Pollutant Release Inventory under the *Canadian Environmental Protection Act, 1999*, the National Energy Board's (NEB's) Certificate of Public Convenience and Necessity, *Canada Oil and Gas Operations Act* authorizations and approvals, and the Proponents' Environmental Protection Plan. Other vehicles could include land tenure instruments, water licences or an environmental agreement.

8.2.4 PANEL VIEWS AND RECOMMENDATIONS

In the Panel's view, the key air quality issues identified through the environmental assessment process included:

- The proposed Project would be a long-term source of new air emissions in a generally pristine environment, and while impacts are not predicted to exceed relevant standards and guidelines, participants invoked the principle of "Keeping Clean Areas Clean."
- Environment Canada and the GNWT recommended the use of best available technology to minimize emissions, while the Proponents countered that they would use best practical technology, which is "technology that considers safety,

engineering requirements, cost and environment, to reduce operational emissions." (J-IORVL-01040, p. 45)

- The Project's air emissions would require appropriate monitoring during construction and operations phases.

KEEPING CLEAN AREAS CLEAN

Despite the best efforts of the Proponents, air quality within the Mackenzie River airshed would deteriorate as a result of the Project.

The Panel notes that KCAC is a principle that applies specifically to ozone, particulate matter and acid rain. The Panel also notes that the principle is intended to counter any assumption that air emissions can be allowed to increase provided they remain under the regulated standard, i.e. polluting up to the limit. Environment Canada and the GNWT recommended the use of pollution prevention principles, best available technology and best management practices. The Proponents agreed with this recommendation with the one caveat that the requirement should be for best practical technology rather than best available technology. The Panel comments on this difference later in this chapter.

The Panel recognizes that the Expansion Capacity Scenario and Other Future Scenarios could lead to increased air emissions through the development of additional gas fields. However, the Panel was not presented with evidence to allow it to assess the cumulative impact of emissions from these scenarios on the integrity of the KCAC principle.

The Panel endorses the use of the KCAC principle in the regional airsheds that would be affected by the Project and by any future expansion of the pipeline. The Panel also agrees with Environment Canada's and the GNWT's recommendation that the Proponents should take appropriate steps to minimize air emissions. The Panel is of the view that Project performance, and the evaluation and mitigation of other existing and future air emissions sources that could interact cumulatively with Project emissions, should be addressed through a regional KCAC framework.

RECOMMENDATION 8-1

The Panel recommends that, prior to approval of any facility that would enable the throughput of the Mackenzie Valley Pipeline to be increased above 1.2 Bcf/d, Environment Canada and the Government of the Northwest Territories develop a Regional Air Quality Management Strategy for the Northwest Territories to uphold the "Keeping Clean Areas Clean" principle and provide clear guidance to industry on air quality targets and expectations. The strategy should be developed in collaboration with key stakeholders, including industry. The Panel recommends that the National Energy Board not issue any certificate or approvals for any such facility until the Regional Air Quality Management Strategy and related targets are in place.

USE OF BEST AVAILABLE TECHNOLOGIES

The Panel notes that the NEB would be the prime regulator of emissions from the Project and that Environment Canada and the GNWT would play advisory roles. The Panel recognizes the NEB's expertise and experience in regulating interprovincial aspects of the oil, gas and electric utility industries, including environmental matters. The Panel also recognizes the extensive environmental and local knowledge that Environment Canada and the GNWT would bring to bear. The Panel is of the view that, before construction begins, the Project's air emissions should receive a level of regulatory scrutiny that is similar to what would be applied in other jurisdictions and that all available expertise be used.

The Panel notes that the NEB has included in its *Proposed Conditions for the Mackenzie Valley Pipeline and Mackenzie Gathering System* Condition 23, which requires the Proponents to evaluate the technologies and practices available to reduce particulate matter and ozone emissions from its facilities and construction-related activities, and incorporate best management practices and best available technologies.

The Panel supports this Condition and makes one further recommendation regarding the use of the best available technologies.

RECOMMENDATION 8-2

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, six months prior to the commencement of construction, for review by Environment Canada and the Government of the Northwest Territories, details of their final design as well as construction and operations procedures for upstream facilities, compressor facilities, gathering systems and pipelines that include information on:

- *measures to mitigate methane leakage and venting from all Project-related activities arising from well testing and completion, gas gathering and processing, compressor stations and the mainline piping and valve systems, taking into account existing and new best management practices under development in the natural gas industry;*
- *overall system operation optimization and maintenance scheduling to maximize system reliability and safety, optimize energy efficiency and minimize methane and air contaminant releases;*
- *design choices for the capture and use of exhaust energy at the Inuvik Area Facility; and*
- *design of compressor stations, including unit size, efficiency and conformity with* National Emission Guidelines for Stationary Combustion Turbines *(Canadian Council of Ministers of the Environment, 1992).*

MONITORING

The Proponents committed to carrying out all compliance monitoring required by regulation and to passive monitoring of nitrogen dioxide. In addition, the Proponents indicated that they would establish impacts monitoring programs in consultation with communities and regulators. The Panel observes that the Proponents did not provide details regarding how and when such programs would be developed or what their probable parameters would be.

RECOMMENDATION 8-3

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, prior to the commencement of construction, a comprehensive Air Quality and Emissions Management Plan that:

- *demonstrates the application of best available technology and best management practices;*
- *provides for identifying, mitigating and tracking emissions of air pollutants and greenhouse gases from all Project-related sources throughout the life of the Mackenzie Gas Project; and*
- *enables the Mackenzie Gas Project's residual air pollutant emissions to meet the Northwest Territories' ambient air quality standards,* Canada-Wide Standards for Particulate Matter (PM) and Ozone, National Ambient Air Quality Objectives*, and any other applicable thresholds, including any air quality targets developed by Environment Canada and the Government of the Northwest Territories in compliance with Panel Recommendation 8-1.*

The Air Quality and Emissions Management Plan should include, but not be limited to:

- *a description of the best available technology to be implemented at each facility or, if best available technology is not proposed, evidence that a different technology standard will in fact enable the Mackenzie Gas Project to meet comparable goals;*
- *a description of the best management practices to be implemented at each facility and the Proponents' proposed continuous improvement efforts, including plans or strategies to prevent unnecessary vehicle idling and mitigate dust within and outside communities;*
- *an emissions tracking and monitoring system, including emissions reporting that is legally required (e.g. the National Pollutant Release Inventory);*
- *a commitment to reassess environmental impacts, in consultation with Environment Canada and the Government of the Northwest Territories, should significant changes occur to quality and quantity of existing facility emissions sources and new sources to be added to the Mackenzie Gas Project;*
- *an ambient Air Quality Monitoring Program including, but not necessarily limited to, passive nitrogen dioxide monitoring; and*
- *procedures for publicly available annual reporting.*

RECOMMENDATION 8-4

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, prior to the commencement of construction, an Impacts Monitoring Program that addresses, but is not limited to, the following air quality issues:

- *impacts on northern communities during the construction phase;*
- *impacts of Project-related nitrogen deposition within the Project Review Area on vegetation and wildlife habitat; and*
- *impacts of accidents and malfunctions.*

The Impacts Monitoring Program must be developed in consultation with Environment Canada, the Government of the Northwest Territories, affected communities and Health Canada, and must identify mitigation measures and the means for implementation of those measures.

If the Proponents' commitments and the Panel's recommendations 8-1, 8-2, 8-3 and 8-4 are implemented, the Panel is of the view that impacts on air quality from the Project as Filed would not likely be significant. The Panel does not have enough evidence before it to determine the air quality parameters for the Expansion Capacity Scenario or Other Future Scenarios, so the Panel is unable to make a determination of significance for these two scenarios.

8.3 WASTE INCINERATION

8.3.1 PROPONENTS' VIEWS

The Proponents propose to use waste incinerators at temporary construction camps to dispose of solid non-hazardous waste. The Proponents also indicated that incineration would likely be used during the operations phase at all permanent facilities.

Environment Canada sought more information on the grounds that incinerator emissions can have considerable impact and may include toxic components, such as heavy metals and organic pollutants at construction camps, which may be of particular concern because of their persistence in the environment, their capacity to bioaccumulate, or their toxicity.

The Proponents indicated that they had not yet selected the type of incinerator technology they would use, with the choice depending on the types and quantities of wastes. Materials likely to be incinerated would include:

- cardboard;
- construction waste;
- domestic waste;
- wood;
- domestic wastewater treatment sludge;
- drained absorbents and lubricating oil filters; and
- lubricating oil as supplementary fuel.

Some materials such as polyvinyl chloride plastic, glass and metals would be segregated and sent to an approved landfill, as would ash from incinerators.

Environment Canada sought further information on the justification for not modelling emissions from waste incinerators and on plans to minimize the emission of toxic components and monitor their fate and impacts.

The Proponents responded with two tables that estimated emissions of criteria air contaminants (sulphur dioxide, oxides of nitrogen, carbon monoxide and $PM_{2.5}$) from incinerators at proposed permanent facilities and four proposed construction camps. The Proponents stated that this information proved that emissions from incinerators at construction camps would be minor compared with emissions from Project operations. If used, a permanent incinerator at Parsons Lake would contribute amounts equivalent to less than 0.6% of the total emissions modelled for the operations phase. Similarly, at peak usage (expected to last a month), the largest construction camp would contribute about 16% of the emissions modelled for the operations phase. As no exceedances were predicted for emissions during the operations phase, incinerators are not expected to cause exceedances during the construction phase.

The Proponents provided an estimate of maximum emissions of mercury, dioxins and furans by multiplying the maximum allowable releases under the *Canada-Wide Standards for Particulate Matter (PM) and Ozone* by the estimated quantities of waste that would be generated at permanent camps.

The Proponents committed to meet the requirements of the appropriate standards established by CCME, use proven technology with trained personnel, and implement a Waste Management Plan. Monitoring would meet regulatory requirements.

The Proponents were of the view that the best way to deal with potential toxic emissions would be to minimize their creation through a rigorous Waste Management Plan that emphasized separation of wastes to ensure that only appropriate wastes were incinerated. They also pointed out that, while they committed to use dual-chambered incinerator technology wherever possible, these incinerators may not be manufactured in sizes suitable for use at camps that would have less than 120 workers.

The Proponents made the following commitments with respect to incineration:

- consult with the GNWT and Environment Canada on plans for incineration, including monitoring;
- include relevant information in the Proponents' Waste Management Plan and Air Quality and Emissions Management Plan;
- use equipment provided by third-party vendors that is of proven design for northern conditions;
- use trained personnel to operate the incinerators;
- use best management practices, including waste segregation, to prevent incineration of materials such as batteries and plastics;
- track volumes and types of wastes incinerated; and
- monitor incinerator operating performance.

8.3.2 PARTICIPANTS' VIEWS AND RECOMMENDATIONS

During the hearings, Environment Canada reiterated its concern about the lack of attention paid in the EIS to the potential impacts of toxic emissions from incinerators. Environment Canada also stated the importance of using dual-chambered incinerators with controlled-air technology to meet standards for dioxins and furans. After the Proponents clarified that they propose to monitor incinerator operating performance and not the dispersal and impacts of emissions in the environment, Environment Canada and the GNWT jointly recommended that the Proponents develop an Environmental Impacts Monitoring Plan in consultation with Health Canada, specifically for heavy metals and organic pollutants.

Environment Canada and the GNWT jointly recommended that an Incineration Management Plan be developed in consultation with Environment Canada and the GNWT to ensure that any incinerators used would meet all limits and standards, by-products would be appropriately treated, and environmental impacts of residual toxic emissions would be monitored. They recommended that the plan be reviewed every five years and that monitoring results be made public.

The Proponents disagreed that a separate Incineration Management Plan was necessary, stating that relevant information would be included in the Waste Management Plan and the Air Quality and Emissions Management Plan. The Proponents also disagreed that impacts monitoring would be necessary; they stated that emissions of dioxins would be low, and monitoring would focus on tracking volumes and types of wastes incinerated and the performance of the incinerator.

8.3.3 PANEL VIEWS AND RECOMMENDATION

The Panel is satisfied that emissions of criteria air contaminants from incinerators would be very low. The Panel notes that the emissions of possible concern from incineration are toxic air pollutants, specifically, heavy metals such as mercury and organic pollutants such as dioxins and furans.

The Panel notes that no evidence was brought forward with respect to alternatives to using incineration at proposed construction camps and permanent camps. Therefore, the

Panel concludes that the main issues to be considered are the following:

- The use of dual-chamber incineration technology has been recommended to achieve the highest standards of emissions control; however, this technology might not be manufactured in smaller sizes.
- After the use of appropriate technology, the most important mitigative strategy would involve the use of trained operators and a Waste Separation Program to ensure that only acceptable wastes (i.e. wastes that would not produce toxic by-products during combustion) were incinerated.
- An Incineration Management Plan might be necessary rather than having commitments and procedures incorporated into comprehensive Environmental Management Plans for the Project.
- Environmental impacts monitoring might be necessary to confirm predictions that toxic emissions will be adequately controlled through waste separation and through efficient operation of the incinerator; however, in the case of incinerators at construction camps, environmental impacts monitoring might not be able to deliver this feedback in a timely fashion.

It is the Panel's view that, given the persistent nature of toxic compounds that could be emitted by incineration and in keeping with the principle of "Keeping Clean Areas Clean," every effort should be made to minimize the impacts of incineration on the environment. The Panel also is of the view that all alternatives to incineration should be examined, particularly with respect to solid waste management at permanent facilities.

The Panel recognizes that successful waste segregation is a vital mitigative strategy, but it can be challenging to implement as it would require the understanding and cooperation of all personnel at the facilities where incineration is used as well as the vigilance of the incinerator operator.

One important monitoring task would be to determine to what extent the Proponents' waste separation strategy was keeping unsuitable materials out of the incinerator waste stream. If problems were identified, separation procedures may need to be changed and personnel information and awareness programs reinforced.

The Panel is unable to conclude whether the environmental impacts monitoring for incinerator emissions recommended by Environment Canada, the GNWT and Health Canada would provide timely and reliable information to determine whether incinerators at temporary construction camps were having any deleterious impacts. This is an issue that should be examined in more detail when Environment Canada and the GNWT review the Proponents' plans for incineration. However, if incineration is selected as the preferred solid waste management method at permanent facilities, it is the Panel's view that impacts monitoring should be required until regulatory authorities are satisfied that environmental predictions have been verified.

The Panel notes that the NEB has included in its *Proposed Conditions for the Mackenzie Valley Pipeline and Mackenzie Gathering System* Condition 24, which requires the Proponent to evaluate and implement technologies and practices available to reduce mercury, dioxin and furan emissions from incinerators operating at construction camps and at its station facilities to the extent practicable.

The Panel supports this Condition and makes the following recommendation regarding incineration.

RECOMMENDATION 8-5

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, prior to the commencement of construction, as part of their Waste Management Plan, a specific incineration management strategy that has been approved by the Government of the Northwest Territories and Environment Canada. The strategy should include:

- *an analysis of alternatives to incineration and, where incineration has been selected, an analysis of why it was the preferred option;*
- *a description of technology and practices employed at each facility, including the incineration technology selected, the facility Waste Separation Program and the facility waste tracking system, to document the amount and types of waste incinerated;*
- *a commitment to ship to an approved landfill all material that cannot be incinerated properly;*
- *procedures for operational and maintenance record keeping;*
- *details of operator training requirements;*
- *details of emissions measurement methods, where applicable;*
- *an Incineration Residuals-Testing and Reporting Program as well as disposal procedures that are in compliance with criteria specified in the Government of the Northwest Territories'* Guideline for Industrial Waste Discharges in the NWT*;*
- *procedures for publicly available annual reporting;*
- *a review of the strategy every five years if permanent incineration facilities are proposed; and*
- *where permanent incineration facilities are proposed for the Mackenzie Gas Project, an Environmental Impacts Monitoring Plan to measure incineration-related toxins that is based on the results of further consultation with Environment Canada, the Government of the Northwest Territories and Health Canada.*

If the Proponents' commitments and Panel Recommendation 8-5 are implemented, the Panel is of the view that impacts on air quality from incineration of waste from the Project as Filed would not likely be significant. The Panel does not have enough evidence before it to determine the air quality parameters for the Expanded Capacity Scenario or Other Future Scenarios, so it is unable to make a determination of significance for these two scenarios.

8.4 GREENHOUSE GAS EMISSIONS

8.4.1 PROPONENTS' VIEWS

GHG emissions include CO_2, methane and nitrogen dioxide. Each compound has a different climate change potential. For example, 1 t of methane is equivalent in its effect to 21 t of CO_2. Therefore, the Proponents converted existing and potential GHG emissions into equivalent CO_2 (ECO_2) units to allow for comparisons and calculation of total impacts.

The Proponents compiled baseline levels of GHG emissions in the NWT and Canada, and they calculated existing GHG emissions for the area within 50 km of Project activities. In 2005, ECO_2 emissions totalled 728,000 kilotonnes/annum (kt/a) for Canada, 1,708 kt/a for the NWT and 183.2 kt/a for the local area around the proposed Project.

The Proponents stated that they would use the following mitigative strategies to reduce the Project's GHG emissions:

- use equipment that meets appropriate standards;
- consider efficiency when selecting equipment;
- manage the need for and duration of flaring;
- ensure that flaring equipment and performance follows Alberta's EUB guidelines;
- apply best management practices to reduce fuel use; and
- avoid idling vehicles except under extremely cold conditions.

During detailed engineering, the Proponents would identify best practical technologies to reduce GHG emissions. In response to an Information Request regarding plans to minimize GHG emissions throughout the life of the Project, the Proponents identified some examples of these technologies, such as the use of waste heat from compressors to heat the Inuvik Area Facility. In the Proponents' view, best practical technologies must consider engineering as well as environmental, safety and cost factors and must have a proven performance record. The Proponents have not assessed new technologies to address GHG reductions but indicated that these would be considered over the life of the Project during repairs and maintenance.

In the EIS, the Proponents predicted that the combined GHG emissions for a throughput of 1.2 Bcf/d using four compressor stations during the Project's operations phase would be 1,830 kt/a of ECO_2. This calculation was based on the conservative assumption that all equipment would be operating at full capacity at all times and included emissions from the compressors that may be required in the future as reservoir pressures at Taglu and Parsons Lake decline. This total did not include well testing, venting or fugitive emissions. To calculate the emissions, the Proponents used emission factors developed by the Canadian Association of Petroleum Producers for use at the scale of an individual project. The Proponents also indicated that other emission factor methods used by Environment Canada and the Intergovernmental Panel on Climate Change were developed to address national or international inventories.

Subsequently, the Proponents provided the following additional information:

- fugitive emissions from all facilities would be 50.87 ECO_2 kt/a;
- emissions from blow-down venting events would range from 0.05 ECO_2 kt/event for compressor blow-down for maintenance to 109.79 ECO_2 kt/event during the blow-down of 80 km of pipeline; and
- a blow-down of a complete section of pipeline would occur only once every seven years.

To reduce the amount of venting, compressor stations have been designed for three different levels of shutdown during maintenance or emergency situations, which means that the entire compressor station would not need to be depressurized for all situations.

With this additional information covering all foreseeable events, total GHG emissions during operations would, on average, be between 1,881 kt/a and 1,991 kt/a of ECO_2 for the Project with a throughput of 1.2 Bcf/d using four compressor stations.

Subsequent to the Proponents' filing of their May 2007 *Supplemental Information — Project Update*, estimated GHG emissions during the operations phase for the Project as Filed with associated throughput of 0.8 Bcf/d (one compressor station) ranged from 1,070 kt/a to 1,470 kt/a of ECO_2.

Emissions during the construction phase were considered to be minor and were not included in the EIS. In a response to an Information Request from the Panel, the Proponents quantified GHG emissions during the construction phase to consider the changes proposed in their May 2007 *Supplemental Information — Project Update*, including all modes of transportation, facility and pipeline construction, and the construction camps (including GHGs from waste incineration). Emissions would range from 123.4 kt/a to 550.3 kt/a of ECO_2, peaking in the third year of construction. Most of the GHG emissions associated with well completion and testing would occur during well test flaring. These events would occur intermittently.

The Proponents determined that GHG emissions during operations would not be significant because they would be less than 1% of Canada's total emissions. The pipeline operating at a throughput of 1.2 Bcf/d would double the total GHG emissions in the NWT, but this was because the NWT has a small population base and a low level of existing industrial activity.

The Proponents indicated that they were not considering offsetting the Project's GHG emissions through the purchase of carbon credits because this would impose a significant cost burden on the Project not currently applied to other energy projects. They did not attempt to quantify these costs. If the Project's gas were not produced, alternative sources of energy would have to be developed to satisfy demand, and these sources would also create GHG emissions. A future federal government policy to address GHG emissions reductions might include various compliance mechanisms, one of which could be offset credits. The Proponents would then evaluate all options to meet new regulations as they were introduced.

Compression and other processes at Project facilities would be fueled by natural gas from the pipeline. The Proponents do not currently plan to use renewable energy sources for Project operations. In response to an Information Request regarding potential GHG reductions through the use of renewable energy, the Proponents projected that a total of 619.25 kt/a of ECO_2, or 80.9% of GHG emissions, would be eliminated at the Inuvik Area Facility and the Norman Wells and Little Chicago compressor stations. However, the Proponents indicated that "it is not currently viable to use electric drivers on the Mackenzie Gas Project, compared to using gas turbine drivers." (J-IORVL-00259, p. 2)

The Proponents have been participating in the Canadian GHG Challenge Registry, a voluntary initiative, and stated that they would comply with any legislation put in place to implement the *Climate Change Plan for Canada*.

GREENHOUSE GAS INTENSITY

During the hearings, the Proponents asserted that the Project can be considered energy-efficient because it produces sweet natural gas that requires less processing than sour natural gas, and because the proposed high-pressure pipeline allows for a larger volume of gas to flow using fewer compressor stations.

In order to compare the efficiency of the Project to other energy projects in terms of GHG emissions per unit of energy produced, the Panel requested that the Proponents provide comparable information on the GHG intensity of several projects.

The Panel defined GHG intensity of a project as the amount of GHG in grams of ECO_2 emitted per gigajoule (GJ) of produced energy, including production, processing and transport to a common destination (selected as Edmonton). Based on information provided by the Proponents, the figures presented in Table 8-2 compare the GHG intensities for several projects. They do not contain an estimate of GHG intensities due to construction of the physical facilities, which the Proponents stated would be insignificant.

The Proponents provided some of this information based on publicly available information, including regulatory applications, annual GHG reporting and GHG reference documents. In some cases, assumptions had to be made in calculating GHG intensities. In the case of coal bed methane, no public information was available and GHG intensity could not be estimated. The GHG intensity calculations do not include final combustion of the fuel.

Table 8-2 suggests that a gigajoule of energy delivered to Edmonton in the form of natural gas from the Project generates

Table 8-2 Comparison of Greenhouse Gas Intensities for Several Energy Projects

Energy Project	GHG Intensity (ECO_2 g/GJ)	Notes
Mackenzie Gas Project	5,275	Production and processing represent 3,341 g/GJ; transportation represents 1,934 g/GJ
Natural gas from Zama City/Rainbow Lake area gas fields, Alberta	5,125 to 6,470	Based on the three Apache sour gas plants and does not include upstream activities such as dehydration or additional compression
Conventional oil from Norman Wells oil field, NWT	2,687	Does not include refining the oil
Oil produced from oil sands using steam-assisted gravity drainage techniques and upgrader	30,218	Production/processing intensity calculated from target range and transportation adapted from another project
Oil sands mine and upgrader	15,252	Production/processing intensity calculated from target range and transportation adapted from another project
Coal bed methane from Drumheller area, Alberta	Not available	Project not required to report GHG emissions to Environment Canada
Coal extraction and rail transportation	3,203 (Brooks area) and 4,069 (Wabamun area), Alberta	—

Source: Adapted from J-IORVL-00889, pp. 3-5 as little as one sixth the level of GHGs as the same amount of energy delivered from the oil sands, and about the same level of GHGs as sour gas from northwest Alberta.

END USES OF GAS

The Proponents asserted that the impact of the end use of Project gas on Canada's GHG inventory cannot be assessed because the gas produced by the Project would be used within the North American market and that its final use cannot be determined.

Although the Proponents were unable to predict which markets would be served by the Project's gas or what the end uses would be, they calculated that GHG emissions associated with the downstream transport and end use of 1.2 Bcf/d of natural gas from the Project would be 23,420 kt/a, by using a generic gas combustion emission factor of 1,887 g/m^3 provided by Environment Canada. Combining the Proponents' upstream and downstream estimates would result in cumulative GHG emissions of 25,250 kt/a.

Using the same assumptions, the end-use GHG emissions alone from a scenario delivering 1.8 Bcf/d of natural gas would be 33,749 kt/a. No upstream estimates were provided by the Proponent for this scenario.

It was the Proponents' position that:

> The use of gas is determined by the market. Directing the market is the job of governments and their public policies. Also, tolls and tariffs approved by the National Energy Board (NEB) must be non-discriminatory according to the *National Energy Board Act*. For the Mackenzie Gas Project proponents to ensure that the gas produced will or will not be used for any purpose other than those determined by the markets and public policy, would be to extend control over the natural gas beyond their responsibility or capability. (J-IORVL-00815, p. 37)

8.4.2 PARTICIPANTS' VIEWS AND RECOMMENDATIONS

CONTROLLING GHG EMISSIONS

In their joint submission, Environment Canada and the GNWT pointed out that, unlike criteria air contaminants, the location of GHG emission sources is not critical and that total GHG Project emissions should be assessed in a national context. They also indicated that some pollution prevention strategies, such as emission control systems, may decrease emissions in one category but increase them in another category. They also noted that potential trade-offs between reduction of criteria air contaminants and GHG emissions must be taken into consideration.

The primary source of GHG emissions would be CO_2 and small amounts of methane and nitrous oxide from the combustion of natural gas for compression, power generation and heating at the pipeline and production facilities. Another source would be releases of methane and nitrous oxide from leaks, pipeline and facility blow-downs, and intentional venting. If a well blow-out were to occur, it would result in a large, unplanned source of GHGs, mostly methane.

When asked in the hearings about the increased emissions from an expanded Project, Environment Canada responded that recommendations to use best available technology and best management practices would still apply and that other issues would be addressed at the time of expansion through additional environmental assessments.

Environment Canada and the GNWT highlighted two key pollution prevention approaches to reduce GHGs and other emissions:

- reduce the amount of fuel burned to drive compressor units and small electric generators through station design and use of efficient, low-emission gas turbine drivers; and
- recover and reuse waste heat for compression, electricity generation or thermal heating purposes, including possible use in nearby processing plants or communities.

The Proponents committed to use gas turbines that meet the CCME's *National Emission Guidelines for Stationary Combustion Turbines* and several reciprocating engines that meet Alberta's standards in EUB *Directive 056*. Environment Canada and the GNWT supported these commitments but noted that the Proponents had not investigated options for cogeneration or district heating and indicated that this should be an ongoing process.

Environment Canada and the GNWT emphasized the importance of reducing methane leakage, blow-down and venting and identified a number of best practices. They recommended that the Proponents be required to provide a detailed submission regarding design choices before the start of construction to address methane leakage and venting, overall system optimization, the capture and use of waste heat at Inuvik, and details of compressor stations. They also recommended that the Proponents implement the new best management practices for fugitive emissions being developed by the Canadian Association of Petroleum Producers as soon as the Project starts, and not wait for them to be adopted by the EUB.

REGULATING GHG EMISSIONS

Environment Canada was asked to explain how the Project would affect Canada's ability to meet or go beyond its international obligations under the *Kyoto Protocol*. Environment Canada responded that firms involved in natural gas production would be designated as "large final emitters" and would be addressed through the large final emitters component of the *Climate Change Plan for Canada.*

In response to an undertaking, Environment Canada told the Panel that the Project would be subject to the federal *Regulatory*

Framework for Air Emissions announced in April 2007. As a new facility, the Project would be granted a three-year grace period before it would have to meet an emissions-intensity reduction target. After three years, the Project would be required to improve its GHG emissions intensity by 2% each year.

The GNWT indicated that it does not have in place a renewable portfolio standard (a tool used to increase the percentage of renewable energy sources feeding into a provincial electricity grid) and does not anticipate establishing one before approval of the Project. Similarly, the GNWT does not require large industrial operations to use a certain proportion of renewable energy. In 2003, hydroelectricity provided 20% of the total electricity used by industry in the NWT.

IMPACTS OF CLIMATE CHANGE AND GLOBAL WARMING

Environment Canada filed with the Panel the November 2004 *Arctic Climate Impact Assessment* (ACIA), which provides the results of a four-year study by 300 scientists. The ACIA noted concerns over wide-ranging changes in the Arctic, including rising temperatures, rising river flows, declining snow cover, thawing permafrost, increased precipitation, diminishing lake and river ice, rising sea levels, and retreating summer sea ice. Environment Canada referred to the ACIA report extensively in its submission on the impacts of climate change on the Project and its routing and design.

Concerns over climate change and its impacts are widespread in communities throughout the Project Review Area and were raised in most of the communities that the Panel visited. The Panel heard from several participants that negative impacts of climate change are being experienced to a greater extent in the North than at southern latitudes. The Pembina Institute, appearing on behalf of the Sierra Club of Canada (SCC), captured the sentiments of some participants when it stated that the North should "serve as a model low-carbon society that demonstrates to the rest of Canada how it is possible to reduce greenhouse gas emissions for the sake of protecting what we all depend on for survival." (Ellen Francis, HT V83, p. 8206)

According to Ecology North, the impacts of climate change already experienced in the Arctic include "eroding shorelines, winter roads closing early, tree line moving north, melting permafrost and ground shifting, new types of insects, changing weather affecting caribou." (J-ECNO-00010, p. 4)

The SCC told the Panel that ACIA found that:

> … the Arctic is [already] experiencing some of the most rapid and severe climate change on earth. The ACIA's prognosis is disappearing Arctic sea ice, extinction of polar bears and seal species, serious health and food security challenges for aboriginal peoples, and flooding and erosion of coastal towns and facilities. (J-SCC-00002, p. 1)

In addition to examples of impacts on the North, participants also provided information from national and international studies on impacts from climate change as well as legal and economic policy instruments that had been introduced to address impacts arising from those changes. In response to undertakings and an Information Request, Environment Canada referenced the federal *Kyoto Protocol Implementation Act* (KPIA). Canada was an original signatory to the *Kyoto Protocol*, which was concluded a decade ago and ratified by Parliament in December 2002. The preamble of the KPIA states, among other things, that "Canada has a clear responsibility to take action on climate change, given that our per capita greenhouse gas emissions and wealth are among the highest in the world, and that some of the most severe impacts of climate change are already unfolding in Canada, particularly in the Arctic."

Targets set under the *Kyoto Protocol* binds all parties to reduce their levels of GHG emissions over the five-year period 2008–12. Canada committed to reduce its average annual GHG emissions to 6% below 1990 levels. This target is confirmed in the KPIA, as is the requirement for the Minister of Environment to prepare an annual Climate Change Plan and to state the GHG emissions reductions that are reasonably expected to result for each year, up to and including 2012. The KPIA requires the National Round Table on the Environment and the Economy to undertake research and analysis of the Climate Change Plan and the Minister's statement in the context of sustainable development, and to advise the Minister on the likelihood that the proposed measures will achieve the projected emissions reductions and enable Canada to meet its obligations under the Protocol. The KPIA also requires the Commissioner of the Environment and Sustainable Development to prepare, at least once every two years, a report that includes an analysis of Canada's progress in implementing its Climate Change Plans, its progress in meeting its *Kyoto Protocol* obligations, and any other observations the Commissioner considers relevant.

The SCC and Ecology North presented the Panel with copies of international and Canadian reports on climate change. Canadian reports related to the KPIA included:

- *Response of the National Round Table on the Environment and the Economy to its Obligations* under the *Kyoto Protocol Implementation Act* (September 2007); and
- *Estimating the Effect of the Canadian Government's 2006–2007 Greenhouse Gas Policies* (Jaccard and Rivers).

The first report concluded from its evaluation of policies and measures contained in the *Climate Change Plan for Canada* that there would be reductions in the 2008–2012 period but that the extent of reductions in the plan was likely overestimated and that Canada was unlikely to meet its Kyoto commitments. The Round Table also indicated that these estimates were subject to possible changes in subsequent annual reviews and that it was not in a position to provide estimates beyond 2012.

The second report estimated that the Government of Canada's 2006–2007 GHG policies on future emissions (including its proposed 2007 *Regulatory Framework for Air Emissions*) are likely to reduce emissions substantially when compared with the absence of such measures. However, these estimates also suggest that overall emissions in Canada are unlikely to fall below current levels and will fall short of federal targets for 2020 by almost 200 Mt, making it unlikely to reach the 2050 reduction target.

Wise and Efficient Use

Many participants expressed concern that gas from the Project would be used as a fuel source to produce oil extracted from bitumen in the oil sands of northern Alberta, the burning of which would result in significantly higher GHG emissions than if the gas were burned directly. Indian and Northern Affairs Canada, Environment Canada and the GNWT stated that consideration of issues relating to end use of gas is beyond the Panel's mandate. Indian and Northern Affairs Canada stated that the Proponents have not indicated that they are targeting the gas for use in the oil sands. If TransCanada PipeLines decides to construct additional pipeline facilities to supply gas to the oil sands, separate approvals would be required, and an environmental assessment would be carried out. Even then no one could be certain whether natural gas from the Mackenzie Project was being used for heavy oil extraction, as it would be in the general distribution grid and could be transported around the country or exported to the United States.

Those participants who believed that the primary objective of the Project is to supply energy to the oil sands told the Panel that oil sands projects may eventually emit 5% of GHGs in Canada if the oil sands' full expansion plans are completed. The SCC asserted that, without significant improvements in efficiency at the oil sands, "there is no possible way that Canada will be able to meet its greenhouse gas emission reduction targets under Kyoto or under the more stringent regimes which are sure to follow." (Stephen Hazell, HT V83, p. 8217) Similarly, World Wildlife Fund Canada attributed a 26% increase in Canada's GHG emissions since 1990 to the rapid and massive expansion of oil sands development.

According to the SCC, if natural gas from the Project were used to produce gasoline from oil extracted from the oil sands, the GHG life-cycle emissions would be 55% higher than if the same gas were used directly to power a natural gas vehicle. The SCC stated that "these findings clearly point to the fact that it does not make sense to use relatively clean natural gas to extract relatively dirty oil from the bitumen in the oil sands." (J-SCC-00047, p. 16)

Several participants saw natural gas as a transition fuel between coal and oil and renewable energy sources. The Pembina Institute asserted that natural gas has a bridging role as a fossil fuel between fuels that have a higher GHG output per unit of energy and renewable fuels such as wind and solar power. If gas from the Project were to be used exclusively to displace coal-fired generation in Alberta, major reductions in GHG emissions would occur over a long period of time. World Wildlife Fund Canada stated that "given that natural gas produces less greenhouse gas emissions per unit of energy than coal or oil, for instance, in the short term it can reduce reliance on more carbon-intensive fuel." (Julia Langer, HT V83, p. 8246)

Estimation of Greenhouse Gas Emissions

In a report prepared for SCC, *Mackenzie Gas Project Greenhouse Gas Analysis — A Consolidated Report by the Pembina Institute*, the Pembina Institute calculated the annual and cumulative (combined) upstream and downstream GHG emissions from the Project for six scenarios. The six scenarios presented in the Pembina report fall generally within what has been defined for the purposes of the Panel's Report as the Expansion Capacity Scenario and Other Future Scenarios but with additional assumptions.

The evidence provided in the Pembina report was not contested by other parties. While the Panel cannot verify the accuracy of the estimates in the report, the Panel is of the view that this information is important in considering the Project's contribution to sustainability, particularly in the context of the Expansion Capacity Scenario and Other Future Scenarios.

The Panel has developed the following three tables, Tables 8-3, 8-4 and 8-5, to present some of the estimates of upstream, downstream and total GHG emissions from the Pembina report. The information presented in the tables is to illustrate potential Project impacts, their significance and Project contributions to sustainability.

The calculations in the Pembina report are based on the emissions data in the Proponents' EIS and its response to an Information Request from the SCC; they do not account for any changes the Proponents made in the design of the Project after that time. The authors of the Pembina report noted that their calculations may be over-estimated by 10% as a result of the Proponents' May 2007 *Supplemental Information — Project Update*, which proposed one less compressor station and incorporated waste heat recovery. The figures in the following tables are the numbers presented by Pembina in its report. In addition, the GHG estimates do not include the downstream use of natural gas liquids.

Three scenarios are shown in Tables 8-3, 8-4 and 8-5:

- Case 1 represents a peak gas flow of 1.2 Bcf/d for a period of 3 years, with gas flowing through the system for 28 years.
- Case 2 represents a peak gas flow of 1.8 Bcf/d for a period of 15 years, with gas flowing through the system for 40 years.
- Case 3 represents a peak gas flow of 3.2 Bcf/d for a period of 20 years, with gas flowing through the system for 50 years.

Upstream Emissions

Table 8-3 summarizes upstream GHG emissions calculated by Pembina. Upstream emissions refer to the emission sources reported in the EIS. This includes the production area, the pipeline corridor, emissions sources from construction activities, compressors, power generation for pipeline operation and process equipment. Upstream emissions include annual emissions for well testing, fugitive emissions, emissions from changes in land use and annual emissions for blow-down venting emissions. Pembina's calculation of 1,902 kt/a of ECO_2 for the maximum annual GHG emissions is similar to the Proponents' estimate of maximum annual GHG emissions of 1,881 kt/a to 1,991 kt/a of ECO_2 (Section 8.4.1). The Pembina report also

Table 8-3 Upstream Greenhouse Gas Emissions by Scenario

	Project Time Period	Peak Gas Flow	Operation at Full Capacity	Average Annual GHG Emissions [1]	Maximum Annual GHG Emissions [2]	Cumulative GHG Emissions [3]
Scenario		(Bcf/d)		(kt/a ECO_2)	(kt/a ECO_2)	(kt ECO_2)
Case 1	28 years	1.2	3 years	1,443	1,902	44,730
Case 2	40 years	1.8	15 years	2,712	3,709	111,200
Case 3	50 years	3.2	20 years	N/A	5,034	183,270

Notes:
1. Total emissions divided by total Project years.
2. The highest level of emissions for one year during the life of the Project.
3. Total emissions summed for the life of the Project.

Source: Adapted from J-SCC-00097, Tables 1 and 2, pp. 14–15

Table 8-4 Downstream Greenhouse Gas Emissions by Scenario

	Peak Gas Flow	Total Sales Gas (for Life of Project)	Cumulative Downstream GHG Emissions		Maximum Annual Downstream GHG Emissions		Average Annual Downstream GHG Emissions	
			(Low) [1]	(High) [2]	(Low)	(High)	(Low)	(High)
Scenario	(Bcf/d)	(Mm^3)	(kt ECO_2)		(kt/a ECO_2)		(kt/a ECO_2)	
Case 1	1.2	193,800	320,330	361,246	20,518	23,139	10,333	11,653
Case 2	1.8	476,000	787,004	887,531	30,778	34,709	20,711	23,356
Case 3	3.2	1,265,700	2,092,692	2,359,997	N/A	N/A	N/A	N/A

Notes:
1. "Low" corresponds to the downstream combustion of 87% of the natural gas conveyed by the pipeline, based on natural gas uses in Alberta.
2. "High" corresponds to the downstream combustion of 98% of the natural gas conveyed by the pipeline, based on natural gas uses in the United States.

Source: Adapted from J-SCC-00097, Table 4, pp. 18–19

Table 8-5 Total (Upstream and Downstream) Greenhouse Gas Emissions by Scenario

	Peak Gas Flow	Total Sales Gas	Total (Upstream and Downstream) Cumulative GHG Emissions		Maximum Total Annual GHG Emissions		Average Total Annual GHG Emissions	
			(Low) [1]	(High) [2]	(Low)	(High)	(Low)	(High)
Scenario	(Bcf/d)	(Mm^3)	(kt ECO_2)		(kt ECO_2/a)		(kt ECO_2/a)	
Case 1	1.2	193,800	365,100	406,000	22,100	24,700	11,800	13,100
Case 2	1.8	476,000	898,200	998,700	33,800	37,800	21,900	24,400
Case 3	3.2	1,265,700	2,276,000	2,543,300	N/A	N/A	N/A	N/A

Notes:
1. "Low" corresponds to the downstream combustion of 87% of the natural gas conveyed by the pipeline, based on natural gas uses in Alberta.
2. "High" corresponds to the downstream combustion of 98% of the natural gas conveyed by the pipeline, based on natural gas uses in the United States.

Source: Adapted from J-SCC-00097, Table 6, p. 21

indicated that GHG emissions would increase over the life of the Project due to the need to increase compression.

Downstream Emissions

Table 8-4 summarizes the downstream GHG emissions calculated by the Pembina Institute. Downstream emissions refer to the emissions associated with the combustion of gas transported by the pipeline. Downstream emissions estimates were generated from sales gas volumes from the Project and were based on the proportion of natural gas combusted in Alberta and in the United States (potential markets for the gas) compared with total natural gas produced in those regions. The low- to high-range thresholds reflect the percentages of gas combusted in Alberta (87% low estimate) and the United States (98% high estimate). In Alberta, more of the gas is used in the petrochemical industry and is not available for burning.

The Pembina report's estimates of downstream GHG emissions do not include emissions associated with the combustion of natural gas liquids. The report suggests that once data on production of natural gas liquids from the Project is available, further work is needed to determine the additional downstream GHG emissions from natural gas liquids in calculating total Project downstream emissions.

Total Emissions

Table 8-5 summarizes the upstream and downstream GHG emissions for the scenarios and represents the sum of the estimated emissions in Table 8-3 and Table 8-4. The assumptions stated for Table 8-3 and Table 8-4 also apply to Table 8-5.

Table 8-5 indicates that for total life-cycle (upstream and downstream) GHG emissions:

- Downstream emissions from the natural gas sold from the Project represent the majority of total Project emissions and are 7 to 13 times more than upstream emissions.
- Based on various assumptions about the location, pace and scale of future gas supply developments, a gas flow of 1.2 Bcf/d over a period of time ranging from 28 to 50 years may contribute up to twice the GHG emissions than the Project as Filed.
- Based on various assumptions made about the location, pace and scale of future gas supply developments, a gas flow of between 1.2 Bcf/d and a peak of 3.2 Bcf/d over a period of time ranging from 28 to 50 years may contribute approximately 2 to 6 times more GHG emissions than the Project as Filed.

GHG EMISSIONS ASSOCIATED WITH OIL SANDS USE

In the event that Project gas was used to supply oil sands operations, the Pembina Institute also calculated Project life-cycle (upstream and downstream) emissions that would be produced in the oil sands from natural gas production, bitumen production and upgrading, crude oil transmission, crude oil refining, transport fuel delivery, and transport fuel combustion. Based on a pipeline maximum flow rate of 1.2 Bcf/d and an estimated 10 Mm^3/d (353.4 Mcf/d) of natural gas supplied to the oil sands, the total GHG emissions produced would be 40 Mt/a of ECO_2. This amount is approximately 30 times higher than the average annual upstream emissions for a throughput of 1.2 Bcf/d (described in Table 8-3) and 4 times higher than the average total annual upstream and downstream emissions associated with that throughput (described in Table 8-5).

SIGNIFICANCE OF GREENHOUSE GAS EMISSIONS

The Pembina report also considered the significance of the Project's GHG emissions by comparing Project emissions with total emissions projected for the NWT and Canada. Based on 1997 forecasts from Natural Resources Canada for the NWT, Pembina estimated that the percentage increase in cumulative NWT GHG emissions over the period 2006 to 2053 due to the upstream GHG emissions from the Project would be 41% for a throughput of 1.2 Bcf/d, 101% for a throughput of 1.8 Bcf/d, and 167% for a throughput of 3.2 Bcf/d. Downstream emissions were not included because the end use of Project gas is not expected to be in the NWT.

Based on 1999 forecasts from Natural Resources Canada for all of Canada, Pembina estimated that, over the same time period (2006 to 2053), the percentage increase in Canada's cumulative GHG emissions due to the upstream GHG emissions from the Project would be 0.1% for a throughput of 1.2 Bcf/d, 0.3% for a throughput of 1.8 Bcf/d, and 0.5% for a throughput of 3.2 Bcf/d.

For the same time period (2006 to 2053), Pembina estimated that the percentage increase in Canada's forecast cumulative GHG emissions due to the total upstream and downstream GHG emissions from the Project would range from 1% for a throughput of 1.2 Bcf/d to 6% for a throughput of 3.2 Bcf/d. This percentage would be higher if Canada reduced its emissions over time based on federal and provincial policies. On this basis and given that downstream emissions estimates accounted for roughly 90 percent of total emissions, Pembina determined that "these emissions are significant when compared to both the Northwest Territories and the country."(Matt McCulloch, HT V105, p. 10401)

If 10 Mm^3/d of Project natural gas were delivered to the oil sands, Pembina estimated that GHG emissions associated with Project upstream operations would account for less than 2% of the total emissions of 40 Mt/a of ECO_2 generated at the oil sands from the use of Project natural gas.

OFFSETTING GREENHOUSE GAS EMISSIONS

A number of participants recommended that the Project be required to offset its GHG emissions to be carbon-neutral. In some cases, the recommendation included both upstream and downstream GHG emissions.

Ecology North suggested that, based on its understanding of Case 3, carbon neutrality could be achieved by building 7,700 wind generators, renovating 6.4 million homes and preserving 21 million acres of forest. It estimated that this would add $1 million per day to operating costs, or 10% of the revenues based on a gas price of $8/GJ. Ecology North suggested that some of the cost could be passed on to consumers if the product were sold as "green gas."

Carbon neutrality could also be achieved by purchasing GHG offsets through the *Kyoto Protocol*'s Clean Development Mechanism, purchasing domestic agricultural-based GHG offsets, establishing internal corporate GHG emissions trading systems, or investing in domestic GHG-reduction offset projects.

The Canadian Parks and Wilderness Society recommended that the Proponents and other companies using the pipeline purchase or undertake GHG offsets to make the Project carbon-neutral.

The SCC also made this recommendation, adding that a monitoring agency should be assigned or created to report on compliance. In addition, the SCC recommended that limitations be placed on the end use of all gas transported by the Project to ensure that the gas goes to those end uses that reduce GHG emissions by, for example, displacing coal-fired electricity generation.

Ecology North recommended that the Proponents offset upstream and downstream GHG emissions to make the Project carbon-neutral, subject to an annual NEB review. It also proposed that offsets should be achieved by funding alternative energy efficiency and conservation projects, with priority given to projects in the NWT. Ecology North also recommended that the Proponents undertake to use best available technology and operational practices to reduce GHG emissions, and that it investigate and report to the NEB on the feasibility of further GHG reduction measures, including carbon sequestration and use of alternative energy.

Ecology North also directed several recommendations to the Government of Canada and the GNWT. Among these were that there be:

- no grandfathering of projects once regulations are established to require full GHG offsets;
- maintenance of full GHG offset requirements by the GNWT in the event of devolution and resource revenue-sharing agreements;
- development of a regulatory process by the NEB to track GHG emissions and enforce offsets; and
- development of mandatory guidelines to be used in environmental impact assessment processes to assess the full range of impacts of GHG emissions.

The Proponents specifically disagreed with most of these recommendations and did not comment on the others. The Proponents replied that:

- requiring carbon neutrality through the purchase of offsets would impose a significant cost burden on the Project and has not been required of previous projects;
- the Project would comply with federal GHG management regulations once implemented;
- they would commit to use best practical technology rather than the potentially more stringent best available technology;
- alternative energy options were reviewed and rejected, and carbon sequestration is outside the scope of the EIS Terms of Reference; and
- the end use of gas is outside the scope of the EIS Terms of Reference.

The GNWT stated that it has no jurisdiction to require GHG offsets.

8.4.3 PANEL VIEWS AND RECOMMENDATIONS

Climate change is widely considered to be one of the most urgent and far-reaching challenges to sustainability facing the world today. It brings with it threats to the livelihood, health, culture and well-being of all northern peoples, including residents of the NWT.

It is also widely considered that responding to climate change will require significant net reductions of GHGs, involve all countries and all sectors of the economy, and will require targets far beyond those set by the *Kyoto Protocol*. Overall GHG emissions will need to stabilize and then decline.

The Panel notes that Canada is a party to the *Kyoto Protocol* and has enacted the KPIA. However, the federal government's 2007 *Climate Change Plan for Canada* indicates that Canada will not meet the Kyoto emissions targets and sets out new measures to reduce Canada's total GHG emissions, relative to 2007 levels, by 20% by 2020 and by 65% by 2050.

Canada has experienced an almost continuous growth in GHG emissions since 1990. With no new actions from government or industry to control emissions growth, emissions will continue to grow steadily between 2008 and 2012. However, new federal regulations, combined with new initiatives by provincial and territorial governments, mean that Canada's GHG emissions from all sources are expected to decline during the 2010–12 period.

The Panel's findings fall into four categories relating to:

- the Panel's mandate to consider the end use of gas;
- minimization or possible offsetting of the Project's direct GHG emissions;

- consideration of the Project's complete life-cycle impacts on GHG emissions, including emissions from the end uses of Project gas; and
- the Project's potential contribution to sustainability.

PANEL MANDATE AND END USE OF GAS

The Panel heard extensive concerns and received substantial submissions regarding the end use of gas from the Project. Generally, comments focused on two matters: the estimated contribution of the future end use of gas from the Project to projected total GHG emissions, and the wise use or best use of gas from the Project. Both of these have important implications for the Panel's review of proposed mitigation and management measures, the Project's impacts and their significance, and the Project's potential contribution to sustainability.

The Panel also heard divergent views from several parties as to whether issues associated with the end use of gas were within the mandate of the Panel to consider and address. The Proponents argued that end use of gas is outside the Panel's mandate on the grounds that including end use would be inconsistent with previous case law, the Joint Review Panel Agreement, and what can be practically assessed on a project-specific basis. The SCC, with supporting comments from Ecology North and World Wildlife Fund Canada, disagreed and provided arguments on each of these points.

The Government of Canada submitted a consolidated response on behalf of the federal departments registered as interveners that stated:

> With respect to greenhouse gas (GHG) emissions and offsets, the Government of Canada's (GOC) approach to-date is not to impose requirements on an ad hoc, project by project basis. Such an approach could impose an unfair burden on the MGP and would do little to address Canada's contribution to overall carbon footprint in a comprehensive manner. The government's intention is to implement industry-wide targets for GHG emissions. (J-INAC-00187, p. 73)

The GNWT indicated that, while the Panel has the mandate to review the cumulative impacts of the Project, it "does not believe the downstream end-use of gas is capable of meaningful assessment" and that "further assessment should not be required as a condition precedent for Project authorization." (J-GNWT-00315, p. 19)

The Panel notes that its mandate does not include explicit reference to the end use of gas, and the EIS Terms of Reference do not provide explicit direction for the assessment of GHG emissions from the end use of gas. However, as discussed in Chapter 5, "Approach and Methods," sustainability is a key underlying principle of the environmental assessment review process, as described in the Joint Review Panel Agreement and the EIS Terms of Reference. The Panel indicated through its *Guidance Document for Hearings* its intention to undertake a review of the Project's environmental impacts within a sustainability framework. The Proponents also indicated their intention to predict the significance of impacts within such a framework. No party to the review took exception to the Panel's mandate or to its intention to consider the Project's contribution to sustainability.

The principle of sustainability when applied to environmental assessment includes core considerations that are intrinsically linked and particularly relevant to the Panel's review: life-cycle impacts, intergenerational equity, and resource conservation and efficiency. Life-cycle impacts, by definition, would include the upstream and downstream impacts of the Project in determining the Project's contribution to sustainability. Intergenerational equity is explicitly referenced in the *Joint Review Panel Agreement* and establishes that the review "shall have regard to the protection of the environment from the significant adverse impacts of the proposed developments, and to the protection of the existing and future social, cultural and economic well-being of residents and communities."

In the Panel's view, while consideration of the end use of gas from the Project is not referred to explicitly in the Panel's mandate, it is nevertheless relevant in assessing the Project's contribution to sustainability. The Panel has therefore considered the evidence and views presented on the end use of gas as a relevant factor in its review of the environmental impacts of the Project within a sustainability framework as discussed further in Chapter 19, "Sustainability and Net Contribution."

DIRECT PROJECT GREENHOUSE GAS EMISSIONS (UPSTREAM EMISSIONS)

The Panel considers that it would be the responsibility of the Proponents to minimize GHG emissions from the Project, initially through decisions made at the detailed design stage and subsequently through the use of best management practices, including training for all Project personnel, a commitment to continuous improvement throughout the life of the Project, and an effective monitoring and reporting system. The Panel observes that, as there are currently no GHG regulations to drive the ongoing minimization of emissions, it would be desirable to establish and work toward Project-specific targets that should be made more stringent as more effective mitigation measures are developed.

The Proponents indicated that they are waiting for the federal government to prepare legislation to implement the *Climate Change Plan for Canada*. The Panel recognizes that this legislation will likely provide the overall framework and level playing field needed to address industrial GHG reductions. However, the Panel is also of the view that climate change is a long-term issue that requires a long-term approach. In the event that the Project were to proceed before this legislation were in place, the Panel recommends that the Proponents, in consultation with Environment Canada and the GNWT, establish a GHG emissions target that will establish a sound benchmark for natural gas projects and drive a process of continuous improvement. The Panel is confident that this process would stand the Project in good stead to respond to future legislated requirements.

RECOMMENDATION 8-6

The Panel recommends that, if federal regulations under the Kyoto Protocol Implementation Act *are not in place by the time the Proponents make their Decision to Construct the Mackenzie Gas Project, the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to establish, in collaboration with Environment Canada and the Government of the Northwest Territories, prior to the commencement of construction and in sufficient time to inform the final design, a greenhouse gas emissions target or series of targets based on an effective program involving:*

- *a design philosophy based on rigorous conservation and efficiency;*
- *extensive use of best available technology;*
- *use of renewable energy technologies;*
- *best management practices;*
- *training and motivation of personnel; and*
- *a commitment to continuous improvement.*

Should the legislation contemplated by Panel Recommendation 8-8 come into effect during the life of the Mackenzie Gas Project, whichever is the lower target should apply to the Project.

RECOMMENDATION 8-7

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to include greenhouse gas emissions from their facilities in the Mackenzie Gas Project's ongoing monitoring program and to report annually following the commencement of construction, to the National Energy Board, Environment Canada, the Government of the Northwest Territories and the public on the Project's achievements with respect to the greenhouse gas emissions target.

The Panel heard from some participants that the Proponents should be required to go beyond minimizing direct GHG emissions and should offset all Project GHG emissions to achieve a carbon-neutral status. Ecology North suggested that the Proponents sell the gas as "green energy" and sell it at a premium. However, the Panel also heard from the Proponents that once Project gas enters the NGTL pipeline system, there is no way to track it or to distinguish it from other sources of natural gas in the NGTL pipelines. Therefore, it is unclear to the Panel how Ecology North's proposal could be implemented.

The Panel notes that it is the intention of governments to reverse the trend toward increased GHG emissions. The Panel recognizes that this will be driven by a combination of policy and regulatory requirements developed by the federal and provincial governments, and by voluntary stewardship by industry, business, organizations and individuals. The Panel acknowledges the Proponents' concern that, until this policy and regulatory framework is in place, they would not be participating on a level playing field if the Project were to have requirements placed upon it that would be significantly different from those placed on other energy projects serving similar markets. Therefore, the Panel has not recommended that the Project be required to offset its GHG emissions at this stage.

Instead, the Panel recommends the following.

RECOMMENDATION 8-8

The Panel recommends that the Government of Canada develop and implement, as soon as possible, legislation and regulations to reduce greenhouse gas emissions in Canada to meet or exceed existing national targets in the Climate Change Plan for Canada.

LIFE-CYCLE GREENHOUSE GAS IMPACTS

The Panel notes that the GHG emissions associated with the end use of Project gas would likely exceed emissions from the Project's operations phase by an order of magnitude. Several participants recommended that the Proponents therefore be required to offset the GHG impacts of end uses. The Panel notes the logic of this approach, which would make the producer of the energy responsible for its life-cycle impacts in the same way that some manufacturers are now made responsible for the ultimate recycling or disposal of their products. The cost of this approach is then passed on to the consumer. An end user who is required to achieve carbon-neutral status or who is voluntarily moving in that direction would pay extra for "green energy" or would need to offset the GHG emissions associated with "non-green energy."

The Government of Canada submitted a consolidated response on behalf of the federal departments registered as participants that stated:

> the Canadian natural gas market operates on an integrated North American basis, with producers selling into a common market and end-users bidding into this market. A willingness to pay the market clearing price is essentially the only factor producers use to discriminate between potential end-users. Imposing specific conditions on the the MGP would be inconsistent with this market-based approach and would impose an unfair burden on the project. It would also be administratively complex and likely require an increase in government staffing and statutory authority. (J-INAC-00187, p. 73)

For the same reasons stated in the previous section with respect to offsetting direct GHG emissions, the Panel does not recommend requiring the Proponents to offset life-cycle GHG emissions. The Panel is of the view that the merits and disadvantages of this approach would need to be examined in the context of a comprehensive climate change strategy.

The Panel heard considerable opposition to the potential use of gas from the Project as a fuel source for the extraction of oil from oil sands deposits. The Panel agrees that the use of carbon-efficient and clean-burning natural gas to produce oil that is itself more carbon-intensive is undesirable and squanders the valuable attributes of natural gas as a transition fuel.

Notwithstanding the application that has been filed to construct a gas pipeline from west to east across northern Alberta, the Panel is not persuaded by arguments made to the effect that Project gas is, in fact, going to be used by the oil sands. The Panel notes that production from the oil sands is increasing even though there is no certainty that the Project will be built. The Panel recognizes that unless a specific contract is signed between a gas producer and an end user involved in oil sands activity, it would be impossible to conclude that gas from any given project is being applied to any specific end use. The Panel sees no viable way by which specific end uses could be assigned to or excluded from Project gas.

GREENHOUSE GAS EMISSIONS AND A SUSTAINABILITY APPROACH

Local and regional concerns about climate change and its impacts are high, as expressed verbally in Community Hearings and in participants' written presentations. Concerns about climate change and the urgent need for action were also expressed by national organizations. Environment Canada also noted climate change as an issue.

The Panel considered the Project as a potential contributor to climate change and whether the problem of climate change in the North would be ameliorated if the Project did not proceed. The Panel recognizes that climate change is occurring in the absence of the Project and that, unless aggregate global energy consumption could somehow be reduced by not bringing the Project's gas on stream, the Project's gas would simply be substituted by something else to meet global energy demands.

Table 8-2 demonstrates the possible consequences of substituting Project gas for other energy sources. Compared with other potential energy sources, the Project's gas is relatively low in GHG output per unit of energy produced. It follows that by substituting almost any other form of carbon-based energy for Project gas, climate change on a global scale would be aggravated rather than ameliorated. Further, from a global perspective, it makes no difference where additional carbon-based energy projects come on stream; all will have the same impact, and the incremental output of GHG measured by some arbitrary geographical unit is of no consequence.

The Proponents' position was that the Project's GHG emissions would constitute only a very small percentage (approximately 0.25%) of Canada's national emissions per year. If the Project were to expand, according to Environment Canada's estimates, the Project's GHG emissions would roughly double and would therefore be in the order of 0.5% of Canada's total emissions.

When the downstream use of gas is considered, the number increases roughly 10 times to between 5 to 6% of Canada's GHG emissions in 2005. Canada contributes approximately 2% of total global GHG emissions. Therefore, even taking into consideration the possible expansion of the Project and the GHG emissions associated with end uses of the gas, the ultimate impacts of the Project on global climate change could be viewed as minor (approximately 0.1%).

The Panel recognizes that natural gas is a more efficient source of energy than many others in terms of production, processing, transportation and eventual end use. Natural gas is a clean-burning source of energy and is less carbon-intensive than either coal or oil. In particular, the Proponents provided information indicating that Project gas per unit of energy would produce as little as one fifth as much GHG emissions in the course of production and transport compared with a similar unit of energy produced from some oil sands plants. Therefore, the Panel is persuaded that natural gas can and should play an important role in the transition to a low-carbon economy.

The Panel heard that there is a range of measures to combat global warming, which include reducing the use of carbon-based fuels, switching to renewable energy, and offsetting GHG emissions through investment in GHG reductions or carbon sequestration in other locations.

Participants raised the following questions:

- whether the Project should be carbon-neutral;
- whether all GHG emissions derived from the end uses of Project gas should also be offset in some manner;
- whether the Project's gas should not be permitted to fuel certain activities or projects, specifically the oil sands; and
- whether the Project's gas should be applied to certain preferred end uses, such as the replacement of power currently generated by carbon-intensive fuels such as coal.

The Panel is of the opinion that the responses to these questions are fundamental in determining the potential role of the Project in helping to move Canada toward a sustainable future. However, the Panel also concludes that mandating carbon neutrality and intervening in the market to specify preferred end uses for natural gas cannot be resolved on a project-by-project basis through the environmental assessment process, but must be addressed by governments through comprehensive climate change strategies.

RECOMMENDATION 8-9

The Panel recommends that governments, particularly the Government of Canada, within three years of the date of the Government Response to the Panel's Report, include in their climate change policies and their climate action plans an implementation strategy involving legislation and non-legislative tools that will:

- *optimize the benefits of using natural gas as a transitional fuel in the process of developing a sustainable low-carbon economy; and*
- *ensure that cleaner natural gas is preferentially used to replace and not augment more carbon-intensive and polluting fuels.*

An important element in managing GHG emissions from new and expanding development activities is to minimize emissions to a level that is as low as possible. The assessment of GHG emissions at the environmental assessment and review stage can make an important contribution toward achieving this management objective in the NWT and the rest of Canada. In the Beaufort Delta and Mackenzie Valley regions, future assessment of GHG emissions from developments associated with the Expansion Capacity Scenario and Other Future Scenarios will be required to assess their Project-level and cumulative impacts on current and future GHG emissions targets and regulatory standards. Efforts by the Proponents, industry and government to make a positive contribution to sustainability will also be required. As demonstrated in submissions made to the Panel, there was considerable debate among parties regarding the scope of the environmental assessment of GHG emissions and related information, particularly with respect to the Project's life cycle and the end use of hydrocarbons. In the absence of explicit guidance and in reviewing the evidence before it, the Panel developed the approach and rationale presented in this report. Explicit guidance would greatly assist future proponents, environmental assessment panels and review bodies to assess GHG emissions in a sustainability context.

RECOMMENDATION 8-10

The Panel recommends that the Canadian Environmental Assessment Agency, the Environmental Impact Review Board for the Inuvialuit Settlement Region, and the Mackenzie Valley Environmental Impact Review Board, within two years of the date of the Government Response to the Panel's Report, develop a guidance document on the assessment of greenhouse gas emissions in environmental assessments in which sustainability is an overarching objective or principle.

CONCLUSIONS

The Panel reviewed extensive evidence associated with the Project as Filed, Expansion Capacity Scenario and Other Future Scenarios for upstream and downstream GHG emissions. This evidence did not establish that the Project's GHG emissions would result in significant adverse environmental impacts. However, the Panel recognizes that there is great public concern about climate change impacts — such as increasing average temperatures and evaporation rates, variation in rainfall and incidence of floods, a rise in sea level, and increased intensity and frequency of extreme weather events — and their resulting impacts on wildlife, habitat, people and communities. The broad goal of minimizing GHG emissions to a level that is as low as possible has found partial expression globally in the *Kyoto Protocol*, in Canada in the federal government's KPIA, and in some federal and provincial policy initiatives.

For the NWT and the rest of Canada, the Project represents both an opportunity and a challenge to achieve sustainability objectives associated with resource use efficiency and to enhance any future positive trends of emissions reductions directed at achieving international and national targets. Depending on how emissions from the Project are managed over its life, the Project also has the potential to erode and delay progress on future emissions reductions.

The Project's upstream emissions represent a small percentage of its total life-cycle emissions. The Panel is confident that commitments by the Proponents and requirements to work with Environment Canada and the GNWT in implementing evolving regulatory instruments and guidance as they become available could result in further reductions in GHG emissions from the Project's construction and operations phases.

However, the very large percentage of the Project's total GHG emissions associated with the end-use combustion of gas makes it clear that a determining factor in assessing the Project's contribution to sustainability is how the gas is used, which is a matter for government policy. Beyond the Project as Filed, the total cumulative GHG emissions from the Expansion Capacity Scenario and Other Future Scenarios pose real management challenges. To optimize emissions reductions, current and future governments will need to enhance their progress toward reducing GHG emissions to below current levels. The large increase in emissions that would occur in the event that Project gas was used in the service of Alberta oil sands production and subsequent combustion would clearly represent a setback in this regard. Although there is no evidence to substantiate the suggestion that the Alberta oil sands are directly associated with the end use of Project gas, the absence of any policy to prevent such an occurrence renders it a possibility, if not a probability. From the standpoint of resource-use efficiency, there is no certainty that clean-burning Project gas would be used as an energy substitute for more carbon-intensive fuels or directly for uses and purposes that burn natural gas, such as vehicles or home heating systems.

The various future scenarios considered by the Panel are uncertain with respect to the timing, pace and exact geography of development. However, they clearly underscore the need for the federal government to assume timely and aggressive leadership in establishing policy and regulatory instruments and other initiatives that will better ensure that Project gas is used as a clean-burning, carbon-efficient bridging fuel to a low-carbon economy.

Currently, a fully developed policy with a suite of instruments including regulations to implement the policy — and evidence as to how industries and households will react to the policy and regulatory instruments — is absent. Without the implementation of Panel Recommendations 8-6 through 8-8 the Panel is not confident that the appropriate conditions exist for the Project to make a positive contribution to sustainability through the management of its total cumulative GHG emissions. To accomplish this, appropriate policy and regulations should be in place to ensure that the Project's GHG emissions contribute to or enhance a national trend of overall reduction in GHG emissions to meet or exceed existing national targets in the *Climate Change Plan for Canada*.

8.5 WATER QUALITY AND DRINKING WATER

8.5.1 PROPONENTS' VIEWS

The Proponents used Health Canada's drinking water guidelines for protecting community drinking water supplies as benchmarks for evaluating potential Project impacts on drinking water. The Proponents submitted that, although drinking water guidelines are not normally applied to untreated surface waters, they are used for evaluating impacts on surface waters in northern Canada, where drinking minimally treated or untreated water is more common than elsewhere in the country.

Potential Project impacts on drinking water are predominantly associated with:

- acid deposition resulting from air emissions;
- wastewater releases associated with discharge of domestic wastewater and pipeline pressure test water;
- suspended sediment inputs associated with land disturbance and watercourse crossings; and
- leaks and spills throughout Project construction and operations.

Regarding water quality impacts associated with acid deposition, the Proponents' assessment found no Project-related occurrences of acid deposition rates exceeding critical loads, and stream sensitivity to acid deposition was considered low. No Project-related impacts from acid deposition were predicted in the production area, along the gathering pipeline routes, or for lake or stream water quality along the pipeline corridor.

Potential water quality impacts resulting from barge traffic and dredging, watercourse crossings, and accidents and malfunctions are discussed in Chapter 7, "Accidents, Malfunctions and Emergency Response" and Chapter 9, "Fish and Marine Mammals."

WATER SUPPLY FOR THE TOWN OF WRIGLEY

The only community in the Project Review Area that uses groundwater as a potable water supply is Wrigley. The proposed pipeline right-of-way would be about 2 km from Wrigley at its nearest point. The pipeline would cross Hodgson Creek about 8 km to the north of the town. These are the only Project activities currently planned near the town of Wrigley. The Proponents stated that because Project activities are well removed from Wrigley's groundwater supply, no studies were undertaken to delineate aquifers in this area of the pipeline corridor. The Proponents submitted that a leak or rupture of the pipeline would not be expected to have any impact on the quality of the local groundwater because natural gas is lighter than air and dissipates into the atmosphere as it is released. The Proponents stated that they do not expect the pipeline to have any impact on groundwater sources near the town of Wrigley. Therefore, no specific emergency response or Groundwater Monitoring Plans were developed for the area.

CAMP WASTEWATER AND TREATMENT

The construction camps that house facilities and pipeline workers would generate typical domestic wastewater from kitchen, laundry, bathroom and washing facilities. The Proponents currently plan to use commercially available, self-contained sewage and wastewater treatment systems. The Proponents also noted that treated wastewater could be used to create winter roads and on the travel lane of the pipeline right-of-way to increase road quality and longevity.

The Proponents noted that they would be selecting wastewater treatment equipment that has been shown to be effective in northern environments.

DRILLING WASTE AND INDUSTRIAL WASTEWATER

The Project would generate wastewater from Project facilities and drilling activities during construction and operations. Although engineering design is ongoing, the Proponents provided preliminary information on treatment and disposal options for drilling fluids and cuttings, produced water, and industrial process wastewater. In the event that drilling wastes were deep-well injected, the Proponents stated that the design and integrity of the injection wells would isolate the injected waste and wastewater from any ground or surface water. Thus, the Proponents submitted that there is an extremely low probability that any injected material could be transmitted to aquifers through a fault zone. They also noted that any injection wells used by the Project would have to be approved by the NEB and that "chemical characterization of the waste and wastewater planned for injection is expected to be required as part of the approval process." (J-IORVL-00258, p. 64)

ConocoPhillips and IORL stated that, at the Taglu and Parsons Lake sites, they were proposing to dispose of drilling discharges by injection on site, into a subsurface formation. At both fields, the Proponents stated that drilling, completion and rig cleaning fluids would be recovered and reused as much as practical to reduce disposal volumes.

At Niglintgak, Shell originally intended to use a combination of on-site injection and containment in a nearby purpose-built sump. However, in response to concerns from participants regarding sump development, Shell later stated that it intended to dispose of drilling waste by transporting it to a waste management facility outside of the NWT instead of using a remote sump.

Drilling, completion and rig cleaning fluids would be recovered and reused as much as practical to reduce disposal volumes. Drilling fluids and cuttings ready for disposal would be contained in steel tanks at the drill site before being transported out of the Kendall Island Bird Sanctuary to a final disposal site in Alberta or British Columbia.

The Proponents stated that all disposal solutions would be designed to provide long-term containment of waste materials. The Proponents further submitted that subsurface injection of drilling discharges and process fluids is currently a proven industry practice and has become more common in recent years.

PROPONENTS' COMMITMENTS

Over the course of the Panel's process, the Proponents made a number of commitments to protect water quality. Key commitments included:

- Wastewater treatment units would be of proven design with successful operation in similar field conditions and would be operated and maintained according to the vendor's specifications.
- Potable Water and Wastewater Treatment Plans and specifications would be developed to ensure that potable water and wastewater used by the Project is safe throughout its life cycle. Water use would be managed in the following ways:
    - designing potable water treatment and wastewater treatment systems to meet applicable legislation and guidelines;
    - developing and implementing a Raw-Water Monitoring Program, including laboratory analysis and on-site monitoring;
    - monitoring potable water treatment and wastewater treatment systems, including laboratory analysis during system operation; and
    - releasing treated wastewater that meets applicable guidelines and regulatory approvals.
- Treated wastewater would be tested before being used for activities such as winter road construction to confirm that it satisfies the requirements of the *Canadian Environmental Protection Act*, section 36(3) of the *Fisheries Act*, and other conditions from local land and water boards.
- Impacts of release of treated wastewater on receiving water bodies would be reduced by:
    - using alternative approved disposal methods, such as deep-well injection; and
    - considering community input.
- Community wastewater treatment facilities such as sewage lagoons might be used to dispose of domestic wastewater generated from the temporary camps during early work and demobilization and from permanent facilities during operations.
- Portable toilet facilities would be provided for workers along the pipeline construction right-of-way. Wastewater would be collected and transferred to a nearby camp for treatment.
- Construction activities would be monitored to reduce contact or discharge near traditional water sources, and Project water intake facilities would be situated to avoid adversely affecting the traditional water intake location, should a common water source be used.
- Wastewater would be recycled to reduce the demands on water sources.
- A team would ensure compliance with applicable regulations for water supply and treatment. Team members would include:
    - on-site camp management;
    - vendor representatives for water treatment systems; and
    - environmental and regulatory staff.
- The GNWT, Health Canada, local regulators and communities would be consulted regarding the development of management practices and contingency, mitigation and Emergency Response Plans and monitoring programs for Project activities within community watersheds.
- Disposal procedures and locations for fluids and solids from horizontal directional drilling would be selected to reduce any potential impacts from such drilling materials on local water supplies and quality or future use of borrow sources.
- Water bodies affected by domestic wastewater and hydrostatic test water releases would be monitored.
- Water quality would be monitored for such things as hydrocarbons, coliform, bacteria, turbidity, pH, dissolved oxygen and fish abnormalities. Monitoring would be conducted at selected lakes and watercourses within the zone of influence of Anchor Fields and infrastructure facilities.
- Process wastewater, produced water and drilling wastewater generated at all locations would be deep-well injected, transported off-site for disposal or be recycled.
- Each of the Anchor Field operators — Shell Canada Limited for Niglintgak, Imperial Oil Resources Limited for Taglu, and ConocoPhillips Canada (North) Limited for Parsons Lake — would implement a waste management program that provides details on the recommended management practices, including disposal methods, for waste generated from each of the Taglu, Parsons Lake and Niglintgak processing facilities.

8.5.2 PARTICIPANTS' VIEWS AND RECOMMENDATIONS

The GNWT informed the Panel that it was responsible for ensuring safe drinking water in the NWT. Its approach to protecting drinking water is based on a nationally recognized approach developed by the CCME that highlights the multi-stakeholder importance of keeping clean water clean.

The GNWT undertook a risk assessment of the impact of the Project on community drinking water in the Mackenzie Valley. Potential exposures were identified and categorized for an initial screening by Project activities. These included pathways from each Project component and activity and the potential impact on each community that might be impacted by each exposure. Impacts from accidents and malfunctions were included in the analysis. The GNWT's assessment included assessment of:

- barge- and ship-related impacts;
- construction and dredging;
- stream crossings and pipeline construction;
- borrow sites;
- impact of wastewater and effluents; and
- hydrostatic testing.

Impacts were assessed for communities along the Mackenzie River.

In its final recommendations filed with the Panel, the GNWT stated that the Proponents had responded positively to many of the issues and proposed resolutions that the GNWT had raised throughout the Panel proceedings. The Proponents had committed on the record to apply and implement these resolutions in their Project plans.

The GNWT stated that it endorsed the concept of adequate treatment of domestic wastewater as key to protecting human health and water sources, and it agreed that the Proponents' commitments would meet the goal of protecting human health. Further, the GNWT acknowledged the efforts of the Proponents to identify domestic wastewater treatment as an important and integral part of the design and operation of their camps and facilities. In light of the Proponents' commitments and the future regulatory review processes, the GNWT stated that its preliminary recommendations regarding the need for a Source Water Protection Plan by the Proponents were resolved and that such a plan was no longer needed.

The GNWT also noted the Proponents' commitments to developing Environmental Management Plans as a means of managing the environmental impacts of the Project. Many of these plans would be relevant to managing impacts on water resources. The Proponents also committed to involving federal, territorial and regional agencies in reviewing and approving Environmental Management Plans, as appropriate.

Health Canada noted that it supported the approach and findings of the drinking water hazard assessment presented by the GNWT. It also supported the current and best practices already established by the GNWT regarding source water protection, monitoring practices and water treatment. Health Canada emphasized that its existing drinking water guidelines are not specific to the Project but are national standards that must continue to be met by the provinces and territories. It also stated that, although potential contaminant issues regarding the Project were identified, drinking water is not expected to be an issue as long as proper mitigative measures are implemented throughout the construction and operation of the proposed pipeline.

Environment Canada stated that it accepts the level of the aquatic information, generic stream crossing designs and proposed mitigation measures described in the Proponents' EIS, provided that follow-up environmental monitoring programs that have an adaptive management approach would be defined and implemented in the regulatory process. This approach should be designed to ensure that mitigation measures are effective, apply corrective actions if required, and determine the validity of the environmental assessment conclusions. Aquatic water quality monitoring is normally developed during the regulatory phase for incorporation into the Project monitoring follow-up program in consultation with regulatory agencies and stakeholders.

The Jean Marie River First Nation recommended to the Panel that the Proponents and the GNWT devise a monitoring system for the Jean Marie River watershed. The Proponents did not agree with this recommendation and submitted that a system for testing water quality in the Jean Marie River watershed is the responsibility of government agencies. However, they noted that Project-specific monitoring would be conducted and data provided to the appropriate regulatory authorities, as required for Project permits, licences and approvals. The GNWT replied that a recommendation was not needed as the Proponents' commitments addressed the GNWT's concerns about drinking water quality.

The Pehdzeh Ki First Nation recommended to the Panel that, with respect to community water treatment and supply, local people be trained to continuously monitor the aquatic environment. The Proponents agreed with the premise of this recommendation but noted that they intended to have appropriately trained environmental monitors on site.

The Pehdzeh Ki First Nation also recommended that all sewage from work camps near Wrigley be taken to the community sewage lagoon and that this lagoon be expanded. It asked that all recyclable material be donated to the Pehdzeh Ki First Nation for youth programs. The Proponents did not agree with this recommendation, noting that the Project's construction camps would be self-contained and that current plans included releasing treated wastewater, not sewage, from construction camps to the land or using the wastewater for winter road construction. They further noted that treated wastewater would meet government water quality guidelines and that other Project construction camp

Fort Good Hope Region

Source: Kevin Morin

waste would be transported to approved landfills, likely outside the NWT. Project camps would use community infrastructure and services only if there would be a benefit for the community and for the Project, and if the community and the Proponents agree on an arrangement for such use.

The Sambaa K'e Dene Band and the Gwich'in Social and Cultural Institute recommended to the Panel that water quality and flow be monitored along the proposed pipeline route. The Government of Canada responded that details of regulatory monitoring will be a component of the regulatory phase of the Project. The GNWT responded that water quality testing and monitoring in communities has been addressed through commitments made by the Proponents.

8.5.3 PANEL VIEWS

It is the Panel's view that the Proponents have responded effectively to the issues, concerns and recommendations of the participants with respect to the potential impacts of the Project on water quality.

The Panel is of the view that, if Panel Recommendation 5-1 is implemented and there is an appropriate exercise of regulatory responsibilities by the NEB and other downstream regulatory agencies, the impacts of the Project on water quality would not likely be significant.

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9.1 INTRODUCTION

The Mackenzie River is the largest north-flowing river in North America, draining almost 1.8 million km^2 of terrain, or almost 20% of Canada's total surface area. The Mackenzie Basin is the second largest basin in North America and the sixth largest in the world. The Mackenzie Delta is the largest delta in Canada, extending almost 200 km from Point Separation in the south to the Beaufort Sea in the north. Over 25% of the Delta is covered by water and is dominated by shallow, flood plain lakes. The discharge of large quantities of fresh nutrient-rich water from the Mackenzie River creates a band of reduced salinity extending through the estuary and along the shore of the Beaufort Sea. This zone provides a unique habitat used by marine, freshwater and diadromous fish. The Beaufort Sea and adjacent coastal areas provide a wide array of important habitats for species of international, national and regional importance, including the largest summer feeding population of bowhead whales and perhaps the world's largest summering stock of beluga whales.

Fish are important components of the natural environment of the Mackenzie River. They are a valuable commercial, recreational and cultural resource and are indicators of the health of aquatic ecosystems. Marine mammals, like other wildlife in the Mackenzie Valley and Delta, are of critical value to northern residents and other Canadians. Many aspects of the culture and identity of people in northern communities are vitally connected to wildlife and the habitats that support wildlife.

Fisheries and Oceans Canada (DFO) has a mandate to protect fish and fish habitat. Section 35(1) of the *Fisheries Act* prohibits the "harmful alteration, disruption or destruction" (HADD) of fish habitat unless DFO issues an authorization under section 35(2) to allow the activity. Other sections of the *Fisheries Act* require maintenance of fish passage and prohibit the killing of fish by means other than fishing (e.g. by the use of explosives). The avoidance of HADD to fish habitat is preferred through the identification, development and implementation of mitigation measures to address adverse impacts. When sufficient mitigation is not possible and HADD is predicted, the Policy for the Management of Fish Habitat (referred to as the Habitat Policy) provides direction for issuing authorizations. The Habitat Policy requires that authorizations provide for no net loss in the productive capacity of fish habitat. Habitat losses must be offset through habitat compensation measures to ensure no net loss. Habitat compensation measures could also be required to ensure fish passage, although the first choice would be to maintain natural fish passage.

DFO is also responsible for the conservation and protection of fish, which includes marine mammals and their habitats, according to the definition in the *Fisheries Act*. The *Oceans Act* charges the Minister of Fisheries and Oceans with leading oceans management. The management of fisheries resources in the Northwest Territories (NWT) is also a DFO responsibility. However, the Department actively engages with management partners, such as the Fisheries Joint Management Committee (FJMC), the Gwich'in Renewable Resources Board (GRRB) and Sahtu Renewable Resources Board (SRRB), Hunters and Trappers Committees (HTCs), and other Renewable Resource Councils. In the Dehcho Region, DFO interacts mainly with communities through two programs: the Aboriginal Fisheries Strategy and the Aboriginal Aquatic Resources and Oceans Management Program. The priorities of DFO's fisheries management are to ensure the conservation of fish stocks, ensure access to fish stocks for subsistence purposes, and allow access to commercial, domestic and recreational fisheries. These three priorities are managed jointly with management partners and are consistent with the management processes and harvesting established under the various land claim agreements, the Aboriginal Fisheries Strategy, and the Aboriginal Aquatic Resources and Oceans Management Program.

There is a wide range of activities proposed in relation to the Mackenzie Gas Project (MGP or the Project) that may impact fish, fish habitat, marine mammals, and the marine and aquatic environments (e.g. stream crossings, barging, construction and excavation in rivers, and dredging in the marine environment). The Project would require the transport of various materials (e.g. pipe, granular resources, petroleum products, and chemical, industrial and domestic wastes). These materials and activities have the potential to affect the inland and marine waters of the NWT and Alberta, and represent an exceptional volume and intensity of resource development activity. The Project would involve development both across the Mackenzie Delta and some 1,200 km along the Mackenzie River watershed. Water crossings alone, estimated at approximately 700, have the potential to impact water quality and fisheries at a local and regional scale, with most water bodies flowing into the Mackenzie River, which in turn flows into the Beaufort Sea. The Project would cross many of the watercourses near their confluence with the Mackenzie River. The interconnectedness of the ecosystems suggests an approach is needed that goes beyond considering the crossings as local, isolated occurrences and that recognizes and considers the potential for combined and cumulative impacts to occur across the watershed.

The Panel held 10 days of hearings specifically devoted to these matters. A variety of concerns about potential Project impacts on the aquatic and marine environments, including fisheries, marine mammals, barging and dredging were raised throughout the process and, in particular, during Community Hearings.

Certain related issues arising from the review of the Project's potential impacts on fish, marine mammals, and the aquatic and marine environments are addressed in other chapters. Chapter 11, "Conservation Management and Protected Areas," discusses protected areas and broader conservation measures. Chapter 12, "Harvesting," considers issues related to harvesting of fisheries. There are also linkages between this chapter and Chapter 6, "Project Design, Construction and Operations."

9.2 PROPONENTS' APPROACH TO IMPACT ASSESSMENT

9.2.1 INTRODUCTION

The Proponents' overall approach to identifying and assessing potential impacts to fish, marine mammals, and the aquatic and marine environments was to apply sufficient mitigation to each Project-related impact to the point where significant adverse impacts would be considered not likely to occur. If significant adverse impacts were not considered likely to occur as a result of the individual Project activities, the Proponents then concluded that, in aggregate, there would also not be any significant cumulative adverse impacts. The Proponents' conclusion depended on the effective application of mitigation measures, monitoring and adaptive management.

Throughout the Panel's review process, it became clear that site-specific information was not complete in terms of baseline environmental information and that appropriate mitigation measures had not been fully designed. Nevertheless, the Proponents expressed confidence that they had appropriate and effective mitigation measures available to them and that they could and would apply them. The Proponents made many commitments to provide, during subsequent steps in the regulatory review of the Project, detailed plans, actions and measures to avoid, reduce or otherwise minimize the potential adverse impacts to fish, fish habitat, marine mammals, and the aquatic and marine environments.

Participants questioned the approach taken by the Proponents, specifically the lack of an adequate baseline and the approach to examine potential cumulative impacts.

9.2.2 BASELINE CONDITIONS

PROPONENTS' VIEWS

The Proponents obtained information about fish species and habitat requirements from literature reviews and consultations with local residents and HTCs. While regional information on the use of habitat by fish was available for some water bodies affected by the Project, site-specific information was often lacking.

To obtain additional information, the Proponents conducted reconnaissance and detailed fish and fish habitat field studies in the Local Study Areas at individual watercourse crossings. Concurrently, the Proponents conducted hydrogeology, hydrology and water quality studies and gathered information for streams and rivers. For purposes of the assessment, watercourses were grouped into classes based on their hydrologic regime, morphology and drainage area. As noted in Chapter 6, "Project Design, Construction and Operations," four classes of watercourses were identified:

- Large River;
- Active I Channel;
- Active II Channel; and
- Vegetated Channel.

In examining fish and fish habitat at watercourses potentially affected by the Project, the Proponents identified a Local Study Area and examined the habitat within it. The Local Study Area extended from 100 m upstream of the proposed crossing location to a point downstream of the proposed crossing location where it was estimated that 90% of the sediment entrained during crossing construction would be deposited. This distance downstream is roughly equivalent to 45 times the width of the stream (from bank to bank) at the crossing location (referred to as the bankfull width). They also considered the basin or sub-basin being drained by the watercourse, at least as far down as the Mackenzie River. For some migratory fish species, this included the length of the Mackenzie River Basin.

PARTICIPANTS' VIEWS AND RECOMMENDATIONS

DFO indicated that, in many cases, the baseline information supplied by the Proponents was the only recent record of the aquatic habitat in the study corridor. The limited information on the existing aquatic environment makes the prediction and assessment of potential impacts and the implementation of effective monitoring a challenge.

DFO also indicated that, for the 75% of the watercourses characterized by the Proponents as not having flowing water throughout the year, there is little information available on the importance of these watercourses as migratory pathways for fish or their role in contributing forage and nutrients to other connecting bodies. DFO also indicated that, within the Regional Study Areas crossed by the pipeline right-of-way, some water bodies contain fish species that are commercially harvested or caught for subsistence or recreational purposes, and that relatively little is known about fish populations and harvest rates.

In order to increase the existing knowledge of the aquatic environment, DFO indicated that it has undertaken or is undertaking several baseline research and monitoring projects within the Mackenzie Valley and that these projects, in combination with the Proponents' baseline information, would assist DFO in assessing and adaptively managing any changes to the aquatic ecosystem that might result from the Project.

Environment Canada indicated that:

> For the Environmental Assessment (EA) phase, EC accepts the level of aquatic environmental information, generic stream crossing designs and proposed mitigation measures described in the EIS and supporting documents with the understanding that environmental monitoring and follow-up programs designed to identify and correct unacceptable aquatic impacts should be collaboratively developed and implemented by the Proponent. (J-EC-00113, p. 3)

The FJMC indicated that the Proponents had not provided enough data for adequate estimates of the true baseline of fish and fish habitat in the Mackenzie River. The Committee also indicated that, since there were few measures of geographical or temporal variability, even if there were large changes in fish populations or fish habitat, it would be impossible to determine with statistical confidence that the changes were caused by the Project. The FJMC recommended that the Panel direct that government, management bodies and industry establish an integrated long-term aquatic monitoring program for the Mackenzie River watershed and that the Proponents should be a major partner and funder of this overall aquatic monitoring program. The Committee indicated that one of the objectives of such a monitoring program would be to collect baseline biophysical data to characterize the variability in the Mackenzie River watershed and biophysical data in order to assess the predictions in the Proponents' Environmental Impact Statement (EIS) and potential future environmental impacts. The Proponents indicated that they were not opposed to this proposed program but considered such an initiative to be primarily a government undertaking. The Proponents would not be a major partner or funder of such a monitoring program. The Proponents stated that they could contribute current baseline data as well as future Project-specific monitoring results, which could be integrated into an information management database system or monitoring portal.

The Deh Gah Got'ie Dene Council also expressed concerns regarding baseline information, indicating that final approval of the Project should not be granted without first establishing baseline conditions in the Mackenzie River and the major tributaries.

With respect to the cumulative impacts analysis, DFO submitted that, while the temporal boundaries used by the Proponents were reasonable, the spatial boundaries used were limited and resulted in fewer projects being assessed for their potential cumulative impacts. In DFO's view, the spatial boundaries should have included the Mackenzie Delta and the southern portion of the Beaufort Sea, where supply shipping is expected. DFO also indicated that there were several potential residual impacts to fisheries resources from the Project that were not included in the cumulative impacts assessment conducted by the Proponents. These included, but were not limited to, potential impacts on fish passage and habitat from frost bulbs, impacts on marine mammals from shipping and industrial marine activity in the Beaufort Sea and Mackenzie estuary, and impacts on fish and fish habitat from other potential development activities. In DFO's view, the combination of these limitations has resulted in an underestimation of the potential impacts that should have been considered in the cumulative impact assessment.

9.2.3 PANEL VIEWS

The Panel notes that, for the Proponents' significance determinations to be valid, their mitigation measures would need to be appropriate to the situation in which they were applied and fully effective in their implementation.

The Panel is of the view that neither the Proponents nor the resource managers could speak with confidence that there was sufficient baseline information. They were also not in a position to determine whether any changes to the baseline condition would result from the Project. As the Panel noted in Chapter 5, "Approach and Methods," having a sound understanding of baseline conditions is an essential requirement, not only to understand what might be impacted by the Project, but also to be in a position to respond to unanticipated impacts and ensure that mitigation measures are in fact working. The Panel also notes that, while the Proponents require an understanding of baseline conditions for the purposes of the assessment, it is the responsibility of resource managers to have a basic understanding of the resources they are managing.

For the approach proposed by the Proponents to be effective, a consistent and comprehensive method is required to integrate the understanding of the site-specific conditions at each location potentially affected by the Project with the range of mitigation measures available. This is so that the appropriate mitigation measures necessary to avoid significant adverse impacts to fish and fish habitat can be identified and implemented, and that any monitoring efforts can be focused appropriately.

To rely on such an approach requires that the Proponents:

- understand the site-specific environmental conditions and how they would interact with the Project to enable the correct choice of mitigation measures;
- ensure mitigation measures and actions are completely effective and reliable, even though they are not yet fully described or defined;
- look beyond each watercourse impacted as an individual isolated event and consider the combined and cumulative impacts throughout the watershed and ecosystem; and
- together with regulators and other parties, identify when mitigation measures have not been effective and take the appropriate action to remedy the situation.

The Panel notes the challenges in reaching a reasonable conclusion on the likely significance of the potential adverse impacts on fish, fish habitat, and the aquatic and marine environments. The Panel has addressed these concerns in its recommendations in this chapter and in Chapter 5, "Approach and Methods."

In the EIS and in the course of the Panel's proceedings, the Proponents made many commitments regarding the actions, plans and measures they would employ to avoid, reduce or otherwise minimize potential adverse impacts of the Project to fish, fish habitat, marine mammals, and the aquatic and marine environments. These included, but are not limited to:

- providing final crossing designs and mitigation plans to DFO;
- developing site-specific erosion and sediment control plans for Large River Channels and Active I Channels, and a generic plan for all Active II Channels and Vegetated Channels; and
- developing and providing decision trees and mitigation tables, Species Protection Plans, Environmental Protection Plans, Water Resources Management Plans, Ballast Water Management Plans, Waste Management Plans and other management plans.

The Panel notes the generic recommendation regarding the implementation of the Proponents' commitments, as outlined in Chapter 5, "Approach and Methods," and has relied on the implementation of that recommendation, along with the additional specific recommendations that follow, in coming to its conclusions on the likely significance of any potential adverse impacts to fish, fish habitat, marine mammals, and the aquatic and marine environments.

9.3 WATERCOURSE CROSSINGS

9.3.1 EXISTING CONDITIONS

As noted in Chapter 6, "Project Design, Construction and Operations," the right-of-way for the Project would cross almost 700 watercourses between its origin in the gathering fields in the Mackenzie Delta and its terminus in northern Alberta. As DFO noted many of these watercourses flow year-round, although most flow seasonally. Both year-round and seasonal watercourses may support permanent fish populations and, therefore, could be considered fish habitat as defined under the *Fisheries Act*.

Using the classifications Large, Active I, Active II and Vegetated, the Proponents noted that about 74% of the Project's watercourse crossings in the NWT and Alberta are classified as Vegetated Channels. These watercourses flow only after rainfall or snowmelt but might provide habitat during brief periods of flow. They are typically dry or frozen to the bed in winter and do not provide overwintering habitat. The Proponents noted that Vegetated Channels might provide spawning habitat for northern pike.

The Proponents noted that about 10% of the watercourse crossings are classified as Active II Channels, which are watercourses that have intermittent flow but might provide habitat during that flow. According to the Proponents, Active II Channels are mostly dry or frozen to the bed in winter and do not provide overwintering habitat. They likely provide spawning habitat or movement corridors for Arctic grayling and northern pike.

The Proponents noted that about 12% of the watercourse crossings are classified as Active I Channels. These watercourses have perennial or year-round flow; provide rearing and holding habitat in the spring, summer and fall; and most provide overwintering and spawning habitats.

According to the Proponents, about 3% of the watercourse crossings are classified as Large Rivers. Large Rivers are characterized by perennial or year-round flow and provide habitat for all species and life stages.

The Proponents also noted that less than 1% of the watercourse crossings are classified as lakes. The Proponents considered the majority to be small shallow lakes and ponds, with all but one expected to freeze to the bed during winter. The Proponents noted that one lake has the potential to provide overwintering habitat. None were located in northern Alberta.

9.3.2 PROPONENTS' VIEWS

The Proponents assessed the potential impacts of watercourse crossings on fish by examining three key indicators: fish habitat, fish health, and fish distribution and abundance.

The Proponents considered that potential direct impacts on habitat could result from:

- changes in stream morphology;
- changes in streambed from disturbance during trench excavation;
- changes in composition and size of bed materials;
- changes in bank configuration; and
- removal of bank vegetation.

The Proponents indicated that watercourse crossing installation methods are broadly divided into three categories: horizontal directional drilling (HDD), isolation and open-cut.

The Proponents stated that less than 5% of the watercourse crossings would be installed using the HDD method, less than 10% would be installed using the isolation method, and more than 85% of the watercourse crossings would be installed using the open-cut method.

Impacts on fish health as a result of watercourse crossing construction might occur through changes in water quality or through exposure to suspended sediments.

Changes in fish distribution and abundance could be influenced by the following:

- effects on fish habitat and fish health;
- increased harvest;
- blockage of movements;
- entrainment by potential dredging; and
- pressure or noise disturbance from vehicles on winter roads and from barges.

The Proponents indicated that potential impacts associated with sediment deposition from crossing construction would depend on the stream type, habitat use in the vicinity of the crossing and the installation method. The Proponents indicated that lower winter flow and less turbulence under ice would limit the distance that sediment could travel during winter construction, with most particles the size of coarse silt or larger settling within 45 bankfull widths downstream of the crossing. The Proponents indicated that Active II and Vegetated Channels would not likely be impacted by sediment deposition because they would be dry or frozen to the bottom during construction. Rather, the potential impacts from sediment deposition from crossing construction would be limited to the habitats within Active I Channels and Large Rivers.

The Proponents also indicated that changes in channel morphology cause changes in habitat distribution and could potentially alter fish abundance and distribution. Changes in channel morphology can result from frost bulb formation, bed and bank disturbance, bank subsidence, runoff amount and sediment yield.

As noted in Chapter 6, "Project Design, Construction and Operations," potential impacts to fish and fish habitat as a result of alteration of channel morphology are predicted at crossings in the gathering system and pipeline corridor. Small-scale changes in morphology are expected at crossings, with impacts expected to be low in magnitude and local in extent. The Proponents concluded that Active I and II Channels would be the most likely to be affected. The Proponents did not expect impacts on Vegetated Channels because many do not have defined banks.

The Proponents indicated that disturbance of banks at crossings of large rivers would be unlikely to change channel morphology and that impacts from bank subsidence would be similar to the impacts of bed and bank disturbance.

The Proponents considered that the potential adverse impacts on fish health from the in-water use of explosives would be low in magnitude because they would affect fish only in the immediate vicinity. Potential adverse impacts would be short in duration because they would be limited to trench construction, and would be local in extent because they would be confined to the crossing location.

Temporary crossing structures during pipeline construction include temporary bridges and snow and ice bridges. Potential direct impacts on habitat would be limited to disturbance of the banks at the approaches to the watercourse. All temporary bridges would be removed and restored before spring breakup. The Proponents expected no direct impacts on fish habitat due to the use of temporary crossing structures.

All-weather road crossings might affect habitat for spawning, rearing and overwintering at or near the road crossing. Potential impacts would occur primarily during crossing construction by the direct disturbance of the streambed, banks or riparian areas. The potential impacts would depend on the type of habitat at the crossing site, the detailed construction plan and the crossing type selected (e.g. bridge or culvert).

As noted in Chapter 6, "Project Design, Construction and Operations," the Proponents also assessed potential impacts associated with HDD activities. In the Proponents' view, accidental release of HDD mud would not likely adversely change water quality because it stays bound together in a gel-like suspension when mixed with water and would eventually settle out.

An overall mitigation strategy for the Project involves reducing the amount and duration of in-water work. To limit sediment release, the Proponents plan to construct watercourse crossings during the winter, when approximately 84% of the watercourses are expected to be dry or frozen to the bed and the flow in the remaining watercourses is expected to be low.

The Proponents stated that the watercourse crossing methods were chosen to avoid potential adverse impacts on fish habitat. Open-cut crossing installation methods would be limited wherever possible to streams that were considered to be dry or frozen to the channel bed. Isolation or trenchless methods would be selected where overwintering or spawning and egg incubation habitats were present downstream. Matching the installation method with the watercourse type and habitat present would reduce the likelihood that fish and fish habitat would be adversely impacted by crossing installation. The Proponents outlined a range of mitigation strategies (referred to as the mitigation toolbox) that could be applied during the Project.

The Proponents indicated that watercourse crossings would be designed and constructed to reduce potential impacts on fish and fish habitat, according to the mitigation toolbox and decision trees, and in consultation with DFO. Crossing installation would consider industry practices, as defined in *Pipeline Associated Watercourse Crossings* (3rd edition), prepared by the Canadian Association of Petroleum Producers, the Canadian Energy Pipeline Association and Canadian Gas Association, and adapted to Project-specific and northern conditions.

The Proponents also submitted that use of the isolation method would limit the amount of sediment released during crossing installation and would avoid adverse impacts on incubating eggs and overwintering fish.

In response to a request from DFO, the Proponents outlined the process and criteria that would be used in deciding which mitigation measures they would apply in response to various circumstances at crossing sites. The Proponents' approach recognized that not all crossings had been assessed in detail, that detailed crossing designs had not yet been completed, and that there was a range of mitigation options available for consideration and application in response to site specific requirements. The Proponents produced material that included:

- an integrated flowchart showing how the decision trees and mitigation tables would be used to reduce or avoid harmful impacts on fish and fish habitat during construction and operation of the proposed pipeline watercourse crossings;
- three crossing technique selection decision trees for use in preliminary design, detailed design and at the time the watercourse crossings are installed (the decision trees show key decisions triggering selection of one crossing technique over another, decision pathways for contingency techniques, data inputs required for key decisions, and feasibility criteria for use during design and installation);
- 10 mitigation decision trees, each focusing on a specific impact pathway for fish and fish habitat, that show the decision-making process to be used to select and implement an appropriate combination of activity-related and physical works to mitigate impacts at pipeline watercourse crossings on fish and fish habitat, including:
    - key decisions that determine the need for specific mitigation measures at individual crossing sites;
    - data inputs that are required to support the decision-making process; and
    - examples of the types of activity-related or physical works mitigation measures that could be used where the need is identified;
- a table of activity-related mitigation measures (referred to as a toolbox);
- a table of physical works mitigation measures (referred to as a toolbox);

- typical drawings; and
- photographs from other pipeline projects.

To further mitigate potential impacts to fish and fish habitat, the Proponents committed to preparing site-specific erosion and sediment control plans for the construction and operations phases for each crossing of an Active I Channel and a Large River. The Proponents would prepare generic erosion and sediment control plans for all Active II and Vegetated Channels. Mitigation measures to maintain bank stability and re-vegetation of approach slopes would prevent inputs of sediment from bank erosion. Regular monitoring of erosion-prone slopes and repair of eroded areas as they were encountered would limit erosion and prevent sediment from reaching the water body.

The Proponents indicated that the potential impacts to fish and fish habitat from watercourse crossing installation were expected to be adverse, have a magnitude ranging from no impact to low (depending on the habitat and the crossing method), be local in geographic extent (i.e. confined to the immediate area of the crossing), and be short-term in duration. As these impacts are predicted to be confined primarily to construction, no impacts were expected during operations or decommissioning and abandonment. Overall, the Proponents submitted that watercourse crossing impacts on sediment concentrations, channel morphology, and water and sediment quality would not be significant.

The Proponents expected the magnitude of impacts from suspended sediment on fish health due to changes in runoff or total suspended sediments entrained during crossing installation to be adverse and range from no impact to low. The Proponents predicted that the extent of impact from suspended sediments would be local, with the amount of sediment input depending upon the crossing type. The Proponents expected suspended sediment entrainment from land disturbance to decrease as the land is stabilized and re-vegetated following construction.

The Proponents concluded that, with the implementation of mitigation measures, fish passage would not be affected by the construction of access roads.

As noted in Chapter 6, "Project Design, Construction and Operations," the Proponents concluded that the Project's contribution to cumulative impacts on sediment concentration would not be significant and that overall cumulative impacts on sediment concentrations would not be significant.

With respect to potential cumulative impacts on fish and fish habitat, the Proponents identified that existing pipeline, bridge or winter road crossings could already be impacting fish populations and fish habitat in the study areas. The Proponents indicated that while most Project components were not expected to act cumulatively because any potential interacting impacts with these types of land uses would be limited in duration and spatial extent, there are some Project components that could interact cumulatively with other developments. Cumulative impacts could occur if the crossings were near existing pipeline or road crossings that have already affected the same fish habitat. Depending on the proximity of the new crossing to the existing crossing, hydraulic conditions at the site and crossing method used, cumulative impacts could occur during construction from alteration to the streambed or bank approach, and from temporary flow blockages or increased sedimentation. The Proponents concluded that any cumulative impacts from these interactions, if measurable, were expected to be local. The Proponents also concluded that for the portion of the Project that is beside the existing Enbridge pipeline, that the Project would cause a cumulative impact because of the alteration and loss of riparian habitat due to right-of-way clearing at watercourse crossings but that the Project's contribution to cumulative impacts on fish habitat would not be significant and, therefore, that overall cumulative impacts on fish habitat would not be significant.

In terms of potential cumulative impacts to fish health, the Proponents considered that suspended sediment could impact the health of fish and that of other aquatic organisms. In the Proponents' view, the extent of such potential impacts range from minor physiological stress to mortality. The Proponents suggested that the magnitude of these potential impacts is a function of the concentration of suspended sediment and the duration of exposure. The Proponents concluded that most of the potential impacts of increased suspended sediments during construction of the watercourse crossings would be of short duration and localized within a short distance downstream of the crossing sites. Therefore, the Proponents concluded that the likelihood of these impacts to be cumulative with other land uses would be low. Increased sedimentation could also result from erosion of stream banks and other disturbed lands. Increased sediment load in surface runoff would continue during construction of the Project and during operations until the banks were stabilized and the disturbed habitat was re-vegetated. The Proponents concluded that while cumulative impacts could occur, any cumulative impacts would likely be negligible as any disturbance related to current land uses has been stabilized and the rate of erosion is low. The Proponents concluded that the Project's contribution to cumulative impacts on fish health would not be significant and that overall cumulative impacts on fish health would not be significant.

9.3.3 PARTICIPANTS' VIEWS AND RECOMMENDATIONS

During the Panel's proceedings, DFO indicated that it did not have enough information from the Proponents to make informed decisions to ensure that productive capacity of the watercourses would be maintained, particularly with respect to meeting the No Net Loss objective. DFO stated that further information would be required, including details of habitat compensation and detailed engineering that describes the precise footprint of the impact and changes in water depth. DFO indicated that if the Proponents met all of DFO's recommendations and if the Proponents fulfilled all of the commitments they had made during the Panel proceedings, then the Department would have a higher degree of comfort that adverse impacts from the Project could be mitigated.

DFO also stated that, for the purpose of environmental assessment, the Proponents' classification of watercourse types and crossing methods was informative. However, in the DFO regulatory process, as more information becomes available, the final determination of crossing methods might change from those outlined in the EIS in order to further reduce impacts to fish habitat.

As noted in Chapter 6, "Project Design, Construction and Operations," DFO expressed concern over the number of Active II Channels that had not been adequately assessed. It noted that not all watercourses categorized as Active II Channels would be frozen to the bottom.

DFO recommended that the Proponents avoid the open-cut installation method in watercourses where water is flowing under ice because fish are more vulnerable to potential sediment impacts due to reduced activity levels and limited opportunities to escape. The Proponents disagreed with the recommendation, noting that their construction methods have been selected based on stream classifications and consideration of the local conditions. In the case of Active I Channels and Large Rivers where an open-cut is planned, field programs have confirmed that overwintering or fall spawning habitat is not present. The Proponents' conclusion was based on field assessments conducted by aquatics specialists and included both summer and winter studies. Given that no overwintering or spawning habitat exists at these sites, the Proponents' stated that "an open-cut crossing is an appropriate crossing method." (Ray Boivin, HT V12, p. 1162) The Proponents also indicated that there might be cases where the primary crossing method, such as an HDD or an isolated crossing proposed for the installation, is not successful or is inappropriate due to stream conditions at the time of construction. In these cases, the Proponents indicated that the contingency crossing method would be an open-cut crossing. At the planned open-cut sites, the Proponents noted that their field programs did identify spring and rearing habitat. The Proponents further noted that although additional sedimentation could occur during the first spring freshet, the amount of sediment generated would be small and incremental to that already being transported downstream through natural processes. The Proponents committed to consult with DFO through the project permitting process. DFO indicated that, in their view, there is some uncertainty with respect to the amount of fish habitat in those watercourses and they would like the Proponents to consider the other two crossing methods (isolation and HDD) before choosing an open-cut method.

In view of the number of watercourses involved, the diversity of site-specific characteristics and considerations, and the conceptual nature of the designs available for review by the Panel, DFO asked the Proponents to develop decision trees to describe the process and criteria for decision making on individual watercourse crossing method and mitigation measures. During the hearings, DFO indicated that the Proponents had made considerable progress in addressing its requests for decision trees and that it was confident the decision trees would be finalized to DFO's satisfaction. Decision trees provide DFO with increased certainty and confidence that appropriate construction methods and mitigation measures would be used during construction and operations, as situations arise in the field. However, DFO did caution that the decision trees filed by the Proponents do not take into account habitat use by fish (e.g. migration) or the value of a given fish stock that might be affected.

DFO recommended that the Proponents follow a "precautionary approach" in the design and implementation of all in-water works to achieve the principle of No Net Loss of productive capacity of fish habitat, and to eliminate or reduce impacts to fish. DFO also stated that Habitat Compensation Plans or a process for developing and implementing such plans must be provided to DFO prior to the issuance of a *Fisheries Act* authorization for those works or activities that could result in the harmful alteration, disruption or destruction of fish habitat (HADD). The Proponents agreed with the recommendation.

DFO also recommended that the Proponents follow existing DFO standard operating policies and protocols, best management practices and guidelines during the design, construction and monitoring of the Project. The Proponent agreed with this recommendation, noting that some best management practices would need to be modified to suit northern construction conditions.

DFO also recommended that the Proponents provide their final designs and mitigation measures to DFO for review and approval, as required, as part of DFO's requirements for *Fisheries Act* authorizations. The Proponents agreed with this recommendation and noted that it was addressed by Project commitments and the subject of National Energy Board (NEB) Proposed Condition 18.

While DFO indicated that it was pleased with the information that the Proponents had provided up to that point, DFO recommended that the Proponents continue to work with DFO to refine and enhance the mitigation toolboxes and decision trees for the protection of fish and fish habitat, including consideration of factors such as seasonal access, traditional knowledge, cost, design limitations, lessons from previous projects, ease of construction and change management. The Proponents agreed, with variation. They committed to work with DFO to refine the mitigation measures and decision trees to protect fish and fish habitat. They also agreed to consult with DFO to develop decision trees that include the recommended factors and satisfy DFO requirements.

DFO told the Panel that rather than reviewing every single stream potentially affected by the Project, it would aggregate and prioritize proposed stream crossings based on a risk assessment and risk management process. For administrative and review purposes, DFO would group crossing locations that are similar where HADDs are required, likely on a regional basis. DFO also stated that it would consult with local affected communities before making decisions.

With respect to verifying the information provided by the Proponents, DFO reported that some sites had been examined during a field program and that it was considering a pilot monitoring program that would look broadly at the aquatic ecosystem health across the NWT, including many of the MGP sites. However, DFO would not look at every MGP watercourse crossing site before the filing of *Fisheries Act* authorization applications to verify information.

DFO also stated that it would focus as well on high-risk crossings. Low-risk crossings that could be addressed by DFO's Operational Statements would not require the Proponents to contact DFO or apply for a permit or advice if the activity did not cause HADD for fish habitat. In such circumstances, compliance with an Operational Statement would be a form of due diligence. DFO would monitor to determine whether its Operational Statements had been implemented or if its advice issued in relation to those Operations Statements had been effective in avoiding HADD.

With respect to potential cumulative impacts, DFO submitted that, without the implementation of mitigation, cumulative impacts to fish habitat and fisheries would likely occur as a result of the MGP and other projects. In DFO's view, cumulative impacts to fish and fish habitat could occur from the Project and specific activities, such as the construction, operation and maintenance of water crossings for roads and pipelines; navigational dredging in the Mackenzie River and Delta; and water withdrawal for resource exploration and winter road construction. DFO submitted that the impacts that are likely to result in cumulative impacts to fish habitat include:

- changes to fish passage in tributary streams of the Mackenzie River;
- sediment release and increased load to watercourses; and
- changes to stream channel morphology.

DFO stated that where a *Fisheries Act* authorization is not required, cumulative impacts to fish passage could result. This is particularly relevant for Active II Channels that are typically dry or frozen during construction, but are used by Arctic grayling as spawning grounds during the spring and as migratory routes to overwintering lakes in the fall. Further discussion of this issue is provided in Section 9.4.

With respect to potential cumulative impacts of sediment release and increased sediment load to watercourses, DFO noted that cumulative impacts could occur in the Jean Marie River due to three pipeline crossings and in tributary streams where previously disturbed banks have not stabilized prior to watercourse crossings for other projects. However, DFO concluded that at Jean Marie River, and more broadly with the implementation of adequate sediment control plans and stabilization methods during and after construction and followed by a monitoring program, the potential cumulative impacts would likely be mitigated. Similarly, DFO noted that with the application of best management practices either as conditions in a *Fisheries Act* authorization or as operational procedures during construction, the loss of riparian vegetation or changes to channel bed morphology could be mitigated to avoid cumulative impacts. Any residual losses would also be mitigated through compensation, as required by DFO.

DFO also submitted that cumulative impacts to fish habitat could occur from changes in the channel bed and banks at areas disturbed within the same watercourse for a number of water crossings associated with seismic lines, pipeline construction and operations, and watercourse crossings for roads. This could result in loss of riparian vegetation, changes to channel morphology and substrate, and changes to channel morphology due to increased sediment concentrations. DFO noted that through the application of best management practices as conditions under a *Fisheries Act* authorization, or through operational procedures during construction, the loss of riparian vegetation or changes to channel bed morphology could be mitigated to avoid cumulative impacts.

DFO recommended that the Proponents develop a scientifically defensible monitoring program, including the principles of adaptive management and best management practices, for implementation during all aspects of the construction, operations and maintenance, and abandonment phases of the Project. DFO noted that, in its view, this program could be used to evaluate and measure change, and verify impact predictions made for fish, fish habitat and marine mammal valued components and key indicators in the EIS as discussed during the Joint Review Panel hearings. DFO recommended that the program be developed in consultation with Aboriginal groups and DFO in advance of construction, and be provided to DFO with sufficient time for review and approval. DFO also recommended that the Proponents consult with Aboriginal groups and DFO throughout the lifespan of the monitoring program to evaluate the effectiveness of the program and make adaptive management decisions based on the results. DFO recommended that the program include:

- proven approaches that are sensitive to local scale impacts (e.g. Before-After-Control-Impact [BACI]) and regional scale impacts (e.g. reference condition approach);
- a suite of indicators that are measurable and provide clear linkages along an impact pathway between the source of impact and an ecological response;
- sufficient spatial and temporal monitoring frequency to detect an impact, including pre-assessment data sets that allow for detection of change;

- benthic invertebrate analysis and a subset of the physical, chemical and biological components required to maintain healthy and productive aquatic ecosystems;
- means to identify frost bulb and aufeis at stream crossings;
- representative stream crossings and road crossings;
- sediment core sampling for at least seven of the most likely dredging sites along the proposed route of the Niglintgak gas conditioning facility, including polycyclic aromatic hydrocarbons, heavy metals and trace metals;
- monitor water quality in the vicinity of the dredging sites in Kittigazuit Bay throughout the dredging operations; and
- sub-sampling of sediment in anoxic conditions where dredging is proposed.

The Proponents agreed with this recommendation, with variation. The Proponents stated that a monitoring program would be developed in consultation with DFO to ensure that the objectives of the monitoring program, as described in this recommendation, were achieved. Details, including sampling methods, would be determined in consultation with DFO and EC.

Environment Canada recommended that the Proponents develop and implement a monitoring program to assess aquatic impacts at selected watercourse crossings, especially where isolated or open-cut installation methods are proposed. EC indicated that the program should include monitoring before and during construction, and during operations and decommissioning. The Environmental Effects Monitoring approach should utilize either a BACI and/or a Reference Condition approach.

The Proponents agreed with this recommendation, with variation. The Proponents noted that a monitoring program would be developed in consultation with regulators, as described in Project commitments and the Instream Works Profile section of the Environmental Protection Plan. They also noted that, as noted by DFO, government is responsible for developing Reference Condition approach models.

The Jean Marie River First Nation recommended that HDD be used for the main Tthets'hke Deli (Jean Marie River) crossing. The Proponents disagreed with this recommendation and submitted that isolation methods planned for the crossing would limit the amount of sediment entrained during crossing construction and that increases in suspended sediment concentrations would be small and of short duration downstream of the crossing.

The Dehcho Elders Council told the Panel that:

> In Dene culture and spirituality, water has sacred importance and is treated with great respect. The Dehcho river has profound importance and its recognized as vital in the survival of the Boreal ecosystem and the planet. That is why keeping these waters pristine is viewed as sacred responsibility of all Dene any activity under or over it must not disturb or pollute the water in any way. Therefore, the Naxehcho (elders) recommend that no in-river or in-stream work be allowed for the installation of the proposed pipeline and that the fish and the water be given the highest degree of protection possible. (J-DEC-00015, p. 2)

The Proponents did not agree with this recommendation and stated that in-stream work is required for installing some watercourse crossings, constructing barge landing sites and withdrawing water. They noted that mitigation measures would be implemented to reduce the impacts on water and fish, and that these measures are described in the Project commitments and the Instream Works Profile section of the Environmental Protection Plan.

The Gwich'in Social and Cultural Institute recommended that best practices should be used when crossing streams and creeks. Crossings should be monitored for possible impacts. Creeks should not be blocked by debris or construction. If they are blocked, they must be opened again within the same season. The Proponents agreed with the premise of this recommendation but submitted that it is addressed by Project commitments.

9.3.4 PANEL VIEWS AND RECOMMENDATIONS

In the Panel's view, a consistent and effective means for making decisions regarding crossing characteristics and appropriate, specific mitigation measures to be applied to those crossing characteristics are crucial to avoiding and managing potential adverse impacts to fish and fish habitat. The decision trees requested by DFO represent a basis for making such decisions. Although the Panel was not provided with those decision trees, the Panel received assurance from DFO that they were appropriate. Despite scepticism on the part of some participants regarding the effectiveness of certain mitigation measures, the Panel did not hear evidence that the use of decision trees as an approach to mitigation would be ineffective. However, the Panel notes that the decision trees received by DFO by the close of the Panel's record were not considered by DFO to be complete because they did not take into account habitat use by fish or the value of a given fish stock.

In the Panel's view, the decision trees represent an effective means to determine which mitigation measures should be applied, based on the specific physical characteristics of a crossing location. In the Panel's view, there is also a need to identify which watercourses are the most important, based on their fisheries potential, or the value of the habitat or fisheries resource. The Panel is of the view that for some watercourses the fisheries resource may be of sufficient importance and value that extra effort or mitigation, beyond the actions specified in the decision trees, would be required to adequately protect the resource. This could be accomplished within the decision trees or as an addition to them. The Panel notes that DFO's approach for administering the review of the Proponents' plans for watercourse crossings is to focus their attention on the most important watercourses.

RECOMMENDATION 9-1

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, six months prior to the commencement of construction, the final suite of decision trees they propose to employ to manage the impacts of the Mackenzie Gas Project on fish and fish habitat, including the decision-making process, the criteria for decision-making and the mitigation options. The decision trees should be developed in consultation with, and to the satisfaction of, Fisheries and Oceans Canada and the relevant management boards and agencies.

In preparing the decision trees, the Proponents should outline how they will address the importance of relevant fish habitat and fish populations to local communities and harvesters, taking into consideration the information provided to them by Fisheries and Oceans Canada and the appropriate management boards and agencies.

The Proponents committed to implement the necessary mitigation and monitoring actions during the construction and operations phases of the Project, and to work with DFO to refine and enhance their mitigation toolboxes and decision trees for the protection of fish habitat during the regulatory review phase. The Panel notes DFO's concerns with respect to the use of open-cut crossing methods on watercourses where water is flowing under the ice. The Panel supports the greater use of HDD specifically in such situations, as well as generally, to avoid impacts to fish and fish habitat.

The Panel notes that the primary tool for DFO to protect fish habitat is the *Fisheries Act*, but that the *Fisheries Act* itself does not permit the Project or Project activities to proceed. Rather, a *Fisheries Act* authorization would provide the Proponents with permission to cause the harmful alteration, disruption or destruction (HADD) of fish habitat in accordance with the provisions of the authorization. Furthermore, DFO reminded the Panel that the onus is on the Proponents to determine if their proposed activity has the potential to result in a HADD and, if it does, then to work with DFO to determine the necessary mitigation or identify the appropriate compensation to offset any residual losses, and to ensure there is no net loss of fish habitat. If a watercourse crossing does not contravene section 35(1) of the *Fisheries Act* (i.e. does not cause HADD), the Proponents do not require an authorization under the Act. The Panel is not clear how this is determined and whether DFO is involved in the decision. If the Proponents are making the decisions in such cases, the Panel is of the view that there is a risk that crossings involving HADD might not be considered as such by the Proponents. Similarly, there is a risk that a DFO fishery officer could conclude that an unauthorized crossing resulted in HADD and find that the Proponents had actually contravened the *Fisheries Act*.

RECOMMENDATION 9-2

The Panel recommends that Fisheries and Oceans Canada outline its strategic approach to managing the large number of watercourse crossings by the Mackenzie Gas Project and make that approach available to its management partners, the Proponents, stakeholders and the public. This strategic approach should be completed within three months of the date of the Government Response to the Panel's Report. The approach should make clear how Fisheries and Oceans Canada proposes to manage the review of the watercourse crossings and should set out the information it will require the Proponents to file and the time frame for filing same.

Provided that the Proponents' commitments and the Panel's recommendations are implemented, the Panel is of the view that the impacts of the Project as Filed on fish and fish habitat due to sedimentation and watercourse crossings would not likely be significant. The Panel does not have sufficient information before it with respect to the Expansion Capacity Scenario or Other Future Scenarios, so it is unable to make a determination of significance of the impacts of developments associated with these two scenarios.

9.4 FROST BULBS AND AUFEIS

9.4.1 PROPONENTS' VIEWS

As described in Chapter 6, "Project Design, Construction and Operations," the Proponents indicated that it was possible for a frost bulb to penetrate the water column above a stream bed, especially under conditions of low or intermittent flow, which could have the impact of displacing stream flow to the surface where it could lead to the creation of aufeis. Similarly, groundwater flow in unfrozen soils could also be disrupted. With respect to potential impacts to fish and fish habitat, the Proponents identified the following impact pathways:

- blockage of fish passage;
- changes in channel morphology, resulting in restricted fish passage or erosion and increased sediment load;
- changes in groundwater quantity and surface water flow patterns and velocity, which could affect fish passage and spawning areas; and
- changes in surface water level and velocity.

Since the pipeline would cross a large number of watercourses near their confluence with the Mackenzie River, interference with fish passage as a result of frost bulbs and aufeis in some watercourses could impact fish populations.

The Proponents indicated that the likelihood of a frost bulb or icing affecting fish passage would depend upon the type of stream, crossing method, substrate composition, location of the crossing and mitigation measures applied. The Proponents considered that this pathway would be applicable only to

Active I and Active II Channels. The magnitude of the impact was considered to be low, the extent local to regional, and the duration only during operations.

As described in Chapter 6, "Project Design, Construction and Operations," the Proponents' proposed mitigation measures to limit the migration of frost bulbs into watercourses and limit the formation of aufeis included the installation of insulated pipe or burying the pipeline deeper beneath the watercourse, or both, depending upon the site-specific conditions.

The Proponents committed to apply appropriate mitigation at all pipeline watercourse crossings where frost bulbs could affect the environment, including sites with habitat for overwintering fish without sufficient flow to prevent excess ice formation, and sites that might freeze to the bottom but have sufficient groundwater so that large icings could form and affect downstream fish habitat.

The Proponents concluded that groundwater flow changes caused by frost bulb formation would have no impact on fish habitat for Vegetated and Active II Channels, and Large Rivers. Given that mitigation measures would be applied at all crossings susceptible to frost bulb formation where spawning or overwintering habitat was present, impacts on Active I Channels were expected to range from no impact to low impact. As described in Chapter 6, "Project Design, Construction and Operations," the Proponents considered small Active I Channels to have the highest risk of complete flow blockage by frost bulbs in winter because of the shallower depth of flow and narrower river width. The Proponents expected that low impacts would only occur at Active I Channels where mitigation measures were not implemented.

Although Active II Channels freeze to the bottom in winter, they can serve as migratory corridors for fish during the open water period. The persistence of frost bulbs and icings into spring, when fish might be moving in Active II Channels, could impede access to spawning areas or rearing habitats. The Proponents predicted that pipe temperatures would not delay thawing in the spring and that the frost bulb above the pipe would continue to thaw throughout the summer. Therefore, the Proponents concluded that blockage or interference with spring fish movements would not be expected.

The Proponents indicated that chilled pipe might cause Active II Channels to freeze earlier in the fall, but because Active II Channels are unlikely to provide overwintering or spawning habitat due to their intermittent flow, earlier freezing was not expected to affect fish movement. Fish in an Active II Channel would migrate out of the system to overwintering habitats at the onset of lower flow and colder temperatures.

The Proponents agreed that suitable mitigation measures should be applied at locations susceptible to frost bulb and thaw-related impacts on fish and fish habitat. However, the Proponents indicated that mitigation would only be required at streams with overwintering or fall spawning habitat, and thermal and ground conditions that could enable frost bulb growth that could block flow. The Proponents stated that they were developing preliminary plans to determine which streams would require mitigation. Information gathered in the Geotechnical Verification Program during the year of right-of-way clearing would be used to refine mitigation plans. Initiation of spring flow is dependent on climatic conditions in the watershed and, thus, is independent of the presence or extent of the local frost bulb around the pipeline. Therefore, the Proponents did not expect complete blockage of fish passage in the spring due to frost bulb impacts. Similarly, the Proponents did not expect early freeze-up to result in disruption of fish migration.

The Proponents concluded that the adverse impacts to fish and fish habitat due to frost bulbs would not be significant.

9.4.2 PARTICIPANTS' VIEWS AND RECOMMENDATIONS

DFO agreed with the Proponents' identification of impact pathways and noted that, in its view, there were three additional pathways:

- changes in freeze/thaw cycle or timing at watercourses, resulting in temporary restriction to fish passage;
- thaw settlement within and adjacent to watercourses located downstream of the compressor stations, resulting in erosion, ponding and piping; and
- temporary redirection of surface water and/or groundwater out of the active channel, which, in winter, might lead to less water being available to fish as water freezes on the surface and, in spring, might lead to erosion of the bed and banks.

DFO stated that some of the identified Active II Channels might support overwintering fish communities that could be adversely affected by frost bulb formation. DFO indicated that the Proponents had not identified how the potential for frost bulbs or aufeis would be identified and that no information had been provided on the effectiveness of pipe insulation or deeper burial as mitigation measures. Therefore, DFO indicated that it was not possible to determine which mitigation measures, or combinations of mitigation measures, would be most effective in mitigating frost bulb formation and aufeis.

DFO stated that pipe temperature, which would be below 0°C for most of the spring and into the summer, could delay spring breakup at the crossing locations. In the smaller tributaries, such as Active II or Vegetated Channels where the Proponents propose no mitigation, frost impacts from a cold pipeline could delay breakup, and prevent or delay fish movement. The buried pipelines upstream of the compressor station intakes would be consistently below freezing. This cold pipe could result in persistent impacts to fish and fish habitat, such as changes to in-stream hydraulics and channel morphology. As a result of pipeline temperature, DFO expressed concern that early freeze-up of stream sections due to cold pipe could disrupt migration escape from seasonal watercourses to overwintering habitat.

In response to the May 2007 *Supplemental Information — Project Update*, which reduced the number of compressor stations, DFO stated that "in the one-compressor station scenario, and possibly the one-compressor scenario where construction of additional compressors is delayed, that there could be an increased — even more increased risk of some blockage of flow or fish movement in those shoulder seasons" by frost bulb development along the pipeline route. (Marc Lange, HT V100, p. 9901)

DFO noted that the Proponents had not yet developed specific details on monitoring for frost bulbs and aufeis, but had indicated a preference for visual monitoring by aerial patrol. DFO noted that visual monitoring by aerial patrol might not be a reliable way to identify under-ice frost bulb formation, delayed thaw or early freeze-up of streams, all of which might impede fish movements during critical freeze/thaw periods.

DFO indicated that Project-induced frost hazards might pose a long-term and persistent risk to fish and fish habitat, and that frost and thaw impacts to watercourses from the pipeline could occur at all types of stream crossings, whether they were channels with perennial flow or seasonal channels with spring spawning.

With respect to potential cumulative impacts on fish passage, DFO indicated that, while construction of a pipeline watercourse crossing is unlikely to affect fish passage if constructed using best management practices, the operation of a chilled gas pipeline could result in impacts during operations if measures to mitigate the impacts of frost bulb development were not implemented. DFO noted that they include requirements to monitor and adjust fish passages in *Fisheries Act* authorizations where required. However, if a *Fisheries Act* authorization is not required, cumulative impacts to fish passage could result, particularly in the case of Active II Channels that are typically dry or frozen during construction but are used by Arctic grayling as spawning areas during the spring and as migratory routes to overwintering lakes in the fall.

DFO was of the opinion that Project-induced frost hazards might pose a long-term and persistent risk to fish and fish habitat.

As discussed in Chapter 6, "Project Design, Construction and Operations," DFO recommended to the Panel and Proponents that a precautionary and adaptive management approach be applied at the outset of the design, construction and operations phases to mitigate potential impacts from frost hazards so that:

- impacts are prevented from happening;
- any unforeseen impacts or mitigation failures are detected early through an effective monitoring program; and
- actions are taken immediately to rectify impacts.

The Proponents agreed with this recommendation and indicated that it was addressed by Project commitments and was also the subject of NEB Proposed Condition 18.

9.4.3 PANEL VIEWS AND RECOMMENDATION

The Project involves numerous watercourse crossings in permafrost and discontinuous permafrost involving a pipeline the temperature of which would vary above and below 0°C. In many cases, the pipeline would cross watercourses close to where a watershed discharged into the Mackenzie River. The Proponents recognized that the Project has the potential to result in frost bulbs and aufeis, which could impede or alter the timing of fish passage if not effectively mitigated.

Frost bulbs and aufeis represent a potential risk to fisheries resources due to their potential to disrupt fish migration, an activity upon which fish populations depend for reproduction. However, the risk and likelihood that frost bulbs and aufeis may occur were not clearly described to the Panel. The potential risks are further complicated by the Proponents' plan to start with a one-compressor station scenario (allowing for a throughput of up to 0.83 Bcf/d), to be followed by the addition of two compressor stations in the near future (to provide a throughput up to 1.2 Bcf/d) and potentially the addition of more compressor stations in the future. The addition of compressor stations beyond the initial three would result in a changing pipeline operating temperature regime. As noted in Chapter 6, "Project Design, Construction and Operations," the Proponents indicated that they would identify locations where there was a risk to fish as a result of additional compressor stations and would implement appropriate mitigation measures. During the detailed design phase of the Project, the Proponents and DFO could identify the locations where frost bulb and aufeis might occur and the necessary measures during the design and/or construction phases to mitigate the potential impacts to fish.

As set out in Chapter 6, "Project Design, Construction and Operations," the first step is to avoid the creation of frost bulbs and aufeis through appropriate design. Failing this, the Panel has recommended, in Panel Recommendation 6-6, that the Proponents file their plan for identifying how they would avoid the creation of frost bulbs and aufeis and, in locations where frost bulbs and aufeis cannot be avoided, how they would mitigate any impacts to fish and fish habitat that may result from frost bulb and aufeis creation. To ensure that the measures described in the Proponents' plan are effective, it is the Panel's view that monitoring and some capacity to respond to monitoring results are also required.

RECOMMENDATION 9-3

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, six months prior to the commencement of construction, the monitoring program for impacts on fish and response actions to be taken for frost bulbs and aufeis, including monitoring at an appropriate level of coverage in space and time. The response actions should address situations where mitigation measures are not working as expected (e.g. reduced effectiveness of pipe insulation), and the Mackenzie Gas Project is posing a risk to fish populations. The monitoring program and response protocols should be reviewed and agreed to by the appropriate regulatory authorities prior to the commencement of construction.

Provided that the Proponents' commitments and the Panel's recommendation is implemented, the Panel is of the view that the impacts of the Project as Filed on fish and fish habitat due to frost bulb and aufeis creation would not likely be significant. The Panel does not have sufficient information before it with respect to the Expansion Capacity Scenario and Other Future Scenarios, so it is unable to make a determination of significance of the impacts of developments associated with this scenario.

9.5 HABITAT COMPENSATION

9.5.1 PROPONENTS' VIEWS

The Proponents indicated that the Project was planned to avoid HADD of fish and fish habitat through avoidance and mitigation. In keeping with DFO's No Net Loss objective, the Proponents indicated that measures would be implemented to prevent or reduce the loss of fish habitat associated with any Project activities. If HADD were identified, the Proponents would work with DFO staff to determine an appropriate compensation strategy. The Proponents noted that the preferred option would be to develop effective replacement fish habitat, or enhance existing fish habitat within the Project area and as close to the HADD site as possible. However, the Proponents indicated that they might consider potential compensation outside the Project area. Other actions, which the Proponents suggested were also potential compensation strategies, included:

- monitoring and research to evaluate the effectiveness of replacement habitat; and
- providing educational and employment opportunities to Northerners to help them gain experience and knowledge in effective fish habitat preservation and enhancement.

The Proponents indicated that detailed habitat compensation measures had not yet been developed but would be determined through discussions with DFO in the permitting process. The Proponents indicated that they were confident that the Project would be able to achieve No Net Loss.

The Proponents outlined several approaches to fish habitat compensation that they were considering, including restoring gravel pits, and connecting abandoned borrow sites to create lakes and river systems. According to the Proponents, such approaches have been carried out fairly successfully in Alaska as a means to enhance habitat for Arctic grayling. The Proponents also indicated that constructing off-channel habitats or excavating side channels within existing floodplains have also been tried. The Proponents also noted that there were a number of options in the literature that could be tried, but that they had not yet explored any of these options. They suggested that in the permitting phase, they would discuss with DFO the acceptable compensation measures and the types of activities for which the resulting losses would require compensation. Those discussions had not yet taken place by the end of the hearing process.

9.5.2 PARTICIPANTS' VIEWS AND RECOMMENDATIONS

DFO told the Panel that identifying reasonable options to replace lost productive fish habitat requires time and resources. DFO's position was that, based on the polluter-pays principle, the burden is on proponents to present a list of well-researched options for compensation. DFO noted that there has been a range of successes in terms of fish habitat compensation in the NWT, including instances where compensation did not work and proponents were required to try new mitigation until the habitat was effective for fish.

Implementation of effective fish habitat compensation requires available opportunities for enhancement and creation of habitat, along with good knowledge of the biology and life-cycle of the affected fish species in the affected aquatic environment. DFO underscored the lack of knowledge about the biology and life-cycle of Arctic fish species and reported that there is no comparable ecosystem in North America. The Mackenzie River system is huge in scale and certain fish species that inhabit the system have unique life histories, such that any experiences in other watersheds would be of limited value. While the Lena and Ob Rivers in Siberia might be comparable, the literature on fish in these rivers is very limited. According to DFO, the knowledge gap ranges from successful compensation projects in the Arctic to fish population dynamics. Most of the approved habitat compensation projects are viewed as experiments. In DFO's experience, where success is not achieved the first time around, successive modifications are introduced to try to achieve a useable habitat. Many of the *Fisheries Act* authorizations for large projects include performance measures that require the replacement habitat to function in a way that is similar to the pre-impacted habitat.

9.5.3 PANEL VIEWS AND RECOMMENDATIONS

While the Proponents indicated that the Project is being planned to avoid HADD of fish and fish habitat through not impacting the habitat in the first instance or through the application of appropriate mitigation, the Panel heard that, if an authorization is necessary, the Proponents would work with DFO to determine an appropriate compensation strategy. The Proponents' preference is to develop effective replacement fish habitat or enhance existing fish habitat within the Project area and as close to the HADD as possible. The Proponents might consider compensation outside of the Project area. In the Panel's view, the question remains whether compensation would be effective, given that there are gaps in knowledge with respect to the biology of northern species. The Panel notes that there has been a range of successes in implementing compensation measures in northern environments, but the Proponents have not yet defined specific measures and approaches.

While off-site compensation could be an effective solution, the Panel is of the view that the impacts to local resource users might not be directly addressed. If such compensation approaches were used, there would need to be a clear description of the circumstances under which off-site compensation would be acceptable.

In the Panel's view, to ensure the long-term sustainability of fisheries resources in areas affected by the Project, there is a need to:

- improve the fundamental understanding of the biology and life history of relevant fish species;
- determine the options that are available for fish habitat compensation when fish habitat productive capacity is affected by development activities;
- establish baseline and sustainable harvest levels and related monitoring programs; and
- develop a strategy for surveillance and enforcement to meet the needs of increased harvest pressure that may develop if the Project proceeds, and to manage pressure that may accrue from induced development.

The Panel understands that some of these initiatives are under way.

RECOMMENDATION 9-4

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, no later than six months prior to the commencement of construction, a fish habitat compensation plan. The fish habitat compensation plan should be developed in consultation with, and to the satisfaction of, Fisheries and Oceans Canada. The plan should provide the basis for implementing effective habitat compensation measures such that the users of the local fisheries resource benefit from the habitat compensation measures over the long term. The plan should include:

- *the decision-making process to be used for achieving No Net Loss in accordance with Fisheries and Oceans Canada's National Habitat Management Policy, including how public and Aboriginal input will be incorporated;*
- *locations of potential Project-related HADD sites and the method for quantifying HADD fish habitat associated with the Mackenzie Gas Project;*
- *plans for fish habitat compensation measures to address HADD and the achievement of No Net Loss and the locations in which the plans are to be implemented;*
- *the process the Proponents will follow, and the criteria they will consider, in the selection of compensation measures that would be implemented when the location of the mitigation is not at the site of the impacts; and*
- *plans to be used to verify and measure the success of the fish habitat compensation techniques.*

As noted in Section 9.3.4, in the Panel's view, there is a need to ensure that the various regulatory actions being taken in relation to the Project and the protection of fish habitat and potential compensation are consistent. This would allow the Proponents to prepare a single plan that meets all regulatory needs.

The Panel accepts the Proponents' commitment to provide, for DFO's review and approval, the design information that DFO requires. The Panel remains concerned about the likelihood of success related to compensation for habitat destruction or alteration and the use of off-site compensation. However, in some situations, this may be the only viable option, given the difficulty of implementing habitat compensation in northern environments.

RECOMMENDATION 9-5

The Panel recommends that, prior to issuing any authorizations under the Fisheries Act *for activities related to the Mackenzie Gas Project, Fisheries and Oceans Canada develop a strategy for ensuring that effective habitat compensation measures are implemented by the Proponents, such that the users of the local fisheries resource benefit from the habitat compensation measures to the greatest extent possible over the long term and that Fisheries and Oceans Canada reflects the principles of this strategy in any authorizations it issues under the* Fisheries Act *for activities related to the Mackenzie Gas Project.*

If constructed, the Project would involve a wide range of activities extending over a very large geographical area, most of which would, in some way, be on, under or adjacent to the Mackenzie River or Mackenzie Delta. Ensuring that fish, fish habitat, and the aquatic and marine environments are protected requires not only the development of effective mitigation and monitoring measures, but also effective enforcement to ensure that the regulatory requirements are being implemented as prescribed. Surveillance and enforcement are essential functions that support the overall strategic approach to the regulatory process relating to watercourse crossings, fish and fish habitat. If the strategic approach to managing the regulatory process involved a considerable onus on the Proponents to decide whether a crossing causes HADD and implement mitigation measures to avoid HADD, then surveillance and enforcement would be an essential complement to make the strategic approach work.

A number of departments and agencies have enforcement responsibilities related to fish and fish habitat, and the aquatic and marine environments. Due to the realities of northern logistics and costs, these regulators would have to work in a coordinated and collaborative manner with the Government of the Northwest Territories (GNWT), management partners, other regulators and stakeholders as appropriate to ensure that a comprehensive and effective surveillance and enforcement presence was maintained.

The respective agencies have engaged in cooperative inspection and enforcement for some time, and the Panel expects that this will continue and be improved where possible. To ensure the protection of fish, fish habitat, and the aquatic and marine environments, an effective, coordinated program of inspection and enforcement would be required.

RECOMMENDATION 9-6

The Panel recommends that Fisheries and Oceans Canada, Environment Canada, Indian and Northern Affairs Canada, Transport Canada, the National Energy Board and any other department or agency with responsibility for inspection and enforcement in relation to fish or fish habitat or the aquatic and marine environments re-visit existing arrangements and develop a strategy that will provide for effective inspection and enforcement in relation to protecting fish, fish habitat, and the aquatic and marine environments in the north and in relation to Project-related activities. This strategy should also identify the resources necessary for its implementation, including identification of staff needed in the field to carry out the inspection and enforcement. The enforcement and inspection strategy should be completed prior to the commencement of construction and filed with the National Energy Board, as the lead regulatory agency for the Mackenzie Gas Project.

9.6 BARGE TRAFFIC AND LANDING SITE CONSTRUCTION

9.6.1 PROPONENTS' VIEWS

The Mackenzie River would be a major transportation corridor for the Project. As discussed in Chapter 14, "Physical Infrastructure and Housing," the Proponents provided estimates of barge traffic and requirements for landing sites along the Mackenzie River.

The Proponents would use a total of 24 barge landing sites during construction. Twelve are existing sites that are currently in use by others, seven are new sites that would be developed by the Proponents and five are existing sites, not currently in use but which would be put into use by the Proponents. Figures 2-17, 2-18 and 2-19 in Chapter 2, "Project Description," illustrate the barge landing sites.

The Proponents indicated that in-stream work would be required at barge landing sites and that dredge volumes would be estimated following bathymetry work. The Proponents stated that dredging associated with the development of barge landings would likely include clearing shoreline debris and boulders, and levelling bank materials. This would allow placement of the spud barge to off-load materials, which is consistent with practices currently being used along the Mackenzie River.

The Proponents indicated that the wake from vessels creates waves that can affect shorelines. As the number and frequency of barges moving up and down the Mackenzie River increased, there would be an increased potential for wave-generated erosion of the riverbanks.

The Proponents submitted that both dredging and shipping generate low-frequency noise. The Proponents noted that vessel traffic is transitory while dredging is often sustained for days or weeks within a limited area. In respect of noise, the Proponents noted a frequency range of 0.2–5.0 kHz for shipping with noise frequencies from dredging below 0.5 kHz. The Proponents also indicated that transient sounds of about 4.0 kHz might be produced by couplings that join segments of the floating dredge outlet pipeline, if used.

The Proponents submitted that sound travels more efficiently under water than in air and that high-frequency sounds attenuate or lose energy more rapidly under water than do low-frequency sounds. They also indicated that factors such as water depth, salinity, temperature, channel width, slope and bottom type (e.g. silt or rock) influence the quality and quantity of sound received. The Proponents submitted that, in the absence of human activities, ambient or background conditions are dominated by noise from waves, wind, rain, thunder, some fish and marine mammals, and occasional natural seismic events. The Proponents stated that they would develop management plans with their contractors to manage noise in the aquatic and marine environment.

During the course of the Panel's proceedings, the Proponents made commitments with respect to managing the potential impacts of barging and barge landing construction, including:

- bank stability and sediment deposition would be monitored at barge landing sites;
- barge landings would be designed and constructed to control sediment releases in accordance with DFO requirements; and

- measures for managing Project-related noise emissions would be included in the Air Quality and Emissions Management Plan.

FISH AND FISH HABITAT IMPACTS RELATED TO BARGE TRAFFIC AND DREDGING FOR BARGE LANDING CONSTRUCTION

The Proponents concluded that barging activities would not have an impact on fish populations. The Proponents further indicated they were not aware of any specific, related studies from the 1970s and 1980s, when there was generally a higher level of barge activity on the Mackenzie River. The Proponents also noted that the Fort Providence Traditional Knowledge Study did not report any change in fish harvesting or fish populations during the same period.

The Proponents indicated that direct studies have not been done on fish in the channel along the barge route in the vicinity of Mills Lake. However, in the Proponents' view, it is possible to make some inferences about what fish may be present and the habitat they may be using in the main part of the channel just by virtue of the flow and substrate regime and channel morphology. The Proponents considered it unlikely that spawning habitat would be found within the main channel for the species expected to be in Mills Lake. As a result, the Proponents concluded that there would not be an adverse impact on spawning habitat from barge traffic in the Mills Lake area.

The Proponents submitted that the increase in barge traffic on the Mackenzie River would be unlikely to generate noise of sufficient magnitude to physically damage fish, or elicit startle or alarm responses. The impacts of pressure or noise disturbance on fish from barge traffic were predicted to range from no impact to low magnitude, and to be local in extent during construction. Any changes in fish distribution from sound disturbance were expected to be local, short-term and within the normal range of variation in day-to-day distribution of the fish. The impacts were considered to be lower during operations due to a decrease in barge traffic.

The Proponents concluded that the amplitude of waves from barge traffic would not impact shoreline or bank erosion, and so no impacts on fish habitat were predicted. Barge-induced wave activity was considered negligible compared with baseline wind-driven impacts.

Project-induced barge traffic would continue to follow the existing shipping channels. According to the Fort Providence Traditional Knowledge Study, gill nets are typically set along river margins in protected areas away from the marked shipping channel. Given the current location of gill netting sites, as described in the study, the Proponents indicated that they did not expect that the increase in barge traffic would adversely impact fishing through direct interference or wave action.

The Proponents indicated that the impacts of dredging-related entrainment of fish and other organisms on the valued components in the freshwater environment were expected to be adverse, of low magnitude, local and short-term. The impacts of entrainment were considered to be confined to dredging activities carried out during construction, and decommissioning and abandonment.

EROSION AND WATER QUALITY IMPACTS RELATED TO BARGE TRAFFIC

The Proponents' assessment of potential wave impacts resulting from barge traffic indicated that the total wave energy created by intermittent barges over the summer season would be considerably less than the energy created by waves from dominant wind action. The total barge wave energy was estimated to be between 2% and 24% of wind wave energy at Inuvik, Norman Wells and Fort Simpson. Based on these results, the Proponents submitted that increases in bank erosion and sediment concentrations because of the increased barge activity are expected to be of low magnitude. The Proponents noted that the impacts of barge traffic are most pronounced in narrow and shallow river reaches. The Proponents indicated that localized erosion impacts might occur in the East Channel near Inuvik, where the channel is narrow and sinuous. The Proponents noted that reduced vessel speed in this reach would reduce barge-generated wave heights.

WATER QUALITY IMPACTS RELATED TO DREDGING FOR BARGE LANDING CONSTRUCTION

The Proponents stated that river bottom and bank sediments might need to be dredged at new and existing barge landings to facilitate barge landing installation, allow barge access and conduct routine maintenance. Proposed barge landings would be located at existing facilities and at historical temporary spud locations. Dredging could also be done at temporary barge landing locations each spring if continued barge access was required. The predominant impacts associated with dredging include potentially increased total suspended solids (TSS) levels, increased sedimentation on the river bottom and re-suspension of contaminants from disturbed bottom sediments.

The Proponents also noted that there is potential for increased water levels and velocities near barge landings. The Proponents submitted that these impacts were expected to be of low magnitude because of the potential small increases in levels and velocities relative to the large natural range of level and velocity between peak spring, mid-summer and late-winter flow.

9.6.2 PARTICIPANTS' VIEWS AND RECOMMENDATIONS

FISH AND FISH HABITAT IMPACTS RELATED TO BARGE TRAFFIC AND DREDGING FOR BARGE LANDING CONSTRUCTION

The East Dehcho Alliance questioned the mechanism for compensation in the Dehcho, where there is no settled land claim. The Proponents indicated that prior to barging, and certainly prior to construction, meetings would occur with potentially affected harvesters to determine how the compensation process would work. The East Dehcho Alliance indicated that the community would prefer to continue with their traditional activities, rather than be impacted by barge traffic and compensated for their losses.

Initially, DFO recommended that the Proponents undertake a more detailed analysis of barge traffic on bank erosion and riverbank habitat in the Fort Providence area. DFO subsequently withdrew this recommendation. They stated that further analysis concluded that there would be a potential for minor to no erosion impacts due to increased barge traffic during the Project for the portions of the River characterized by the clay-till bed found in the Fort Providence area.

DFO recommended that the Proponents develop and implement, in consultation with Aboriginal groups and responsible authorities, a plan that addresses increased marine and river barge traffic and its potential impacts to the biophysical environment, access to fisheries and other harvest activities. The plan should also include emergency response procedures for accidents and malfunctions, and a communication strategy to notify relevant communities and stakeholders of Project vessel traffic. The plan should take into consideration the *Vessel Traffic Marine Safety Advisory — Mackenzie River*, and existing shipping regulations and guidelines.

The Proponents agreed with this recommendation, with variation. They stated that although the issues described in this recommendation would be managed, a specific plan for all of the aspects would not be required. The Proponents submitted that its evidence had demonstrated that there would be no measurable impacts on the biophysical environment as a result of barge traffic and, therefore, a plan to manage the direct impacts, such as water quality on fish and fish habitat, is not required. They further noted that the barge operator would be responsible for emergency response plans to handle spills and other types of incidents associated with barge activities, in the unlikely event that they occurred. As noted in Chapter 7, "Accidents, Malfunctions and Emergency Response," the Proponents indicated that they would work with the barge companies to ensure that these detailed emergency response plans were adequate for the volumes and types of materials to be transported during Project construction. However, they also indicated that these plans fall under Transport Canada's jurisdiction. To ensure that those who want to fish have access to fish, the Proponents indicated that consultation with Fort Providence and other communities would include a discussion of Project logistics.

DFO also recommended that the Proponents develop a communication and consultation strategy to engage Aboriginal groups, other resource users and DFO in the planning of Project activities (e.g. dredging and barge transit) and during the development of fish habitat compensation plans.

The Proponents agreed with this recommendation, with variation. They stated that consultation with all stakeholders is an ongoing process that would continue during the design, construction and operations phases of the Project. The Proponents stated that this recommendation is addressed by Project commitments and the NEB's Proposed Condition 4, which requires that a consultation program be filed with the NEB, and which could also be provided to DFO.

EROSION AND WATER QUALITY IMPACTS RELATED TO BARGE TRAFFIC

The Deh Gah Go'tie Dene Council raised specific concerns regarding water quality and sedimentation as a result of increased barge traffic in the Fort Providence area. Maximum wind-generated waves, together with river currents during high flows, likely dominate shoreline processes along the reach of the Mackenzie River near Fort Providence. The most likely area where any impacts could be noticed is in the reach near Fort Providence where the channel narrows. As noted earlier, the wave energy analysis completed by the Proponents indicated that, at five Mackenzie River locations assessed near Fort Providence, the energy associated with wind waves over the summer period is significantly greater than the energy associated with the intermittent barge activity. The Proponents submitted that barge-generated waves were not expected to significantly affect shoreline processes in the reach of the Mackenzie River near Fort Providence.

Given the analysis results at Fort Providence, the Proponents further indicated that these wave mechanisms are not expected to cause erosion that is distinguishable from natural processes at other locations along the Mackenzie River. The Proponents indicated that a check of other narrow reaches along the Mackenzie revealed that the River is usually wider and deeper than the narrows at Fort Providence. The exception is the section above Fort Good Hope, known as the Ramparts, which is 450 m wide but lined with bedrock cliffs. Therefore, the Proponents submitted that erosion due to barge-generated waves is expected to be less there than elsewhere along the River.

The Deh Gah Go'tie Dene Council, East Dehcho Alliance and DFO raised concerns regarding contaminated sediments, and increased TSS and turbidity levels as a result of engine thrust and propeller action. The Deh Gah Go'tie Dene Council noted that this might pose a concern for the aquatic ecosystem and for nearby residents who draw their drinking water from the River and use it with little or no treatment. In response, the Proponents submitted that sediment re-suspension from propeller scour is expected to be minimal due to stable and erosion-resistant characteristics of the bed material. For example, in the Fort Providence area where the tugs would be operating, the propellers of the tugs would be about 3 m above the riverbed, limiting the potential for re-suspension of sediment.

The East Dehcho Alliance asked the Proponents to describe their plans for monitoring changes in turbidity and TSS as a result of increased barging activity. The East Dehcho Alliance highlighted the Canadian Council of Ministers of the Environment (CCME) guidelines for the protection of aquatic life, which state that TSS should not exceed 5 mg/L over background conditions. The Proponents indicated they had no plans to monitor additional contributions that the increased Project-related barging might have on the Mackenzie River. However, they noted that the Mackenzie was a turbid river and had regular natural occurrences of TSS levels above the CCME guidelines. The Proponents also pointed out that the 5 mg/L CCME guideline was for increases above long-term averages and that there is also a maximum 25 mg/L increase criteria for short-duration events, such as barge passing. Environment Canada also pointed out that the CCME guidelines allow for a broader range of TSS loads in a river, such as the Mackenzie, when there is already high flow and high TSS.

The East Dehcho Alliance asked whether low flow levels of the Mackenzie River were taken into consideration when predicting the potential impacts of increased barging on the River near Hay River/Fort Providence. The Proponents indicated that the analysis considered the low flow part of the season, though not the variation between the years, nor the lowest possible or recorded levels of the River.

The Deh Gah Go’tie Dene Council made a number of recommendations regarding the need for water quality monitoring and the specific parameters to monitor in relation to barging. The Proponents did not agree with these recommendations and responded that because water quality in the Mackenzie River would not be affected by barge traffic, additional drinking water and source water monitoring would not be required. Further, changes in water quality resulting from barge traffic would be too small to be measurable.

The Dehcho First Nations also made recommendations regarding monitoring water quality in relation to barge traffic. They also recommended that Dehcho monitors be established to monitor and patrol sensitive and vulnerable river ecosystems. The Proponents did not agree with this recommendation and responded that changes to water quality resulting from Project-related barge traffic would be too small to be measurable and monitoring of water quality is not required. They further noted that barges would use existing navigation corridors and would be expected to safely pass along the river, in accordance with the *Vessel Traffic Marine Safety Advisory — Mackenzie River*. Therefore, the Proponents submitted that restrictions on barge passage would not be required.

The Dehcho First Nations also recommended that Northern Transportation Company Limited (NTCL) and all other river traffic, including other barges, should limit their speed, travel in a single file and follow maximum load weights to avoid erosion. Each season, water conditions should be modeled and adjusted, in consultation with Dehcho First Nations, based on precipitation, wind and water levels and considering upstream withdrawals, such as those related to the oil sands in Alberta and hydro development in British Columbia. The Proponents did not agree with this recommendation and responded that wave studies demonstrated that no significant wave damage would occur with current operating practices and that barge operators currently take into account water conditions in planning barge loading and during transit on the River. Therefore, the Proponents submitted that further modeling is not required.

WATER QUALITY IMPACTS RELATED TO DREDGING FOR BARGE LANDING CONSTRUCTION

Indian and Northern Affairs Canada (INAC) and DFO questioned whether metals, nutrients and organic compounds would be released as a result of dredging under oxygen-rich conditions. The Proponents indicated that, upon disturbance of sediments in oxygen-deprived conditions, these dissolved parameters might be released to the overlying water. Given that the overlying water is oxygenated, the Proponents indicated that “rapid precipitation of dissolved chemicals would occur by partitioning to iron oxides and ambient TSS in the water column, with subsequent settling to the bottom.” (J-IORVL-00119, p. 111) Because sediment-bound metals and organic parameters are not bioavailable, despite potentially elevated concentrations when measured as total concentrations, the Proponents did not carry out any detailed modeling of water quality for dredging impacts because the water is oxygenated.

The Proponents also noted that if dredging is required it would be subject to a separate regulatory process and that, in all likelihood, the application would be made by the barge company, rather than the Proponents. The Proponents also stated that they had not identified the need for any dredging within the Dehcho Region.

The Town of Inuvik expressed some concerns over the proposed new barge landing site near Inuvik. The site would require considerable dredging and the Town noted that they were led to believe that some of this dredging would occur upstream from the winter water intake. The Proponents noted that they expected that any suspended sediment in the River would settle out very quickly and did not expect any impacts on drinking water. Further, they stated that they are committed to working with the Town of Inuvik and its residents to inform them about proposed activities and to reduce associated concerns.

The Gwich’in Tribal Council asked about regulations that might apply to construction and operation of the proposed barge landing near Inuvik and the type of proposed mitigative measures. The Proponents responded that there are regulations and the Proponents made a number of commitments regarding activities near water bodies, such as having secondary containment around fuel tanks and following specific pre-fuelling practices when near water. The Gwich'in Tribal Council also asked about the potential long-term impacts of the proposed new docking facility on water intake and downstream users, and whether sediment build-up over time would force the community to relocate their existing water intakes and boat launch. The Proponents responded that their hydrology and transport assessment did not identify any concerns with sediment build-up around the proposed barge landing that could affect Inuvik's water intakes.

DFO recommended that the Proponents provide additional information regarding proposed dredging activities for DFO's review and approval, including:

- the method, volume and timing of all proposed dredge activities and disposal locations;
- environmental information, including fish habitat assessment, sediment quality and composition; and
- site-specific mitigation and decision criteria for all final dredge site locations.

The Proponents agreed with the recommendation, with variation. The Proponents recognized that DFO has regulatory jurisdiction for those portions of the Project that could affect fish or fish habitat and will continue to work with DFO staff and provide the design information DFO requires for its authorizations, including information on dredging.

9.6.3 PANEL VIEWS AND RECOMMENDATION

FISH AND FISH HABITAT IMPACTS RELATED TO BARGE TRAFFIC AND DREDGING FOR BARGE LANDING CONSTRUCTION

The Panel accepts the Proponents' analysis that barge traffic associated with the Project is not likely to cause a significant adverse impact on fish and fish habitat, provided the Proponents implement their commitments. The Panel heard concerns regarding the potential for interference with fishing activities in the Fort Providence area. In addition, general concerns were expressed regarding the need for compensation, should Project-related barge traffic interfere with harvesting. Further discussion of the issue of compensation is provided in Chapter 12, "Harvesting."

EROSION AND WATER QUALITY IMPACTS RELATED TO BARGE TRAFFIC

The Panel heard many concerns from participants, particularly from the East Dehcho Alliance and the residents of Fort Providence, regarding the potential for adverse impacts to water quality from increased barge traffic. However, the Panel accepts the Proponents' conclusion that the quantity of re-suspended sediment resulting from barge traffic would be too small to be measurable and that water quality would not be adversely affected by normal barge traffic. In the Panel's view, the Proponents' commitments to consult the community of Fort Providence and others regarding appropriate mitigation measures related to barging is an essential step to address community concerns.

WATER QUALITY IMPACTS RELATED TO DREDGING AND BARGE LANDINGS

The Panel heard many concerns about the potential impacts from dredging and the installation of barge landings. The Panel considers that the Proponents' commitments are important elements of an approach to mitigate these potential impacts. The Proponents committed to develop Environmental Protection Plans, comply with regulatory requirements, monitor impacts, and consult with communities regarding Environmental Protection Plans and the site-specific mitigation measures to be implemented. Notwithstanding those commitments, the Panel received a number of specific recommendations with respect to dredging and installing barge landings in the Mackenzie River. The Panel also recognizes that communities were not reassured by the future regulatory review of these activities.

RECOMMENDATION 9-7

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, at least six months prior to the commencement of construction, their final plans for Project-related dredging and installing barge landings. The plans should be developed in consultation with potentially affected communities and identify the concerns expressed by those communities and how those concerns have been addressed in the development of the plans. The plans should also be developed in consultation with, and to the satisfaction of, Fisheries and Oceans Canada and Transport Canada, and indicate how dredging activities will be undertaken so as to avoid conflict with community fisheries and provide for monitoring.

Provided that the Proponents' commitments and the Panel's recommendation are implemented, the Panel is of the view that the environmental impacts of barge traffic and barge landing construction would not likely be significant. The Panel does not have sufficient information before it with respect to the Expansion Capacity Scenario or Other Future Scenarios to make a determination of significance of the impacts of developments associated with these two scenarios.

9.7 MARINE AND RIVER DREDGING, AND DISPOSAL AT SEA

9.7.1 PROPONENTS' VIEWS

The Proponents indicated that in order to ship the Very Large Modules (VLMs) from the Beaufort Sea south to Inuvik, selected dredging may be required in the Mackenzie River. Bathymetric surveys were to be undertaken in the summer of 2007 to determine the extent, if any, of required dredging. At the time of the Project Update in May 2007, the Proponents estimated the amount of dredging to be approximately 130,000 m^3 at seven locations ranging from 5 km to 30 km downstream of Inuvik, as identified in Table 9-1 and in Figure 9-1.

The Proponents' proposed route to ship the gas conditioning facility (GCF) to the Niglintgak site — through Kittigazuit Bay, up the East Channel, then down the Middle Channel of the Mackenzie River to reach the site — would follow Transport Canada (TC) designated routes but might require dredging at some locations. The Proponents' preliminary evaluation of local bathymetry and channel configurations suggested that 11 km of dredging might be required in southern Kugmallit Bay and Kittigazuit Bay. The current estimated 11 km of potential dredging would affect a total area of about 88 ha, excluding the area affected by the deposition of dredge spoil. The Proponents indicated that, in the absence of more definitive modeling, they assumed that about 176 ha could be affected by dredge spoil, making the total area affected to be about 264 ha. In the May 2007 *Supplemental Information — Project Update*, the Proponents estimated that about 148,000 m^3 over a 6-km section of the existing shipping channel in the Kittigazuit S-bends would be required for moving the GCF. That estimated volume also includes the predicted marine dredging at the Kittigazuit S-bends of up to 52,000 m^3 over a length of about 3 km that might be required for moving the Niglintgak GCF barge. Notwithstanding plans to dredge at the Kittigazuit S-bends, the Proponents were continuing to pursue Shallow Bay as a possible route that would not require dredging. The Proponents did not want to exclude the possibility of using this route if it ultimately represents a better option.

The Proponents stated that the Kittigazuit Bay area is in Beluga Management Zone 1(a) and is classified as Category E by the Inuvialuit community conservation plans. They further indicated that "all Beluga Management 1A zones are under consideration to become marine protected areas." (EIS, V6B, Section 7, p. 70)

The Proponents noted that dredging and shipping are permitted in Beluga Management Zone 1(a) at all times of the year, provided that the activity takes place along a designated route. The designated routes are those marine transportation corridors established by Transport Canada, following consultation with DFO. A designated shipping route through the Beluga Management Zone 1(a) is currently used by NTCL for barging activities.

The preferred method for dredging north of Inuvik for the VLMs would be to use a cutter-suction dredge. Dredging activities would be undertaken in the year of transport from June to August. Dredge spoils would be disposed of by side-casting in the channel near the dredge sites. In the case of dredging at the Kittigazuit S-bends, the Proponents said they would side-cast dredge spoils via a floating pipeline, thus enabling the deposition of the dredged material into "specific locations that have been discussed and accepted by the communities and the regulators." (Kim Johnson, HT V54, p. 5143)

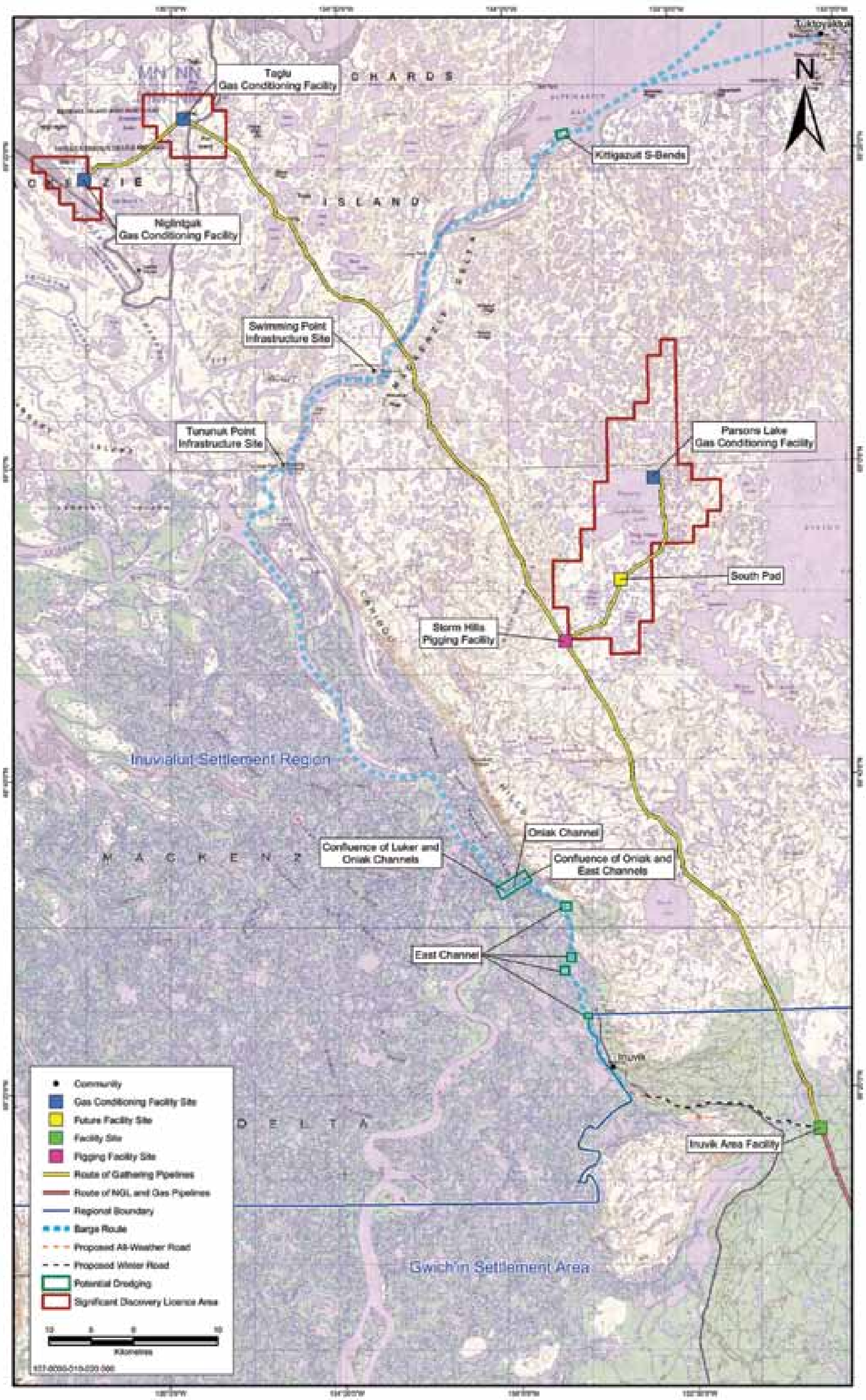
The Proponents indicated that dredging would take place two years prior to the transportation of the GCF. Dredging operations would continue until freeze-up, which generally occurs in October. The Proponents reported that, during its consultations, concerns about dredging were related to potential harm to or displacement of fish and marine mammals, as well as potential interference with or displacement of community shipping and harvesting activities. The Proponents indicated that their plans provide for some over-dredging as a contingency in the event

Table 9-1 Potential Dredging Volumes for Very Large Module Transport

Location	Distance from Inuvik (km)	Dredging Volumes for 4,200 t VLMs (m^3)	Length (m)
Confluence of Luker and Oniak Channels	29.1	45,000	750
Oniak Channel	27.5	6,500	500
Confluence of Oniak and East Channel	26.0	17,600	500
East Channel	19.9	43,800	110
East Channel	13.6	6,600	250
East Channel	11.9	6,500	500
East Channel	4.7	3,200	250
	Total	129,200	2,860

Source: Adapted from J-IORVL-000953, Table 4-1, p. 2

Figure 9-1 Locations of Potential Marine and River Dredging



Source: J-IORVL-00953, Figure 4-1, p. 3

that a portion of the channel fills in before the GCF barge is brought to the set-down site. In addition, the shipping schedule would allow time in the second year to complete any clean-up work that might be required. Prior to the transit of the GCF, the Proponents would confirm that the channel was sufficiently clear to enable passage of the GCF barge. Although there is no historical record regarding the S-bends that a major event ever blocked shippers from using the channel, the Proponents plan, as a contingency, to have a smaller-scale dredge on-site to conduct small-scale clean-up dredging if necessary. Timing of dredging would balance the benefits of completing the dredging in one season with potential interference to the annual beluga harvest. The Proponents' plans call for the dredging activity to occur after the beluga harvest or, if necessary, after August 15, the date set out in the *Beluga Management Plan* and proposed Marine Protected Area regulations.

In the May 2007 *Supplemental Information — Project Update*, the Proponents confirmed that the Niglintgak GCF would be a land-based facility located in an excavation on the flood plain of the Kumak Channel. The installation would require up to 50,000 m^3 of materials to be excavated. The Proponents indicated that excavation would occur primarily in winter.

The Proponents noted that additional information would be required to support potential dredging to satisfy DFO regulatory requirements under the *Fisheries Act*, which would likely include:

- bathymetric data to confirm dredging locations and volumes;
- sediment characterization data;
- fish and fish habitat studies;
- sediment transport analysis; and
- data required to support the selection of dredge spoil disposal sites.

During the course of the Panel's proceedings, the Proponents made a number of commitments with respect to dredging, including:

- Environmental Protection Plans (EPPs) for dredging would be developed as detailed engineering design proceeds. During the development of the EPPs, the Proponents would consult with applicable experts for input on the proposed measures and then provide revised EPPs to the regulators who have inspection authority. The public would then have the opportunity to review and comment on these site-specific environmental protection measures. The EPPs would be finalized after Project approvals have been received and the applicable regulatory conditions are considered.
- dredging and sediment control methods would be selected to comply with *Fisheries Act* authorizations.
- dredging locations would be monitored in nearshore coastal waters and delta channels. Parameters monitored could include conventional key indicators, total suspended solids, nutrients, metals, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenols (PCBs).
- dredging would be planned two years before transporting the gas conditioning facility module and after the beluga harvest or August 15, as set out in the beluga management plans.

The Proponents indicated that Mackenzie Delta channels are used primarily as corridors for upstream and downstream movement by adult and juvenile diadromous fish, with deeper channels also providing overwintering habitat. The Proponents further stated that the bulk of the fish that actually move through the area do not move through the S-bends. In fisheries studies, the Proponents caught fewer fish in the S-bends than along the shoreline. The Proponents also noted that those who fish in the area indicate that fish are primarily found immediately adjacent to beach areas and in the shallows, and that they tend to move up along the shoreline, taking advantage of the embayments. Most people fish along the shore rather than in the area of the S-bends. The Proponents indicated that a large number of migratory fish species would be found further up the Delta and not in the S-bends during the time that dredging would occur.

The Proponents identified the following potential impacts on fish and fish habitat associated with river and marine dredging:

- disruption of fish habitat by removal of bottom sediments at the dredge site and blanketing existing habitat at the disposal site with dredge spoils;
- entrainment of larval and juvenile fish by the suction dredge;
- potential displacement of fishing activities during dredging operations; and
- re-distribution of any contaminants that might be found in the sediments to be dredged.

Discussion of the potential dredging impacts on marine mammals is provided in Section 9.8.

The Proponents indicated that dredging can result in large amounts of suspended sediments by disturbed bottom sediments. The Proponents submitted that much of the dredged sediment that became suspended would settle to the bottom within several hundred metres and, therefore, would be removed from the water column. Although the increase in sediment load would be high near the dredging and disposal sites, the Proponents submitted that the overall downstream load would likely be within the normal range of variability in the East Channel of the River. They also submitted that, due to sediment composition and the dynamic nature of natural processes operating in the area, it would be difficult to differentiate conditions at the disposal site from the original conditions within a very short period of time. The Proponents considered the overall impact of dredging on sediment loads to be low.

The Proponents also examined potential impacts of dredging on water and sediment quality in terms of the potential for re-suspension of contaminants in the sediment. They noted that field studies of dredged material disposal have found that chemical releases are transient and localized during dredging and that water quality tends to return to background conditions shortly after dredging. The Proponents noted that available sediment quality data for the Mackenzie River suggest that levels of certain chemicals (arsenic, cadmium and certain polycyclic aromatic hydrocarbons [PAHs]) could exceed freshwater sediment quality guideline levels for the protection of aquatic life. However, these chemicals are likely of natural origin, resulting from geological sources and forest fires.

The Proponents stated that the potential impacts on fish from dredging activities are expected to be low and localized because:

- dredging is unlikely to affect the use of the Delta channels as upstream and downstream movement corridors;
- changes in bed material is unlikely;
- entrainment of fish and benthic invertebrates would be limited to organisms in the immediate path of the dredge; and
- benthic invertebrates are expected to recover within one to two years.

At the time the May 2007 *Supplemental Information — Project Update* was presented, the Proponents could not provide a comparison of potential impacts at dredging locations because data on the physical characteristics of the material to be disposed of and specific disposal locations were not available. However, they did predict that potential impacts of dredging were expected to be similar at all disposal locations.

While dredging activities have been carried out in the S-bends in the past, it appears that there was no follow-up monitoring conducted of those operations. The Proponents indicated that the literature suggests that the substrate is of a type that is re-colonized by benthos within a few years of disturbance.

The Proponents predicted that the impacts of dredging-related entrainment of fish and other organisms on the valued components in the marine environment would be adverse, low magnitude, local and short-term. The Proponents considered the impacts of entrainment to be confined to dredging during construction, and decommissioning and abandonment.

9.7.2 PARTICIPANTS' VIEWS AND RECOMMENDATIONS

Environment Canada told the Panel that dredging and disposal of dredge spoils in Kugmallit Bay are subject to regulatory approval under the Disposal at Sea provisions of the *Canadian Environmental Protection Act, 1999*. Before a permit is granted, EC solicits input from appropriate government agencies, including DFO and the Inuvialuit Review Process, and consults other interested parties and communities. Permits are published for a 30-day public comment period in the *Canada Gazette* prior to issuance.

EC noted that the Proponents had not yet submitted detailed information supporting a disposal at sea permit. However, based on its assessment of the information provided to date, historical knowledge of the area and expertise in the subject matter, EC expected that potential adverse environmental impacts from disposal of dredged sediments would be minimal, as long as the Proponents:

- followed the regulatory approval process;
- complied with Part 7 of the *Canadian Environmental Protection Act, 1999* and its *Disposal at Sea Regulations*; and
- complied with the terms and conditions of any permit issued, including implementation of mitigation measures.

In addition, follow-up monitoring would be required to confirm the assumptions made at the time of permit issuance. EC indicated that it would require monitoring as a condition attached to a disposal at sea permit. Since EC is also responsible for monitoring disposal areas, it would assess its impact hypotheses on the re-colonization of the benthos.

Environment Canada further indicated that it could attach timing restrictions to a permit and that it would consult with hunters, trappers and other government agencies to obtain advice on potential timing restrictions. For example, a permit could specify an August 1 start date with the additional requirement that the actual start date for loading and disposal of dredge spoils to be dependent upon on the progress of the beluga harvest and any additional timing restrictions that might be required by hunters and trappers.

DFO's assessment showed that there would likely be harmful alteration of fish habitat associated with the proposed dredging and spoil disposal at the Kittigazuit S-bends. The harmful alteration would be the removal of substrate at the dredge site and deposit of the substrate on other fish habitat at disposal locations. For this reason, the dredging and spoil disposal would require regulatory review under the *Fisheries Act* and would likely require a *Fisheries Act* authorization.

DFO indicated that it would need further information to conduct its regulatory review under the *Fisheries Act*. DFO recommended that the Proponents provide DFO with additional information on the method, volume and timing of all proposed dredging activities and disposal locations, as well as environmental information, including fish habitat assessment, sediment quality and composition, and site-specific decision criteria for selecting mitigation for all final dredging sites. DFO suggested that habitat compensation would be considered as a potential requirement of an authorization. The Proponents agreed with DFO's recommendation regarding the provision of further information, recognizing that DFO has regulatory jurisdiction for those portions of the Project that could affect fish or fish habitat. The Proponents will continue to work with DFO and provide the design information DFO requires for its authorizations, including information on dredging.

DFO indicated that dredging in the Tarium Niryutait Marine Protected Area could be allowed, but it would have to be consistent with the conservation objectives outlined in the management plan for the area. DFO concurred that if the Proponents are compliant with the existing regulatory framework and the existence of the Marine Protected Area is taken into account by DFO and that DFO considers the conservation objectives in deciding whether and how to issue regulatory approvals, then the protective mechanisms of the Marine Protected Area would be essentially addressed.

DFO recommended that the Proponents conduct sediment core sampling at a minimum of seven of the sites most likely to be dredged along the proposed route to the set-down location of the Niglintgak GCF and that the samples be analyzed for PAHs, heavy metals and trace metals. DFO recommended that the Proponents monitor water quality in the vicinity of the dredging sites in Kittigazuit Bay for all Project dredging operations. DFO also recommended that sub-sampling of sediment in anoxic conditions where dredging is proposed should adhere to a specified methodology. The Proponents agreed with these recommendations, with variation, indicating that a monitoring program would be developed in consultation with DFO to achieve the objectives described by DFO.

Following the review of sediment data gathered by Shell Canada Limited (Shell) in the S-bends region of Kittigazuit Bay, Health Canada noted that it was unlikely that proposed dredging activities would release sufficient amounts of contaminants to negatively impact the quality or chemical safety of country foods. Therefore, Health Canada concluded that the potential risk to human health from the possible impacts to country foods from dredging would be low. Health Canada further noted that they were satisfied with the information that the Proponents provided and would not require further assessment of possible impacts or monitoring of country foods related to dredging at the Kittigazuit S-bends.

Natural Resources Canada (NRCan) stated that the EIS adequately describes the potential impacts from disposal of dredged spoils and noted that if dredging occurs, further assessment would be undertaken during the Project permitting phase. In particular, if dredging in the Kittigazuit area was required, then the exact nature of sediments would be important to understand the impact of dredge disposal and the longevity of dredged channels.

NRCan recommended that the Proponents provide detailed information on sediment characteristics and mobility in Kittigazuit Bay and that further assessment was required related to dumping of dredged spoils. The Proponents agreed to both of these recommendations.

NRCan made further recommendations regarding the specific locations and extent of dredging required for the Niglintgak GCF, analysis of changes in sediment concentrations, and more detailed assessments of bed and bank disturbances following decommissioning and abandonment. The Proponents agreed with these recommendations, with variation. The Proponents noted that these recommendations are applicable to the GCF set-down site only. Further, the Proponents stated that they would include winter excavation requirements for the set-down site, together with any minor summer dredging requirements as part of the permitting process for that activity. The Proponents also noted that the plans for abandonment, reclamation and decommissioning would be covered in the relevant permitting process, and would be discussed, and enhanced as needed, with regulators and other appropriate stakeholders.

The Joint Secretariat—Inuvialuit Renewable Resource Committees (Joint Secretariat) indicated that not all of the concerns it had raised with the Proponents regarding the barge-based GCF concept had been appropriately addressed. While the Joint Secretariat did not oppose the barge-based GCF concept in principle, they required additional information before they would be satisfied that this was a suitable design option, including:

- fish and fish habitat studies along the proposed barge transport route;
- fish and fish habitat studies in the area of the proposed set-down location for the GCF;
- information regarding the proposed winter excavation and summer dredging of the channel at the set-down location for the GCF, including:
    - how this activity would be carried out and how the integrity of the winter excavation would be maintained into the summer (e.g. after the spring flooding);
    - the potential impacts in the area;
- the final dredging locations, volume and extent of dredging in each area, and identification of the potential impacts of dredging these volumes;
- confirmation of plans for dredge spoil disposal; and
- the plans for monitoring impacts to fish and fish habitat after dredging is complete.

Shell indicated that it was undertaking the work necessary to address the concerns of the Joint Secretariat and that it is committed to continuing consultation with the Inuvialuit throughout all phases of development to facilitate understanding and acceptance of the barge-based GCF.

9.7.3 PANEL VIEWS AND RECOMMENDATIONS

Given the overlap between marine and river dredging and disposal, and barge traffic and landing site construction described in Section 9.6, the Panel is of the view that its Recommendation 9-7 regarding barging should also be implemented for river and marine dredging activities.

RECOMMENDATION 9-8

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, at least six months prior to the commencement of dredging, their final plans for dredging in support of transport of the Very Large Modules and the Gas Conditioning Facility. The plans should be developed in consultation with, and to the satisfaction of, Fisheries and Oceans Canada, Environment Canada and Transport Canada. The plans should be developed in consultation with the Fisheries Joint Management Committee and the Inuvialuit Game Council, as well as the potentially affected communities, and identify the concerns expressed by those bodies and how those concerns have been addressed in the development of the plans. The plans should include the specific measures proposed to address any adverse impacts and provide for monitoring.

The Panel notes that the Proponents indicated an interest in the use of Shallow Bay as a potential route for marine transport. In the Panel's view, there was not sufficient analysis or evidence put before the Panel with regard to the potential impacts of this option, or whether or how it may be preferred to the current proposal. As such, the Panel has not considered it further and is of the view that should Shell wish to pursue this option that it be the subject of a separate environmental/regulatory review.

Regarding the proposal for winter excavation at the Niglintgak GCF, the Panel notes Shell's commitment to undertake the work necessary to address the Joint Secretariat's concerns and provide regulators with the information required for permitting purposes. The Panel was not presented with sufficient evidence to determine whether there would be adverse impacts from the installation of the Niglintgak GCF or whether the proposed mitigation would be adequate.

RECOMMENDATION 9-9

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require Shell Canada Limited to file, either as an individual applicant or as a part of a filing in support of Panel Recommendation 9-8, at least six months prior to the commencement of construction, its plan for excavation/dredging at the site of the Gas Conditioning Facility at Niglintgak. Shell Canada Limited's plan should describe the potential impacts associated with dredging and the site-specific mitigation measures proposed to address those adverse impacts. The plan should be developed in consultation with the Fisheries Joint Management Committee and the Inuvialuit Game Council and indicate how the concerns of these bodies have been addressed in the plan. The plan should be developed in consultation with, and to the satisfaction of, Fisheries and Oceans Canada.

Provided that the Proponents' commitments and the Panel's recommendations are implemented, the Panel is of the view that the environmental impacts of marine and river dredging and disposal at sea would not likely be significant. The Panel does not have sufficient information before it with respect to the Expansion Capacity Scenario or Other Future Scenarios, so it is unable to make a determination of significance of the impacts of developments associated with these two scenarios.

9.8 MARINE MAMMALS

9.8.1 EXISTING CONDITIONS

BELUGA WHALE

The Beaufort Sea beluga whale is listed as not at risk nationally and secure on the NWT General Status Ranks. The minimum population of beluga whales was estimated recently to be more than 32,000. The population is considered to be stable or increasing, based on the continued presence of large and old individuals, and the lack of change in the age and size structure of the harvest in recent years. Ecologically, the beluga is at the top of the marine food chain, is abundant and preys on a diverse array of fish and invertebrates.

The beluga whale is important to the subsistence economy of the Inuvialuit Settlement Region. The species is hunted primarily by whalers from Tuktoyaktuk, Aklavik, Inuvik and Paulatuk. The products of the hunt are shared among all Inuvialuit communities. In addition to the value of the beluga whale as food, the annual harvest is an important Inuvialuit cultural tradition. The number of beluga whales taken annually by the Inuvialuit averaged 120 from 1987 to 1998. Beluga whales are also important to neighbouring Inupiat communities in Alaska where the average annual take is about 68. Whales are harvested in the summer concentration areas from June through to mid- to late August.

BOWHEAD WHALE

The bowhead whale is classified as endangered in Canada (listed on Schedule 2 of the *Species at Risk Act*) and sensitive on the NWT General Status Ranks. The population of the western Arctic bowhead whale stock, estimated at about 8,200, represents more than 90% of the world's population. Commercial hunting of bowhead whales from the late 1800s to the early 1900s greatly reduced the population. Bowhead whales are now being managed for recovery. There is a substantial subsistence harvest by Alaskan Inupiat and a small, but culturally important, harvest by the Inuvialuit in Aklavik in recent years. For subsistence purposes, the Inupiat harvest about 60 bowhead whales annually by permit. Inuvialuit from Aklavik harvested one whale in 1991 and another in 1996. The species also has value for tourism, particularly when they frequent nearshore waters near Herschel Island and along the Yukon coast.

DFO indicated that there are approximately 10,000 bowhead whales in the Bering Sea stock, which come to the Beaufort Sea each summer to feed. The Bering Sea stock is presently approximately 30 to 40% of its pre-whaling size. DFO and the Inuvialuit have been concerned about some unexplained mortalities in the last decade, where bowhead carcasses have washed ashore in the southeast Beaufort. DFO indicated that a precautionary approach needs to be applied to this species. Bowhead whales live for more than 100 years and possibly up to 200 years. They are very slow to mature and have a low reproductive rate. Bowhead whales feed primarily on zooplankton. DFO indicated that bowhead whales travel a long distance each summer to the Beaufort Sea to feed on dense aggregations of prey in certain areas from mid-August through September.

9.8.2 PROPONENTS' VIEWS

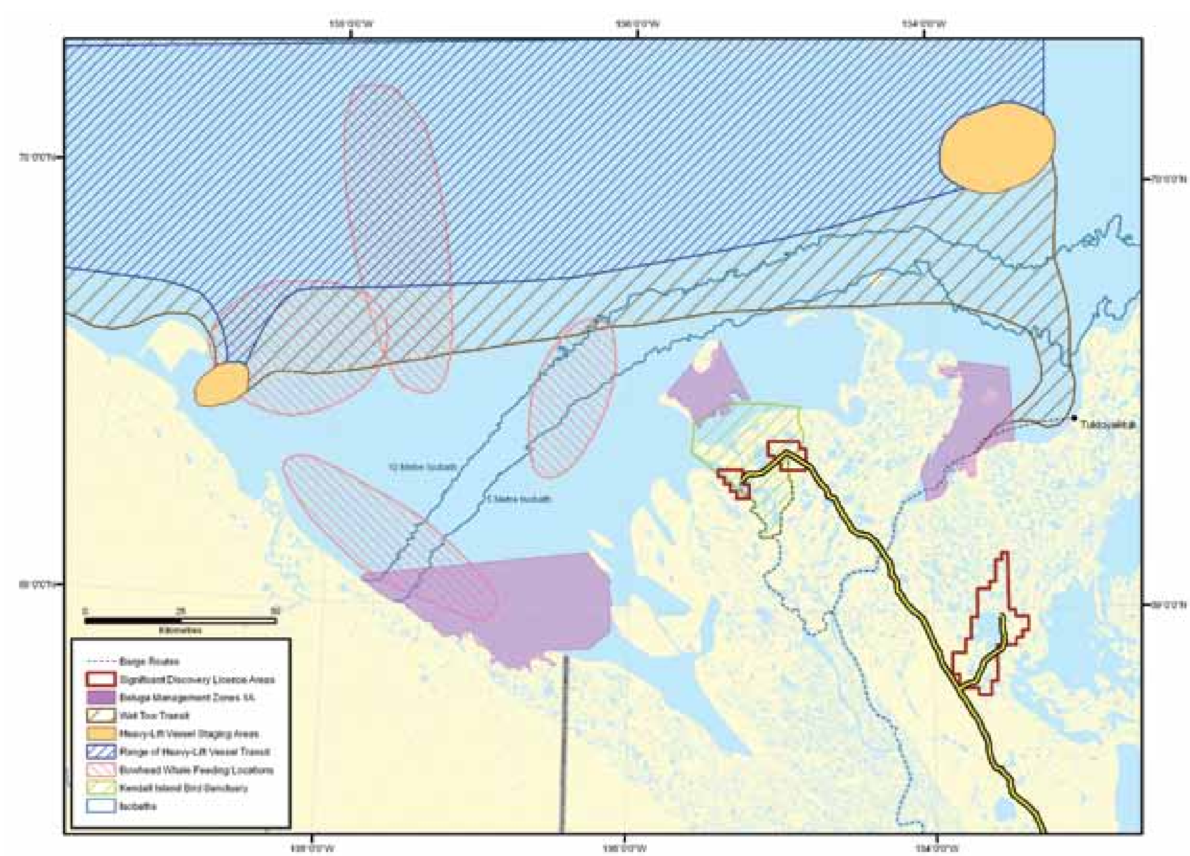
BELUGA WHALE

The Proponents' proposed dredging activities and barge transport of the VLMs and the GCF would occur in areas that are seasonally frequented by beluga whales and beluga whale hunters. Figure 9-2 illustrates the proposed transport corridor. The corridor passes through the southernmost part of the Kugmallit Bay and Kittigazuit Bay summer concentration area for beluga whales, one of three shallow estuarine summer habitats used by beluga whales from late June to mid-August. Individual beluga whales remain in the concentration area for a few to several days at a time and then move out again to the Beaufort Sea offshore. Few beluga whales remain in the concentration area by late July or early August. Approximately 20 km of the proposed barge transport route passes through the southernmost part of a beluga whale management area — the Kugmallit Bay Beluga Management Zone 1(a), as designated in the Fisheries Joint Management Committee's *Beluga Management Plan*.

The Proponents said that they intended to begin dredging on August 15 to avoid disruption of beluga hunting activities. The Proponents indicated that they had researched harvest data and reported the following end dates for the beluga harvest in recent years: August 9, 1998; August 10, 1999; September 8, 2000; August 2, 2001; August 12, 2002; August 3, 2003; August 11, 2004; and August 7, 2005.

The Proponents indicated that they are interested in continuing communication with the Inuvialuit Game Council, FJMC and local hunters to see if dredging can begin earlier, when the harvest is essentially complete, with a view to completing the dredging in one year.

Figure 9-2 Marine Activities in Relation to Bowhead Whale Feeding Locations Near the Beluga Management Zone 1(a)



Source: Adapted from J-IORVL-00735, p. 4; J-DFO-00051, p. 11; J-IORVL-00279, Figure JRP DFO 2.01-1, p. 23; and J-SCL-00043, p. 2

The Proponents indicated that they would take the following actions to avoid interference with the beluga hunt:

- communicate with the local Hunters and Trappers Committee to discuss the time period for dredging;
- schedule the dredging operation to reduce overlap with the major beluga whale use of the Kugmallit Bay Beluga Management Zone 1(a) and the beluga whale hunt; and
- employ a whale monitor from the community to observe dredging operations.

The Proponents indicated that they would prefer to start dredging activities earlier than August 15, as this would increase the potential for dredging to be completed in one season. They also indicated in the event that beluga harvesting extends past August 15 or harvesting starts again after dredging or transit activities begin, that they would discuss this and consult with hunters to determine if they could start these activities earlier than August 15. At a minimum, they would like to rely on August 15 as the start date for these activities.

The Proponents indicated that the Project's planned marine activities would comply with the proposed regulations for the Tarium Niryutait Marine Protected Area, which control transit and dredging, and the Beluga Management Guidelines in the *Beluga Management Plan*.

The Proponents predicted that sensory disturbance during barge transport would change beluga whale habitat availability. They predicted that few beluga whales would be in the Beaufort Sea when the barge is travelling to the Mackenzie estuary. Based upon numerous studies and empirical observations of beluga whale behaviour, the Proponents predicted that indirect habitat loss as a result of noise disturbance from barge transport in the Beaufort Sea and Mackenzie Delta area would affect only a few whales and only for the short period when the barge was passing nearby. The Proponents predicted that the extent of indirect habitat loss that might occur from sensory disturbance would be low. The Proponents concluded that barging might affect whale hunting by causing the few beluga whales in the area to move up to 5 km away from the southern shore of Kugmallit Bay. The Proponents noted that hunters normally have to travel further than 5 km to encounter beluga whales and that this shift would not substantively alter access to beluga whales by hunters.

The Proponents predicted dredging impacts in Kugmallit and Kittigazuit bays to include physical disturbance, change in water quality, sensory disturbance causing active avoidance of estuarine areas, and changes in beluga whale habitat availability. The Proponents do not expect changes in beluga whale habitat availability at Niglintgak. The Proponents concluded that, in the Mackenzie River estuary, beluga whales would be the only marine mammals that might be affected by the proposed dredging operations. They noted that previous observations near dredging operations suggest the maximum distance of temporary disturbance to beluga whales is approximately 2.4 km from dredge and service vessels. The shipping channel in Kugmallit Bay lies approximately 2.5 km from shore. Therefore, the area within approximately 5 km from shore might be temporarily affected by dredging. The Proponents indicated that this would represent about 4% of the total area of the Kugmallit Bay Beluga Management Zone 1(a), located primarily along the southern shore of Kugmallit Bay, and the disturbance may occur over a one to three week period. In addition to the radius of disturbance associated with the dredge, there would also be periodic disturbance from support vessel traffic during crew movements and barge re-supply. The Proponents indicated that the potentially affected area is the least-used part of the beluga whale concentration area and whales would still have access to the remainder of the area. Acoustic displacement would be potentially less than 2.4 km because of the very shallow water and the greater potential for sound attenuation. In terms of the area to be directly disturbed by dredging, the Proponents estimated it to be 264 ha, or less than 1% of the 44,000 ha Kugmallit Bay Beluga Management Zone 1(a).

Dredging has the potential to disrupt fish habitat both physically and by changing water quality. The Proponents indicated that seabed disruption, and changes in the size and composition of bed material would affect benthic habitats in the dredged area, either directly by the actions of the cutter head or indirectly by burial with side-cast dredge spoils. Changes in benthic habitat would affect the community structure, distribution and abundance of benthic invertebrates in the dredged and disposal areas. In the worst case, benthic fauna in the dredged and disposal areas would be destroyed. Although dredging would affect benthic marine organisms, impacts of reduced food availability on fish would be unlikely. The total potential area to be dredged is less than 0.6% of the benthic habitat available in the Kugmallit and Kittigazuit Bays. Impacts on availability of fish food would be negligible because only a very small part of the invertebrate food supply would be affected. The Proponents concluded that dredging would not affect critical or limited habitats for the production of prey on which beluga whales or other marine mammals feed.

Assessment of the potential dredging impacts considered timing to avoid interactions with beluga whales and the harvest, recognizing that it would be preferable to complete the dredging in one summer season. The Proponents expected no significant adverse impacts on beluga habitat.

With regards to potential impacts on beluga whale habitat availability during dredging and installation of the GCF, the Proponents concluded that the impacts would be adverse, of low magnitude, local in extent and short-term in duration.

The Proponents also concluded that changes in beluga whale habitat availability would not likely occur during facility operations, or decommissioning and abandonment. The Niglintgak GCF is designed to operate year-round for 25 to 30 years. Noise would be created primarily by compressors and piping. The site would be at least 20 km from any beluga whale concentration areas, and would be physically and acoustically isolated from the open water to the north in the Beluga Bay–Kendall Island Bird Sanctuary beluga concentration area. However, the Proponents noted that there might be instances where individual beluga whales could be exposed to operational noise disturbance. The Proponents concluded that the largest potential impacts of the Niglintgak GCF during operations, decommissioning and abandonment on beluga whale habitat availability would be of adverse, moderate magnitude, local in extent and short-term in duration. Low magnitude impacts from operations would be long-term.

BOWHEAD WHALE

The principal interactions between the Project and bowhead whales would involve marine transportation via the over-the-top route (ocean transits that ship goods around Alaska and into the Beaufort Sea). The Proponents estimated that Project-related marine traffic would involve in the order of 5–6 heavy-lift ship and ocean barge trips and 10–13 transits into the Mackenzie Delta and Beaufort Sea over a two-year period. Weather permitting, a total of approximately four weeks of activity over two years would be required for transit and staging. In the Proponents' view, this represents a small amount of activity over a short period of time. The Proponents indicated that, currently, there are up to 20 transits (a combination of cruise ships and barges) on the over-the-top route in a typical year. Three transits over-the-top would be considered very low, particularly relative to the traffic of earlier exploration days when the route was busy in the 1970s and 1980s.

The Proponents indicated that bowhead whales would not be present in the nearshore areas subject to dredging or exposed to potential operational noise. During summer, bowhead whales are far offshore, north of the Mackenzie Delta and off the Tuktoyaktuk Peninsula in areas of high zooplankton concentrations.

To avoid encountering marine mammals during vessel transit, the Proponents committed to fly a pre-transit reconnaissance flight with monitors to identify any aggregations of bowhead or beluga whales. The surveys would identify whale feeding areas, which would allow re-routing of the barges around, rather than through, the feeding areas. During transit, a marine mammal monitor would be on the vessel to look out for marine mammals. If any marine mammals were identified, pre-planned procedures would be in place to avoid them. DFO indicated that this would be a satisfactory approach if all conditions were met.

The Proponents predicted that any change in habitat availability during barge transport would result from sensory disturbance. Barge towing in August might encounter bowhead whales travelling and feeding in the Beaufort Sea. Based on observed bowhead responses to vessel traffic, the nature of indirect displacement of bowhead whales by a single barge in the Beaufort Sea was considered to be temporary, perhaps an hour, in any one area through which the barge and any support vessels pass. The Proponents predicted that noise disturbance to more than a few bowhead whales would occur only if the barge was towed through, or very close to, a bowhead feeding aggregation. The barge tow and any support vessels could briefly disturb some of these animals if they passed within approximately 3.4 km of bowhead whales, though the whales might not respond until the barge is much closer (e.g. 0.8 km). The Proponents predicted that the extent of short-term exclusion from habitat would be extremely small compared with the available habitat in immediately adjacent areas.

The Proponents predicted that a change in bowhead whale habitat availability would be expected during dredging, only if dredging were to affect the habitat of species in the bowhead whale food chain (e.g. plankton) as a direct result of physical disturbance or change in water quality. It was noted that potential dredging in southern Kugmallit Bay would be at least 25 km from the closest area where bowhead whales might normally be encountered. Bowhead whales would also be too far away to be disturbed by any dredging that might be required at the Niglintgak GCF. While dredging would disturb very little fish and invertebrate habitat that might contribute to the region's marine mammal productivity in the mid- to upper part of the Mackenzie River estuary, the Proponents considered it unlikely that dredging would measurably alter pelagic habitats that produce or distribute plankton on which bowhead whales depend.

The Proponents predicted no changes in bowhead whale habitat availability during operations. They considered that the Niglintgak GCF would be physically remote and acoustically isolated from areas used by bowhead whales, and that the whales would not be exposed to operational disturbance. The Proponents considered that impacts of decommissioning would be similar to impacts of the initial dredging and transport activities.

9.8.3 PARTICIPANTS' VIEWS AND RECOMMENDATIONS

BELUGA WHALE

DFO indicated that it was working with the Inuvialuit to establish a Marine Protected Area in the shallow estuarine waters where beluga whales aggregate in July. The importance of this area to the beluga was recognized with the development of the *Beluga Management Plan*, the most recent edition being in 2001. The plan was a joint effort between the FJMC, affected HTCs, the Inuvialuit Game Council and DFO. The Beluga Management Zone 1(a) of the *Beluga Management Plan* is currently being proposed as a Marine Protected Area under Canada's *Oceans Act*. This would convey regulatory protection to beluga and their habitat. The Beaufort Sea Integrated Management Planning Initiative, which includes DFO, FJMC, Inuvialuit Game Council, Canadian Association of Petroleum Producers, INAC and the Inuvialuit Regional Corporation, has been instrumental in moving this designation forward.

Assuming proposed mitigation measures for timing were implemented, DFO concurred with the Proponents' conclusions that the number of beluga whales possibly exposed to activities (because of the timing and location of the activity) would be low. However, DFO was of the view that it would be possible to estimate the zone of influence and that the Proponents should still attempt to estimate the extent of the potential overlap between impacts from barging and areas of beluga use and identify the means to attenuate underwater sounds. This analysis should also incorporate the available data on sound levels for various industrial sources. DFO noted that there could be short-term impacts on individual whales. DFO indicated that maps prepared by the department from aerial surveys conducted from 1977 to 1985, which show the use of specific areas of Kugmallit Bay, reveal that the southeast portion of Kugmallit Bay is used quite extensively by beluga whales during July, but not during August.

DFO indicated that its main concern was that the Proponents had not fully evaluated or presented the appropriate data or details, yet had still concluded that there would be no impacts on belugas. DFO indicated that more information is needed on the distribution of beluga and how this would overlap with Project activities in space and time. Information requirements include the timing and routing of the barge transport, the timing and location of dredging activity, the amount of activity associated with dredging and transportation, and the amount of underwater noise that would be produced and to what extent this would affect belugas. In the absence of this information from the Proponents, DFO noted that the maps presented by DFO in the public hearings provide a starting point. Those maps show the distribution of beluga whales and indicate that, with current knowledge of whale clumping behaviour, and the timing and their distribution in the estuary, it should be possible to avoid consequential impacts on whales through careful planning and mitigation by dredging at distances from whales rather than among them. DFO further indicated that the level of detail provided in the DFO maps is the level that the Proponents should use in its mitigation planning.

DFO indicated that satellite tagging of belugas in the estuary revealed that they move back and forth between different parts of the estuary and also between the estuary and the offshore. Based out of traditional hunting camps, beluga harvesters from Tuktoyaktuk, Aklavik, and Inuvik hunt beluga from these waters during the month of July and tend to hunt only in their usual hunting areas. A change in the distribution of whales due to disturbance may make the whales inaccessible to hunters in some areas. This was apparent in 1985 when ice prevented belugas from entering the Kugmallit Bay side of the estuary until much later in the season.

DFO indicated that over a 26-year period, 87% of the harvest took place in July and 12% in August. According to DFO records, the latest date that a whale was harvested in August was August 23 in 1980, and beluga whales have been harvested by residents of Tuktoyaktuk as late as October from the open water. The *Beluga Management Plan* states that any shipping outside of designated routes should occur after August 15, although DFO noted that the plan does not indicate that the harvest is over on August 15.

DFO also noted that the protocols for observing, reporting observations and translating observations into mitigation actions would have to be established and agreed to prior to transporting the GCF. Timing of the dredging and transport of the GCF are critical to ensure beluga whales would not be adversely affected. DFO indicated that there should be a system established and agreed upon in advance by industry and communities for collecting information on harvest timing and impacts with beluga whales. DFO noted that communication would be a key factor to ensure that mitigation was effective and that this communication process/network must be established in advance. The Proponents should include details on how and when this communication network would be set up and monitored. Indicating a willingness to contact the HTCs would likely not suffice in this case. For example, DFO suggested that it would be prudent to arrange for one or two persons to be the central point of contact and provide them with funding to obtain accurate and timely information on harvest timing and success, barge movements and dredging activity.

While it was the Proponents' view that a significant impact would be characterized as lasting for more than 30 years after decommissioning, DFO pointed out that loss of harvesting opportunities, for even one season, could have implications for some Aboriginal families who rely on beluga whales as a major source of country food. Nevertheless, DFO's overall assessment was that, with the application of appropriate measures, impacts on beluga whales resulting from the Project could be mitigated.

DFO further noted that the Proponents had predicted that there would be little or no long-term significant impact on beluga whales, either from the movement of barges or from dredging at the Kittigazuit S-bends. DFO indicated that, if this conclusion is valid, then it would follow that the harvest would not be affected either. On the assumption that the mitigation measures proposed with respect to timing are put in place, DFO concurred with the Proponents' conclusion that impacts on the harvest of beluga would be limited to a local, short-term impact. DFO considered that short-term impacts on individual whales would definitely be possible, but in the case of harvesting, it would be essential to avoid disturbances until after the harvest was finished for the season. DFO also noted that impacts on the harvest could be real or perceived. DFO indicated that the Proponents should demonstrate that all available literature and the primary sources have been considered in its assessment.

DFO noted that there was no prediction of or reference to potential impacts of the Project on long-term marine vessel traffic in the southern Beaufort Sea. DFO also noted that the Proponents' predictions that the proposed low speed of the barge transport would make a whale strike unlikely and, at most, cause a minor displacement of whales with no significant impact. DFO agreed that this was most likely a reasonable conclusion based on available information to date.

DFO recommended that:

- marine traffic associated with the Project should follow existing community supply routes when transiting the Mackenzie Delta estuary and adhere to all existing shipping regulations and guidelines;
- the Proponents should develop protocols for observing, reporting and responding to monitoring results before dredging and transportation of the GCF and these protocols should be developed in consultation with DFO, other appropriate regulatory authorities and affected communities;
- the Proponents should develop a marine mammal monitoring program and adaptive management plan in consultation with DFO and local community representatives to ensure that marine traffic, dredging and barge transportation would not cause significant adverse impacts; the monitoring program should include development of maps that overlay both Project-related noise distribution and beluga distribution;
- dredging should not commence until August, following the beluga harvest;
- protocols for marine mammal observer programs should be agreed to by DFO and management organizations ahead of time;
- locally-hired marine mammal observers should be part of the monitoring program on the dredge;
- the Proponents should compile and consider available data on the beluga harvest over the past 20 years to refine Project activity timing to avoid disturbing beluga whale harvesting;
- dredging should be completed in one summer season as a one-time event occurring over less than two months in localized areas;
- the Proponents should establish a clear means of consultation and communication between hunters, communities and operators to ensure that dredging and Project-related marine traffic would not occur until after the whale hunt; and
- the Proponents should notify local communities in advance of when the barge would be transported through their areas to avoid negative interactions with whale harvesting activities.

The Proponents agreed with DFO's recommendations, with the following variations:

- the Proponents plan to start dredging on August 15 or, alternatively, before that date provided that is acceptable to local stakeholders; and
- available data on beluga harvest over the past 20 years will be used to refine timing and scheduling of Project activities, subject to the data being made available by the Fisheries Joint Management Committee.

With respect to the Proponents' commitments that it would implement several mitigation and monitoring actions throughout the construction and operational phases of the Project, DFO advised the Panel that it is committed to working with the Proponents to advise on mitigation plans and any further environmental protection measures that need to be developed during the regulatory phase. Through ongoing initiatives, such as the Beaufort Sea Strategic Regional Plan of Action and the Beaufort Sea Integrated Management Plan Initiative, and DFO's Habitat Management Program and Oceans Sector, the department will continue to work with the Proponents, Aboriginal groups and other regulatory agencies to ensure that direct and possible cumulative impacts are considered to ensure the sustainability of Beaufort Sea resources.

The Inuvialuit Game Council indicated that its members were opposed to the marine barge option for Taglu and Niglintgak due to the potential impacts to habitat within the beluga management zones and river systems where barges are moored. The organization stressed that they were not opposed to development in the Inuvialuit Settlement Region, but indicated that there was not enough information on this option to ensure that there would be no negative impacts to fish and marine mammal habitat in the Beluga Management Zone 1(a) areas. They stressed that these areas are of key importance to the Inuvialuit and they are not willing to risk negative impacts.

BOWHEAD WHALE

DFO indicated that the response by bowhead whales to noise disturbance might involve interruption of feeding as well as time and energy spent swimming away from barge activity. Activities that may affect energetic loss by bowhead whales and that should be considered include water contamination from spills, disturbance from noise and ships travelling at speeds greater than or equal to 14 knots, a speed at which large whales may be critically injured. DFO indicated that these concerns could be addressed by having marine mammal monitors on marine vessels and by conducting annual surveys of the region during the time of dredging and barge traffic.

DFO noted that the Proponents had committed to conducting a whale monitoring over-flight with the Inuvialuit marine mammal community observer to identify bowhead concentrations on the proposed route of the Niglintgak GCF barge and to order a detour if necessary to avoid whale aggregations. DFO indicated that this mitigation measure should also include the option to stop and wait until whales have moved out of the area if the shipping route cannot accommodate an adequate detour. DFO noted that more specific and detailed mitigation and monitoring programs would have to be developed in consultation with DFO, other appropriate regulatory agencies and local resource users during the various phases of Project implementation. Mitigation and monitoring programs would have to be developed and approved by DFO before the GCF is transported.

DFO noted that the Proponents' impact predictions regarding bowhead whales were reasonable but that they did not provide in-depth quantitative analyses of risk. While waters of the Mackenzie River estuary are not important bowhead habitat compared with deeper waters offshore, DFO indicated that barge encounters with bowhead are possible if barge transits intersect a bowhead whale feeding area (e.g. approximately 30 km offshore from Tent Island in some years). DFO considered it more likely that increased risk of bowhead strikes would be associated with potential induced development.

DFO noted that at least two, possibly three, bowhead feeding aggregation areas are located within the six potential routes to tow the barges from Herschel Island to Kugmallit Bay. Details of the timing and routing for this marine activity, the amount of related support activity, and the accompanying underwater noise are required to fully assess potential impacts on bowhead whales, particularly whales in the feeding areas. The four weeks of Project transport and staging activity that would occur after mid-August would coincide with the time when bowhead whales were aggregated for feeding.

DFO indicated that bowhead whales hear at much lower frequencies than belugas and they use frequencies that are similar to those generated by industrial noise. These frequencies are generally propagated farther in the deeper offshore waters, so the size of the zone of influence would be greater compared with that for beluga whales in the soft bottom waters of the Mackenzie River estuary. Noise levels above ambient by 20 or 30 dB were reportedly found 3 to 11 km from drill ships and dredges, which provide an indication of the zone of influence. DFO indicated that the present level of detail provided on both species of whales by the Proponents is not sufficient to fully assess any potential impacts. The Proponents need to be able to demonstrate that the potential for overlap in time and space is understood and can be mitigated. DFO noted that not all aggregation areas are used in all years. Four weeks of activity through the offshore area, if not timed and routed appropriately, could affect bowhead whales, depending upon the success of mitigation.

DFO indicated that bowhead whales expend considerable energy to get to the Beaufort Sea to feed, and they have to recoup that energy and obtain some additional energy for the trip to be beneficial. DFO was concerned that it did not know the number and exact timing of vessel transits. If the whales were disrupted on only one occasion, the impact would likely be inconsequential in terms of the individual whale. If the whales were interrupted time and again then it could affect the amount of food that they could obtain during the six-week feeding period and, in turn, their annual energy needs. The point at which too many interruptions begin to affect the whales' ability to obtain sufficient food is not known but more information on planned vessel transits would help to find a suitable solution.

The FJMC noted that whales are migratory species and raised questions about the extent to which the Proponents had considered the cumulative impacts of its proposed activities in combination with potential industrial impacts throughout the Beaufort Sea, and other impacts along the whales' migration route, including the Alaska North Slope and the Bering Sea. The Proponents responded that its assessment had focused on Canadian waters. However, they considered seven proposed offshore developments in the Alaskan Beaufort Sea from 2006 to 2011, based on the findings of the United States Fish and Wildlife Service, and overlaid those projects with the proposed MGP.

DFO noted that the Proponents had not considered the bowhead whale harvest by residents of Aklavik that could occur at Shingle Point. The harvest of bowheads in this area would most likely occur in the aggregation area offshore of the Yukon coast from mid- to late August. Depending on timing, the impacts on the harvest could be mitigated, but the possibility of an overlap between harvest and Project activities exists.

In addition to its recommendations regarding beluga whales that would also apply to bowhead whales, DFO also recommended that a well-planned aerial survey using multiple experienced observers be conducted ahead of the arrival of the barge to the southeast Beaufort Sea. The Proponents agreed with this recommendation.

9.8.4 PANEL VIEWS AND RECOMMENDATIONS

The Panel heard how important beluga whales are to the economy and culture of the Inuvialuit, the Inuvialuit's concern over how the Project may adversely affect the beluga and the habitat upon which they depend, and the need to ensure that the beluga and their habitat are properly protected from potential adverse impacts. The Panel also heard suggestions on ways to avoid and manage potential adverse impacts. In the Panel's view, there are a number of actions that can be taken to avoid significant adverse impacts on beluga from Project activities, such as barging and dredging.

RECOMMENDATION 9-10

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, at least six months prior to any Project-related barging or marine transportation activity in the Beaufort Sea or Kugmallit Bay, a Marine Mammal Protection Plan that has been developed in consultation with, and endorsed, by Fisheries and Oceans Canada, other appropriate regulatory agencies, management boards and affected communities and that:

- *prescribes the measures the Proponents will implement to protect marine mammals from adverse impacts and the monitoring and adaptive management activities to be undertaken;*

- *reflects the compilation and consideration of all available data on the beluga harvest in order to refine Mackenzie Gas Project activity timing to avoid disturbing marine mammals and marine mammal harvesting;*
- *includes development of maps that overlay both Project-related noise distribution and marine mammal distribution;*
- *includes provision for on-board vessel experienced marine mammal observers during shipping activities and dredging. Marine mammal observers should be hired locally and the protocol for observations should be submitted to Fisheries and Oceans Canada and the management organizations for review and approval prior to filing with the National Energy Board;*
- *includes the use of aerial surveys flown before ship transit and dredging in order to schedule or plan activities to avoid impacts to marine mammals;*
- *identifies the zone of influence within which activity must be shut down or the route altered when marine mammals are observed;*
- *consistent with Panel Recommendations 9-8 and 9-9, describes dredging plans, including how dredging in relation to the transport of the Gas Conditioning Facility will be completed in one season. Dredging plans must include provision for consulting Hunters and Trappers Committees in Tuktoyakuk, Inuvik and Aklavik and the Fisheries Joint Management Committee, and must avoid interference with the beluga harvest. Dredging should also be completed in one summer season — a one-time event occurring over less than two months in localized areas, if at all possible;*
- *includes protocols for observing, reporting and responding to monitoring results before dredging and transportation of the Gas Conditioning Facility;*
- *establishes a clear means of consultation and communication between hunters/communities and operators to ensure that dredging and Mackenzie Gas Project-related marine traffic does not occur in the areas to be traversed or dredged until after the communities of Tuktoyaktuk, Inuvik and Aklavik have completed their beluga whale hunt and that advance notification is provided to the Hunters and Trappers Committees in Tuktoyaktuk, Inuvik and Aklavik of when the barges will be transported through their areas in order to avoid negative interactions with marine mammal harvesting activities; and*
- *describes how the plan will be updated with the acquisition of annual monitoring data. The plan should also be filed with the local communities, appropriate regulatory authorities and management organizations.*

The plan should also be filed with the local communities, appropriate regulatory authorities and management organizations.

In addition to the Panel's recommendations regarding dredging activities, as described in Section 9.7, the following recommendation is required to avoid significant adverse impacts to beluga whales.

RECOMMENDATION 9-11

The Panel recommends that Fisheries and Oceans Canada and Environment Canada require, as a condition of any authorization granted under the Fisheries Act *or the* Canadian Environmental Protection Act, 1999 *for Project-related activities in relation to dredging or dredged spoil disposal in the vicinity of the Kittigazuit S-bends, that dredging and disposal of dredge spoils not commence until the date mutually agreed to by the Inuvialuit Game Council, Fisheries Joint Management Committee and local hunters. Fisheries and Oceans Canada and Environment Canada should communicate with the Proponents and with hunters for the purpose of incorporating appropriate measures in their regulatory approvals with a view to enabling dredging to begin as early as possible without adversely affecting the beluga whale hunt and to completing the dredging in one season.*

In the Panel's view, the implementation of Panel Recommendation 9-10 provides a means to also address potential impacts to bowhead whales. It is the Panel's view that additional protective measures would be necessary, particularly in relation to future activity in the Beaufort Sea that would likely occur beyond the Project as Filed. In the Panel's view, specific inclusion of the bowhead whale in the Marine Mammal Protection Plan, as described in Panel Recommendation 9-10, should provide that additional protection.

DFO highlighted the need for bowhead whales to meet their energy requirements by feeding on zooplankton concentrations during the whales' relatively short stay in the Canadian Beaufort Sea. Recognizing the importance of uninterrupted feeding in meeting these energy requirements, DFO recommended that the Proponents conduct marine mammal over-flights in advance of vessel transits to ensure that transit routes avoid aggregations of feeding bowhead and beluga whales. DFO also requested that marine mammal observers be present on vessels during transits.

The Panel notes that the number of proposed Project transits in the Beaufort Sea is relatively low compared to both the current levels of traffic and those levels that might be expected in association with future development initiatives involving vessel transits and other marine-based activities.

However, it is not clear to the Panel whether DFO plans to implement similar requirements for all vessels transiting the Beaufort Sea, or only to select vessels. If only select vessels would be targeted, then the decision-making process and rationale for identifying those vessels should be clearly understood by those implicated.

In light of the concerns raised by DFO, the Panel concludes that the potential exists for cumulative impacts on marine mammals to be significant as a result of vessel traffic and marine activity throughout the Beaufort Sea and in the Mackenzie Delta arising from activities beyond the Project as Filed.

RECOMMENDATION 9-12

The Panel recommends that Fisheries and Oceans Canada, at least six months prior to any Project-related barging or marine transportation activity in the Beaufort Sea or Kugmallit Bay review its position with respect to aerial surveillance and monitoring in support of Mackenzie Gas Project vessel transits in the Beaufort Sea and develop a policy broadly applicable to shipping in the Beaufort Sea and potential increases in marine transportation activity in the future. The policy and program initiatives to manage and monitor vessel transit activities should include the requirement for overflights and observers on a basis that is fair and equitable to all operators and reflects the degree of risk to bowhead and beluga whale individuals and populations associated with particular types of operations.

RECOMMENDATION 9-13

The Panel recommends that Fisheries and Oceans Canada work with its management partners and other international jurisdictions to increase its knowledge base regarding beluga and bowhead whale population levels, movements, feeding areas, behaviour and energetics in the Beaufort Sea and throughout their ranges, and to identify potential cumulative stressors on the populations, to build an understanding of the role and degree of impact that the Mackenzie Gas Project and future development in the Beaufort Sea may have at the individual and population levels.

In the Panel's view, implementation of its recommendations regarding dredging, and beluga and bowhead whales, particularly the development and implementation of the Marine Mammal Protection Plan, would also serve to avoid or mitigate adverse impacts to other marine mammals, such as ringed seals.

Provided that the Proponents' commitments and the Panel's recommendations are implemented, the Panel is of the view that the potential adverse environmental impacts of the Project as Filed on marine mammals would not likely be significant. The Panel does not have sufficient information before it with respect to the Expansion Capacity Scenario or Other Future Scenarios, so it is unable to make a determination of significance of the impacts of developments associated with these two scenarios.

9.9 BALLAST WATER DISPOSAL

9.9.1 PROPONENTS' VIEWS

The Proponents indicated that ballast water would be used to raise and lower heavy-lift vessels that would transport the GCF and VLMs into the Beaufort Sea area from their place of manufacture. In the Beaufort Sea, the seagoing vessels would be ballasted so that the large Project components could be floated off and transferred to barges for local transportation.

The Proponents indicated that its Ballast Water Management Plan had not yet been developed since it would be specific to the heavy-lift vessel selected and would need to be prepared in conjunction with the heavy-lift vessel operator. The Ballast Water Management Plan for the heavy-lift vessel would document applicable mitigation options, including consideration of:

- using a ballast water risk assessment to finalize voyage-specific ballast water procedures;
- exchanging ballast water en route to avoid introducing marine life that is new to the local environment, including exchanging ballast water at various stages of the transit;
- using local water to ballast down and expel the same water after the GCF has been unloaded; and
- retaining bilge water, either in the bilges or in a holding tank, to prevent contaminating local waters.

The Proponents also committed to comply with Transport Canada's *Ballast Water Control and Management Regulations*, which became effective in June 2006.

The Proponents indicated that metals, oils and other hydrocarbons, or exotic organisms in discharged ballast water can affect fish health directly or through changes in water quality. Vessels entering Canadian waters normally discharge freshwater ballast at sea and take on new ballast water before entering freshwater systems. The Proponents suggested that this practice reduces the risk of introducing exotic organisms or contaminants and prevents changes in water quality.

Once the GCF barge has reached the chosen location in the river, the ballast water system would be managed to ensure proper vessel stability. The source of ballast water at this point would be river water. Because ballast water would be physically separated from other water on the barge, no impacts on the quality of the surrounding river water are predicted. Because water quality would not be affected, the Proponents did not expect any impacts on fish health from the release of ballast water.

The Proponents noted that non-indigenous organisms potentially entering the Beaufort Sea, Mackenzie Delta and Mackenzie River via ballast water would likely have originated in warmer climates and the likelihood that they would survive in a cold-water environment and establish themselves as invasive species was, therefore, considered to be low.

9.9.2 PARTICIPANTS' VIEWS AND RECOMMENDATIONS

Transport Canada indicated that the *Ballast Water Control and Management Regulations* came into effect in June 2006. The regulations apply to foreign-going vessels, meaning that any vessel coming from outside Canadian waters must have a Ballast Water Management Plan. Any vessel that operates exclusively in Canadian waters is not required to have such a plan.
TC indicated that there are a range of acceptable approaches available to manage ballast water, such as shore discharge of ballast water, not discharging ballast water or treating ballast water. Any combination of those acceptable approaches would

be considered an adequate plan. The intent is to stop any introduction of foreign biota into Canadian waters.

TC also indicated that Ballast Water Management Plans are approved by its marine safety inspectors. However, foreign vessels that are not Canadian flag ships are not subject to annual inspections by marine safety inspectors. Therefore, Transport Canada indicated that it plans to use the port state control inspection system, which is presently used to monitor foreign vessel compliance with domestic regulations.

TC indicated that it had not yet developed the policy on how the regulations would be applied, but thought that the port state control system would be used. This would require Canadian vessels to be inspected by Canadian inspectors annually. Under international agreements, Canada (as a port state) is authorized to board and inspect a foreign vessel for compliance with international standards. TC has the ability to board these vessels and take samples of the ballast water to confirm compliance with the *Ballast Water Control and Management Regulations*. In the case of the Beaufort Sea, the problem is that there is no port of call where a vessel actually ties up. Ideally, a vessel would make a Canadian port of call first. If that did not happen, Transport Canada would need to rely on the statement made by the vessel before entering Canadian waters that it is in compliance with the regulations, which means the vessel has a plan, the plan was approved and that the vessel is following the plan. The vessel is required to make a report via radio communication to a vessel traffic centre in Canada and part of the information relayed would be the statement regarding compliance with the ballast water regulations. Since it was not obvious from the material presented by the Proponents that there would be a Canadian port of call prior to the transfer of ballast water, TC would likely have to accept the statement of the vessel that it was in compliance with the Canadian regulations.

Transport Canada indicated that it does not have any marine safety inspectors located in the NWT and does not have plans to establish an office in the Beaufort Delta region. Those responsible for inspections in the NWT, Yukon and Nunavut are located in Winnipeg and Edmonton. With respect to whether local community members could act as marine safety inspectors, TC indicated that they would have to have extensive knowledge in one of four disciplines — navigating ships, engineering in ships, naval architecture or electrical. To become a marine safety inspector, a person would have to satisfy one of the disciplines, apply for the position and be appointed by the Minister of Transport under the *Canada Shipping Act*.

DFO noted concerns with the potential introduction of non-indigenous species into local waters as a result of shipping activities. DFO is of the opinion that the *Ballast Water Control and Management Regulations* do not eliminate the possibility of introducing invasive species and there remains a risk. It was DFO's view that the 95% ballast water exchange requirement in the regulations was the best that could be developed as a solution at that time and other options are being considered, such as ballast water exchange zones in areas where there is higher traffic. DFO indicated that it does not have a direct preventive regulatory role with respect to the introduction of invasive species via ballast water.

Environment Canada indicated that, although involved, it had had limited input into the development of the *Ballast Water Control and Management Regulations*. According to EC, ballast water exchange is the most commonly used method of ballast water management available at this time and is the primary option presented in the regulations. Environment Canada indicated that proper ballast water exchange minimizes the risk of invasive species being introduced into the environment, but does not completely eliminate the risk. While there are ballast water treatments available that could ensure that, essentially, no harmful aquatic organisms or pathogens survive in ballast water tanks, some of these methods involve chemical treatment that may pose other risks to the environment. There are currently no Canadian or international guidelines for ballast water treatment. EC is continuing to meet with TC officials to discuss possible amendments to the regulations regarding the discharge of saltwater into freshwater and clarification of ballast water exchange in some southern areas, as well as Environment Canada's broader role in addressing invasive species from marine transportation.

The Deh Gah Go'tie Dene Council recommended that "ballast water from any barges brought in from other regions must not be released into the Mackenzie River or other related water bodies due to the potential for introduction of non-native species." (J-DGGDC-00036, p. 16) The Council requested that they be properly and meaningfully involved in the development of and participation in the monitoring programs that are established.

The Joint Secretariat indicated that concerns related to water were identified through gatherings involving members of all communities in the Inuvialuit Settlement Region and included the dumping of waste, bilge and ballast water in the Beaufort Sea. The Inuvialuit had major concerns about the release of ballast water from seagoing vessels used to transport materials for the Project and the potential for the introduction of invasive species that could have negative impacts on local resources. The Joint Secretariat recommended very stringent enforcement of regulations along with a monitoring program.

9.9.3 PANEL VIEWS AND RECOMMENDATIONS

It is clear to the Panel that there is some risk that non-indigenous aquatic invasive species could be introduced into the Project area via ballast water associated with Project activities. Although the degree of that risk is unknown, it would be mitigated to a certain extent by the existing regulatory requirements and the Proponents' commitments. The Panel was not presented with evidence of a strong scientific basis to the *Ballast Water Control and Management Regulations* and notes that Environment

Canada told the Panel that it had limited involvement in development of the regulations. It appears that the regulatory framework could provide some limited protection against risks of the introduction of non-indigenous aquatic invasive species. However, the circumstances with respect to the operation of the regulatory framework in the North and the specific plans of the Proponents suggest to the Panel that the framework as it existed at the close of the Panel's hearings would be of limited value for the following reasons:

- Transport Canada had not yet developed the policy on how the regulations would be applied;
- foreign vessels are not subject to annual inspections;
- there are no inspectors in the NWT or a port of call in the NWT where foreign vessels would tie up to enable inspection;
- Transport Canada must rely on a statement from the foreign vessel that it is in compliance with the regulations; and
- regardless of how effectively the *Ballast Water Control and Management Regulations* may be implemented, there were doubts about whether they would work in practice.

Imperative to the management of this risk is the need for TC to fully exercise its regulatory responsibilities, particularly with respect to the *Ballast Water Control and Management Regulations*.

RECOMMENDATION 9-14

The Panel recommends that, prior to the commencement of shipping activities in support of the Project that will transit the Beaufort Sea in Canada, Transport Canada prepare and publish its policy on how the Ballast Water Control and Management Regulations will be implemented and that Transport Canada demonstrate that it has an effective system for ensuring compliance with the regulations for Project-related shipping activities, including how and where inspectors will be deployed in order to prevent the introduction of non-indigenous invasive aquatic species.

In the Panel's view, the risk that non-indigenous aquatic invasive species could be introduced through ballast water would increase with developments associated with the Expansion Capacity Scenario and Other Future Scenarios. In the Panel's view, it remains uncertain whether Transport Canada's regulatory response would, in fact, address the potential risks. The Panel is of the opinion that further effort would be required to respond to the potential risks associated with ballast water. The Panel is not persuaded that the regulations would address the risk and notes that the current enforcement capability is inadequate. The Panel notes that the concept of a ballast water exchange zone has the potential to further reduce the risk.

RECOMMENDATION 9-15

The Panel recommends that the Government of Canada determine the feasibility of establishing a ballast water exchange zone for vessels prior to entry into the Beaufort Sea. Provided such a zone is feasible, Transport Canada should create the zone within three years of the date of the Government Response to the Panel's Report.

RECOMMENDATION 9-16

The Panel recommends that Transport Canada evaluate the effectiveness of the Ballast Control and Management Regulations as applied to the Mackenzie Gas Project, with a particular emphasis on the scientific basis for the regulations. The evaluation should be completed and, if any amendments to the Ballast Control and Management Regulations are required as a result of the evaluation, necessary regulatory reform should be implemented within three years of the date of the Government Response to the Panel's Report.

Implementation of the Proponents' commitments and the Panel's recommendations would reduce the likelihood that non-indigenous aquatic species would be introduced into the Beaufort Sea. However, they would not eliminate the risk. Therefore, the degree of risk that vessels would introduce non-indigenous aquatic species to the Beaufort Sea and the magnitude of resulting adverse impacts, if any, are not known.

9.10 WATER WITHDRAWAL AND DISCHARGE

9.10.1 PROPONENTS' VIEWS

Water supply and disposal would be required during construction for camps, winter roads, drilling wells, HDD of watercourses and hydrostatic pressure testing. During operations, water supply and disposal would be required for process water at the anchor fields and along the pipeline corridor. The majority of water for these uses would come from nearby surface waters, predominantly the Mackenzie River, the Mackenzie Delta channels and large lakes. The Mackenzie River has an estimated winter flow rate of 2,500–3,000 m^3/s. The Proponents submitted that Project-related water withdrawals from the Mackenzie would be insignificant and that the Project's impact on the availability of water for other uses would be negligible.

Water withdrawal can affect stream flow and water levels in lakes and streams. Lower lake levels can result in changes to shoreline habitat, overwintering capacity of fish-bearing lakes, primary productivity and outlet creek discharge. Reduced stream flow can affect spawning, feeding, migration and overwintering habitats of fish-bearing streams and rivers, and can affect watercourse productivity and the availability of food for fish, such as benthic invertebrates.

In most cases, water withdrawal would be in the winter from under ice. Many of the freshwater lakes where plans call for water withdrawal are less than 100 hectares. The Proponents indicated that they would comply with the DFO *Protocol for Water Withdrawal for Oil and Gas Activities in the Northwest Territories*.

At the time the EIS was prepared, the specific water sources to be used had not been chosen. Bathymetric surveys conducted by the Proponents identified 143 lakes that were strategically located to proposed construction activities and would meet the DFO protocol. These lakes have an under-ice winter depth that meets or exceeds the 1.5 m requirement and are of sufficient size to provide a suitable amount of water within the limit of the 5% withdrawal volume, as defined in the DFO protocol. For the purpose of the EIS, the Proponents assumed that adverse impacts on water quality, and fish and fish habitat would be avoided by selecting lakes used for water supply according to the DFO protocol, unless otherwise approved, and withdrawing water from lakes and rivers according to permit conditions. Water withdrawal intakes would be screened in accordance with DFO regulatory requirements to prevent fish entrainment.

For the Northwest Alberta Facilities, NOVA Gas Transmission Ltd. (NGTL) noted that it would only require water for pipeline hydrostatic testing. Specific sources for water would be identified during detailed design and would be subject to approval by Alberta Sustainable Resources Development.

The Proponents indicated that water used for pressure testing of pipelines, flow lines and process components might be discharged to surface waters. Test water typically withdrawn from local water bodies might be heated or treated with additives such as corrosion inhibitors, glycol or methanol antifreeze, or products for leak detection. The Proponents noted that some additives can be deleterious to fish and other aquatic organisms.

The following treatments and additives would be considered:

- filtering to remove suspended sediments;
- adding freeze-point depressant to prevent freezing during testing;
- adding corrosion inhibitors to prevent internal corrosion of the pipe; and
- adding oxygen scavengers for use during in situ testing at facility sites.

The Proponents also indicated that where freeze depressants are added to the pipeline for hydrostatic testing, the test mixture would contain methanol, ranging from 35% to 50% by volume, and small amounts of oxygen scavenger and corrosion inhibitor.

The options being evaluated for disposing of hydrostatic test fluid containing chemical additives include:

- downhole injection into Imperial Oil's Norman Wells waterflood;
- a temporary facility to flash off methanol or, if commercially viable, to recover it; treated water would be tested to meet approved water quality standards and then be released to a natural drainage system; and
- temporarily storing the test fluid in tanks or lined ponds for disposal by a chemical salvage contractor.

The Proponents also indicated that they would make final decisions on what additive and treatments would be required after they had analyzed the water quality of the source water and finalized hydrostatic test water specifications.

In addition, the Proponents indicated that a detailed hydrostatic test plan would be developed, with a key objective to reduce spill potential. An Emergency Response Plan to manage fluid spills would be developed and implemented before testing begins. The intent would be to reduce long-distance movement of test fluid, which would reduce the potential for spills. Any temporary processing or storage facilities would be designed with double-walled tanks or tanks with secondary containment systems.

NGTL noted that its hydrostatic testing activities would be in compliance with the *Code of Practice for the Temporary Diversion of Water for Hydrostatic Testing of Pipelines* (Alberta Environment, 1999) and the *Code of Practice for the Release of Hydrostatic Test Water from Hydrostatic Testing of Petroleum Liquid and Gas Pipelines*.

The Proponents expected that there would be no impacts on fish habitat from water-level changes caused by water withdrawal or discharge because criteria would be established and regulatory protocols for selection of water sources, and for withdrawal or discharge, would be followed. The Proponents also did not expect impacts to borrow sites because they did not plan to wash borrow material.

Water required for operating processes at Niglintgak and Taglu, pressure testing and winter roads would be drawn from nearby water sources, including the Mackenzie River or a nearby lake. The magnitude of the impact of water withdrawal on water levels during construction was considered low on the basis of conformance with the DFO protocol. The Proponents did not expect impacts on fish because they would only use lakes as water sources if water withdrawal would not adversely affect fish or fish habitat. Due to reduced water requirements, changes in water levels were predicted to be less during operations than during construction. No water withdrawal would be required for decommissioning.

Parsons Lake would likely be the main source of water for industrial use at the Parsons Lake Anchor Field. A hydrological assessment would be required to quantify the changes in water level in Parsons Lake resulting from water withdrawal. However, the Proponents noted that Parsons Lake has a maximum depth of 8.2 m, a mean depth of 3.2 m and a surface area of 5,825 ha. As such, the Proponents concluded that water withdrawals would not have a measurable impact on water levels or fish habitat in Parsons Lake.

Potable camp water would be drawn from the Mackenzie River or local lakes. No adverse impacts were predicted based upon conformance with the DFO protocol.

9.10.2 PARTICIPANTS' VIEWS AND RECOMMENDATIONS

DFO indicated that it has a water withdrawal protocol, which it has tested experimentally, that describes the volumes of water that could be withdrawn from a water body without causing an impact to fish. The protocol allows for removal of 5% of the volume in a small lake, calculated after ice thickness is removed from lake volume. DFO would apply this protocol to guide the regulation of water withdrawal during pipeline construction and operations.

Environment Canada inquired whether numerous small-scale water withdrawals of low to moderate impact at many sites would have a cumulative impact at the larger scale of the Local Study Area or Regional Study Area. The Proponents submitted that, based on the expected water licence requirements, regulatory constraints and the short duration of water withdrawals related to the Project, cumulative impacts of water withdrawals from these water bodies on water levels would likely be undetectable, depending on the physical and hydrological lake characteristics.

The Liidlii Kue First Nation recommended that any lakes being used not be impacted, that DFO check those lakes and that bigger rivers or muskeg be used. The Proponents agreed with the premise of these recommendations but submitted that they are addressed by the Project commitments.

9.10.3 PANEL VIEWS

It is the Panel's view that the Proponents have effectively responded to the issues, concerns and recommendations of the participants regarding the potential impacts of the Project as Filed related to water withdrawal and discharge. The Panel also notes that DFO has protocols for water withdrawal and discharge, and the Proponents committed to abide by these protocols.

It is the Panel's view that provided the DFO protocol is followed and the Proponents' commitments are implemented, the impacts of water withdrawal and discharge associated with the Project would not likely be significant.

9.11 FISHERIES MANAGEMENT

9.11.1 PROPONENTS' VIEWS

The Proponents stated that the increased workforce and additional access might increase the amount of fish harvested from local streams and lakes, but this was not expected to affect the viability of any fish populations. Most of the increased workforce would be present in the winter, a period not conducive to extensive sport fishing. The Project would create some new access, such as a few all-weather roads and a cleared right-of-way along the pipeline corridor, but most of the area already has substantial winter access along the pipeline corridor south of Norman Wells, along the winter road or along the extensive seismic network in the region.

The Proponents indicated that they would have a policy of no harvesting of fish and wildlife that would apply along the entire pipeline corridor. The policy would apply during the construction phase and would be reassessed, if necessary, for the operations phase. The Proponents indicated that the policy would apply equally to itinerant and local workers on Project work sites, including Project construction camps. The Proponents indicated that the measure to prevent workers from fishing would be a stated condition of employment between the worker and the relevant contractor. The penalty for not meeting the policy would be disciplinary action, up to, and including, loss of employment. The Proponents indicated that contractors would track workers' non-compliance of employment conditions. Communities and regulatory authorities would not have direct access to internal tracking of workers' compliance with employment. However, this information would be reported to the Socio-Economic Effects Monitoring Regional Working Groups that would be established for the Project. The Proponents further indicated that they had not taken any measures to assess current levels of harvesting in local streams because the policy of restricting fishing by the workforce would result in no impacts from the Project. In the Proponents' view, the policy of no fish or wildlife harvesting would avoid any negative changes on local harvesting caused by the Project workforce. The Proponents stated that renewable resource agencies are responsible for monitoring harvesting rates and that, if it appears that changes to harvesting rates might be directly influenced by the Project, the Proponents would discuss the possible need for mitigation with the appropriate agency.

9.11.2 PARTICIPANTS' VIEWS AND RECOMMENDATIONS

DFO expressed the view that there would likely be an increase in access to fisheries due to construction of roads and other works. In DFO's view, increased access could potentially add to the harvest pressure on fish resources. Species such as lake trout, broad whitefish, inconnu, least and Arctic cisco, lake whitefish, northern pike and walleye harvested by Aboriginals are sensitive to slight changes in harvest rate. DFO indicated that subsistence fishing is generally in equilibrium at present but a small change in exploitation rate could result in lower productivity and, in the worst case, could cause collapse of the resource. Studies of increases in harvest levels (creel census) at a number of reference sites might be required to document possible increases in fishing pressure due to Project-related activity. If significant increases in harvest were taking place as a result of Project-related activity then individual assessments might be required to determine the impact of those increases on local stocks.

DFO further expressed the view that it would be difficult to determine how adverse impacts would be detected given that little information is available on the demographics (population structure in terms of growth rates, age of reproductive maturity, and age structure or natural mortality) of fish species in the region. As a result, DFO stated that it would be difficult to attribute future changes in fish abundance and productivity to the Project.

Many communities expressed concern regarding the possibility that a large introduced workforce could have access to fisheries that communities rely upon for subsistence purposes. DFO indicated that it has limited ability to prevent access to fishing where an individual holds a valid fishing license and is in compliance with fisheries regulations.

In terms of potential impacts to fish stocks from increased access, DFO was concerned that impacts, if not managed or mitigated properly, could result mainly from increased access via the MGP right-of-way. DFO indicated that its concerns were reduced from being considered a likely impact to a risk as a result of the Proponents' commitment to a no fishing policy.

DFO proposed recommendations related to a potential multi-party Fisheries Management Plan to be developed in the future. The parties to the plan would include the Proponents, affected Aboriginal communities and management organizations.

DFO indicated that, through this plan, the parties could develop a more comprehensive membership list of participants and decision-makers. Furthermore, DFO indicated that the plan:

- could include clearly identifiable objectives;
- could provide for a funding framework for meeting all objectives of the plan; and
- would include an accountability and implementation framework for managing all Project-induced fisheries impacts, should they occur.

DFO indicated that their vision for the plan was broad and varied. It could mean virtually the status quo, where DFO currently manages fisheries with identified partners. If problems were bigger than envisioned, it could also mean that other measures would be needed, such as targeted monitoring or changing regulations. In either case, all participants, including the Proponents, would be at the table to help address, mitigate or study problems that might be caused by the Project.
DFO further recommended that the Proponents develop, in consultation with Aboriginal groups, management organizations and DFO, a monitoring and adaptive management program, including an accountability and implementation framework, to measure, detect and mitigate direct or indirect Project-induced impacts on commercial, recreational, subsistence and domestic fisheries resources. The FJMC supported this recommendation.

The Proponents did not agree with these recommendations, noting that fisheries management in the NWT is the responsibility of management boards, DFO, the local Hunters and Trappers Committees and Renewable Resource Councils. The Proponents indicated that they would implement reasonable measures to control those aspects of the Project that might lead to over-exploitation of fisheries resources, as described in the Project commitments. The Proponents indicated that they would prohibit recreational use of Project roads and right-of-ways by Project staff during construction and reclaim seasonal roads when they were no longer required for construction or operations. The Proponents noted that they are not responsible for fisheries management and, therefore, they do not need to implement a monitoring program.

DFO also highlighted the potential for cumulative impacts of increased fishing pressure as a result of increased access on fisheries resources. DFO noted that the Project has the potential for both short- and long-term impacts to fisheries resources along the Project corridor and in the Mackenzie Valley in general and that this is a fisheries management concern for DFO and its management partners. DFO believed that the Proponents' commitment to mitigate direct impacts to fisheries resources is adequate for the construction phase. However, DFO reiterated its position that the Proponents would also be responsible during the operations phase to ensure long-term impacts to fisheries resources were not realized. Corridors established during construction could allow increased access during the operations phase. The right-of-ways for the pipeline and access roads to water supply lakes and borrow sites would provide seasonal and possibly year-round access to remote areas of the NWT. DFO is responsible, with its co-managers, to manage fish, fish habitat and fisheries in a sustainable manner. The efforts of the Proponents to manage the operations phase of the Project in support of DFO's and management boards' objectives should be established in the Panel's recommendations.

The FJMC recommended that the Proponents prohibit Project workers from fishing while on the job site during the construction and operations of any facility. The Proponents agreed with this recommendation.

The Fisheries Joint Management Committee also recommended to the Proponents, DFO, management boards, local HTCs and Renewable Resource Councils that there be specific exemptions from the no fishing policy for guided and day fishing charters approved on a site-specific basis, with the agreement of the appropriate management board, DFO, and the local HTCs or Renewable Resource Councils. The FJMC also recommended that local guiding opportunities be supported and that the Proponents work with local Aboriginal industry and development boards, the GNWT, management boards, DFO, HTCs and Renewable Resource Councils to encourage guiding opportunities, specifically to serve workers interested in recreational fishing.

The Proponents did not agree with these recommendations and indicated that it would implement a blanket no fishing policy. DFO indicated that it supports the Proponents' no fishing policy, but is willing to participate in discussions with the Proponents and others regarding exemptions.

The FJMC recommended that the Panel encourage the Proponents and/or service providers of any potential guided and day fishing charters to work with the management boards, DFO, HTCs and Renewable Resource Councils to develop and fund a monitoring program to ensure no negative cumulative impacts. The Proponents did not agree with this recommendation and indicated that the Project policy prohibiting harvesting by all Project workers would prohibit guided and day fishing charters. The Proponents indicated that there would be no exemption to this policy while at work sites.

The Gwich'in Renewable Resource Board recommended that the Proponents prevent employees from fishing and hunting while in Project construction camps, and prohibit access by the general public to construction-related roads during construction and on an ongoing basis. The Proponents agreed to prohibit fishing by employees while on job sites. However, the Proponents indicated that it is not responsible for controlling access to public roads. The Proponents indicated that after construction was completed, access along the pipeline right-of-way and reclaimed Project roads might be restricted by placing timber and brush rollbacks across the pipeline right-of-way.

The Gwich'in Social and Cultural Institute indicated that country foods are very important for the Gwich'in and that Gwich'in employees should have an opportunity to hunt and fish at appropriate times without penalty. The Proponents indicated that it would provide a flexible schedule to allow for this but that no Project workers would be permitted to hunt or fish while on work sites.

The Gwich'in Social and Cultural Institute recommended that camps purchase some country foods from local sources when possible or hire hunters or fishers to supply camps. It was noted that the Proponents had indicated they would include country foods from inspected facilities. The Gwich'in Social and Cultural Institute considered this to be acceptable but preferred that the Proponents make a commitment to try to use local hunters or fishers to supply the inspected facilities.

The Gwich'in Social and Cultural Institute also recommended that the fish species used by the Gwich'in should be studied regularly and monitored to ensure that any impacts to them are minimized. Gwich'in harvesters should participate in identifying fish populations and creating the monitoring plan. DFO indicated that it is committed to working with the Gwich'in Renewable Resource Board under land claim implementation funding to continue existing research and monitoring programs.

The Dehcho First Nations recommended that

> commercial and cultural fisheries (food fisheries) be monitored by Department of Fisheries and Oceans Canada in cooperation with Dehcho First Nations before, during and after the construction phase, and during operations to ensure no net loss occurs. If there are losses the proponent (Imperial Oil, Aboriginal Pipeline Group, Canada and NTCL) should compensate fishers for as long as the water flows, sun shines and grass grows. (J-DFN-00026, p. 3)

The Government of Canada responded that DFO continues to manage and monitor commercial fisheries and monitors subsistence fisheries. It is the responsibility of the Proponents to mitigate any potential impacts of the Project on commercial or subsistence fisheries.

9.11.3 PANEL VIEWS AND RECOMMENDATION

The Project would cause an influx of people into the Mackenzie Valley, both directly related to the Project and indirectly through opportunities in support of the Project. In addition, access would be facilitated by Project infrastructure. The Panel heard that Project developments have the potential to increase fish harvesting activity and pressure on fish stocks, many of which have slow growth rates. In the Panel's view, unless proactive, effective and adequately resourced fisheries management, monitoring, scientific and enforcement programs are in place, the potential exists for adverse impacts on populations of fish species valued in subsistence, recreational and commercial fisheries to occur as a result of increased fish harvesting pressure. However, the Panel is satisfied with the measures proposed by the Proponents to address direct Project-related impacts. The Panel notes that DFO is responsible, with its management partners, for fisheries management in the NWT. As such, it is incumbent upon DFO and its partners to put in place and adequately resource the necessary proactive and effective fisheries management, monitoring, scientific, public education and enforcement programs.

RECOMMENDATION 9-17

The Panel recommends that, within two years of the date of the Government Response to the Panel's Report, Fisheries and Oceans Canada and its management partners review current harvest management programs and take the necessary steps to put in place the policies and programs to manage any increased harvest pressures and to enhance their public education and enforcement programs. Fisheries and Oceans Canada and its management partners should make public the actions they are taking to address increased harvest pressures.

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10.1 INTRODUCTION

The Project Review Area has a rich diversity of species of local, regional, national and global significance. Local residents noted the economic and cultural value of wildlife to them at every Community Hearing, identified concerns about the possible impacts of the Project on wildlife, and stressed the need to avoid such impacts. Resource managers and non-governmental organizations drew attention to the national and international importance of several wildlife species, noting that some species are already threatened or endangered, and likewise called for the avoidance of adverse impacts on wildlife.

The Proponents acknowledged throughout the Panel's process that site-specific detailed designs and environmental information were not complete and that appropriate mitigation measures had not been fully developed for every particular situation. However, the Proponents expressed confidence that they had appropriate and effective mitigation measures available to them and that they could and would apply them. The Proponents made many commitments regarding measures, actions and plans that they would use to avoid, reduce or otherwise minimize adverse impacts of the Project to wildlife and wildlife habitat. In addition, the Proponents committed to completing Wildlife Protection and Management Plans for certain species and for other wildlife in general.

Based on their assessment, the Proponents concluded that there would be no residual Project impacts on wildlife. This conclusion depends (as noted in Chapter 5, "Approach and Methods") on the Proponents' effective application of mitigation measures, monitoring and adaptive management. It also relies on governments' effective implementation of their own existing or proposed measures, as applicable. One purpose of this chapter is to assess the likely effectiveness of the Proponents' and governments' measures in avoiding or mitigating adverse impacts on wildlife.

The Panel has examined Project impacts on the species of most concern to participants, as identified in this chapter. At the outset, however, the Panel considers two general matters. The first is the respective approaches of the Proponents and participants to wildlife impact assessment, as these influence the quality and confidence of predictions, and the appropriateness of mitigations. The second is the federal *Species at Risk Act* (SARA), which imposes specific legal requirements on the environmental impact assessment of species at risk.

Certain issues arising from the review of the Project's impacts on wildlife are addressed in other chapters. Chapter 11, "Conservation Management and Protected Areas," discusses protected areas and broader conservation measures relating to wildlife habitat. Chapter 12, "Harvesting," considers issues related to harvesting of wildlife. The Panel identifies, and makes recommendations to correct specific deficiencies with respect to baseline information, research and monitoring in this chapter, but considers the overall framework for monitoring in Chapter 18, "Monitoring, Follow-up and Management Plans."

Management of terrestrial wildlife in the Northwest Territories (NWT) is the responsibility of the Government of the Northwest Territories (GNWT). Management of migratory birds is the responsibility of Environment Canada. Within those areas of the NWT that have settled land claims, claim agreement-based wildlife management boards, set up jointly with the GNWT and Environment Canada as applicable, establish policies, regulate harvesting, and develop and implement management plans.

For the most part, however, neither government department exercises comprehensive authority over habitat. Indian and Northern Affairs Canada (INAC) has, subject to consultation with Aboriginal peoples, the right to dispose of the surface of Crown lands (surface and subsurface) throughout the NWT. A similar division of responsibility regarding management of land rights as opposed to management of wildlife on the land exists in Alberta. Hence, the authority to determine how wildlife habitat is used and managed, and indeed whether it will continue to be suitable wildlife habitat or diverted to other uses, is not within the control of the agency responsible for wildlife management. The Panel observes that this separation has given rise to concerns about lack of public notification and participation, lack of transparency, and lack of departmental coordination in the context of disposition of ownership rights to lands that are required for management of wildlife and wildlife habitat.

The Panel held six days of hearings specifically devoted to this matter.

10.2 IMPACT ASSESSMENT METHODOLOGY

10.2.1 PROPONENTS' ASSESSMENT METHODS

Several participants questioned the Proponents' impact assessment methodology. Their comments focused on:

- selecting species (wildlife valued components) for assessment, particularly with respect to species at risk;
- using indicator or surrogate species for the assessment of other species, particularly with respect to the assessment of SARA-Listed species;
- using field surveys for establishing baseline information;
- using habitat modelling as the primary means of determining Project impacts; and
- cumulative impact assessment.

Confidence in impact predictions and in the likely effectiveness of mitigations depends in part on the suitability of the assessment methods selected. Given the differences of views among participants, the Panel has considered these concerns as they apply to wildlife generally in this section before proceeding to a consideration of species-specific impacts. The first two concerns also applied particularly to the way the Proponents assessed species at risk and are therefore considered further in that context elsewhere in this chapter.

SELECTION OF VALUED COMPONENTS

The Proponents focused on a limited number of wildlife valued components, rather than a detailed analysis of all wildlife species, in one or more Regional Study Areas as characterized by the Proponents. The Proponents identified these valued components from a candidate list they compiled based on one or a combination of the following attributes:

- regulatory status designation;
- economic or public profile value to northern communities; and
- particular ecological importance.

Candidate species that have a regulatory status designation were identified as those that either the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) or the GNWT had ranked as sensitive to disturbance, along with species listed under SARA and by Alberta. The Proponents' selection of SARA-Listed species is discussed elsewhere in this chapter.

Species of value to northern communities were identified during community engagement sessions. Species of ecological relevance were identified as umbrella species (defined by the Proponents as species whose distribution and habitat requirements are well understood and represent requirements of other species), keystone species (whose loss from the ecosystem would have a disproportionately large impact on other species in a community), and species that play a critical role in food webs.

Other species were not considered as valued component candidates because:

- they had low potential to be affected by the Project;
- impact assessment and mitigation measures could be developed under the umbrella of another valued component species; and/or

- little information was available on the status and ecology of the species, and thus there would be low confidence in an impact assessment.

From the list of candidate species, the Proponents selected a subset of large mammals, fur bearers, waterfowl, birds of prey and other birds of ecological relevance for specific assessment. These were:

- in the Beaufort marine area: beluga whale, bowhead whale, polar bear and ringed seal;
- in the tundra: barren ground caribou, grizzly bear, snow goose, greater white-fronted goose, tundra swan, scaup, peregrine falcon, whimbrel and Arctic tern; and
- in the boreal forest: barren ground and woodland caribou, moose, grizzly bear, marten, lynx, beaver, the amphibian community, snow goose, scaup, peregrine falcon, lesser yellowlegs, Arctic tern and boreal chickadee.

The Proponents also selected as valued components some but not all species of concern whose status for potential designation to Schedule 1 of SARA is pending assessment. However, the Proponents selected these species based on the attributes noted above, not exclusively because of the species' status.

Several participants objected to the Proponents' approach to the selection of valued components. Most noted that the Proponents should have included more species at risk. These comments are discussed elsewhere in this chapter. Participants' objections to the Proponents' choice of valued components based on economic or public profile focused chiefly on the omission of wolverine. This concern is addressed elsewhere in this chapter.

USE OF INDICATOR SPECIES FOR ASSESSMENT

The Proponents did not conduct a detailed analysis of all species selected as valued components on the grounds that this would have been unmanageable, especially for bird species. The Proponents noted:

> Instead, individual species that represent the habitat requirements of several species of local or regional importance are selected for detailed study. This approach greatly reduces the number of species requiring detailed habitat analysis, without compromising the ecological breadth or value of the assessment. The assessment of baseline habitat availability or potential project effects for the selected species…acts as a proxy for the same considerations for similar species. (J-IORVL-00071, p. 23)

The Proponents relied on the principle that the mitigation measures designed to protect the habitat of the valued components would also protect the habitats of species for which the valued component was an umbrella species. For example, protection of the wide-ranging barren ground caribou and grizzly bear would also mitigate potential effects on species such as muskoxen and wolverine. The Proponents asserted that, "for modern environmental assessment practice, the use of indicator species is now a standard approach." (J-IORVL-01050, p. 131)

Nature Canada acknowledged that the use of surrogate species has increased over the last 20 years. However, it provided a literature review indicating that the practice has come under criticism in the scientific community and noted that many recent studies have found surrogate species to be an ineffective environmental assessment tool. Nature Canada also examined the criteria used to select surrogates, evidence supporting surrogates selected, species protected by surrogates, and gaps in surrogate species coverage. It concluded that the Proponents' approach:

- provided insufficient information on the criteria used or the rationale for the criteria to select a surrogate;
- provided insufficient evidence to support the selection of surrogates;
- provided insufficient substantiation of the utility of the umbrella species to confer protection to the at-risk species; and
- omitted several species groups from the impact analysis.

Some participants disagreed with the particular choice of indicator to represent some species and, in some circumstances, the choice of a single rather than multiple surrogates. For example, Environment Canada stated, "it is not apparent how an assessment of grizzly bear would yield a meaningful evaluation of wolverine or how an assessment of moose would provide any meaningful information with respect to rusty blackbird." (J-EC-00076, p. 8)

The Sierra Club of Canada (SCC) noted the discrepancies between the temporal and spatial use of habitat by grizzly bears and wolverines, as well as the foods on which each depends. For example, grizzly bear, while primarily herbivorous, are omnivorous and hibernate in winter, whereas wolverines are carnivorous and active in winter. The SCC was of the view that the wolf would have been a more appropriate surrogate for wolverine than the grizzly bear and advocated the use of multiple surrogate models.

FIELD SURVEYS AND HABITAT MODELLING

The Proponents conducted ground and aerial field surveys to evaluate habitat use of wildlife in the Local Study Area and Regional Study Area. Winter track surveys, ungulate aerial surveys, pellet group surveys, and grizzly bear aerial and ground den surveys were used to quantify habitat use by mammals.

Spring aerial surveys over select water bodies were used to identify and document concentrations of spring-migrating waterfowl and other water birds. Land bird density was determined by point count surveys. In the outer Mackenzie Delta and at Parsons Lake, ground plots (400 m by 400 m) were established to determine density of nesting shorebird populations.

The Proponents also conducted habitat modelling to:

- evaluate the habitat for selected species though all phases of the Project;
- quantify changes to habitat through all Project phases; and
- identify habitats and areas that are preferred by the selected species.

The Proponents developed habitat suitability models for most of the valued components. The amount of effective habitat was calculated by overlaying the Project's footprint, buffered by a zone of influence, on the habitat map. Thus, the measure of the Project's impact on habitat availability was determined by subtracting the amount of effective habitat during a particular Project phase (construction, operations or decommissioning) from the amount of effective habitat before the Project. The Proponents also conducted an analysis of fragmentation and connectivity in 10 areas of high conservation value as another measure of the impacts of the Project on habitat availability.

Measures of the Project's impact on species movements and mortality were quantified to a lesser degree than impacts on habitat availability. In large part, the level of impact on movement and mortality was inferred based on available knowledge of the species and local knowledge of movement corridors.

The Panel heard a number of criticisms of the Proponents' approach to field survey methodology and habitat suitability modelling. GNWT consultant Dr. Chris Johnson conducted a general review of the method. He concluded:

- the habitat-based approach is acceptable as an industry standard;
- the execution of this approach's technique may negate results;
- in the case of the Proponents' execution of the habitat suitability model:
    - the mechanism for assigning ratings was unclear;
    - documentation for assigning ratings seemed inappropriate;
    - expert opinion was not properly documented, and there was no capacity to capture differing opinions;
    - although validation was applauded, validation methodology was poorly documented, and the use of models after they failed validation was unjustified; and
    - no uncertainty and sensitivity analysis was done.

In addition, the Gwich'in Renewable Resources Board noted that the wildlife habitat availability models were of questionable accuracy, suffered from errors in model inputs and adjustments, and created errors in estimated wildlife densities due to low sampling effort or a lack of baseline information.

CUMULATIVE IMPACT ASSESSMENT

The Proponents' approach to cumulative impact assessment is described in Chapter 5, "Approach and Methods." Differences between the Proponents and some participants on actual cumulative effects on wildlife relate chiefly to the basic approaches described in Chapter 5. This chapter considers only the results of the Proponents' cumulative effects assessment, species by species, and does not revisit the question of the scope of that assessment.

The Proponents found that its cumulative effects assessment did not alter its findings about the effects of the Project on wildlife, with the minor exception noted elsewhere in this chapter, and concluded that cumulative effects on habitat availability or movement would in no instance be significant.

In general, the Proponents did not conduct a cumulative impact assessment if the Project assessment was low in magnitude. For example, the Proponents did not conduct a cumulative impact assessment for birds because all Project effects on birds were predicted to be low in magnitude and because all but one (boreal chickadee) are not in the region for most of the year.

Environment Canada's concerns about the Proponents' cumulative impact assessment were:

- [the] lack of conservative conclusions regarding project-specific cumulative effects;
- inadequate documentation of assumptions, data gaps, [and] confidence in data and analyses; [and]
- inadequate detail regarding aspects of mitigation, monitoring, follow-up and approaches to adaptive management. (J-EC-00162, p. 4)

In its presentation on behalf of all federal government departments, INAC stated that "the proponent has likely underestimated predicted cumulative impacts in its assessment." (J-INAC-00162, p. 11)

The SCC stated that cumulative impact assessment should be done on any valued component that is shown to have an adverse impact.

10.2.2 PANEL VIEWS AND RECOMMENDATION

GENERAL APPROACH

The Panel notes that, for the Proponents' significance determinations to be valid, their mitigation measures would need to be appropriate to the situation in which they were applied and be fully effective in their implementation.

The net effect of the Proponents' approach is that, if accepted, all other participants and the Panel would have to:

- rely on the implementation of measures and actions not yet fully defined or described;
- assume that these incompletely described measures and actions would be entirely effective; and
- trust that the Proponents and other parties would know when those measures and actions have not been effective and take the appropriate action to remedy an unforeseen situation.

The Panel is not entirely persuaded of the merits of this approach and acknowledges a number of participants' concerns about it. These concerns, as they apply to particular species, are considered in the discussions of those species in other sections of this chapter.

The Proponents made numerous commitments to avoid, reduce or mitigate adverse Project impacts to wildlife and wildlife habitat. The Proponents also committed to completing Wildlife Protection and Management Plans for key species of concern and other wildlife in general. The Panel views these commitments (see Panel Recommendation 5-1), and the Wildlife Protection and Management Plans, as essential elements in any effort to manage adverse impacts to wildlife and wildlife habitat.

RECOMMENDATION 10-1

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project or to the Northwest Alberta Facilities, require the Proponents and NOVA Gas Transmission Ltd., respectively, to file a Wildlife Protection and Management Plan specific to each of the following species as appropriate — woodland caribou, barren ground caribou, grizzly bear, polar bear and wolverine — and a General Wildlife Protection and Management Plan applicable to all other species of wildlife. These Wildlife Protection and Management Plans must be filed six months prior to the commencement of construction. These Wildlife Protection and Management Plans must be developed in consultation with, and to the satisfaction of, the governments of the Northwest Territories and Alberta, wildlife management boards and others as appropriate. The plans should reflect the geographic region and site-specific details of the facilities to which they will be applied and address issues related to fragmentation. The plans must include:

- *goals of the plan;*
- *area covered by the plan, including at a minimum all areas within a specified radius of any Project-related facility or construction activity;*
- *assumed zones of influence of Project activities, by activity and by species, and rationales for these assumptions;*
- *timing and dates during which Project-related activities would occur so as to avoid or minimize conflict with caribou movement or sensitive feeding or calving times;*
- *mitigation measures, including but not limited to those needed to minimize width of linear disturbances, maximize vegetation recovery, adjust timing of activities, limit harvesting, limit predator travel corridors, implement employee/contractor access management, ensure effective reporting, eliminate barriers to movements, and ensure effective communications and reporting;*
- *monitoring components applicable to all phases of the Project, including but not limited to documenting vegetation recovery; documenting and reporting wildlife incidents, interactions and mortality; evaluating the effectiveness of access management; and establishing and maintaining linkages to regional programs;*
- *any surveys and protocols to be employed to avoid or prevent impacts to wildlife, including the proposed timing of any den survey activities and how the Proponents will identify current year and active dens;*
- *identification of mitigation plans to avoid potential maternal denning areas;*
- *protocols for managing potential interactions between wildlife and humans, including measures to deter wildlife and, in particular, bears from entering camps and other facilities;*
- *any wildlife protection measures included in the Proponents' spill contingency plans;*
- *methods for tracking and reporting human–wildlife interactions and any wildlife mortality that may occur as a result of the implementation of measures contained in the spill contingency plans;*
- *education and awareness activities aimed at reducing the potential for human–wildlife conflicts at the Proponents' facilities;*
- *plans for monitoring responses of wildlife to Project activities during all phases of the Project;*
- *provisions for public consultation on access management;*
- *the process for updating the protection plan as information gaps are addressed; and*
- *processes for oversight and reporting and a description of how those processes will be implemented.*

Each Wildlife Protection and Management Plan must also include details on how it will be implemented by each operator of a facility of the Mackenzie Gas Project or the Northwest Alberta Facilities, and, based on the advice of wildlife management boards, the measures each operator will take to enable the participation of local monitors. The Proponents and NOVA Gas Transmission Ltd. must file copies of the reports required by the monitoring provisions of the plans with the Government of the Northwest Territories, the Government of Alberta and the relevant wildlife management boards, as appropriate.

SPECIFIC METHODS

The Panel finds that the use of indicator species is, in principle, an acceptable method of impact assessment. However, the Panel was not persuaded that the Proponents' choice of indicator species was justified in all cases. As these mainly relate to species at risk, they are considered further elsewhere in this chapter.

The Panel is of the view that the field survey methodology and the application of the habitat suitability models that the Proponents developed and used in the environmental assessment process provided a useful tool for understanding potential impacts to wildlife. However, the Panel acknowledges the limitations of the field survey methodology and the application of the habitat suitability models. In the Panel's view, the results obtained by the use of pellet and track count field surveys provide very little value other than simple evidence that the species studied was either present or absent on the date the survey took place. In addition, the methodology was poorly documented, and the sampling design was not obvious. As expressed by Dr. Johnson, a consultant to the GNWT, the application of the habitat suitability models was flawed; in particular, the validation protocols were poorly documented and, in cases where the habitat model was not validated, it was not clear what the Proponents concluded from the model. In the Panel's view, the field surveys and habitat models provided only an understanding of changes at the habitat level and did not provide an understanding of what may be occurring at the population level. Yet, in the Panel's view, such an understanding is essential if the impacts of the Project and Northwest Alberta Facilities on valued components are to be managed properly over the long term.

The Panel acknowledges participants' criticisms with respect to the appropriate use of indicator species and accepts, in particular, the critique of Dr. Johnson on behalf of the GNWT with respect to habitat modelling. Nonetheless, the Panel considers that sufficient evidence was presented to enable the Panel to review the potential impacts of the Project and the Northwest Alberta Facilities on wildlife and wildlife habitat in a manner that satisfies the Panel's Terms of Reference.

CUMULATIVE IMPACTS

The Panel agrees with participants who considered the Proponents' cumulative impact assessment to be incomplete. Participants themselves, however, drew sufficient attention to concerns about cumulative impacts such that the Panel considers that it was enabled to make findings and recommendations (except where noted specifically in this chapter) on a species-specific basis. To the extent that there remains an overarching need for further cumulative impact assessment on a more comprehensive or systematic basis, and on how that work should be done and by whom, the Panel makes recommendations to that effect in Chapter 18, "Monitoring, Follow-up and Management Plans."

10.3 SPECIES AT RISK

10.3.1 ASSESSMENT REQUIREMENTS

Several participants asserted that the Proponents had not met their obligations with respect to species at risk under SARA, the *Joint Review Panel Agreement* or the Terms of Reference for the Environmental Impact Statement (EIS), either because they had failed to assess certain species altogether or had done so in an inappropriate way. Participants focused on four concerns:

- the list of at-risk species the Proponents assessed was not sufficiently inclusive;
- the methods by which the Proponents assessed the species they did include was inappropriate;
- the Proponents applied the wrong test for impact on a Listed wildlife species; and
- the Proponents did not provide a cumulative impact assessment of Listed wildlife species.

This section considers the merits of those arguments. The actual impacts on species Listed under SARA as well as on other at-risk species, and appropriate mitigations for those species, are discussed in other sections.

In introducing this topic, the Panel notes that, although different agencies maintain various species-at-risk listings, in the context of this review, only SARA — a federal Act — has the potential to give rise to legal obligations on the part of responsible authorities, the Proponents and the Panel.

The entirety of SARA did not come into force and effect until June 2004. SARA's purpose is to:

- prevent Canadian wildlife species from being extirpated or becoming extinct;
- provide for the recovery of extirpated, endangered or threatened species; and
- manage other species of special concern to prevent them from becoming endangered or threatened.

Schedule 1 of SARA lists all those species to which the protective provisions of the Act apply. Species on this list are referred to as "listed" or as "listed species," which for clarity in this Report are referred to as "Listed" or as "Listed species."

In addition, there are species at risk identified in Schedule 2 (threatened or endangered) and Schedule 3 (of special concern) of SARA and in regional lists prepared by provinces and territories. These species have no legal status per se but may benefit from provincial and territorial government conservation programs that identify and protect at-risk species within their borders. The GNWT's Department of Environment and Natural Resources has a species-at-risk management program that assesses the general status of all species, identifies potential risks and coordinates actions for the recovery of Listed species. Alberta Sustainable Resource Development, a department of the Government of Alberta, has a similar strategy. At the close of the Panel's hearings, neither jurisdiction had a specific law that protects endangered species or gives rise to a legal obligation on the part of the Proponents or this Panel. However, both are signatories to the national *Accord for the Protection of Species at Risk in Canada*, which commits them to a national approach to protect species at risk.

The scientific identification of species at risk is performed at the national level by COSEWIC. It makes recommendations to the Minister of the Environment about species that should be added to Schedule 1 of SARA.

Once a species is listed, a number of government obligations come into play. Under SARA, there are:

- prohibitions that must be either enforced or permitted in relation to the species; and
- species-specific protection and recovery measures that must be developed and implemented.

General prohibitions include harming individuals, residences or critical habitat of a Listed species without express permission from the competent minister. When a species is Listed and its recovery is determined to be feasible, the competent minister, who in the case of the Project is the Minister of Environment, must put in place a recovery strategy and an action plan (or in the case of a Schedule 1 species of special concern, simply a management plan) to prevent the reduction or loss of the species and to promote its recovery. Development of both a recovery strategy and an action plan requires the competent minister to consult broadly and to cooperate with appropriate provincial and territorial ministers for each jurisdiction where the Listed species is found and with other pertinent federal departments, wildlife management boards and directly affected Aboriginal organizations.

An action plan must include:

- an identification of the species' critical habitat, to the extent possible, and examples of activities that are likely to result in its destruction;
- a statement of the measures that are proposed to be taken to protect the species' critical habitat;
- an identification of any portions of the species' critical habitat that have not been protected;
- a statement of the measures that are to be taken to implement the recovery strategy;
- the methods to be used to monitor the recovery of the species and its long-term viability; and
- an evaluation of the socio-economic costs of the action plan and the benefits to be derived from its implementation.

In relation to aquatic species, migratory birds or other wildlife species on federal lands, the competent minister must make regulations to implement the measures set out in the action plan. Notably, this obligation as well as other obligatory measures to protect wildlife do not become enforceable until there is an action plan, and an action plan is not complete until a species' critical habitat has been identified. SARA defines the term "critical habitat" as "the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species." (section 2.(1)) The term "residence" is defined as "a dwelling-place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating." (section 2(10))

Under SARA, there are strict timelines by which the competent minister must include a proposed recovery strategy in the SARA public registry, review comments on the draft and finalize it. The deadlines for finalization of a recovery strategy in relation to each of the Listed species potentially impacted by the Project have passed. At the close of the Panel's record, no critical habitat or residences of Listed species had been formally identified, and no action plans for Listed species potentially impacted by the Project were in place.

Another legislated obligation in relation to Listed species is found in the *Canadian Environmental Assessment Act* (CEA Act). The Act requires an assessment by a review panel to consider the "environmental effects" of the Project and any cumulative environmental effects that are likely to result from the Project. It defines "environmental effect" as including "any change that the project may cause in the environment, including any change it may cause to a listed wildlife species, its critical habitat or the residences of individuals of that species, as those terms are defined in subsection 2(1) of the *Species at Risk Act*."

Under the EIS Terms of Reference, the Proponents were required to provide information in relation to two classes of species at risk: Listed species and species of concern. In conformity with the definitions guiding a Panel review under the CEA Act, the Proponents were asked first to "consider any change that the Project may cause to a listed wildlife species, its critical habitat or the residences of individuals of that species, as those terms are defined in subsection 2(1) of SARA" and to "take into account the requirements of SARA and provide the information necessary to evaluate the potential Project impacts on the species contemplated by this Act including mitigation and monitoring." This topic is the subject of this section.

Second, the Proponents were requested to "discuss the potential impacts of the Project on species of concern and proposed mitigation in relation to applicable legislation, policy, management plans, recovery strategies, action plans or land use planning initiatives." (Terms of Reference, p. 43) Discussions of impacts on non-Listed species at risk are addressed in other sections of this chapter.

10.3.2 SELECTION OF SPECIES FOR ASSESSMENT

The steps by which the Proponents selected Listed species to assess involved:

- identifying SARA species that could occur within the Project review area;
- assessing whether there was sufficient species baseline information to undertake an assessment; and
- conducting an assessment of impact on the species.

On this basis, the Proponents assessed two Listed species directly: woodland caribou (boreal population) and peregrine falcon (*anatum*). The assessments of these two species are discussed elsewhere in this chapter. An additional two Listed species, the Eskimo curlew and the wood bison, were assessed using indicator species. The Proponents stated that "all species on SARA Schedule 1 that were found to have temporal and spatial overlap directly with the Project activities or through cumulative effects with other reasonably foreseeable projects were included in the impact assessment." (J-IORVL-01050, p. 130)

The Proponents also assessed species of concern, which are discussed in other sections throughout this Report.

Environment Canada, the GNWT, Nature Canada and the SCC asserted that the Proponents' EIS was deficient because it failed to assess all species in the Project area that are identified in SARA or are species of concern classified by COSEWIC. These participants were of the view that explicit requirements for such assessments had been set out, not only in SARA, but in the EIS Terms of Reference. They maintained that each Listed species and species of concern should have been identified and assessed as a valued component. In Environment Canada's view, this included the 12 species identified in Table 10-1.

Environment Canada's rationale for including species other than those Listed species in Schedule 1 was that these species are currently subject to further assessment, may be added to Schedule 1 before the Project is completed, and should have been assessed as a matter of best practice.

Environment Canada submitted that 3 of the 12 species — wood bison, yellow rail and western toad — had not been assessed by the Proponents. It stated that it had informed the Proponents of sightings of yellow rail within 20 km of the pipeline right-of-way in the NWT and within 80 km of the right-of-way in northern Alberta but that the Proponents had not used this information to conduct an impact assessment. Environment Canada was of the view that these sightings indicated a range extension of the species and, as such, the Proponents were obliged to assess the impact the Project would have on this Listed species. Environment Canada held a similar view with respect to the western toad, which is also a Listed species.

With respect to wood bison, the GNWT expressed concern that, although not within their current habitat range, the pipeline

Table 10-1 Species at Risk that Occur in the Project's Regional and Local Study Areas

Species	Status	SARA Schedule	Management Responsibility
Eskimo curlew	Endangered	1	Environment Canada
Peregrine falcon (*anatum*)	Threatened	1	ENR/SRD
Wood bison	Threatened	1	ENR/SRD
Woodland caribou (boreal population)	Threatened	1	ENR/SRD
Yellow rail	Special concern	1	Environment Canada
Western toad	Special concern	1	ENR/SRD
Peregrine falcon (*tundrius*)	Special concern	3	ENR
Short-eared owl	Special concern	3	ENR/SRD
Polar bear	Special concern	Pending	ENR
Grizzly bear	Special concern	Pending	ENR/SRD
Wolverine	Special concern	Pending	ENR/SRD
Rusty blackbird	Special concern	Pending	ENR/SRD

ENR: NWT Department of Environment and Natural Resources

SRD: Alberta Department of Sustainable Resource Development

Source: Adapted from J-EC-00076, Table 1, p. 7

right-of-way might create corridors of preferred bison habitat that could facilitate contact between isolated herds and, thus, the transmission of diseases to herds that are presently disease-free.

Based on its view that the Proponents had not fully met the requirements of SARA to assess each Listed species and species of concern, the GNWT provided its own species-specific profile and prediction of the Project's impact on wolverine, wood bison, western toad, short-eared owl, and rusty blackbird (see section 10.9).

Nature Canada noted that, of the 62 bird species occurring in the Project study area that are assessed as being at risk by the GNWT or COSEWIC or that are listed by Alberta Sustainable Resource Development or SARA, impacts for only 5 of those species were assessed in the EIS.

The SCC was critical of the Proponents' assessment approach, which was limited to only Listed species occurring in the Project area and to only those at-risk species listed in Schedule 1 of SARA. In their view, the Proponents had failed to select or assess all species listed under all SARA Schedules and had not assessed species identified as being of special concern by COSEWIC, such as the wolverine.

In response, the Proponents stated that SARA requires a proponent to assess the impacts of its project on species on Schedule 1 and that "a species that may currently be under consideration by COSEWIC, but has not yet been moved to Schedule 1, is not subject to Section 29 of the Act and does not have to be included in a project's [environmental assessment] pursuant to SARA." (J-IORVL-01050, p. 128) The species of concern the Proponents did assess were selected as valued components on broader criteria, not solely on the basis of their SARA status.

With respect to Environment Canada's contention that the yellow rail and western toad should have been assessed, the Proponents responded that they considered the species' documented observations "rare and accidental occurrences of a species outside its range" rather than an extension of the species' range. (J-IORVL-01050, p. 130) In response to the GNWT's concerns regarding wood bison, the Proponents stated that, at the time the EIS was filed, the wood bison had been included in the EIS but had not been assessed because the herds were not expected to interact with the Project. Subsequently, in response to an Information Request from the Panel, the Proponents assessed the potential impacts on wood bison based on the use of moose, grizzly bear and woodland caribou as indicators.

10.3.3 ASSESSMENT METHODS

The Proponents assessed several of the species identified by Environment Canada in Table 10.1 indirectly by using indicator species. The Proponents used whimbrel as an indicator for the Eskimo curlew; moose, grizzly bear and caribou for wood bison; boreal chickadee and moose for rusty blackbird; and grizzly bear for wolverine. The appropriateness of using indicators for assessing valued components is discussed elsewhere in this chapter. The Panel finds that, for valued components generally and despite the merits of some of the criticisms presented, sufficient evidence was presented to enable the Panel to review the impacts of the Project on wildlife and wildlife habitat in a manner that satisfies the Panel's mandate.

Environment Canada, the GNWT, Nature Canada and the SCC were critical of the Proponents' use of indicator species to assess Project impacts on Listed species. They asserted that, by not assessing each species directly, the Proponents did not fully meet the obligations of SARA or the EIS Terms of Reference. Environment Canada and the GNWT considered the use of indicator species for species at risk as inappropriate. Environment Canada stated: "Each species has a unique set of species-specific requirements, which cannot be adequately reflected by surrogate species. It is a species-specific requirement and the threats to those requirements that must be explicitly addressed." (Kevin McCormick, HT V47, p. 4602)

The SCC stated that an adequate assessment of the impacts of even the Project itself "on all listed species at risk in the area has not been undertaken." It added: "Further these failures to assess impacts mean that the significance of those impacts and potential mitigation have also not been sufficiently considered." (J-SCC-00119, p. 9)

The general view of these participants was that an environmental impact assessment of a Listed species should be more stringent as a matter of best practice (although no documentation of best practice was offered).

The Proponents offered two responses to these objections. First, "while SARA requires that a project conduct an assessment of its potential effects on any SARA-listed species, it does not dictate how that assessment is to be conducted." It added: "In other words, the legislation does not mandate a particular methodology that a project must follow in conducting its assessment of its potential effects on SARA-listed species." (J-IORVL-01050, p. 128)

Second, the Proponents asserted that "indicators must be measurable and should be sensitive to potential impacts so that potential effects can be determined." (J-IORVL-01050, p. 129) For this reason, and where there may be a scarcity of population or distribution data or empirical assessment data, which is common in the case of species at risk, the use of indicator species is justified. In this connection, the Proponents defended their rationale for use of indicator species by noting that (as of March 2005) no recovery strategies had yet been prepared for any of the species at risk noted in the Project area, critical habitats had not yet been identified, and species' residences had not yet been defined. Therefore, the Proponents explained, for the purpose of assessing "the potential effects of the project on species' residences, key habitat types used during sensitive seasons or life stages were used to represent the species' residence." (J-IORVL-00074, p. 173)

The Proponents acknowledged that residences of all species, including those of species at risk, and the Project's site-specific impact on those residences would not be identified until the Project permit application process. Consequently, it made a commitment to conduct pre-construction surveys at that time. The Proponents further committed to assessing "detailed, site-specific effects of the project footprint on individual residences of all wildlife species, including species at risk" during the Project permit application process when pre-construction surveys of the Project footprint would be undertaken. (J-IORVL-00074, p. 173)

The Proponents noted that no vascular plants, plant communities, bryophytes or lichen in the NWT or northwest Alberta have been "evaluated or listed by SARA." (J-IORVL-00074, p. 177) However, they committed to undertake detailed rare plant surveys in relation to Project facilities before construction.

10.3.4 IMPACT ASSESSMENT

The Proponents considered that the potential impacts on species at risk include habitat destruction (foraging and nesting), habitat avoidance, fragmentation of habitat, and increased mortality resulting from predation and increased access by hunters. For birds, there may also be a decline in nesting sites. The Proponents concluded that the Project would have adverse impacts during construction, operation and decommissioning on the Listed species for which they conducted an assessment but that these impacts would not be significant.

Environment Canada, the GNWT, Nature Canada and the SCC pointed out that the Proponents had not met the requirement of either SARA or the EIS Terms of Reference because essentially the Proponents had responded to the wrong test. The Proponents made conclusions about "significance" of impact as opposed to simply identifying any "change" the Project might cause to a Listed species, its critical habitat or the residence of its individuals. These participants noted that, under the CEA Act, it is the effects that must be identified, regardless of their significance. Environment Canada stated that the Proponents had concluded that the Project would have "no 'significant' impacts on species at risk." It added:

> However, SARA requires the identification of any 'adverse' impacts on listed species, to identify avoidance measures or lessen those impacts and to undertake monitoring to determine the effectiveness of mitigation or identify where further mitigation is required. This requirement was not addressed with respect to wolverine, Eskimo curlew, short-eared owl, rusty blackbird, wood bison, yellow rail, or western toad. (J-EC-00076, p. 11)

The SCC stated that an adequate assessment of the impacts of the Project on all Listed species at risk in the area has not been undertaken and that "these failures to assess impacts mean that the significance of those impacts and potential mitigation have also not been sufficiently considered." (J-SCC-00119, p. 9)

Criticism was not levelled solely at the Proponents. The SCC was also critical of government and the lack of capacity to implement the protective provisions of SARA. The SCC stated that "recovery strategies have not yet been developed for certain listed species at risk that will potentially be impacted" by the Project and "its cumulative effects, such as for woodland caribou." It further stated that "recovery strategies are one of the critical tools under the *Species at Risk Act*…to help ensure the survival and recovery of listed species at risk (e.g. a recovery strategy for a particular listed species must address the threats to the survival of that species and must identify the critical habitat of that species to the extent possible)." Without recovery strategies in place, the SCC stated, it is more difficult to determine the significance of impacts from the Project and its cumulative impacts and to design appropriate mitigation measures. (J-SCC-00119, p. 9)

10.3.5 CUMULATIVE IMPACT ASSESSMENT

The Proponents stated:

> Project-specific effects were in general determined to be adverse, low in magnitude, local to regional in extent, medium to long-term in duration and not significant. It is unlikely that there will be any adverse cumulative effects on SARA-listed species, given that Project-specific effects are not significant. The lack of spatial and temporal overlap of SARA species with the Project and reasonably foreseeable projects further reduces the likelihood of cumulative effects. (J-IORVL-01050, p. 138)

A number of participants pointed out deficiencies in the Proponents' cumulative effects impact assessment. In addition to Environment Canada's concerns noted in Section 10.2, the SCC noted that the CEA Act, SARA and *Joint Review Panel Agreement* require that the impacts on all species at risk listed under SARA be assessed, including impacts resulting directly from the Project and impacts resulting from cumulative effects, such as from induced development. It pointed out that not only had an adequate assessment of the impacts of even the Project itself on all Listed species in the area not been undertaken, but that "an assessment of cumulative impacts on all listed species at risk has not been provided." (J-SCC-00119, p. 9) In line with its observation of governments' lack of capacity to implement SARA, the SCC stated that, without recovery strategies in place, it is more difficult to determine the significance of impacts from the Project and its cumulative impacts, and to design appropriate mitigation measures.

10.3.6 PARTICIPANTS' VIEWS AND RECOMMENDATIONS

Environment Canada concluded that the Proponents had not identified the adverse impacts on species at risk required by SARA, including the wolverine, Eskimo curlew, short-eared owl, rusty blackbird, wood bison, yellow rail and western toad. Environment Canada concluded that SARA obligations for all of these species other than the Eskimo curlew remain to be addressed.

Environment Canada stated that "in light of its current status, there is no need for further action with respect to Eskimo curlew." It added: "An appropriate mitigation and monitoring plan will be developed with the Proponent if it is established that this species does occur in the area." (J-EC-00076, p. 11)

Environment Canada's only recommendation in relation to species at risk was that the Proponents be required to determine the distribution and abundance of yellow rail in the vicinity of the pipeline right-of-way before establishing the final pipeline alignment, and that the plan to address this requirement be developed and implemented to the satisfaction of Environment Canada.

The GNWT concluded that the wolverine, wood bison, western toad, short-eared owl and rusty blackbird had not been assessed to fully meet SARA obligations, and therefore the impacts on these species could not be effectively assessed at this time. However, the GNWT recommended measures that could be implemented to minimize the risk of adverse impacts, which are discussed elsewhere in this chapter.

The SCC made three specific recommendations related to species at risk:

- Environment Canada, Fisheries and Oceans Canada, the GNWT, and the Proponents must jointly complete a thorough assessment of impacts from the Project itself and from cumulative effects, including induced development on all species at risk listed by SARA, the GNWT or COSEWIC, and redesign the Project, limit induced development and design mitigation measures accordingly. This should include developing mandatory thresholds for key species such as caribou.
- Environment Canada, Fisheries and Oceans Canada, and the GNWT must jointly complete recovery strategies for all listed species at risk potentially impacted by the Project and its cumulative effects in accordance with the deadlines prescribed under SARA, and incorporate the findings into the design of the Project, limitations on induced development and other mitigation measures.
- Environment Canada, the GNWT and the Proponents must include wolverine as a valued component and assess it accordingly, and address the deficiencies in the Proponents' mitigation measures for wolverine as identified by the SCC.

The Proponents did not respond directly to the specific mitigation measures proposed by participants. Rather, they indicated their agreement with the recommendation to implement detailed Wildlife Protection and Management Plans, with the variation that the parameters for testing impact predictions would be determined following detailed engineering and as the Project progresses, and as a result of monitoring measures and discussions with regulators, resource managers and affected stakeholders. Adaptive management would be in place throughout the life of the Project. The Proponents committed to contribute to the development of recovery strategies under SARA for species in the NWT through the Canadian Association of Petroleum Producers' representative.

10.3.7 PANEL VIEWS AND RECOMMENDATIONS

SELECTION OF SPECIES FOR ASSESSMENT

The Proponents noted that they were required to assess only those species that were on Schedule 1 of SARA at the time of filing its EIS and, of those species, only those for which a Project-related impact was reasonably likely to occur. The Panel agrees with the Proponents and with their selection of the following Listed species as those that would be potentially affected by the Project as Filed: Eskimo curlew, wood bison, woodland caribou and peregrine falcon (*anatum*).

For the Panel to require the Proponents to meet SARA standards in respect of non-Listed species or Listed species for which no connection with the Project has been established would take the Panel outside its mandate. That is not to say that a species of concern likely to be impacted by the Project need not be assessed or that it would not need to be assessed again for Project-related impacts if it were to become a Listed species. It simply means that the assessment of a non-Listed species at this point in time need not be conducted to the same level required for a Listed species under the provisions of SARA and CEA Act. As a consequence, the Panel finds that the Proponents were not obliged to assess non-Listed species in the same manner as Listed species. The merits of the Proponents' assessment of the four Listed species potentially affected by the Project are considered in the appropriate sections of this chapter.

The Proponents also considered assessing two other Listed species: the yellow rail and western toad. However, using information in published COSEWIC reports, the Proponents determined that the range of each species was outside the

Project study areas, so both were "scoped out…of assessment in the EIS." (J-IORVL-01050, p. 208) Nevertheless, the Proponents did commit to support Environment Canada "in its efforts to understand the extent of the yellow rail range by documenting observations during future right-of-way works in the range extension area." (J-IORVL-01040, p. 84)

The Panel appreciates that the Proponents were not strictly required to undertake an assessment of the yellow rail or western toad because, although these are species of special concern on Schedule 1 of SARA, there was insufficient evidence of the presence of either Listed species in the Project Review Area or a plausible hypothesis about whether, and if so how, the Project was likely to impact these species. Nonetheless, the Panel considers it would be appropriate, from a precautionary perspective, for the Proponents to take the following steps with respect to these two species.

RECOMMENDATION 10-2

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to conduct a survey in those parts of the Local Study Area where, based on the most recent assessment by the Committee on the Status of Endangered Wildlife in Canada, the yellow rail and western toad might occur, to confirm the presence or absence of those species. The survey must be designed to the satisfaction of Environment Canada and conducted prior to the commencement of construction. Where the presence of the yellow rail or western toad is confirmed as a result of the survey, the National Energy Board condition should require the Proponents to notify Environment Canada of the presence of the species, identify their proposed measures to avoid and lessen the impact of the Mackenzie Gas Project on the species, and identify their proposed monitoring measures.

The Panel finds that, based on the foregoing, the Proponents met the requirements of the CEA Act and SARA with respect to selecting the appropriate Listed species for assessing the changes the Project would have on Listed species.

The Panel is mindful that there are species of concern whose status may change during the expected lifespan of the Project and may become Listed species. Notwithstanding the limits of SARA, the Panel is of the view that, based on the precautionary principle and best practices, the Proponents and wildlife resource managers should be continually alert to the impacts the Project may have on any Listed species undergoing changes to its habitat or range that cause it to come within any Regional Study Area (RSA), and on species identified through COSEWIC, GNWT or Alberta processes that are in any RSA and become Listed during the life of the Project. If either of these situations occur, future assessments of other species may be required of the Proponents and any agreements that exempt the Project from SARA prohibitions may need to be amended. The Panel notes that all of the species identified by Environment Canada and the GNWT as being species of concern were assessed by the Proponents, although not necessarily in accordance with the methodology and level of detail preferred by Environment Canada or the GNWT.

IMPACT ASSESSMENT

The Proponents noted that the applicable legislation does not mandate any particular method that a proponent must follow to assess a Listed species. The Panel agrees. It follows that the Proponents' use of indicator species for assessing other species of regulatory concern, as discussed elsewhere in this chapter, is also not inconsistent with SARA and CEA Act requirements.

In the Panel's view, the Proponents provided a reasonable justification for the use of indicators for assessing Eskimo curlew and wood bison.

The Panel notes that Environment Canada concluded that no further assessment was required with respect to Eskimo curlew. The Panel agrees. The GNWT conducted its own assessment of Project impacts on wood bison and made recommendations. These are discussed elsewhere in this chapter.

Participants noted that SARA and the CEA Act require that a proponent identify any change that its project might cause to a Listed species, not an opinion on the significance of the project's effects. The Panel agrees. The responsibility for considering and reporting the significance of environmental impacts, including any change to a Listed species, its critical habitat or its residences, is that of the Panel. As a matter of principle, the Panel also agrees with participants who suggested that a higher standard of assessment should apply with respect to Listed species. That higher standard should include direct assessment of the species where possible and, in the absence of an action plan, pay particular attention to the recovery strategies and management plans that government agencies have in place to conserve and preserve the species. However, the Panel also notes that the Proponents did not have the full range of information required to achieve this higher standard.

When a species is Listed under SARA as endangered or threatened, the competent minister is obliged to put in place a recovery strategy and action plans to prevent the reduction or loss of the species and to promote its recovery. Among other things, these plans must identify the species' critical habitat, the measures proposed for protecting that habitat, and the measures to implement the recovery strategy and monitor its effectiveness. However, the Panel notes (as did all parties, including the Proponents) that by the close of the Panel's record none of these measures had been completed with respect to any of the Listed species.

The rationale behind SARA is to require government to put in place protective mechanisms so that, when activities are proposed, those activities can be designed and managed in order to avoid or minimize impacts on species whose very existence is already under considerable stress. Impact assessment of a Listed species under SARA is distinguished from an ordinary assessment in that a species already recognized as being in danger must be assessed in the context of the vulnerabilities to which it is exposed, as well as the full weight of the protections sanctioned by the legislation and implemented by government. To the extent that an activity is allowed to proceed, it must be assessed in the context of the presence and success of protective efforts being undertaken by wildlife managers and government under recovery strategies and action plans.

In the Panel's view, these obligations of the competent ministers provide essential guidance to both project proponents and environmental assessment panels for assessing the impacts of proposed projects on Listed species. If this guidance is not in place, proponents may be severely limited in their ability to identify any changes their activities might cause to a Listed species. Likewise, panels may be severely limited in their ability to assess the impacts of such changes, the effectiveness of any proposed mitigation, and the significance of a project's impacts.

The Panel notes that, in recognition of the absence of site-specific knowledge of Project impacts on species' residences, the Proponents committed to undertake pre-construction surveys to identify species' residences and the occurrence of any rare plants. The Panel endorses these commitments. Nevertheless, the Panel acknowledges that any change to a Listed species, its residence or critical habitat could affect the species and could be significant.

Therefore, the Panel concludes that there are considerable uncertainties remaining with respect to identifying changes that may occur to Listed species as a result of the Project and the ability to assess the significance of those changes. While the Panel does not necessarily endorse the Proponents' finding that there would be no Project-related significant impacts on Listed species, it recognizes that the basis for making such a determination is largely absent and not within the competence of the Proponents to make at this time. Therefore, simply requiring the Proponents to undertake or revise such assessments in the absence of a recovery strategy and action plan (and for Schedule 1 species of concern, a management plan) would, in the Panel's view, be unproductive.

Information about governments' intentions to manage Listed species is therefore essential because it provides the broader range of efforts being undertaken to protect the species and is the backdrop against which consideration of a single project must take place. Only once this information is known can a proposed activity be assessed for its potential impact on the species' survival. The Panel observes generally that, although details on particular species are discussed in other sections of this chapter, information about how government intends to define critical habitat and manage human activity to facilitate survival of Listed species in the Project Review Area was lacking in the Project review.

Therefore, in the Panel's view, the Proponents went about as far as they could to identify potential impacts that might arise from the Project, many elements of which are still at a conceptual stage.

To the extent that it has any responsibility to do so, the Panel does not have sufficient information with respect to all Listed species that might be affected by the Project to notify the Minister of the Environment under section 79 of SARA that the Project is likely to affect a Listed species, its critical habitat or the residences of its individuals. Where there is likelihood that the Project might affect a Listed species, the Panel has made recommendations in this chapter to avoid or reduce that likelihood.

The Panel notes that the results of its review do not and cannot provide the competent ministers with the full range of information required to exercise their legal responsibilities for SARA-Listed species in respect of the Project. Completion of a recovery strategy and action plan for each of the woodland caribou (discussed further elsewhere in this chapter), wood bison and peregrine falcon (*anatum*) is a legal obligation that, in the Panel's view, the competent ministers should fulfill prior to National Energy Board approval of final detailed routing of the Project as Filed.

RECOMMENDATION 10-3

The Panel recommends that Environment Canada complete recovery strategies and action plans as required by the Species at Risk Act*, including the determination of critical habitat, for each of the woodland caribou, wood bison and peregrine falcon within one year of the date of the Government Response to the Panel's Report.*

Once the Proponents have greater certainty about the location of Project facilities and once critical habitat for Listed species in any of the RSAs has been formally identified, a further assessment of changes the Project is predicted to have on each Listed species should take place.

RECOMMENDATION 10-4

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project or the Northwest Alberta Facilities, require the Proponents and NOVA Gas Transmission Ltd., prior to the National Energy Board approving the final location of the pipeline route or any site for a facility included in the Mackenzie Gas Project or the Northwest Alberta Facilities, to do the following for any Listed species likely to be impacted by either project that is included in the Species At Risk Act *public registry and for which the Ministers have adopted a recovery strategy and action plan:*

- *complete a species-specific survey for each Listed species occurring in any Regional Study Area; and*

- *based on specific mitigative measures developed in response to the information obtained in the survey, complete an assessment of Project-related impacts on each such Listed species in consideration of the requirements of the* Species at Risk Act.

The impact assessments should be conducted directly on the Listed species where possible rather than using one or more indicator species and be filed with Environment Canada, the Government of the Northwest Territories, Alberta Sustainable Resource Development, and all relevant resource managers and wildlife management boards for their review and response.

The Panel further recommends that the National Energy Board take into consideration any responses received from Environment Canada, the Government of the Northwest Territories, Alberta Sustainable Resource Development, or any relevant resource managers and wildlife management boards in response to their review of the impact assessment prior to approving the final location of the pipeline route or any site for a facility included in the Mackenzie Gas Project or the Northwest Alberta Facilities.

The Panel further recommends that the National Energy Board, as a condition of any certificate of approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents, prior to the commencement of construction, to update their assessments of Listed species likely to be affected by the Mackenzie Gas Project.

Based on the evidence before it, the Panel is of the view that, if the measures recommended by the Panel regarding Listed species are implemented, Project-related impacts to the mortality, residences and habitat of those species can, to a large but unquantifiable measure, be avoided or minimized.

CUMULATIVE IMPACTS

Based on their assumption that there would be no significant Project-related impacts on Listed species, the Proponents determined that a cumulative effects assessment was not needed. The Panel does not agree with this rationale because, in the Panel's view, there was insufficient basis for the Proponents to make a determination that there would be no significant Project-related impacts on Listed species. It is not possible at this point to determine whether there would be Project-related impacts on Listed species' critical habitat because critical habitat has not been identified for any of the Listed species that occur in the RSAs. Neither is it possible to determine whether the Project would have significant effects on the residences of Listed species because the Proponents have not finalized the location of their facilities. In the Panel's view, it is reasonable to expect the Proponents to determine the residences of species in relation to their facilities, and the Proponents have committed to doing this prior to construction. However, it is not reasonable to expect the Proponents to determine "critical habitat" of species as that term is defined in SARA. Identifying critical habitat is the job of governments, and this has not been done for the Listed species potentially affected by the Project.

It is also not possible to know whether there would be residual impacts on Listed species because the full range of mitigations and conditions of the Project are not known. Mitigation measures cannot be fully determined until a recovery strategy and action plan are in place for each of the peregrine falcon (*anatum*), woodland caribou and wood bison. It is the action plans and regular monitoring of the success of actions taken under the plans that would inform whether the Project's impacts would be significant to a particular species. Only once this information has been determined can a cumulative impact assessment be conducted.

In the Panel's view, a cumulative impact assessment remains to be conducted in relation to the Listed species that would be impacted by the Project. However, it can be conducted only when residual impacts are known and can be evaluated against the recovery strategy and action plan for each particular Listed species.

RECOMMENDATION 10-5

The Panel recommends that, prior to approval of any facility that would enable the throughput of the Mackenzie Valley Pipeline to be increased above 1.2 Bcf/d, Environment Canada conduct a regional review of the cumulative impacts on each Listed species occurring in the Project Review Area on which the proposed facility could reasonably be expected to have an impact. The regional review should be based on studies appropriate to the species in areas of potentially suitable habitat, generate results that can be used to determine mitigation options to avoid or minimize impacts on each species, and take place every five years thereafter for the life of the Mackenzie Gas Project.

10.4 WOODLAND (BOREAL) CARIBOU

The Panel heard from many participants about the importance of woodland caribou to the northern economy and way of life. The Panel also heard about the sensitivity of woodland caribou to human activity, a sensitivity made particularly acute in view of their low reproductive rate. Habitat fragmentation, over-hunting, disturbance by humans (including construction of roads and pipelines) and predation have contributed to the decline of woodland caribou in other parts of Canada. In the Panel's view, all of these factors contribute to the overall vulnerability of woodland caribou to activities such as the Project.

10.4.1 EXISTING CONDITIONS

There are two populations of woodland caribou in the Project Review Area. The boreal population is found primarily in low density along the proposed pipeline route and, according to the GNWT, as far north as Travaillant Lake and Inuvik. The mountain population is located primarily in the Mackenzie Mountains. It does not migrate across the Mackenzie River, and, according to the GNWT, it would not be affected by the Project. The GNWT also indicated that the NWT boreal population is contiguous and unfragmented across its range, which extends south to include what in Alberta is designated as the Bistcho herd. Figure 10-1 shows the ranges of caribou populations in Alberta. In northern Alberta, woodland caribou range is discontinuous, and the population comprises small isolated herds.

The Proponents stated that little was known about the population size and trends in woodland caribou populations within the RSA. Although actual population size for woodland caribou was not known for the NWT, the EIS quoted GNWT's figure of between 4,000 to 6,400 woodland caribou based on density estimates for typical woodland caribou range. In Alberta, the Proponents cited studies estimating the provincial population of between 3,600 to 6,700 animals, a population that was considered to be stable to declining, although there was no current estimate for the Bistcho caribou herd.

The GNWT has initiated a number of baseline studies to collect more information on woodland caribou populations and movements in the Mackenzie Valley in four study areas: Inuvik, Sahtu, Dehcho and South Slave. The GNWT provided population estimates only for the Inuvik study area (100 to 150 in the north and 350 to 450 in the south).

The GNWT confirmed the lack of trend information, although it offered the view, based on reported local observations, "that boreal woodland caribou populations in the Sahtu are either stable or perhaps decreasing in both numbers and range, and that they have never been particularly plentiful." (J-GNWT-00183, p. 12)

The Proponents used average home range size of woodland caribou as established in Alberta as the basis for defining the size of the RSA in the pipeline corridor. The GNWT indicated that home range sizes in the NWT are larger than in Alberta and thus calculated a RSA twice as large as that determined by the Proponents.

The Proponents noted that woodland caribou prefer old-growth forests where abundant lichens, their preferred winter forage, can be found. Caribou seek out sites that offer abundant lichen and shallow snow in winter and fresh, green vegetation in summer. The Proponents conducted pellet group counts, aerial ungulate surveys and aerial track surveys in order to quantify relative use of different habitat types by woodland caribou. For the purposes of the EIS, and given the difficulty in distinguishing between the tracks of the woodland and barren ground caribou, the Proponents assumed that woodland caribou were distributed in the South Taiga Plains Ecological Zone and occurred with barren ground caribou in the Transition Forest Ecological Zone and the North Taiga Plains Ecological Zone.

The Proponents also developed a habitat suitability index modelling approach, assuming that late winter habitat was the critical habitat for woodland caribou. The objective of the modelling exercise was to identify suitable habitat types along the pipeline route and to quantify the amount of suitable habitat impacted by the Project. Late winter was the only season modelled for woodland caribou based on discussions with GNWT biologists, who indicated that habitat at this time was most limiting. Through a literature review and interviews with biologists, hunters and trappers, the Proponents determined a list of key variables to characterize habitats as suitable for caribou in late winter. These variables were applied to vegetation maps to determine the regional percentage of suitable habitat. The initial suitability assessment, based primarily on lichen abundance, was adjusted by elevation to reflect snow conditions, time since last burned, and zones of impact around human disturbance. Aerial track surveys validated the model, although distribution of pellet groups did not.

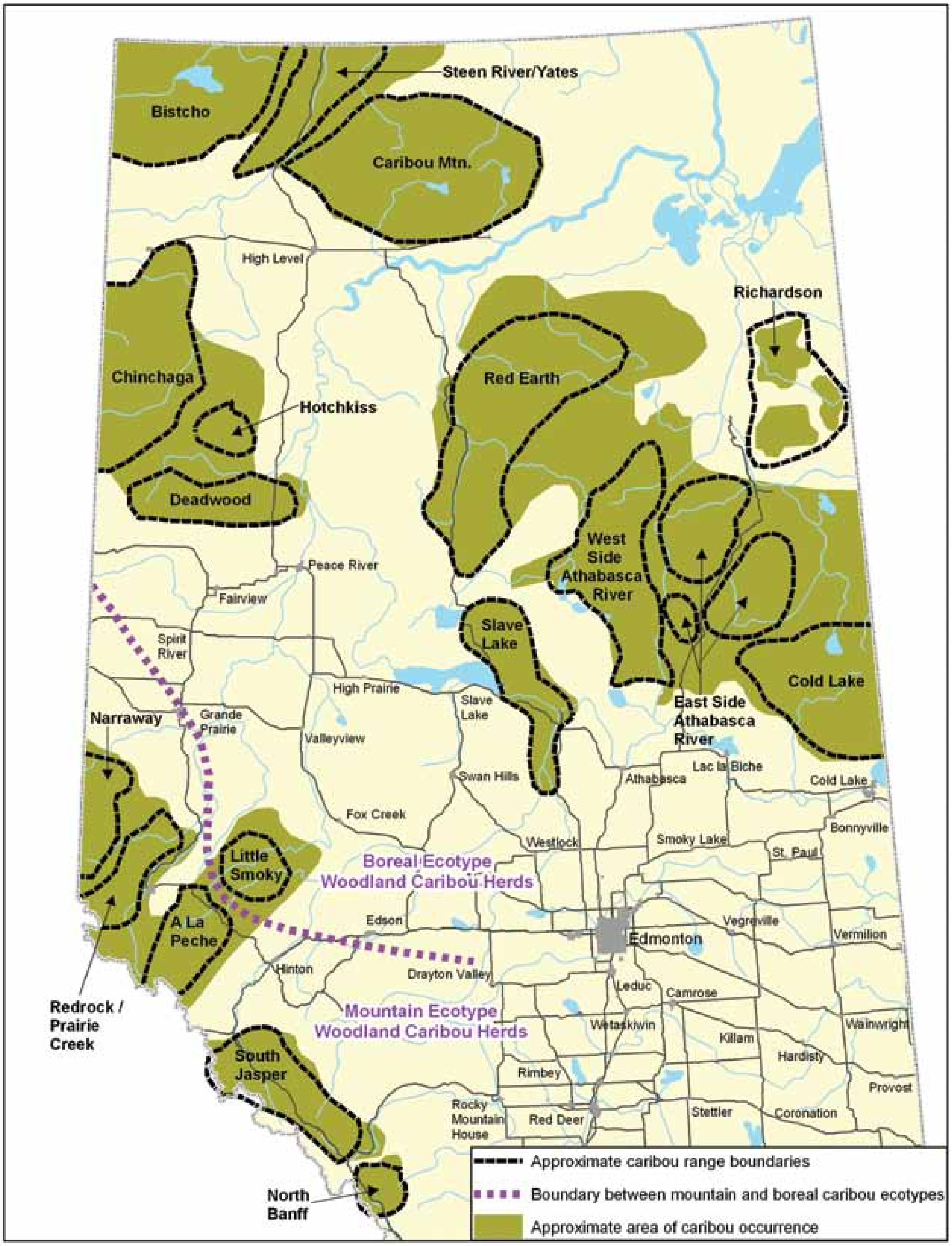
The Proponents found that effective woodland caribou habitat as a proportion of the RSA varied from 42% in the Gwich'in Settlement Area to 51% in the Dehcho Region. No estimate was provided for northwest Alberta. However, as Figure 10-2 indicates, there has been a much higher level of human activity south of the 60th parallel than in the NWT.

The Proponents also noted that reducing mature forests improved habitat conditions for early successional prey species such as moose, deer and elk. This increase in prey density could result in higher wolf densities and increased pressure on woodland caribou. The Proponents noted higher calf survival rates in the north compared with the south but did not provide data. The Proponents identified the key limiting factors for woodland caribou populations as loss of habitat from development, predation by wolves and increased harvest due to increased access.

In contrast to the Proponents' habitat suitability index models, the GNWT used two alternative habitat modelling methods in the RSA. Resource selection function models developed for the Inuvik Study Area identified late winter as the time when habitat is most limiting and when caribou are most vulnerable to disturbance and predation. A second study in the Dehcho Region used caribou occurrence at the landscape scale in a generalized additive model. This latter habitat modelling exercise was used by the Proponents as validation of their modelling approach. Consistent with the Proponents' findings through the habitat suitability index model, the GNWT study in the Dehcho identified a strong relationship between caribou late-winter occurrence and black spruce/lichen forests. Woodland caribou were strongly associated with black spruce and lichen on uplands and in lowlands. However, in contrast to the Proponents' results, the GNWT study in the Dehcho indicated that the probability of caribou use actually increased with elevation and that there was no significant relationship between caribou use and time since the last fire. Less precise relationships were detected with mixed forest and fire regeneration. The GNWT study in the Dehcho also suggested that the presence of bison and moose reduces the probability of woodland caribou presence.

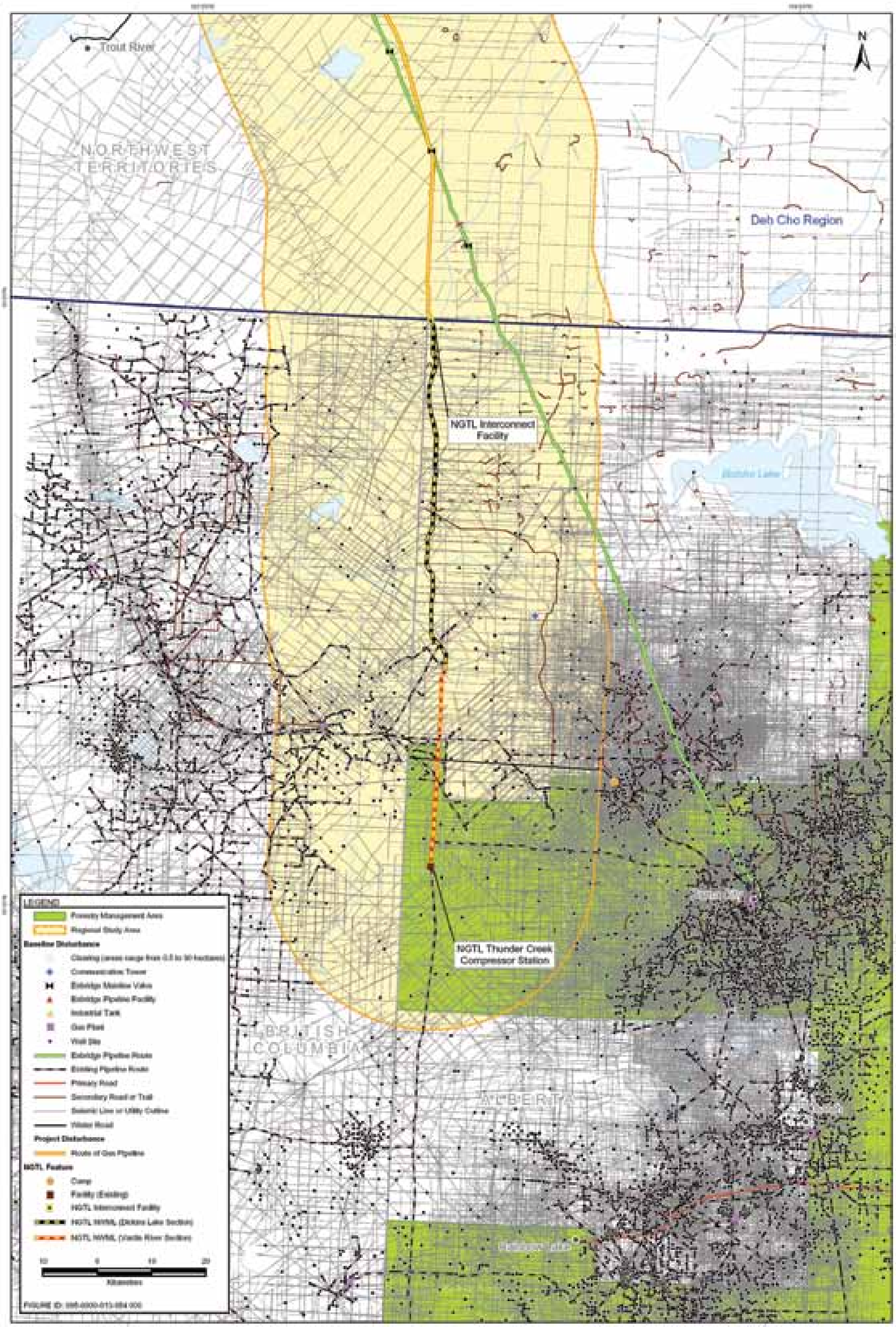
Woodland caribou are a Listed species under SARA. They are designated as threatened, which means that the species is

Figure 10-1 Alberta Woodland Caribou Herd Names and Approximate Range Boundaries



Source: Adapted from J-GNWT-00139, Figure 1, p. 12

Figure 10-2 Existing Land Uses in Region



Source: J-IORVL-00166, Figure JRP 1.49-3

likely to become endangered unless threats are reversed. The woodland caribou (boreal population) is also listed as sensitive in the NWT and at risk in Alberta. There are no specially protected areas for woodland caribou within the Project Review Area. There is no closed season or limit for Aboriginal hunters; however, non-Aboriginal residents are limited to one animal per year.

The GNWT commented on the management implications for a species nationally listed as threatened and noted that SARA requires that the following be considered during the environmental assessment of a project:

- adverse effects of the Project on the Listed species and its critical habitat must be identified;
- all measures must be taken to avoid or lessen the adverse effects consistent with recovery strategies and action plans; and
- monitoring must be undertaken with respect to those adverse effects.

Although woodland caribou is a Listed species, protective mechanisms have not been put in place under federal, provincial or territorial laws. During the hearings, the Panel heard that:

- Environment Canada's Woodland Caribou National Recovery Strategy had not been finalized;
- GNWT's Woodland Caribou Action Plan had not been developed;
- the Bistcho/Caribou Mountains Range Team in northern Alberta had not been convened; and
- critical habitats in the NWT had not been formally identified.

10.4.2 PROPONENTS' VIEWS

The Proponents assessed the potential impacts on habitat availability for woodland caribou from the following Project activities:

- vegetation clearing;
- noise;
- improved access into previously remote areas; and
- interaction of caribou with humans during the construction, operations and decommissioning phases of the Project.

The construction period was predicted to have the biggest impact on woodland caribou. This period would produce noise from vehicles, helicopters, construction equipment and human presence. It is likely that caribou would not habituate quickly to construction disturbances because caribou already avoid contact with humans engaged in hunting. Sensory disturbance during the operations phase would be much less than during construction due to reduced human activities. Clearing and surface material removal would decrease habitat availability.

Caribou movement would be impacted by construction-related physical barriers (e.g. stacked pipe and trenches), avoidance of linear corridors due to increased human and wolf activity, and increased sensory disturbance. Development of the pipeline right-of-way and new all-weather and winter roads in the forested regions would impact woodland caribou habitat availability and movement, and would increase mortality due to increased access to predators, such as wolves, and increased hunting activity.

The Proponents assessed the impact of Project activities on woodland caribou habitat availability, as identified elsewhere in this chapter, by applying a zone of influence of 500 m around the pipeline and associated infrastructure to determine how much effective habitat would be lost because of the Project. The Proponents predicted the loss of effective winter foraging habitat from sensory disturbance would be less than 3% of the Pipeline Corridor RSA during construction and less than 0.45% during operations.

The Proponents made a number of commitments to reduce the impacts of the Project on woodland caribou relating chiefly to avoidance during construction and preparing Caribou Protection Plans. The Panel and some participants sought clarification about the practicality and effectiveness of some of these measures. For example, the Proponents committed to:

> Reduce the effects of increased access on wildlife…hunting and trapping by:
>
> - creating a dogleg in the right-of-way at crossings of existing roads in forested areas;
> - coordinating with government authorities and communities to control access;
> - using slash berms in forested areas for access control. (J-IORVL-00934, p. 26)

The Panel questioned the utility of this mitigation, given that the pipeline corridor is straight and clearing has to be maintained. The Proponents clarified that the measure was meant for access roads. For the pipeline, the Proponents suggested that revegetation and rolled back brush piles could be used to minimize the line of sight. Comments regarding pipeline corridor revegetation included reducing visibility, "creating" habitat versus stabilizing terrain, and whether woodland caribou winter habitat would be lost for a long time given the slow growth rate of lichens. The SCC questioned whether there has ever been a successful example of reclamation benefiting woodland caribou habitat. The Proponents could not cite examples.

The Proponents also made a commitment to "design and construct above-ground pipelines at suitable heights considering all-season wildlife movements." (J-IORVL-00934, p. 28)

The Panel inquired whether this was an applicable mitigation measure, given that the pipeline would be buried for most of its length. The Proponents responded that this would apply to the feeder pipelines. However, the Panel notes that the Proponents' proposed feeder lines would be located in the Anchor Fields, where there are no woodland caribou.

Another commitment made by the Proponents involved using suitable techniques to avoid encounters with caribou, when caribou are present or moving through an area, including altering Project activities temporarily and requiring that construction activity yields to caribou on roads and right-of-ways.

The Sambaa K'e Dene Band questioned how it would be possible for the Project to avoid sensitive habitat and avoid concentrations of caribou, given the short winter construction period and that, within Sambaa K'e territory at least, the corridor would traverse high-quality woodland caribou habitat. The Proponents responded that they would move quickly through an area. However, previous questioning by the Sambaa K'e Dene Band established that there would probably be activity, and thus sensory disturbance, over a three-year construction window from conducting geotechnical surveys, moving camps, bringing in equipment, clearing right-of-ways, marshalling pipe, trenching and laying pipe, and reclamation.

In response to a commitment by the Proponents to "ensure that pipelines and heavily travelled roads are separated by more than 100 m, where practical," (J-IORVL-00934, p. 34) a submission by Donald Harron of Starbuck, Manitoba, noted that the literature supporting this mitigation is valid only for barren ground caribou and that the literature respecting woodland caribou suggests that separation of right-of-ways could increase the Project's footprint and increase fragmentation effects on woodland caribou movement.

The Proponents also committed to ensuring open communication with communities, governments and co-management boards by developing its Woodland Caribou Protection Plan in consultation with communities, resource managers and other affected stakeholders prior to construction, and by providing for monitoring.

With respect to the Northwest Alberta Facilities, NOVA Gas Transmission Ltd. (NGTL) indicated that it was committed to supporting the conservation of caribou in Alberta's boreal forest and that it would ensure that its activities were carried out in a manner that minimizes its footprint on caribou ranges to the extent possible. NGTL made a number of commitments to that effect, relating chiefly to using best management practices, developing a Caribou Protection Plan in cooperation with Alberta Sustainable Resource Development, and developing an access management plan that would limit access to the Project's right-of-way during construction.

Based on the application of its mitigation measures, the Proponents assessed the impact on habitat suitability from vegetation clearing, sensory perception, altered human and predator access, and changes in vegetation health during all phases of the Project as follows:

- impacts to woodland caribou in the pipeline corridor for all activities during all phases of the Project would be adverse, low in magnitude, local in extent and far-future in duration;
- impacts on caribou movement would be adverse, low and local, except during the construction phase when movement impact was considered moderate; and
- impacts on caribou mortality would be adverse, low and regional for all phases of the Project.

Thus, the Proponents determined that the combined effects of all Project components on woodland caribou would not be significant.

10.4.3 PARTICIPANTS' VIEWS AND RECOMMENDATIONS

The Panel heard two main concerns regarding the Proponents' impact assessment. The first related to the Proponents' methods and approach as they relate to the Project as Filed. The second related to the potential effects of future developments, which, in the opinion of participants, the Proponents did not adequately assess.

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Dr. James Schaefer, appearing on behalf of the SCC, stated that the primary mechanisms associated with caribou declines as a result of encroaching development are:

- increases in alternative prey (e.g. moose and deer) associated with earlier successional vegetation stages;
- an increase in predator numbers associated with higher prey densities;
- ease of movement for predators; and
- increased hunter access.

Once displaced, there are no known cases where woodland caribou have reoccupied their previous ranges, thus disruption may be permanent.

Caribou appear to space themselves away from predation risk at the broad landscape scale and to select nutritional needs (e.g. adequate lichen supplies) at a finer scale. Spacing away from development structures and human activity results in a zone of influence within which caribou are absent or occur at densities much lower than expected.

Numerous participants provided a review of estimated zones of influence from previous studies of woodland caribou. These reviews documented avoidance of human structures that range from 500 m for seismic lines to 6 km for major roads, such as the Dempster Highway. The GNWT stated that caribou movements are disrupted by the need to avoid human activity, resulting in a loss of connectivity between preferred habitat patches and, effectively, fragmentation of caribou habitat. A number of participants expressed concern that habitat change due to existing activities is already causing fragmentation and may already be impacting caribou productivity in areas such as the Cameron Hills.

The Gwich'in Renewable Resources Board (GRRB) and the Gwich'in Tribal Council shared many of the concerns of the GNWT and stated that, in their estimation, the Project's impacts to woodland caribou in the Gwich'in Settlement Area "will be greater than predicted by the EIS." They added: "This is due to limited baseline information, failure of the habitat models to consider other key seasonal periods, lack of certainty in the habitat models, and a failure to adequately consider increased mortality of woodland caribou through increased access for hunters and wolves." (J-GTC-00014, p. 14)

Similar concerns were expressed in Trout Lake by the Sambaa K'e Dene Band: "Wolves could move very quickly along the corridor and could see a long ways, so it made it easier for them to hunt woodland caribou and moose." (Chief Dennis Deneron, HT V30, p. 2711)

Some participants also identified problems with the Proponents' habitat suitability modelling for woodland caribou. The SCC noted that the modelling applied a narrow zone of influence to the infrastructure (applied in two increments at 0–100 m and 100–250 m from most infrastructure). The Proponents' own data for the Norman Wells Oil Pipeline right-of-way indicated that caribou density was reduced by 89–94% within 2 km of disturbance based on tracks and by 60–75% within 1 km based on pellet counts. The Proponents' own commissioned report on wildlife modelling recommended using larger zones of influence than were actually used in the EIS analysis. In the SCC's view, the Proponents' RSA does not encompass the full range of woodland caribou and thus does not consider the full impact on the population.

Other comments were that the habitat suitability model:

- failed to consider the reproductive season;
- was not revised after failing to be validated by pellet counts;
- failed to include the area currently cleared from past seismic activity, thus underestimating the amount of disturbed area currently on the landscape;
- underestimated the amount of future seismic activity; and
- failed to assess the direct mortality impacts of hunter and predator access.

All participants agreed that late winter habitat is probably critical for woodland caribou in the RSA, particularly in terms of nutrition and energetics. However, some participants maintained that the calving and post-calving period is also critical although more difficult to map. The SCC stated that caribou are most sensitive to disturbance during the calving period, and energetic demands of the mother are highest during the post-calving period. The calving strategy of woodland caribou is to space out as individuals to reduce predator risk, in contrast to barren ground caribou, which herd in concentrations at calving. This requirement for space is most acute during the calving and post-calving period.

Although the Proponents are committed to "avoid clearing and installing pipe in woodland caribou habitat in April and May, to reduce potential effects on calving caribou, when possible," some participants stated that it was not the timing of the activity so much as it was the changes to habitat brought about by the activity that affected woodland caribou. (J-IORVL-00934, p. 28) The SCC cited findings of an expert workshop on woodland caribou, which indicated that "timing of a human activity has very little effect on woodland caribou populations." (Dr. Schaefer, HT V60, p. 5936) The SCC added that this is "because of the changes to habitat that are brought with those activities." (Dr. Schaefer, HT V60, p. 5939)

Dr. Schaefer, on behalf of the SCC, concluded that the impacts of the Project on woodland caribou would likely be adverse, moderate to high in magnitude, regional in extent, and far-future in duration. Dr. Schaefer was of the view that "this conclusion is reasonably secure — well-founded on our knowledge of their extraordinary sensitivity to industrial developments and of the importance of space in their ecology." (J-SCC-00050, p. 32)

The GNWT recommended that the Proponents follow through with their commitment to develop a woodland Caribou Protection Plan in consultation with the GNWT, wildlife management boards, communities and other stakeholders for approval by the appropriate regulatory authorities. The GNWT stated that, to be comprehensive and effective, the woodland Caribou Protection Plan should:

- cover areas within a set radius of any facility or construction activity from the Inuvik Area Facility to the NWT–Alberta border;
- identify mitigation measures, including, but not limited to, those needed to minimize width of linear disturbances, maximize vegetation recovery, adjust timing of activities, limit harvesting, limit predator travel corridors, implement access management, and ensure effective reporting, thus eliminating barriers to movements, ensuring effective communications and ensuring effective reporting;
- identify monitoring components, including, but not limited to, documenting vegetation recovery, documenting and reporting wildlife incidents, interactions and mortality, evaluating the effectiveness of access management, and establishing and maintaining linkages to regional programs;
- identify and implement processes for oversight and reporting; and

- be submitted to the appropriate regulatory authority for approval six months prior to start of construction.

The Proponents responded that they have "committed to provide support for woodland caribou monitoring studies." They added:

> Results from the habitat baseline assessment studies conducted for the Environmental Impact Statement are being used to develop a Wildlife Management Plan and species-specific protection plans, which include mitigation and monitoring. These plans will be discussed with resource managers, boards and affected stakeholders. (J-IORVL-01040, p. 75)

The GNWT recommended that, in order to test impact predictions, the Proponents should develop a program in consultation with the GNWT and wildlife management boards that should:

- address both predictions of effects and predictions of no effects;
- document and analyze movements and habitat use prior to construction, during construction and during operations;
- build upon recent studies and habitat modeling; and
- address impacts suggested by traditional knowledge. (J-GNWT-00314, p. 13)

In response, the Proponents made the following commitment:

> The parameters for testing impact predictions will be determined following detailed engineering, and as the project progresses, as a result of monitoring measures, discussions with regulators, resource managers and affected stakeholders. Adaptive management will be in place throughout the life of the project. With respect to species at risk, the proponents will contribute to the development of the Northwest Territories' *Species at Risk Act* recovery strategy through its Canadian Association of Petroleum Producers representative. (J-IORVL-01040, p. 74)

Several participants made specific recommendations regarding woodland caribou that were directed to the Proponents, the GNWT or both parties. Some participants recommended that industry and government, in cooperation with co-management groups, conduct new studies or expand existing studies on woodland caribou to assess the impacts of the Project's construction, operations and decommissioning phases.

The Proponents disagreed with these recommendations, indicating that there was sufficient data on habitat requirements, which they used as the basis of their assessment. In the Proponents' view, population level studies are the responsibility of management agencies and not industry.

The GRRB recommended that a study be undertaken of the role of wolf predation on ungulate populations. In response, the GNWT indicated that such a study was not warranted.

The Proponents maintained that research is the responsibility of the GNWT.

CUMULATIVE IMPACTS

The GNWT noted that existing woodland caribou habitat in the NWT has already experienced development impacts, including substantial areas burned since the 1960s, 2,031 km of all-weather roads, 925 km of pipelines and 53,697 km of seismic lines. The GNWT estimated that the physical footprint of all developments to date, plus a zone of influence around them, already amounts to approximately 16% of woodland caribou range in the NWT. They further noted that:

> although the proposed pipeline makes a minor incremental increase in the footprint of linear developments, this small increment comes on what is already a sizeable footprint. One must also keep in mind that[,] although the contribution of habitat loss from the pipeline right-of-way may be only minor at the scale of the entire boreal caribou range, the potential for it to isolate late winter habitat patches that are already highly fragmented is perhaps the most notable effect. … While almost 16% of the boreal caribou range in the NWT is already affected by anthropogenic disturbances, this may increase substantially in the next 10 years. (J-GNWT-00138, p. 22)

The GNWT cited a study commissioned by INAC to forecast exploration and development activity in the Mackenzie Valley up to the year 2016. Using two future scenarios, the study determined that hypothetically induced development could affect an additional 13.9–23.7% of NWT woodland caribou range by 2016.

In addition, activity from future developments may result in a higher incidence of forest fires in the future. In its evidence, the GNWT indicated that low caribou calf-to-cow ratios in the spring appeared related to the combined effect of existing seismic lines and area of forest fires. Thus, in the GNWT's view, the Proponents did not adequately address the impacts of current and future oil and gas exploration on woodland caribou. The GNWT maintained that current seismic exploration is already impacting caribou populations and that likely future exploration would substantially increase the adverse effects on woodland caribou. The landscape is already disturbed by human activity, and habitat fragmentation is already occurring. The Project has the potential to further reduce the size and/or connectivity of mid- and late-winter habitat patches.

The GNWT noted that the cumulative effects of industrial development in Alberta, as illustrated in Figure 10-2, have led to significant reductions in habitat and population levels. An estimated 28%–70% of historical range was reported to have reduced use by woodland caribou. Much of the range is discontinuous. At the same time, the woodland caribou range remained continuous in the NWT, where much less development has occurred, although the GNWT also drew attention to lower recruitment rates in those parts of the Project Review Area where there has been a greater density of seismic exploration, such as the Inuvik area and the Cameron Hills.

Many participants were concerned about the future fate of woodland caribou in the RSA if the development expanded from the Project as Filed to the Expansion Capacity Scenario and Other Future Scenarios. The concern is based primarily on the fate of woodland caribou populations across the country and particularly to the demise of woodland caribou in Alberta, directly south of the Project. In North America, woodland caribou have experienced range contractions and population declines over the past several decades, and resource extraction is implicated as a cause. For example, in Ontario, woodland caribou range has receded northward at a rate of 34 km per decade, coinciding with the expansion of forestry operations. Research in Alberta has shown that cumulative effects of industrial development has led to significant habitat reduction and population level effects to the extent that an estimated 28–70% reduction in the historical woodland caribou range has occurred. The SCC estimated that, if current trends continue, woodland caribou in Alberta are likely to be extirpated in less than 40 years.

The GNWT stated: “If we can learn anything from the Alberta example, it’s not to get to where we’re in a situation of recovering our herds from the extent or landscape change that has been observed in Alberta.” (Dr. Ray Case, HT V60, p. 5921). It further stated that avoiding that outcome in the NWT “may require…further access limitations, development of alternate exploration and extraction techniques; may require that activities be done in a way that might be more expensive [and] more complicated; and that some of the actions that may need to be taken for the conservation of boreal caribou in the Northwest Territories may indeed also be controversial.” (Dr. Case, HT V60, p. 5919)

The possibility and utility of applying development thresholds to future development was introduced by the GNWT. Although thresholds are a way of controlling development, answers to queries such as how to arrive at the appropriate threshold level, how to incorporate natural disturbance factors such as fire and, in the current NWT legislative environment, how to implement threshold limits on activities still need to be established.

The Canadian Arctic Resources Committee commissioned a study to map and assess the impacts of an exploration and development scenario essentially consistent with the Expansion Capacity Scenario. This study noted the following:

> A “critical” linear fragmentation threshold of 1.8 linear km/square km and a “cautionary” linear fragmentation threshold of 1.0 linear km/square km has been also identified for woodland caribou for all linear corridors, including seismic lines, roads, and pipelines. According to a Delphi process conducted with Alberta caribou biologists, it is believed woodland caribou become completely extirpated when total corridor density exceeds 3.0 linear km/square km. In addition, a recent wildlife population modelling study states that woodland caribou will not persist in the long term at linear fragmentations above 1.0 linear km/square km in the absence of predator (i.e. wolf) control and restrictions on hunting. (J-CARC-00021, p. 32)

The study concluded that:

> Total linear corridor density (roads, pipelines, and seismic cut-lines) exceeds the extirpation threshold for woodland caribou (3.0 linear km/sq km) in the Mackenzie Delta (onshore) both above and below the tree-line in all scenarios. Existing seismic cut-lines may have already reached the cautionary threshold for woodland caribou (1.0 linear km/sq km).
>
> Total linear corridor density reaches the cautionary threshold for woodland caribou (1.0 linear km/sq km) in the Colville Hills only under the 4.0 [Bcf/d] scenario. (J-CARC-00021, p. 45)

The SCC concluded that the Proponents’ cumulative effects analysis did not provide enough information to assess impacts. According to the SCC, the Proponents acknowledge in the EIS that the Project may encourage more hydrocarbon activity, require improved transportation and communications facilities, and encourage gas exploration and production to fill the pipeline to its designed capacity. The SCC stated that the Proponents provided very little discussion on cumulative effects in relation to future development; for example, for future hydrocarbon exploration and development, discussion consisted of a description of potential resources and existing leases, a one-page qualitative description of a possible future development scenario, and a one-and-a-half page qualitative list of the type of cumulative effects that might result. The SCC further stated that, despite such a cursory cumulative effects assessment, the Proponents concluded that “there are no significant overall cumulative effects.”

World Wildlife Fund Canada recommended that “the federal and territorial governments develop and implement new regulations to protect caribou and their key habitats by 2008, to help stem widespread major declines to Northwest Territories caribou herds in the face of anticipated further increases in industrial exploration and development pressure.” (J-WWF-00139, p. 7)

Environment Canada responded that it was leading a process to identify critical habitat (as that term is defined in SARA) for boreal caribou to include in the national recovery strategy for woodland caribou (boreal population) but did not know when this would be completed. Environment Canada also indicated that “the SARA prohibitions for boreal caribou do not automatically apply in the Northwest Territories or Alberta.” (J-INAC-00187, p. 68) For Canada to introduce regulations to protect caribou, the Minister of the Environment would have to be of the opinion that the laws of the NWT and Alberta do not effectively protect caribou and, based on that opinion, would then have to recommend that the Governor-in-Council pass an order proclaiming such regulations. Environment Canada indicated that the Minister had not yet formed an opinion on this matter.

The Dene Tha' First Nation (DTFN) submitted that the Project would have potential long-term adverse effects on the habitat and migration of the Bistcho woodland caribou herd. Its concerns included what it regarded as insufficient baseline population data, imprecise impact assessment, lack of information to assess cumulative effects, uncertain effectiveness of Alberta's regulatory measures, and lack of progress on the Alberta Woodland Caribou Recovery Plan with respect to the Bistcho caribou herd.

The DTFN submitted that the Panel should recommend that:

- no authorizations be issued by Canada and Alberta until:
    - the Range Team has been established for the Bistcho caribou herd area;
    - baseline population information on the Bistcho caribou herd has been collected;
    - Caribou Recovery Plans for the Bistcho caribou herd have been developed;
    - the ALCES® (Alberta Landscape Cumulative Effects Simulator) cumulative effects impacts model has been run on the Bistcho caribou area; and
    - the Range Team has had its recommended measures to protect the Bistcho caribou herd considered;
- Canada request Alberta to implement interim measures to protect the Bistcho caribou herd since there is no schedule for development of the Caribou Recovery Plan for the Bistcho area;
- the Alberta and NWT caribou protection programs be integrated;
- no authorizations be issued by Canada and Alberta allowing for non-winter construction until there is full consultation and approval by the DTFN;
- no authorizations be issued by Canada and Alberta until meaningful consultation with the DTFN has occurred on the Caribou Protection Plans in both Alberta and the NWT, and on the information gaps identified by the DTFN and on caribou studies; and
- any authorizations issued by Canada or Alberta must be conditional upon Imperial Oil and NGTL:
    - not constructing the pipeline outside of the winter window without DTFN agreement;
    - establishing no-hunting, -fishing and -shooting policies for staff and contractors;
    - establishing wildlife management and mitigation plans; and
    - pursuing arrangements with other tenure holders to improve habitat effectiveness, manage access, and deactivate roads and seismic lines in DTFN territory.

With respect to cumulative effects, the DTFN recommended that the Panel make a number of recommendations, summarized as follows:

- Canada encourage Alberta to establish and adequately fund a multi-party land use planning process in northwestern Alberta that is consistent with and complimentary to ones established in the NWT, that the DTFN be meaningfully included in the land use planning process so that their objectives could be considered, and that Canada and Alberta not issue any authorizations for the Project until a land use planning process is established;
- Canada encourage Alberta to establish a protected area strategy in northwest Alberta consistent with and complimentary to the *Mackenzie Valley Five-Year Action Plan* of the Northwest Territories Protected Areas Strategy, that DTFN be meaningfully included in the Protected Areas Strategy, and that Canada and Alberta not issue any authorizations for the Project until a protected area strategy is established for the Bistcho area;
- Alberta establish interim protection on the Bistcho Peat Bog area, the "project assessment area," and the gas fields around Meander and Hay Zama until a land use plan, a caribou inventory, and baseline research on rare birds and plants are completed (J-DTFN-00051, p. 5);
- an independent monitoring agency be established on both sides of the NWT–Alberta border; and
- any authorizations issued by Canada and Alberta be conditional on Imperial Oil and NGTL:
    - including a meaningful role for the DTFN in any follow-up and monitoring activities;
    - monitoring the potential direct and indirect effects of the Project on caribou before construction, during construction and at appropriate intervals in the following 10 years after construction, and predicting, detecting and assessing any change (if any) in numbers and distribution;
    - developing and implementing an adaptive management program to evaluate the success of measures for mitigating impacts to caribou and wildlife, which includes identifying performance measures and targets, a decision protocol for the adjustment of mitigation programs, and a mechanism for resolving adaptive management disputes; and
    - including in all environmental management or protection plans, among other things, a caribou protection plan.

Because the DTFN withdrew its recommendations prior to the close of the Panel's record, no responses were placed on the record by the parties to whom they were directed.

The DTFN also filed with the Panel a copy of a petition it had made to the Minister of the Environment. It had sought two orders under SARA: an emergency order under section 80 and an order under section 61(4) to prohibit the destruction of woodland caribou habitat in the Bistcho Peat Bog Plateau area on the basis that the Bistcho woodland caribou herd faces imminent threats to its survival and recovery. Environment Canada advised the Panel that the Minister had denied these requests on the grounds that they did not meet the requirements of the Act. However, the Minister had also stated that:

> …once the woodland caribou's critical habitat is identified in the national recovery strategies and action plans, and if conservation efforts are deemed insufficient, Environment Canada will have the option of recommending, to the Governor in Council, a prohibition on the destruction of portions of the critical habitat that are not effectively protected under section 61 of the Act. (J-EC-00049, p. 2)

Some participants recommended that, based on their conclusion that the assessment of cumulative impacts of existing and future scenarios was lacking, a more thorough assessment be conducted on the impacts of the Project itself and from cumulative effects, including induced development, that consideration be given to researching and establishing quantitative thresholds such as restrictions on linear disturbance, and that a scenario-based cumulative impact assessment result in species-specific five-year renewable management plans.

The Proponents disagreed, stating that a thorough assessment of the Project-specific and cumulative effects of the Project had been conducted. Further, the Proponents maintained that the development of mandatory thresholds for key species, such as caribou, is the responsibility of resource managers and should not be tied to the Project approval.

The GNWT did not believe that a further assessment was required. In regards to thresholds, the GNWT indicated that it has recommended the development of detailed wildlife and management plans as well as comprehensive monitoring plans, which may incorporate the development of applicable thresholds where appropriate.

10.4.4 PANEL VIEWS AND RECOMMENDATION

BASELINE INFORMATION

Participants generally agreed that key baseline demographic data are lacking for woodland caribou, including population size and trends, reproductive rates, mortality rates and factors, and movements. The question of whose responsibility it is to collect this baseline data was raised at a number of hearings. The Panel recognizes that the GNWT is devoting a substantial effort to establish baseline data on these populations, but the studies are still in preliminary stages and will require a number of years to complete. The Panel agrees with the Proponents that population-level research is the responsibility of governments, as managers of the resource.

The Proponents generally agreed that the key limiting factors for woodland caribou are their low reproductive rate (cows deliver only a single calf), habitat disturbance and fragmentation (the need to "space away" from predators, especially during calving and post-calving), and wolf predation and hunting (both enhanced with access provided by linear development). (J-SCC-00050, p. 25) Thus, vulnerability is not limited to sensory disturbance, and impacts cannot be addressed entirely by adjusting the timing of human activities. Fragmentation, regardless of the timing of industrial activities, leads to increased vulnerability to predation from humans and wolves, and it is reversible only over decades following cessation of activities. Furthermore, if barren ground caribou populations continue to decline, the potential for harvesters to shift to woodland caribou could exacerbate the current vulnerability of this species.

The key difference between the views of the Proponents and participants on the Project's impact arises from their respective understandings of the zone of influence within which industrial activities would impact woodland caribou. The Panel was persuaded by information brought forward by participants, based on scientific studies elsewhere in Canada and on local traditional knowledge, that the zone of influence chosen by the Proponents was too narrow and would, therefore, result in an underestimation of Project impacts.

In sum, the Panel notes that there is limited and inconclusive information on the current status and trends for woodland caribou and on the extent, critical timing and magnitude of disturbance impacts on woodland caribou. The Panel therefore takes a cautious or conservative approach in assessing Project impacts on woodland caribou.

PROJECT AS FILED

From the Panel's perspective, it appears that, rather than applying a conservative approach to assessing the Project's impact on woodland caribou, the Proponents' methodology resulted in underestimating the magnitude and extent of the impact. The Panel accepts the following observations made by participants:

- the Proponents underestimated the percent change in effective habitat by the Project because, by not including current seismic clearing, the amount of present effective habitat is overrepresented;
- the Proponents underestimated the impact of the Project by minimizing the size of the zone of influence and, thus, the loss of effective habitat;
- the Proponents failed to consider that caribou avoid high density of moose, deer and bison because of higher predation risk and, thus, overestimated the amount of effective habitat and minimized the impact of the Project;

- the Proponents failed to quantify the real impact of development by failing to quantify the impact of direct mortality by providing access to predators and hunters; and
- the Proponents assessed only loss of habitat, but woodland caribou need to enter and cross seismic lines and other linear corridors in order to travel to suitable habitat patches (in the Dehcho, 75% of mortalities occurred within 500 m of a linear disturbance, and studies in the Sahtu showed that the highest density of harvest was along existing linear corridors).

The shortcomings identified in the Proponents' impact assessment methodology and its lack of adequate baseline data made it very difficult to discern and assess what the real Project impacts on woodland caribou might be. Like many of the participants, the Panel is not persuaded by the Proponents' assessment that Project impacts on woodland caribou would be of a low level from loss of habitat, changes to movement and direct mortality (with the exception of moderate impact on movement in the construction phase). This is especially the case in light of reported experience across Canada.

The Panel notes that the GNWT did not identify current harvest levels as being a threat to the woodland (boreal) caribou population. The Panel also notes that no participant identified the possible loss of forage associated with thaw subsidence on the right-of-way (as identified in Chapter 6, "Project Design, Construction and Operations") as an important consequence of the Project.

Participants believed that the Proponents' proposed mitigation measures would not adequately avoid or reduce the Project's adverse impacts on woodland caribou as is required under SARA. For example, the Proponents' proposed response to woodland caribou within the construction zone would be decided on a case-by-case basis with tools that already appear to have been ineffective in northern Alberta. If the Panel were to accept such a commitment, however, it would need to accept on face value that the tools would be effective. In addition, the Panel considers that the Proponents relied too heavily on plans and commitments that, in the manner presented to the Panel, were too vague. For example, it was not clear to the Panel that:

- there would be effective management of access to harvesting along newly created access routes; in fact, there were no examples presented to the Panel that showed access restrictions have been successful;
- species management plans would be effective in minimizing impacts caused by the Project; and
- the components of the Proponents' proposed woodland Caribou Protection Plan are clearly identified.

Although adaptive management would be important, the Panel is of the view that this approach cannot be assumed to solve all future problems that might arise. The Proponents were given sufficient opportunity to demonstrate to the Panel's satisfaction that they knew how to develop and implement mitigation and management plans. The Panel found the Proponents' information in this regard insufficient and unpersuasive. The Panel is not prepared to accept on faith that the Proponents' mitigation and management plans, the details of which are not known, would avoid either identified or unforeseen adverse impacts, particularly with respect to a Listed species.

The Panel is of the view that some of the Proponents' proposed mitigations are neither proven nor appropriate in the context of the Project. This applies particularly to the commitment to separate pipelines and heavily travelled roads by more than 100 m. In the Panel's view, this commitment would encourage rather than discourage fragmentation of woodland caribou habitat.

The Panel is also of the view that the proposed mitigations that might be effective are, even in combination, not sufficient to address all of the potential impacts of the Project on woodland caribou. Implementation of the Panel's generic wildlife Recommendations 5-1 and 10-1 are essential elements of an approach to manage the potential Project impacts on woodland caribou. However, in the Panel's view, further measures are required. The most critical of those measures is implementation of government obligations under SARA.

Woodland caribou are a Listed species under SARA. That means the species matters not just to harvesters and the northern communities that depend on caribou for sustenance and for cultural well-being, but to Canada as a whole. It also means that the responsible authorities are obliged to address any changes that activities such as the Project might cause to woodland caribou or their habitat, and to do so in light of the protections that they themselves are responsible for putting in place to protect a species whose existence is under threat. This includes rigorous identification of impacts and any measures to avoid or lessen those impacts. Yet, at the close of the Panel's record, neither the completed national recovery strategy for woodland caribou (boreal population) nor regional action plans or management strategies for NWT or northwest Alberta for woodland (boreal) caribou were in place. Further, the Bistcho/Caribou Mountains Range Team, the entity responsible for developing a strategy, had not been put in place in northern Alberta.

Ideally, to make recommendations on impacts from development at the scale of the Project, the Panel would be presented with sufficient baseline data on key species and there would be guiding documents in place to inform decision making. This is particularly important where the species is formally acknowledged as threatened in Canada and where a precautionary approach to management is merited.

These initiatives are essential because they provide the framework for conserving the species throughout its range and the context within which the impacts of a proposed development activity can be assessed. They help developers, land managers and governments to identify risks, plan mitigation to reduce or eliminate impacts, and monitor the success of mitigation measures. They are the key policy and regulatory tools for ensuring survival of a species experiencing a major decline across Canada. In the Panel's view, the absence of these key initiatives means that proponents and resource managers lack the tools necessary to address project-specific impacts.

Notwithstanding the preceding, the Panel notes that, having identified the adverse impacts the Project was likely to have on woodland caribou and the measures it intended to take to avoid or lessen those impacts and to monitor them, the Proponents concluded that the Project would not have a significant impact on woodland caribou. While participants disagreed with the methods used by the Proponents in their EIS and were of the view that the Project's impacts would be greater than estimated by the Proponents, they did not go so far as to conclude that impacts from the Project as Filed, on its own, would be significant.

The Panel observes that woodland caribou habitat is spread over a range of several hundred thousand square kilometres in the Project Review Area. During the course of the Panel's proceedings, the Panel was told of habitat types preferred by caribou but was not directed to specific locations within or outside of the pipeline RSA that should not be disturbed. Neither was the Panel advised that a process for identifying and designating critical habitat, as is required of SARA, was imminent.

In considering the foregoing, the Panel is of the view that, while the intention under SARA is that an assessment of impact to a Listed species is to take place against the backdrop of and in the context of the recovery strategies and action plans established to protect the species, in the absence of those protective mechanisms, the assessment process is no different for a Listed species than it is for a non-Listed species, with the exception that the assessment should be species-specific and, where possible, done directly rather than by way of a surrogate. In the absence of the framework provided by a recovery strategy and action plans, the Panel is not aware of any criteria for determining whether changes to a Listed species would be significant. Therefore, the only fallback for a panel (and participants) is to use the significance determination ratings used for non-Listed species.

The Panel was presented with information about declining population trends in response to industrial development generally. The evidence before the Panel gives rise to some uncertainty about the impacts the Project as Filed might have on woodland caribou, and the effectiveness of measures that could be introduced to avoid or reduce adverse impacts on woodland caribou or their habitat. However, in the absence of a national recovery strategy, action plans and the identification of critical habitat for woodland caribou, the Panel is unable to reach a view on the significance of the environmental impacts on woodland caribou that are likely to result from the Project as Filed. At a minimum, however, the Panel considers that the implementation of its Recommendations 5-1 and 10-1 are essential to reducing the likelihood that adverse impacts of the Project as Filed would be significant.

EXPANSION CAPACITY SCENARIO AND OTHER FUTURE SCENARIOS

The Panel is of the view that implementation of its Recommendations 5-1 and 10-1 alone would not be sufficient in and of themselves to address potential cumulative impacts on woodland caribou associated with activities beyond the Project as Filed.

Experience in other parts of Canada's boreal forest suggests that there are major adverse impacts on woodland caribou where there is continuing and intensive development. For example, the industrial expansion in Alberta, as illustrated in Figure 10-2, associated with a progressive fragmentation of habitat, reduction of caribou range and isolation of caribou herds, as illustrated in Figure 10-1. Given the experience of receding woodland caribou range in Ontario, the full impact on caribou populations in Alberta may not yet be fully realized. Experience in Ontario indicated that there is a 20-year lag time between forest extraction and declines in caribou population.

The Panel understands that major adverse impacts on woodland caribou from continuing and intensive development cannot be avoided simply by restricting the timing of activities. Mitigations must include restrictions on the location and geographic extent of activities. Thus, adaptive management at the population level may be fruitless, even with the best designed and funded monitoring program. The SCC provided the Panel with a review of limiting factors for woodland caribou populations. The SCC concluded that few mitigation measures, and certainly not the ones proposed by the Proponents, have been demonstrated to reduce adequately the negative impacts of industrial development. In the SCC's words, "'existing best-management practices'…may not be good enough." (J-SCC-00050, p. 33) Learning from the Alberta experience is absolutely crucial.

The Panel concludes that, despite the level of protection potentially available under SARA and various attempts by industry to mitigate industrial impacts, experience in Alberta and elsewhere shows either continuing declines in caribou range or declines in abundance, or at best, no progress in recovery. The Panel therefore reiterates that the implementation of its Recommendation 10-3 is a necessary condition for ensuring that the Expansion Capacity Scenario and Other Future Scenarios would not likely have significant adverse impacts on woodland caribou. However, even this action alone is not sufficient.

In the Panel's view, the lack of effective activity-specific mitigations lends urgency to the adoption of land use plans. The zoning element of these plans would restrict certain types of activities on lands that, while not protected areas, are otherwise not open to all forms of development. In the

Panel's view, thresholds would permit linear developments up to a limit, which would allow for development on certain lands at a lower pace and scale, so that caribou populations could coexist with limited development. These issues are addressed by the Panel in Chapter 11, "Conservation Management and Protected Areas." For the time being, however, in order to protect woodland caribou from significant adverse cumulative impacts associated with the Expansion Capacity Scenario and Other Future Scenarios, the Panel recommends that all future development activities in woodland caribou range in the Project Review Area be subject to at least the same level of protection that Panel Recommendations 5-1 and 10-1 afford as applied to the activities of the Proponents.

RECOMMENDATION 10-6

The Panel recommends that, prior to authorizing any development beyond the Project as Filed, no agency having authority to permit resource development-related activities on the lands or waters within the range of woodland caribou in the Northwest Territories or northwest Alberta issue any new land use permit, lease, licence, authorization, water use permit or licence, certificate, or other form of permission unless the regulatory instrument contains site-specific or activity-specific measures that are the same as or similar to those the Panel is recommending be conditions of any certificate or approvals the National Energy Board might issue to the Proponents or to NOVA Gas Transmission Ltd. that are for the purpose of protecting woodland caribou, more specifically, those conditions set out in Panel Recommendations 5-1 and 10-1. For greater certainty, the recommended conditions, as noted, should be applied to all oil, gas and mineral exploration and development activities as well as the placement, construction, and operation of facilities and infrastructure, within the range of woodland caribou.

10.5 BARREN GROUND CARIBOU

10.5.1 EXISTING CONDITIONS

Figure 10-3 shows the ranges of barren ground caribou herds in the NWT. The GNWT stated that, on the basis of radio collar locations, the Cape Bathurst and Bluenose West herds are those most likely to interact with Project infrastructure.

Hunters confirmed the importance of Parsons Lake to barren ground caribou in early winter and that caribou generally leave the area by the end of December. In its Traditional Knowledge Study, the Inuvik Community Corporation reported that one interviewee mentioned that, "when he hunts west of Parsons Lake, he knows that the caribou will be 'hanging around' there from the early part of November until December before moving east." (J-ICC-00003, Part 1, pp. 155–56) Another mentioned that he hunts wherever the caribou migrate through, "in November when there's quite a bit of snow, even in December." (J-ICC-00003, Part 1, p. 156)

A similar view was expressed at the Community Hearing in Tuktoyaktuk: "The Parsons Lake area, that whole plains area, in the winter is a good harvesting area for caribou, and that's where we go." (Vince Teddy in Tuktoyaktuk, HT V53, p. 5067)

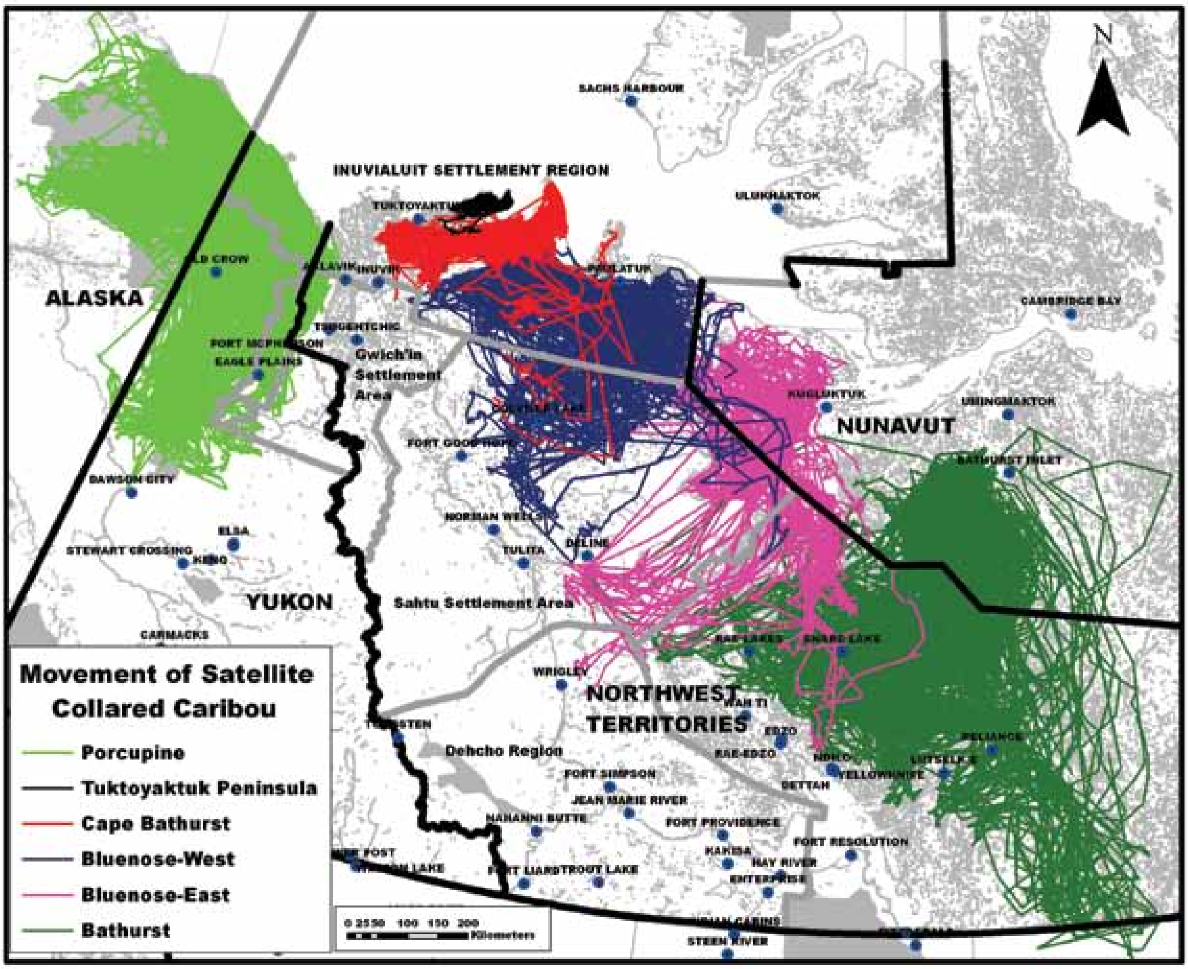
The GNWT conducted three population counts, which were not available to the Proponents prior to the drafting of the EIS, for the Bluenose West and Cape Bathurst herds between 2000 and 2006. The Bluenose West herd declined from approximately 75,000 animals in 2000 to 18,000 in 2006. The Cape Bathurst herd declined from approximately 10,000 in 2000 to 1,800 in 2006. The GNWT stated that, in view of the low number of calves associated with the post-calving aggregations observed in the latest census, it expected a continued decline in herd populations.

The Proponents stated that, during the winter, the Cape Bathurst herd extends west from the Parsons Lake production area to the Mackenzie River. The timing of movements to and from the Local Study Area varies. Radio tracking data collected between 2002 and 2004 indicated that caribou moved out of the area in December, with only a few remaining in January. The Bluenose West herd enters the Parsons Lake area in early winter during its southward migration, taking it along the proposed pipeline corridor.

The Proponents also noted that, during winter, caribou movements and habitat selection are primarily governed by the availability of terrestrial lichens and snow depth. Typically, barren ground caribou leave their summer and fall range above the treeline and move south to the treed taiga regions. In the north, terrestrial lichens rather than arboreal lichens are the primary winter food source. Thermal cover is not as important to caribou given that they have a well-insulated winter coat. Barren ground caribou rely on their dispersed distribution, speed and numbers to avoid predation. Caribou have a low reproductive rate, giving birth to single calves and not until they have reached three years of age.

Currently, no habitat protection measures for barren ground caribou have been put in place within the RSA, although the Proponents noted broad concern on the need to identify critical habitats and protect those habitats as conservation areas or special caribou management areas. For example, the draft Sahtu Land Use Plan, although not yet formally adopted by INAC, designates the Great Bear Lake region as a Special Management Area because of its importance to barren ground caribou during migration. Barren ground caribou are not listed on any of the schedules in SARA but are listed as secure in the NWT.

Figure 10-3 Ranges of the Porcupine, Cape Bathurst, Bluenose West, Bluenose East and Bathurst Barren Ground Caribou Herds



Source: Adapted from J-GNWT-00168, p. 6

10.5.2 PROPONENTS' VIEWS

The Proponents considered Project activities that could impact barren ground caribou as similar to those identified for woodland caribou and include sensory and habitat disturbance, physical structures, and increased access.

The Proponents assessed the impact of the Project on habitat availability, changes to movement and mortality. Habitat availability may be reduced due to vegetation clearing, sensory disturbance, displacement attributed to altered human and predator access, and changes in vegetation health. Based on range-use patterns of caribou in the region, the Parsons Lake Anchor Field (including associated infrastructure such as the airstrip and lateral) and the pipeline corridor were the only portions of the Project that the Proponents considered would impact barren ground caribou.

In modelling habitat suitability for barren ground caribou, the Proponents focused on the winter range because calving and post-calving grounds are well away from the Project area. They did not model habitats chosen for predator avoidance because habitat characteristics with high predator risk are largely unknown. The Proponents therefore considered areas to be of greatest habitat suitability if they had a high percentage of caribou-preferred lichen species, shallow snow and rolling rather than flat terrain. The primary determinant of habitat suitability, as modelled by the Proponents, is the percentage of forage lichen in the habitat. Overlaying Project footprints and zones of influence on suitable habitat resulted in a net loss of habitat in the Inuvialuit Settlement Region of 2.61% during construction and 0.46% during operations.

Construction-related physical barriers were considered to alter movement patterns of barren ground caribou during the construction phase. Berms, roads and deep ditches may also affect caribou movements. Elevated flow and gathering lines could affect caribou crossing success; however, as those pipelines would be elevated at least 1.5 m above the ground, crossing success was not considered a problem. Movements may also be impacted if barren ground caribou avoid areas due to improved access to hunters and predators. Caribou may also alter their movement routes by choosing to travel along linear corridors.

If vegetation clearing occurred in key winter habitat, the energetic stress could lead to lower body mass of females and their subsequent survival. Repeated exposure to sensory disturbance could result in additional energetic stress in winter, resulting in greater overwinter weight loss and poorer body condition for females and their young, leading to reduced survival. Additional mortality could also occur from increased access by hunters and predators due to new roads, cleared right-of-ways and seismic lines.

The Proponents made several commitments to reduce the impact of the Project on barren ground caribou relating chiefly to avoidance during construction, preparing caribou management plans and allocating funds for caribou studies.

ConocoPhillips developed a detailed draft *Barren-Ground Caribou Protection Plan for the Parsons Lake Field Development* area to minimize adverse impacts of the Parsons Lake Anchor Field on barren ground caribou and committed to complete the plan with input from agencies and boards. The Proponents generally committed to develop wildlife management plans and species-specific protection plans in consultation with pertinent agencies and boards.

The ConocoPhillips draft Caribou Protection Plan was reviewed by the Wildlife Management Advisory Committee (NWT), which indicated that, while the plan would not meet the full requirements of monitoring for the Project, it did provide a good example of Project-specific plans that could be adapted to other projects in the region and could be part of a more extensive regional monitoring program.

The Proponents assessed the impact of the Project on barren ground caribou habitat availability as adverse, low and local for all of the potential sources of impact during the construction, operations and decommissioning phases. The only exception was that sensory disturbance during the construction phase was assessed as being at moderate magnitude. The Proponents assessed the impact of Project activities in the pipeline corridor as adverse, low and local on barren ground caribou movements, except for moderate impact during construction.

The Proponents indicated that access provided to hunters and wolves would likely cause an increase in caribou mortality and indicated that the effects of pipeline construction on mortality rates for these caribou herds were difficult to predict. In spite of this uncertainty, the Proponents assessed the potential impacts on caribou mortality as adverse, low and regional throughout all phases of the Project.

The Proponents considered that the combined effects of Project components on barren ground caribou would not be significant. The Proponents did not provide any further cumulative impact assessment based on their identification of what they characterized as reasonably foreseeable developments. However, in response to a Panel request, the Proponents described a future scenario of induced development that could supply the pipeline with gas volumes consistent with a fully expanded pipeline. They concluded that this could result in additional habitat reduction due to clearing in the winter range in the Colville Hills area but did not consider the effects to be significant.

10.5.3 PARTICIPANTS' VIEWS AND RECOMMENDATIONS

SENSORY DISTURBANCE

Several communities have experienced the disappearance of caribou in the past and were concerned that pipeline construction and operations would adversely impact caribou movement. The Pehdzeh Ki First Nation highlighted the impacts of pipeline construction on caribou, stating, "recently, after a 25-year absence, the caribou have begun to migrate back into our region," and that, since the Norman Wells Oil Pipeline was constructed, "the caribou have been gone and our membership believes that these caribou will disappear again during the construction phase" of the Project. (Chief D'arcy Moses in Wrigley, HT V59, p. 5819)

At the Colville Lake Community Hearing, the Panel also heard observations about the disruption to caribou from industrial development activities:

> Last winter we had noise disturbance all the time going continuously, machines from the companies…and because of that, there was no caribou last year.
>
> So this winter we said we didn't want to have any disturbance, no development on our land, and because we didn't have any work on the land this year, all the caribou came back. (Alexis Blancho in Colville Lake, HT V21, p. 1972)

Several participants made recommendations to the Proponents and government to reduce impacts on barren ground caribou. The GNWT recommended that the Proponents prepare and implement, with full consultation, a barren ground caribou protection and management plan. The plan should be designed to test impact predictions, identify mitigation measures and contain a monitoring plan. In responding to this and similar recommendations, the Proponents indicated that they would prepare wildlife protection and management plans prior to construction.

World Wildlife Fund Canada recommended that the federal and territorial governments

> develop and implement new regulations to protect caribou and their key habitats by 2008 to help stem widespread major

> declines to NWT caribou herds in the face of anticipated further increases in industrial exploration and development pressure. (J-WWF-00139, p.10)

The GNWT responded that it is committed to implementing the NWT Barren Ground Caribou Management Strategy, which identifies actions to help barren ground caribou herds recover. The GNWT noted that regulatory changes would be determined in consultation with co-management boards and implemented as required.

Participants raised three additional concerns about Project impacts on barren ground caribou. These related to the proposed airstrip at the Parsons Lake Anchor Field, the proposed routing of the gathering system north of Inuvik, and the impact of Dempster Highway traffic on the Porcupine caribou herd in the Yukon.

PARSONS LAKE AIRSTRIP

On behalf of the Inuvialuit, the Joint Secretariat requested that the Proponents consider an alternative to the Parsons Lake airstrip due to its location within the culturally and ecologically sensitive Husky Lakes region. The Joint Secretariat noted that the Husky Lakes are zoned "Category D" in the Aklavik, Inuvik and Tuktoyaktuk Community Conservation Plans. Category D lands are considered areas where cultural or renewable resources are of particular significance and sensitivity throughout the year and where disturbance should be avoided or minimized. The Joint Secretariat asserted that the airstrip would:

- negatively affect struggling caribou populations through habitat destruction and noise resulting from air traffic;
- disturb migratory bird staging, nesting and harvesting;
- disturb grizzly bears that range within the area;
- affect cabin owners and recreational opportunities in the area; and
- increase the risk of aircraft accidents and the potential for fuel contamination in the area.

These concerns were also highlighted during Community Hearings in Tuktoyaktuk. The concerns regarding the airstrip included:

- the proposed airstrip at Parsons Lake would cut across a caribou migration path, increasing stress on the herd and ultimately impacting Inuvialuit hunting habits and traditions;
- construction of the airstrip would contribute to noise pollution, stress wildlife and people, push hunting grounds further away, and risk the long-term health of animals;
- use of existing airstrips would be far less disruptive to the environment and would allow the community to capitalize on previous projects without creating new problems; and
- an all-weather road would minimize possible damage to wildlife and leave a legacy that would contribute to local economic development.

Vince Teddy in Tuktoyaktuk noted that:

> A lot of us in Tuk, and other places, are opposed to [the Parsons Lake airstrip] for many reasons.
>
> One of the biggest ones is harvesting of caribou. The Parsons Lake area, that whole plains area, in the winter is a good harvesting area for caribou, and that's where we go. And we only got them back in the last 20 years. So…that one airstrip will have a major impact on that. (HT V53, p. 5067)

In the view of the Joint Secretariat, the only alternative to the Parsons Lake airstrip would be to use the Inuvik and Tuktoyaktuk airports and construct an all-weather road from Inuvik to Tuktoyaktuk, with an extension into the Parsons Lake facilities. The Joint Secretariat's assessment acknowledged that the Parsons Lake airstrip and the all-weather road would create a significant impact on wildlife and migratory birds.

The Proponents stated that they had conducted a detailed evaluation of options to transport people, equipment and supplies to and from the proposed production area. The options considered included all-weather roads, service roads, an all-weather Hercules airstrip with winter road access, a Twin Otter airstrip with winter road access, a Dash 7 airstrip with winter road access and a heavy-lift helicopter supported operation. The Proponents indicated that the proposed access option for the Parsons Lake Anchor Field is a blend of winter ice roads, fixed-wing aircraft using a permanent year-round gravel airstrip, helicopter access and low-ground-pressure vehicles.

At the end of the Tuktoyaktuk Community Hearings, the Proponents summarized their approach to the Parsons Lake airstrip and listed their reasons for choosing the airstrip option over the permanent road as being:

- to ensure safe and efficient movement of personnel;
- to resupply construction activities, recalibrate specialized drilling equipment used year-round and provide emergency response capabilities;
- Parsons Lake is land-locked and remote from existing roads;
- a public highway would not be built in time to meet the projected construction schedule; and
- an access road to Inuvik or Tuktoyaktuk would be cost-prohibitive and far beyond the needs of the Project.

The Proponents also stated that, if a public highway to Tuktoyaktuk were constructed, it would be a government responsibility, not the Proponents', and would be beyond the scope of the Project.

With respect to the use of the Parsons Lake airstrip, the Proponents indicated that they would develop mitigation measures to reduce the effects of aircraft on harvesters and wildlife, including:

- using designated flight corridors to avoid flying directly over harvester camps;
- using insulation to reduce granular requirements;
- reducing road height;
- managing snow bank heights along the all-weather site roads to allow for the passage of caribou and harvesters;
- contributing to the GNWT's Department of Environment and Natural Resources satellite tracking program;
- working with the GNWT's Department of Environment and Natural Resources to obtain information as to when caribou are approaching the development area;
- adjusting flight and vehicle traffic to reduce disruption during migration to the wintering range; and
- compensating harvesters, as provided for under the *Inuvialuit Final Agreement*.

IKHIL PIPELINE ALTERNATIVE ROUTE

A number of participants favoured rerouting the pipeline south of the East Channel crossing from the Proponents' proposed route through the Storm Hills to align instead with the existing Ikhil gas pipeline right-of-way. They were concerned that the critical caribou habitat "east of [Inuvik] all the way to Holmes Creek" would be threatened. (J-ICC-00003, Part 2, p. 180) This area is one of the main hunting and migration areas, and hunters asked the Proponents if they would consider diverting the pipeline to turn west and follow the Ikhil route. They wanted the Proponents to focus development on previously disturbed areas and allow areas of critical habitat to remain undisturbed, in particular the areas around Noell Lake and Jimmy Lake.

In response to questioning from the Panel, the GNWT indicated that the use of the Ikhil right-of-way would minimize impacts to barren ground caribou from a caribou ecology point of view. The Ikhil route would be consistent with the GNWT's objective of minimizing linear features on the winter range and would lead to a more contiguous block of winter range and habitat.

In response to these concerns, the Proponents undertook a comparative evaluation of their preferred route through the Storm Hills and the suggested alternative route using the existing right-of-way of the Ikhil gas pipeline. The Proponents maintained their preference for the Storm Hills route because it:

- is at least 19 km shorter;
- would cause less impact because of its smaller footprint;
- crosses fewer and shorter areas of sidehill slopes;
- has fewer or the same frost heave concerns;
- is shorter or the same length within the Kendall Island Bird Sanctuary (KIBS);
- has less of its length close to lakes; and
- is less costly.

DEMPSTER HIGHWAY TRAFFIC

Some participants suggested that the Porcupine caribou herd in northern Yukon may be impacted by the Project, even though the Proponents did not assess this possibility. The Porcupine Caribou Management Board indicated that, although "the physical location of the pipeline and project footprint themselves do not affect the porcupine caribou directly,...the anticipated increase in traffic along the Dempster Highway is a very real concern" and would disturb the herd, which has declined over the last 18 years. (J-OHP-00325, p. 2) The Management Board identified the following potential Project-related impacts on the herd:

- increased levels of traffic resulting in direct loss of caribou due to road kills and injuries, and indirect loss due to displacement of caribou from roads;
- increased recreational activity;
- increased harvesting interests along the Dempster Highway;
- increased risk of wildfire;
- increased risk of invasive species introduced along the road;
- increased demands on the Porcupine Caribou Management Board itself; and
- increased cumulative effects.

The Government of Yukon expressed similar concerns regarding the mitigation of potential adverse impacts to wildlife situated along portions of Yukon's Alaska, North Klondike and Dempster highways. Noting the Proponents' predicted sixfold increase in total volumes of truck traffic and a threefold increase in peak-year volumes of truck traffic using Yukon highways as a result of the Project, the Government of Yukon indicated it believed that the mitigation measures intended for all northern Project vehicular traffic, regardless of whether it is within or outside the Proponents' RSA, should be applied consistently and uniformly, and that it understood that the Proponents have agreed with this principle.

10.5.4 PANEL VIEWS AND RECOMMENDATIONS

SENSORY DISTURBANCE

The Panel considers that the baseline data presented at the hearings by the GNWT were adequate to assess the impacts of the Project on barren ground caribou. The continuation of active radio collar monitoring on the Cape Bathurst herd and the Bluenose West herd by the GNWT and the Proponents is important to determine the timing and location of movements in relation to the proposed Project. In the Panel's view, this monitoring program should continue.

The impacts to barren ground caribou are primarily sensory in nature, of seasonal occurrence and of limited duration. The major zone of impact for barren ground caribou would be the Parsons Lake area and the activity surrounding the production facility. ConocoPhillips' Caribou Protection Plan was well received by participants as an appropriate means to minimize impacts. In the Panel's view, this plan would help to minimize adverse impacts to barren ground caribou.

PARSONS LAKE AIRSTRIP

The Panel recognizes that the location and size of the proposed Parsons Lake airstrip is of concern to residents of Tuktoyaktuk and Inuvik, in part because of the:

- perceived interference with the fall movements of the Cape Bathurst and Bluenose West caribou herds;
- interference with migratory bird staging, nesting and harvesting;
- disturbance to grizzly bears;
- disturbance to nearby cabins; and
- increased risk of an aircraft accident and fuel spill in the area.

However, the Panel was not presented with any evidence on the extent or seriousness of the anticipated interference or disturbance. On the other hand, the Panel heard from wildlife managers that mitigation would reduce the impacts of the airstrip to acceptable limits. It heard from the Proponent (ConocoPhillips) that a year-round airstrip would be necessary at the Parsons Lake site for safety and operational reasons. ConocoPhillips agreed that it would work with local wildlife officials to:

- track caribou movements;
- suspend operations along the road to the airstrip to allow caribou to pass;
- limit the frequency of flights during spring waterfowl migration (May 10 to 31);
- observe prescribed flight elevations; and
- continue consultations with impacted parties to minimize the impact of the airstrip on local hunters.

The Panel also heard that use of the airstrip after the four years of construction would decline significantly.

After considering the evidence before it, the Panel finds that the environmental impacts of the Parsons Lake airstrip could be mitigated and that the resulting impacts would not likely be significant.

RECOMMENDATION 10-7

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, prior to the commencement of construction, operating procedures for the Parsons Lake airstrip. The operating procedures should minimize the environmental impacts of airstrip operations, be developed in consultation with the Inuvik and Tuktoyaktuk Hunters and Trappers Committees, and indicate how the concerns of the Hunters and Trappers Committees have been addressed. These operating procedures should receive endorsement from Transport Canada prior to being filed with the National Energy Board.

IKHIL PIPELINE ALTERNATIVE ROUTE

The Panel acknowledges the concerns of participants with respect to the proposed gathering line north of Inuvik, and it agrees that the use of the Ikhil gas pipeline right-of-way would reduce impacts on barren ground caribou range. The GNWT indicated that using the existing Ikhil route would be preferable from a caribou conservation perspective, as it would limit habitat fragmentation. However, no evidence was provided to the Panel that suggested that the impacts of the Storm Hills route preferred by the Proponents would in fact be significant. It is unlikely that the preferred route would cause population-level impacts, but it could cause displacement of animals from a preferred harvesting area during the year of construction.

DEMPSTER HIGHWAY

The Panel notes the concerns raised by the Porcupine Caribou Management Board regarding potential impacts on the Porcupine caribou herd from the increased use of the Dempster Highway during Project construction. The Panel accepts that the Project's footprint would not directly impact the Porcupine caribou herd; however, increased traffic on the Dempster Highway resulting from the Project could impact the Porcupine caribou herd.

The Panel notes that implementation of the Panel's generic wildlife Recommendations 5-1 and 10-1 are essential elements of an approach to manage the potential impacts of the Project as Filed on barren ground caribou. However, in the Panel's view, further measures would be required to ensure that the adverse impacts of the Project would not be significant.

RECOMMENDATION 10-8

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, prior to the commencement of construction, a plan to address any impacts from the Mackenzie Gas Project on the Porcupine caribou herd resulting from increased use of the Dempster Highway. This plan could be included as part of the Barren Ground Caribou Protection and Management Plan described in Panel Recommendation 10-1 or be developed in a stand-alone manner. The plan should address the concerns of and be developed in consultation with the Porcupine Caribou Management Board and the Government of Yukon. The contents, distribution and endorsement of the plan should also reflect the *requirements outlined in Panel Recommendation 10-1 but be specific to the Porcupine caribou herd. As a matter of principle, the mitigation measures to reduce the impacts of vehicular traffic on wildlife should be developed and applied in a uniform and consistent manner throughout the Project Review Area.*

Provided the Panel's recommendations were implemented, the Panel is of the view that the Project as Filed would not likely cause significant adverse environmental effects on barren ground caribou.

Maintenance of unfragmented winter range and habitat is important for barren ground caribou populations. The Panel is concerned that an unregulated proliferation of developments and associated infrastructure across the landscape could pose a population-level risk to barren ground caribou herds. The Panel recognizes that barren ground caribou populations are cyclical. However, given the recent steep population decline in the Cape Bathurst and Bluenose West herds, it is the Panel's view that there should be some upper limit to development in the winter range to minimize any industry-related mortality that might deepen the decline or delay recovery of the herds. In the Panel's view, this objective is best achieved by developing range management plans that have defined linear and area density development thresholds for specified activities. The Panel notes that the actions cited by the GNWT in its strategy to assist in caribou herd recovery, in response to World Wildlife Fund Canada's recommendation, are only to "identify, monitor and mitigate impacts of exploration and development activities and improve understanding of the mechanisms for any impacts." (J-GNWT-00079, p. 25) The strategy does not contemplate the identification of defined linear and area density thresholds for specified activities. Therefore, in the Panel's view, the GNWT's response to World Wildlife Fund Canada's recommendation is insufficient.

RECOMMENDATION 10-9

The Panel recommends that the Government of the Northwest Territories, within two years of the date of the Government Response to the Panel's Report, develop range management plans for the winter ranges of the Cape Bathurst and Bluenose West barren ground caribou herds that include linear and area density development thresholds. These plans should be developed in consultation with the appropriate wildlife management boards.

The Panel further recommends that these management plans be filed with the appropriate local and regional bodies responsible for environmental assessment and wildlife management, as well as with the administrative and regulatory bodies responsible for disposition of rights to land and water, for consideration when processing regulatory permits for any industrial or commercial activity in the Project Review Area that is within the winter ranges of the Cape Bathurst and Bluenose West barren ground caribou herds.

In the absence of a formal land use planning regime in the Inuvialuit Settlement Region, the Panel recommends that the appropriate agencies address the potential adverse impacts on caribou of further development of roads and airstrips in caribou ranges in the Inuvialuit Settlement Region.

RECOMMENDATION 10-10

The Panel recommends that the Government of Canada, the Inuvialuit Land Administration and the Government of the Northwest Territories jointly develop policies to restrict the proliferation of roads and airstrips within the ranges of Cape Bathurst and Bluenose West barren ground caribou herds. Those policies should be reflected in the Range Management Plans and the setting of linear and area density development thresholds, as outlined in Panel Recommendation 10-9.

10.6 GRIZZLY BEAR

10.6.1 EXISTING CONDITIONS

The GNWT considers the grizzly bear an "umbrella" species and an indicator of overall ecosystem health. Declines in grizzly bears across its historical range illustrate its sensitivity to human activity. Two populations of grizzlies occur in the Project Review Area: the Arctic coastal population occupying the region north and east of Inuvik with concentrations on Richards Island, and the northern interior population in the Yukon. According to the GNWT, the Mackenzie Delta area "is an important connection point for grizzly bears in North America," but there is a lack of information on the interaction between the populations and the extent of fragmentation the Project may cause. (Dr. Andrew Derocher, HT V74, p. 7403) As the GNWT's consultant noted, "any fragmentation in populations, especially one that would separate two major groups of animals, is not beneficial for the long-term conservation of a species." (Dr. Derocher, HT V74, p. 7403) Regional populations are characterized by low recruitment rates, low population densities (ranging from four to eight bears per 1,000 km^2) and large home ranges (up to several thousand square kilometres). Because access is difficult and human activity levels are low, regional populations are thought to be stable and current harvesting levels sustainable. However, there are no quantitative studies to confirm this view, as obtaining accurate population levels is difficult and costly.

Dens are considered critical habitat, especially if den sites are limited. However, in the tundra zone, the Proponents indicated that den habitats are probably not limiting, at least around Richards Island and the Tuktoyaktuk Peninsula. The Proponents pointed out that, as the landscape becomes more fragmented, patches may get so small that they become less effective habitat, particularly for species that need large patches of undisturbed habitat, such as the grizzly bear.

Most Aboriginal communities place a high importance on grizzly bears as a valued part of the ecosystem and a potential source of revenue through outfitting. In the Inuvialuit Settlement Region, Community Conservation Plans identify high-quality denning habitat as critical and classify these as areas needing special protection. These designations are noted by the Environmental Impact Screening Committee, but their acceptance for land use permitting purposes by INAC is discretionary. There are no legally protected areas for grizzly bears in the RSA. In the Inuvialuit Settlement Region and Gwich'in Settlement Area, grizzlies are under a tag quota where 3% of the population of animals older than 2 years can be harvested. However, defence kills are deducted from this quota.

COSEWIC assessed grizzly bears as a species of special concern in 2002. In the NWT, grizzly populations were considered stable, but their sensitive status means they have to be managed carefully to prevent them from becoming at risk. In Alberta, the grizzly is designated as a species that may be at risk.

10.6.2 PROPONENTS' VIEWS

The Project could affect grizzly bears mainly through alteration and reduction of key habitat as a result of physical barriers to movement and through direct disturbance or mortality due to increased human activity.

The Proponents stated that grizzly bears will avoid areas near seismic blasting, roads and other industrial activity, with bears in open tundra being more reactive than bears that have protective cover in the forest. The zone of influence depends on the density of bears, individual bear behaviour, age/sex and reproductive status of the bear, season, characteristics of the disturbance, and terrain. In addition, low-flying aircraft, helicopters and construction noise, if frequent enough, can cause bears to abandon their dens. Direct mortality of mothers and young could also occur from den abandonment.

There is a high potential that borrow pits would disturb existing or eliminate future den sites. Many of the borrow sites are associated with eskers, which have high potential as denning habitat for grizzlies. Evidence of bear use was found in about 30% of borrow pits inspected during reconnaissance surveys.

Grizzly movements could be impacted in the production areas because grizzlies access the sites in spring to feed on eggs and birds in bird colonies. As well, pipeline infrastructure could alter local movement of bears through response to the physical structure and associated noise and human activity.

Grizzlies can be attracted and habituated to human food sources, which could result in an increase in mortality from controlled removals. The Proponents noted that revegetation of forbs and grasses, important components of grizzly bear diet, along disturbed areas may actually attract grizzlies into these openings, making them more vulnerable to hunters.

The Proponents concluded that total disturbance during Project construction would reduce the amount of effective fall and spring foraging habitat for barren ground grizzlies by less than 2% in all regions. The facilities at Niglintgak would reduce spring and fall forage habitat by about 7 km^2. Denning habitat loss would be less than 2% in the Inuvialuit Settlement Region and between 0.74% and 9.23% south of the treeline. Less habitat would be disturbed during the operations and decommissioning phases.

The Proponents noted that most construction would occur in winter when bears were hibernating. During construction at the Anchor Fields, grizzlies may alter movement due to sensory disturbance. They may also be attracted to early snowmelt along right-of-ways to access fresh, green vegetation. Grizzlies may also avoid areas that allow increased access from hunters, such as ice roads and pipeline corridors.

The Parsons Lake facility is most likely to impact denning, as Parsons Lake contains more denning habitat than the other production facilities; 37% of the Parson Lake lease is rated very high to moderate for grizzly denning.

Another source of mortality could be controlled removals, especially if bears were attracted and habituated to garbage at work sites and camps. Between 1986 and 1997 in the Slave Geological Province, 24% of the grizzly kills occurred at industrial camps. Despite mitigation to reduce the attraction of bears to oil facilities, studies in Alaska determined that 21% of the bears in the North Slope oil fields supplemented natural foods with food from human sources. In addition, habituation of cubs to oil field sites made them more vulnerable to legal and illegal hunters outside the oil field area after weaning. Hunters also became more efficient from the improved access resulting from North Slope development.

The Proponents made several commitments to reduce Project impacts on grizzly bears relating chiefly to den surveys prior to construction, avoidance during construction, and preparing grizzly bear protection plans, waste management plans, and protocols for managing interactions between bears and humans.

ConocoPhillips developed a discussion draft *Grizzly Bear and Wolverine Protection Plan for the Parsons Lake Field Development*. The plan is specific to the Parsons Lake facilities and addresses bear awareness and safety training for employees and contractors, implementation of a waste management plan, design considerations for camps and facilities, detection procedures, establishment of a bear response team and protocol, and monitoring.

The Proponents also indicated that specific best practices would also be integrated into Project activities that occurred within grizzly bear habitat. For example, the Proponents would use existing land use disturbance, concentrate equipment and facilities on development pads, and use the east side of Parsons Lake to reduce fragmentation of grizzly habitat.

The Proponents assessed individual Project components separately for impacts on grizzly bear habitat, movement and mortality. With respect to grizzly bear habitat, the Proponents predicted that most of the Project's components would have impacts that were adverse, low in magnitude, local in extent and long-term. The Proponents predicted that production area infrastructure would have a similar impact on bear habitat but would be moderate in magnitude and regional in extent. The Proponents predicted that the Project would have adverse, low, local and long-term impacts on bear movements for all Project components.

The Proponents predicted that Project impacts on increased bear mortality would be low in magnitude, regional in extent and medium- to long-term for each of the Anchor Fields, except the Parsons Lake field, for the gathering pipelines and associated facilities and for the pipeline corridor. Impacts on barren ground grizzly bear mortality from the Parsons Lake field were predicted to be moderate in magnitude during construction and operations, regional in extent, and medium-term.

The Proponents predicted that impacts to grizzly bears would be localized in relation to destruction of habitat and denning areas and loss of seasonal food sources surrounding Project infrastructure and borrow sites. In the EIS, the Proponents noted that physical barriers could include roads, barge landings, camps, fuel storage areas, airstrips, and pipe and equipment storage and stockpiling areas. The EIS noted that "better access to bear habitat could increase hunting pressure and human and bear interactions, including attraction of bears to facilities and infrastructure sites." (EIS V5E, Section 1, p. 3)

The Proponents concluded that the combined effect of all Project components on grizzly bear would be moderate because of the potential for disturbance of denning bears and the attraction of bears to camps, and that this combined potential effect would not be significant. They further stated that "assuming that industry-induced bear mortality does not exceed the quota, this combined effect will not affect the viability of the bear population or render harvest unsustainable." (EIS V5E, Section 2, p. 138)

The Proponents concluded that the cumulative effects of development could lead to additional direct mortality from defence kills but that this could be addressed by diligent monitoring and management. The Proponents' subsequent cumulative effects assessment that included hypothetical additional exploration in the Mackenzie Delta concluded that the exploration activities identified in their assessment could have effects on denning grizzly bears but that they would not be significant.

10.6.3 PARTICIPANTS' VIEWS AND RECOMMENDATIONS

The GNWT characterized grizzly bear response to human activity in the Mackenzie Delta area as uncertain and requiring further study but considered the species generally vulnerable to disturbance effects. The GNWT pointed out that "low resiliency makes it difficult for population numbers to persist or recover in multi-use landscapes where the cumulative impacts of industry, subsistence and sport hunting, problem and defence kills, and recreational activities are the norm." (J-GNWT-00167, p. 5)

The GNWT also raised a concern regarding the lack of information specific to barren ground grizzly bear, particularly in view of their vulnerability to disturbance effects. The GNWT noted that Project impacts could increase avoidance behaviour, which, in turn, could "increase energy expenditure and limit the grizzly bear[s'] ability to meet their requisite resource needs." (J-GNWT-00167, p. 5)

The GNWT is of the view that low, chronic mortality as a result of the Project, especially if it disproportionately targeted females, combined with a harvest that is already considered at maximum to sustain the grizzly population, could cause considerable problems for harvesters and the grizzly population. Thus, the GNWT emphasized that it would be critical to prevent additional mortality in the population.

Supporting the GNWT's concern regarding the lack of specific information, the GRRB highlighted the uncertainty regarding potential impacts on grizzlies in the Gwich'in Settlement Area, indicating that "modeling results conducted to assess potential impacts to grizzly bears do not appear to adequately represent bears residing in the [Gwich'in Settlement Area,] and there is a high degree of uncertainty for impacts based on these models." (J-GTC-00014, p. 20) Further, movement patterns of bears in the Gwich'in Settlement Area are not well understood. The GRRB criticized the EIS for not having a denning model for south of the treeline and for not verifying forage models.

The GRRB believes that impacts would be greater than indicated in the EIS because of limited baseline data, lack of certainty in the habitat models and the failure to adequately consider increased grizzly mortality during construction. The GRRB also believes that thorough pre-construction den surveys would be critical to reducing mortality from disturbing bears in dens.

Both the GNWT and the GRRB recommended that the Proponents conduct further research with respect to barren ground grizzly bear and develop an adequate monitoring plan as well as a protection and management plan in consultation with the appropriate management agencies, boards and committees.

The GRRB and the Gwich'in Tribal Council noted that ConocoPhillip's draft *Grizzly Bear and Wolverine Protection Plan for the Parsons Lake Field Development* was "generally well thought out and comprehensive." (J-GRRB-00016, p. 1) They recommended that companies planning work within the Gwich'in Settlement Area adopt a similar plan, subject to a number of refinements that could be incorporated into a final plan. The GRRB endorsed the plan, subject to 10 recommendations that the Proponents generally agreed with.

The Wildlife Management Advisory Committee (NWT) stated that the ConocoPhillips plans were a "good example of project specific Plans that could be adapted to other developments in the region," (J-WMAC(NWT)-00003, p. 2) but there is still a need for an extensive regional monitoring program using a coordinated, multi-stakeholder approach.

In response to the recommendations from the GNWT and the GRRB, the Proponents pointed to the draft *Grizzly Bear and Wolverine Protection Plan for the Parsons Lake Field Development*, stated that the Project has already supported grizzly bear research, and agreed that the Proponents would be responsible to monitor Project impacts. However, the Proponents considered that enforcing environmental management plans and mitigation measures is the responsibility of resource managers.

10.6.4 PANEL VIEWS AND RECOMMENDATIONS

The Panel acknowledges the concerns of the GNWT and the GRRB regarding insufficient information on grizzly populations (especially in the forested areas of the RSA) and uncertainties with respect to development impact on grizzly bear populations. There is insufficient information for the Panel to accept the Proponents' conclusion that the effects of the Project on grizzly bears would not be significant. Further baseline information and research are required. The Panel notes the Proponents' commitment to conduct pre-construction surveys to identify active bear dens and considers this commitment critical to reducing disruption and abandonment of dens.

It is the Panel's view that the Project's most significant impact on the grizzly bear population would occur from bear–human interactions due to problem wildlife and from increased vulnerability of bears to poachers and legitimate hunters. The Panel is of the view that it would be essential for the Proponents to ensure that the attraction of bears to camps, construction sites and right-of-ways be reduced as much as possible. The use of stringent waste disposal methods and camp monitors would help considerably, but as the experience in Alaska and elsewhere in the NWT has shown, nuisance bear problems cannot be entirely prevented. The Panel notes that the draft *Grizzly Bear and Wolverine Protection Plan for the Parsons Lake Field Development* was positively reviewed by several participants, and it endorses this draft plan as a sound basis for further developing the specific means of reducing impacts on grizzly bears.

The Panel notes that, under the existing grizzly bear harvest quota system, any defence kills would be deducted from the quota, which would have an adverse impact on harvesters. The Panel considers the issue of harvester compensation in detail in Chapter 12, "Harvesting."

Implementation of the Panel's Recommendations 5-1 and 10-1 is an essential element of an approach to manage the potential impacts of the Project as Filed on grizzly bears. However, the Panel is of the view that further measures would be required to ensure that the Project's adverse impacts were not significant.

RECOMMENDATION 10-11

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file annually during the construction phase, prior to the commencement of construction planned for the coming season, the results of their grizzly bear den surveys and whether and how grizzly bear dens would be avoided during construction. This information should also be provided to the Government of the Northwest Territories and wildlife management boards.

Provided that the Proponents' commitments and the Panel's recommendations were implemented, the Panel is of the view that the impacts of the Project as Filed on grizzly bears would not likely be significant.

The Panel is of the view that the cumulative impacts associated with the Expansion Capacity Scenario and Other Future Scenarios could be significant for grizzly bear populations. It is the Panel's view that activities beyond those included in the Project as Filed should not be approved without having in place intensive population-level monitoring to address and manage such impacts. In addition, it is the Panel's view that future developments that would increase the throughput of the pipeline beyond 1.2 Bcf/d would have to be rigorously managed.

RECOMMENDATION 10-12

The Panel recommends that the governments of the Northwest Territories and Yukon and Parks Canada, within two years of the date of the Government Response to the Panel's Report, develop range management plans for grizzly bear, in consultation with the appropriate management agencies, boards and committees.

Finally, the Panel notes that the Mackenzie Delta, where Project activity might continue for several decades and where activities associated with the Expansion Capacity Scenario and Other Future Scenarios are most likely to occur, does not have any areas designated for grizzly bear protection or that serve as such.

10.7 POLAR BEAR

10.7.1 EXISTING CONDITIONS

Environment Canada reported that current information indicated that the southern Beaufort Sea polar bear population had declined from 1,800 animals to 1,500 animals since the previous survey.

COSEWIC assessed the polar bear as a species of special concern in 2002. Based on recent surveys of polar bear populations, the status of the species is currently being reassessed. Upon completion of this assessment and after consultations with the relevant communities and wildlife management boards, polar bears may be added to Schedule 1 of SARA. The International Union for the Conservation of Nature, which lists polar bears as vulnerable internationally, considers habitat loss, climate change, harvesting and pollution as major threats to polar bear populations. Presently, there is no habitat protected specifically for polar bears in the Beaufort Marine RSA, the only RSA in which the Proponents predicted there could be impacts from the Project.

There is little evidence of maternal denning on the mainland coast of the RSA. Only one den was located on Richards Island between 1981 and 1999. Some dens were located in the outer Mackenzie Delta.

Polar bear populations are limited mainly by hunting due to their low reproductive rate. Threats also include increasing human activity, oil spills, problem kills and changes to prey populations. There is concern for the viability of mainland populations of polar bears because of climate warming, which has resulted in the recession of the ice pack that contains seal populations, polar bears' primary prey. Although reported to be tolerant of human activities, polar bears may be adversely affected during denning by oil and gas development.

Management responsibility for polar bears and their habitat rests with the GNWT and the wildlife management boards in the Inuvialuit Settlement Region. Under the current regime, a quota of 40 bears can be harvested in the Canadian portion of the management area. Harvest quotas are reduced by the number of problem bears killed.

10.7.2 PROPONENTS' VIEWS

The RSA for the Proponents' assessment of Project effects on polar bear was the Beaufort Marine RSA. It included impacts from the Niglintgak barge-based gas conditioning facility, the potential dredging area, the barge transport corridor and the Niglintgak field. The Proponents assessed potential impacts from the construction (barge transport, potential dredging and facility installation), operations, and decommissioning and abandonment (barge transport and potential dredging) phases.

The Proponents stated that the only impacts on habitat availability during construction would be from physical disturbance and changes in water quality from dredging and facility installation that would affect polar bear food supply. During operations, polar bears could be disturbed by sensory stimuli, including air, noise and odours, which may act to displace them from preferred denning sites near the Niglintgak facility. Although it is not common for bears to den inland, there is a trend in the Beaufort Sea region for increasing use of onshore den sites. Thus, even though Niglintgak "is about 10 km inland from the coast of Richards Island and is relatively far from areas where polar bears regularly travel or den and is even farther from more intensively used offshore hunting and denning areas," the incidence of dens near the facilities may increase in the future. (EIS V5E, Section 1, p. 77)

Barge transport and potential dredging would occur from late July to mid-August, when polar bears are well offshore. Thus, sensory disturbance, movements and mortality would not likely be impacts. During the operations phase, polar bears attracted to human activity might have to be removed for safety reasons. As well, a large-scale spill of hydrocarbons during operations could impact bears directly or through ingesting contaminated materials.

The Proponents did not develop specific mitigation plans for polar bears but referred to commitments made with respect to grizzly bears, in particular the development of Polar Bear Protection Plans and protocols for managing bear–human interactions.

Given that all barge and potential dredging activities would occur when polar bears were far offshore and that very little denning occurs near the Niglintgak facility, the Proponents assessed the potential impacts on polar bears as adverse, low in magnitude, local in extent and short-term (impact to sensory disturbance during operations) to long-term (impact to water quality during construction) in duration. The only issue that the Proponents addressed relative to cumulative effects and polar bears was mortality. The Proponents concluded that, because direct or indirect polar bear mortality from the Project would be unlikely, the cumulative effects of the Project on polar bear mortality would be insignificant. However, the Proponents recognized the possibility that polar bears could be attracted to camps and be killed as problem animals.

10.7.3 PARTICIPANTS' VIEWS AND RECOMMENDATIONS

Environment Canada identified bear–human conflicts, disruption to denning, oil spills and impacts on harvesting as the major potential impact on polar bears of Beaufort Sea oil and gas activities. Environment Canada agreed with the GNWT's Department of Environment and Natural Resources that the risk of potential Project effects on polar bears would be low and, in most circumstances, would likely be of a local nature if appropriate mitigation measures were implemented. In its review, Environment Canada identified the required mitigation as:

- the identification of mitigation plans to avoid potential maternal denning areas;
- a spill contingency plan that includes wildlife protection measures; and
- mitigation measures to avoid human–bear conflicts.

However, Environment Canada's primary concern is with induced development in the future, especially offshore development. Before offshore development proceeds, Environment Canada indicated that the following information needs to be in place:

  - delineation of potential maternity denning habitat and assessment of the potential for den disturbance;

- assessment of the risk and potential impacts of offshore activities to the [s]outhern Beaufort Sea polar bear population;
- assessment of the impact of nearshore activities on Inuvialuit polar bear hunting along the nearshore areas of the southern Beaufort Sea coast from Mackenzie Bay to the Tuktoyaktuk Peninsula;
- identification of key feeding areas in nearshore areas that are used by family groups of polar bears, especially females with young of the year just out of their maternity dens, and prime seal and bear habitat near the outer edge of the landfast ice; and
- consideration of potential interaction of industrial development impacts with effects arising from climate variability and long-term climate change. (J-EC-00089, pp. 10–11)

During questioning, the Proponents agreed with and indicated that they are already committing to mitigation measures requested by Environment Canada for the Project. However, the Proponents stated that it should be government's responsibility to develop management plans and programs to prepare for potential offshore development in the future. Environment Canada's vision is to begin planning now in anticipation of the measures that would be needed in two or three decades. Environment Canada proposed a number of recommendations to reduce the impact on polar bears. It wished to ensure that adequate mitigation and monitoring plans were developed, especially to identify and avoid den sites. It also wanted to ensure that emergency spill plans gave specific consideration to polar bears.

The Proponents agreed with Environment Canada's recommendations, indicating that either plans were already in place or would be included in a Polar Bear Protection and Management Plan to be developed prior to construction.

10.7.4 PANEL VIEWS AND RECOMMENDATIONS

The Panel agrees with the Proponents and governments that the impacts of the Project as Filed on polar bears would be low and not significant, provided the Proponents implement the Panel's Recommendations 5-1 and 10-1.

In the Panel's view, the cumulative impacts of future developments offshore (including but not limited to the Expansion Capacity Scenario and Other Future Scenarios) have the potential for significant impacts on polar bears, especially combined with the expected impacts of climate change. To be better prepared to address the impacts of future offshore development, better baseline information is needed on polar bear habitat, activities and risks. The opportunity exists to put the necessary baseline studies and management plans in place before extensive offshore development occurs.

RECOMMENDATION 10-13

The Panel recommends that the Government of the Northwest Territories and Environment Canada immediately develop a program in relation to the southern Beaufort Sea polar bear population to:

- *delineate potential maternity denning habitat and assessment of the potential for den disturbance;*
- *assess the risk and potential impacts of offshore activities to the southern Beaufort Sea polar bear population;*
- *assess the impact of nearshore activities on Inuvialuit polar bear hunting along the nearshore areas of the southern Beaufort Sea coast from Mackenzie Bay to the Tuktoyaktuk Peninsula;*
- *identify key feeding areas in nearshore areas that are used by family groups of polar bears, especially females with young of the year just out of their maternity dens, and prime seal and bear habitat near the outer edge of the landfast ice;*
- *consider potential interaction of industrial development impacts with effects arising from climate variability and long-term climate change; and*
- *monitor the Beaufort Sea polar bear populations so that such data can inform the management plan noted in Panel Recommendation 10-14.*

RECOMMENDATION 10-14

The Panel recommends that, within two years of the date of the Government Response to the Panel's Report, the Government of the Northwest Territories and Environment Canada develop a range management plan for polar bears in the southern Beaufort Sea Region based on information obtained from the program noted in Panel Recommendation 10-13.

RECOMMENDATION 10-15

The Panel recommends that, subject to any existing commitments, no government department or regulatory agency issue any rights for the exploration or development of any offshore oil and gas fields in the southern Beaufort Sea Region until the range management plan for polar bear referred to in Panel Recommendation 10-14 has been finalized and implemented.

10.8 MOOSE

10.8.1 EXISTING CONDITIONS

Moose are widespread throughout the treed portion of the Pipeline Corridor RSA. Moose winter throughout the Mackenzie Valley, preferring floodplains and valley bottoms of the Mackenzie River and its major tributaries. In summer, moose can move north into the tundra along shrub-dominated riparian habitat, although year-round radio tracking studies in the region indicate that, for the most part, moose are non-migratory in the region, with home ranges averaging 174 km^2.

The Proponents reported that densities were low relative to other parts of North America, ranging from 0.006 moose/km^2 in the Delta to about 0.17 moose/km^2 in the lower Mackenzie Valley. Moose populations appeared to be stable or increasing, depending on the age of major burns in the area. The reasons for low density of moose relative to the quality of the habitat are not known, although hunting and predators may be important factors.

The Proponents found that winter habitats appear to be most critical in the Mackenzie Valley, with moose preferring a complex of habitat types rather than homogeneous stands of conifers. The constant flooding and scouring associated with the Mackenzie River maintains abundant stands of willow, the primary winter food for moose, interspersed with coniferous cover habitat, which is ideal for wintering moose.

Detailed studies of moose mortality conducted between 1985 and 1988 found that, although wolves were the primary source of mortality (about 50% of mortality of adult females), survival rates of calves in the first two months of life were high compared with the findings of studies in Alaska.

There are no legally protected areas for moose in the RSA. However, in view of the importance of moose to communities in the region, some communities have identified special moose management areas associated with prime moose habitat and traditional moose hunting areas.

10.8.2 PROPONENTS' VIEWS

The Proponents considered that vegetation clearing, sensory disturbance, physical structures and increased access would be the primary Project activities that could impact moose.

The pipeline corridor would be the main area of impact on moose habitat since their presence north of the treeline is considered sporadic. The construction phase would reduce effective habitat through vegetation clearing, habitat avoidance due to noise, and habitat degradation from dust that limits vegetation growth.

Moose would face the most significant impacts of any species in the Project area with respect to loss of effective habitat. In their habitat suitability modelling for moose, the Proponents ranked the most valuable winter habitat as those areas that:

- contain the highest percent cover of shrubs;
- contain taller shrubs;
- contain burns between 2 and 40 years old;
- are located close to lakes; and
- are located away from human disturbance and access.

The results of the modelling indicated the percentage of effective moose habitat for each of the regions to be 64% of the Gwich'in Settlement Area, 67% of the Sahtu Settlement Area and 50% of the Dehcho Region. Winter track surveys failed to verify the Proponents' winter model for moose, although the model was verified by pellet count surveys. The Proponents estimated a loss of 1.8%–2.92% of effective habitat during the construction phase because moose would avoid human activity associated with the construction of the pipeline. However, during the operations phase, the Proponents considered that there would be a net improvement in habitat effectiveness as plants recolonize and human activity decreases.

Increased access to key wintering areas could result in a significant increase in moose mortality though hunting and predation. The impact of increased mortality would depend on the extent to which the areas are already open due to existing linear development and on the local densities of moose as they "yard up" in the winter.

The Proponents conducted a detailed analysis of effective habitat loss and fragmentation within a 4 km buffer area along the proposed right-of-way, in 9 areas of high conservation value. The Travaillant Lake conservation area would be the most impacted. The study area of 393 km^2 would experience declines in effective habitat of 12.6%, in mean patch size of 49.5% and in maximum patch size of 41.3%. The Proponents asserted that these levels were below the threshold at which population effects on moose might be observed.

No moose-specific commitments were made by the Proponents, but they did note certain commitments with respect to wildlife generally that would apply:

- limit the disturbance to riparian vegetation communities, where practical; and
- maintain buffer zones between access roads and other infrastructure sites and riparian zones associated with streams, lakes or wetlands, where practical, except where the water bodies need to be crossed by a road.

Regarding fragmentation impacts, the Proponents stated:

> Wildlife management plans and access management will address issues related to fragmentation and will use community guidance and involvement in plan design, incorporate community concerns and regulatory requirements, monitor wildlife responses and develop protocols and will be based on site-specific conditions."
> (Dr. Petr Komers, HT V31, pp. 2791–92)

The Panel understands this to be a commitment.

The Proponents assessed the potential impacts on moose habitat from the Project as adverse, low, local and generally long-term as a result of vegetation clearing, sensory disturbance, altered human and predator access, and changes in vegetation health. The only exception was a moderate impact during the construction phase resulting from sensory disturbance. Potential impacts on moose movements were assessed as low, except for a moderate rating during the construction phase of the Project. Direct mortality impacts would occur as a consequence of increased access to predators and hunters. The Proponents maintained that, because the pipeline would run through areas that already have considerable access and because hunting pressure is low along the corridor, except where close to communities, impacts would be moderate during the construction phase, low to moderate during the operations phase, and low during the decommissioning phase.

10.8.3 PARTICIPANTS' VIEWS AND RECOMMENDATIONS

Several communities expressed a general concern regarding the overall impact of the pipeline on moose populations. The GRRB and Gwich'in Tribal Council had concerns regarding the lack of adequate site-specific data on moose in the RSA. They cited a study filed by the GNWT that identified a lack of information on moose abundance, productivity, predation rates, habitat status and the effects of increased access for the Mackenzie River Valley south of the Inuvialuit Settlement Region. The GRRB also criticized the habitat suitability model developed and used by the Proponents because it underestimated the zone of influence around human infrastructure and failed to consider the reproductive season. Moreover, the model for winter use habitat was only partially verified because the Proponents had used pellet counts to verify the results rather than animal tracking — a method that does not verify winter use habitat.

The GRRB and Gwich'in Tribal Council believed that Project impacts to moose in the Gwich'in Settlement Area would be greater than predicted in the EIS. This was due to limited baseline information, lack of certainty in the habitat models, and a failure to adequately consider increased mortality of moose through increased access for hunters and wolves.

The GRRB recommended that adequate research and monitoring be conducted, including moose–wolf predation studies, and that a management plan be developed prior to construction. The Proponents agreed that management plans would be developed and that monitoring of Project impacts would be the Proponents' responsibility, but they submitted that population studies are the responsibility of management agencies. The Proponents and the GNWT disagreed with the need for a moose–wolf predation study.

10.8.4 PANEL VIEWS

The Panel considers that, with the implementation of Recommendations 5-1 and 10-1, Project impacts on moose populations in the Mackenzie Valley would not likely be significant. In the Panel's view, the key to this sustainability would be well-managed harvest regulations. Moose, compared with bears and caribou, have a high reproductive potential and are more resilient in response to habitat disturbance and increased mortality. The general solitary nature and non-migratory behaviour of moose would mean that geographically concentrated adverse impacts would result in local declines only. If this were to occur during the construction phase, moose populations would likely rebound once human activity was reduced. The Panel heard no evidence to suggest that these findings would not also apply to the Expansion Capacity Scenario and Other Future Scenarios.

10.9 OTHER WILDLIFE

During the course of the Panel's proceedings, some participants suggested that the Proponents should have assessed additional species as valued components or that certain species at risk had not been appropriately assessed. These concerns focused on wolverine, wood bison, rusty blackbird and short-eared owl.

10.9.1 WOLVERINE

EXISTING CONDITIONS, PROPONENTS' VIEWS AND PARTICIPANTS' CONCERNS

Wolverines are present in low densities within the Project Review Area. Although not a SARA-Listed species, wolverine is ranked as sensitive on the *NWT Species 2006–2010 — General Status Ranks of Wild Species in the Northwest Territories* (referred to as the NWT General Status Ranks) and is listed by COSEWIC as being of special concern. Threats identified by COSEWIC include "fragmentation of habitat by industrial activity, especially in the southern part of its range, and increased motorized access leading to increased harvest pressure and other disturbances." (J-GNWT-00123, p. 5) These impacts could reduce wolverine populations because wolverines have a low reproductive rate and require vast secure areas to maintain viable populations.

The Proponents did not select wolverines as a valued component because, in their view, the wolverine is a particularly notable example of a valued component that is "not useful for an impact assessment" because:

- wolverine baseline habitat use and abundance cannot be determined due to low densities;
- since observations of wolverine are infrequent, it is difficult to determine true relationships in ecological field studies;
- population parameters are practically unknown for the study area;
- lack of information does not allow for meaningful impact predictions or allow for monitoring results to be used in evaluating changes in habitat use or abundance;
- low densities make it almost impossible to obtain meaningful monitoring results;

- other furbearers use similar habitat and can serve as indicators for habitats used by wolverines;
- other carnivores such as bears experience similar potential Project effects as the wolverine, such as attraction to waste sites, and thus similar mitigative measures to reduce the attraction and potential source of mortality can be applied; and
- using a suite of valued components as umbrella species for the wolverine and the wolf ensures that these traditionally important species are also evaluated, although indirectly, and protected.

The GNWT, Environment Canada and the SCC maintained that the wolverine should have been added as a valued component because of its ranking by COSEWIC and the GNWT. Further, these participants considered that the species used by the Proponents to assess Project-related impacts on the wolverine (grizzly bear, martin and lynx) were not appropriate indicator species. They argued that wolverines have a unique set of species-specific requirements that cannot be adequately reflected by indicator species, and it was these species-specific requirements and the threats to those requirements that should have been directly assessed.

Of concern to both the GNWT and the SCC was that:

- wolverine movements and, ultimately, gene flow and population stability are impeded by transportation corridors and other land uses;
- mortality may be a factor along transportation corridors where motorized access is improved for hunters, trappers and recreational users into remote areas; and
- disturbance of wolverine maternal den sites may lead to den relocation or litter abandonment.

In the GNWT's and the SCC's view, wolverine-specific management and protection measures would need to be extended throughout the year (when bears are hibernating) and across the entire pipeline corridor, including areas where grizzly bears were absent.

PARTICIPANTS' RECOMMENDATIONS AND PROPONENTS' COMMITMENTS

The SCC recommended that the Proponents either specifically assess wolverine as a valued component or use a more appropriate surrogate species. The SCC considered the wolf to be a more effective umbrella species for the wolverine. Alternatively, a multiple surrogate species model, such as the wolf–ungulate dynamic, would more effectively model impacts on wolverines and develop mitigation strategies.

The SCC and the GNWT highlighted the need for a wolverine-specific protection plan since the differences between behaviours of wolverines and grizzly bears were significant and the mitigation measures identified for grizzly would not adequately protect wolverines.

In response, the Proponents provided a list of wolverine mitigation measures, including:

> - avoiding clearing and construction during sensitive periods, such as during denning, where practical;
> - conducting pre-construction surveys to identify critical habitat, nests or dens;
> - placing barriers across the right-of-way at key entrance points, if necessary; [and]
> - following the Waste Management Plan outlined in EIS Volume 5, Part E, Section 10, Table 10-8. (J-IORVL-00890, p. 1)

In response to a Panel request regarding the adequacy of the draft Grizzly Bear and Wolverine Protection Plan for the Parsons Lake Field Development, the SCC highlighted the following deficiencies:

> Wolverine must also be protected from harvesting by all project-related personnel.
>
> …Types of vehicles are not specified but are assumed to include only public-owned trucks and cars. Access management must be expanded to include ATV's and snowmobiles. Significant wolverine [mortality] could result from local hunters and trappers enjoying improved access to formerly inaccessible areas. Disturbance to wolverine den sites by vehicular traffic, leading to litter abandonment, may also occur.
>
> Finally, wolverine protection must be expanded to include the entire footprint of the Mackenzie Gas Project, including non-grizzly bear habitat. (J-SCC-00069, p. 4)

In order to mitigate impacts on wolverines, the GNWT recommended that the Proponents:

- Conduct pre-construction surveys for wolverine tracks, maternal dens and individuals to assess the potential for adverse impacts.
- Include wolverine deterrent measures in the design of camps and facilities, including the elimination of potential attractants, control of odours, limitation of shelter and prevention of human–wolverine interaction.
- Include wolverine protection measures in final Project design and construction methods to minimize new access for motorized vehicles.
- Wildlife Management Plans and Wildlife Protection Plans need to clearly set out monitoring, reporting, deterrence, access management, waste management and odour management requirements for wolverine.

PANEL VIEWS

Wolverine is a species that is vulnerable to human activity. The Proponents' approach to assessing impacts was to use the grizzly bear as a surrogate species, which raised a number of concerns from some participants, primarily because of the importance and sensitivity of the wolverine nationally. Largely because of prompting from participants and the Panel, the Proponents tried to foresee and address these concerns through mitigation.

Several participants were concerned about the potential attraction of wolverines to camps and the need for control measures. In the Panel's view, the Proponents' mitigation regarding conduct of personnel and management of waste for avoidance and reduction of impacts on grizzly bear would be effective for wolverine if extended throughout the year. The ConocoPhillips draft *Grizzly Bear and Wolverine Protection Plan for the Parsons Lake Field Development* specifically addresses these concerns. The Panel is confident that, if these measures, with respect to grizzly bear, were applied to wolverine and implemented, impacts to wolverine would not likely be significant.

Regarding increased access, the Proponents have already addressed some mitigation measures to control access, largely targeting wolves and hunters. The Panel is of the view that these measures would be appropriate for wolverines as well.

Several participants noted concerns about habitat fragmentation. Wolverines are found at low densities within the Project Review Area, and numbers, movements and limiting factors are largely unknown. Given this lack of baseline data, it would be extremely difficult to assess impacts of habitat fragmentation, and the Panel questions the use of the considerable resources that would be required to conduct such an evaluation.

The Panel concludes that there is no need for specific studies on wolverine as a valued component. Provided that Panel Recommendations 5-1 and 10-1 were implemented, the Panel concludes that Project impacts on wolverine would not likely be significant. In the Panel's view, the ConocoPhillips draft *Grizzly Bear and Wolverine Protection Plan for the Parsons Lake Field Development* adequately addresses participants' concerns with respect to the Project as Filed. However, the Panel observes that the possibility of significant adverse impacts could increase with the Expansion Capacity Scenario and Other Future Scenarios.

10.9.2 OTHER SPECIES AT RISK

Participants identified some species that had been recognized as being of concern through federal and territorial classification processes and, in their view, the Proponents had not assessed or had not assessed properly. These species include the wood bison (Listed species), rusty blackbird, short-eared owl and the western toad. The western toad is discussed elsewhere in this chapter.

EXISTING CONDITIONS, PROPONENTS' VIEWS AND PARTICIPANTS' CONCERNS

Wood Bison

In the Proponents' EIS, wood bison were included in the assessment but were not expected to interact with the Project because the Project's right-of-way was not within their current habitat range.

The wood bison is Listed under SARA as threatened and ranked as at risk on the NWT General Status Ranks. The GNWT reported that disease, cross-breeding and habitat loss are the main threats to wood bison recovery in Canada and that planning for a national recovery strategy under SARA is ongoing. The GNWT noted that the current distribution of wood bison in the NWT is not within the Project's right-of-way but that free-ranging populations are expanding.

The GNWT raised the concern that the pipeline right-of-way may create preferred bison habitat, thereby enabling the Mackenzie and Nahanni herds to interact and spread disease (brucellosis and tuberculosis) from a diseased to a disease-free herd.

In response, the Proponents provided an impact assessment based on moose, grizzly bear and woodland caribou as surrogates. The Proponents predicted that impacts on habitat availability and mortality would be adverse, moderate and medium- to long-term, respectively, and be regional during construction and reduced to low and local during operations and decommissioning. Effects on movement or winter foraging habitat were predicted to be adverse, moderate, local and medium-term during construction. Impacts would be low and long-term during operations and decommissioning. The Proponents determined that the impacts would not be significant.

Rusty Blackbird

The Proponents included the rusty blackbird with other passerine species and selected the boreal chickadee as the surrogate to represent passerines. Neither the rusty blackbird nor the boreal chickadee is Listed under SARA, but the rusty blackbird is designated as of conservation concern and the boreal chickadee is designated as sensitive on the NWT General Status Ranks. The non-migratory boreal chickadee resides year-round in the treed parts of the Mackenzie Valley. Habitat availability for the boreal chickadee during construction could be affected by direct loss of nesting and feeding habitat as a result of vegetation clearing, and by disturbance of nesting and feeding areas by human activities. The Proponents remarked in the EIS that "detailed quantitative information on the amount of available habitat for boreal chickadees along the pipeline corridor is currently unavailable" (EIS V5E, Section 1, p. 118) but predicted that the potential impacts during all Project phases on boreal chickadee habitat availability along the pipeline corridor would be adverse, low, local and long-term. The Proponents were of the view that the boreal chickadee was widespread and that population numbers would not be affected by the relatively small amount of land to be cleared for the pipeline right-of-way in comparison with the large amount of habitat available throughout the Mackenzie Valley.

The GNWT and Environment Canada were of the view that the rusty blackbird had not been fully assessed as required under SARA because it had not been assessed directly. The Proponents responded that the rusty blackbird was not a Listed species and therefore did not require a SARA-level assessment. However, the Proponents committed to mitigation measures, as outlined elsewhere in this chapter.

Short-Eared Owl

Although the short-eared owl is not a Listed species, it is included in Schedule 3 of SARA as a species of special concern and is classified as sensitive on the NWT General Status Ranks.

The Proponents used two surrogates to assess potential Project-related impacts to nesting habitat of the short-eared owl: whimbrel in the production area and lesser yellowlegs in the pipeline corridor. They also provided field observations collected during wildlife habitat field assessments in the summer of 2004. The Proponents concluded that potential Project-related effects would be adverse, low, local, long-term and not significant.

The GNWT and Environment Canada were of the view that the short-eared owl had not been fully assessed as required under SARA, primarily because it had not been assessed directly. The GNWT noted its concerns: "The Project has the potential to impact short-eared owls during construction by creating openings in the boreal forest to which short-eared owls will be attracted. This increases the potential for interactions with construction activities and for collisions with aircraft. Post construction, the Project will create preferred habitat which may be a positive benefit." (J-GNWT-00123, p. 10)

PROPONENTS' MITIGATION FOR LISTED SPECIES

The Proponents' approach to mitigation and monitoring of species at risk was to commit to implementing general measures aimed at all species under the umbrella of a group of valued components and specific measures designed for particular species at risk. As a result, the Proponents outlined their proposed mitigation strategies for wildlife, including species at risk, and stated that the measures would be refined through discussions with communities, regulators and resource management agencies. Traditional Knowledge would be used to guide the development of mitigation measures. Measures would be continually reviewed and adjusted to reflect changing Project circumstances, activities and schedules.

The Proponents committed to conduct pre-construction surveys to identify critical habitat and residences (as defined in SARA) and to protect these areas where feasible. Other commitments (in addition to those noted elsewhere in this chapter) related to avoidance during construction; the development of wildlife management plans, waste management plans and safety protocols; and monitoring.

PARTICIPANTS' VIEWS AND RECOMMENDATIONS

Notwithstanding criticism of the Proponents' methods in selecting and assessing valued components, participants provided recommendations on the steps to be followed in the event the Project were to proceed.

Environment Canada was of the view that the Project could be built, operated and decommissioned in an environmentally sustainable manner, subject to several conditions that included:

- clarifying commitments to mitigations prior to initiation of construction;
- meeting obligations under SARA and the CEA Act before Project approval; and
- meeting SARA requirements throughout all stages of the Project.

The GNWT expressed concern that the Proponents had not met the impact assessment requirements of SARA or the EIS Terms of Reference for some species at risk. With respect to wood bison, short-eared owl and rusty blackbird, the GNWT submitted its own identification of the geographic range of each species, views on whether the Proponents had conducted an assessment, and concerns about the potential adverse Project impacts on the species. The GNWT concluded that the identified species could not be effectively assessed at this time because a species-specific assessment had not been conducted by the Proponents of the short-eared owl, wolverine and rusty blackbird; information in the NWT is lacking on the rusty blackbird; and no impact assessment had been conducted at all for wood bison.

Further, the GNWT concluded that it was not clear that the Proponents' yet-to-be developed Wildlife Management Plan would address these species. The GNWT considered that, to be comprehensive and effective, a species-at-risk management plan should:

- cover all aspects of the Project including anchor fields, gathering systems, pipeline and related facilities and construction activities;
- identify mitigation measures including, but not limited to, those required to document, prior to construction, the location of any observations of species listed as "at risk" or "may be at risk" in the *General Status Ranks of Wild Species in the Northwest Territories…* minimize disturbance [of] any documented occurrence, minimize development footprint in habitats known to support listed species, schedule activities in relation to listed species activity/presence, implement access management, ensure effective reporting and data sharing, minimize disturbance from vehicle and air traffic, and ensure effective communication;

- identify monitoring activities including, but not limited to, those necessary to document habitat loss and habitat change; document incidents, interactions, and mortality; and assess effectiveness of access management;
- identify linkages to the general status assessment program for the NWT; and
- identify and implement processes for oversight and reporting. (J-GNWT-00314, p. 18)

The GNWT acknowledged the Proponents' proposed mitigation and monitoring measures but submitted overarching recommendations to initiate general monitoring programs and mitigation strategies and species-specific measures for each of the species noted. The GNWT's overarching recommendations were:

> In relation to all proposed monitoring programs and mitigation strategies, the GNWT generally recommends that monitoring and reporting programs:
>
> - be designed to test impact predictions in the environmental review process, including predictions of no impact or no significance;
> - be conducted to assess effectiveness of mitigation and to support adaptive management approaches;
> - be for the life of the project, including construction, operations and decommissioning; and
> - support and contribute to improving baseline data at a regional and territorial level and contribute to cumulative effects monitoring. (J-GNWT-00123, pp. 13–14)

The GNWT further recommended that the Proponents:

- initiate research, mitigation and monitoring programs for all species at risk in the Project area and commit to participating in the development and implementation of NWT recovery strategies, action plans and management plans as revised from time to time under Schedule 1 of SARA;
- prepare and implement, in consultation with the GNWT, Environment Canada and wildlife management boards, detailed protection and management plans that include programs that quantitatively test impact predictions, identify mitigation measures, identify monitoring components, and ensure broad and full industry participation in planning, research, monitoring and management processes for species at risk identified under SARA or in the *NWT General Status Ranks* and, in particular, for the following species: boreal caribou, barren ground caribou, grizzly bear, wolverine and peregrine falcons.

The GNWT's species-specific recommendations for wood bison were as follows:

> - Minimize the creation of preferred bison habitat including avoiding use of preferred forage species and creation of wallows.
> - Establish a monitoring program to detect wood bison use of the Project area.
> - Develop mitigation measures in consultation with the GNWT should wood bison begin to use the Project area. (J-GNWT-00123, pp. 14–15)

The GNWT's species-specific recommendations for the short-eared owl and rusty blackbird were as follows:

> - Conduct pre-construction surveys for each species' individuals and nest sites to assess the potential for adverse impacts.
> - Include each species in construction and post-construction monitoring programs.
> - Report information on each species to the GNWT to improve status assessment of each species. (J-GNWT-00123, p. 15)

The Proponents agreed with the overarching recommendations with the following exceptions. The Proponents indicated that they would address these issues through their adaptive management program, and that they "will test impact predictions where a valid linkage between the project and an environmental effect has been identified" and that "monitoring will be conducted in compliance with regulatory requirements and according to the conditions or project permits." (J-IORVL-01040, p. 136)

PANEL VIEWS AND RECOMMENDATIONS

The Panel agrees with the GNWT's overarching recommendations and its species-specific recommendations related to species at risk. The Panel is mindful that it has recommended that the National Energy Board require the Proponents to cause all of their commitments to be implemented (Panel Recommendation 5-1) and that the Board require the Proponents to file comprehensive Wildlife Protection and Management Plans (Panel Recommendation 10-1). However, the Panel agrees with participants that additional requirements for such plans are appropriate for species at risk.

The Panel notes the GNWT recommendation that the Proponents commit to participating in the development and implementation of NWT recovery strategies, action plans and management plans as revised from time to time under Schedule 1 of SARA. The Panel also acknowledges that the Proponents committed to comply with all regulatory requirements regarding SARA Listed species and their habitat and contribute to developing the NWT's species-at-risk recovery strategies by participating through the Canadian Association of Petroleum Producers. The Panel encourages industry participation in the development and implementation of recovery strategies, action plans and management plans for Listed species and other species at risk but notes that it is the responsibility of government to develop and implement these plans.

RECOMMENDATION 10-16

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project or the Northwest Alberta Facilities, require the Proponents and NOVA Gas Transmission Ltd. to include in their Wildlife Protection and Management Plans required by Panel Recommendation 10-1 for each species at risk for which there is a plausible and likely interaction with any Project-related activity or facility measures that include but are not limited to:

- *the location of any observations of Listed species or species classified as at risk or that may be at risk on the most recent* NWT General Status Ranks *or* The General Status of Alberta Wild Species*;*
- *identification of mitigation measures that:*
    - *avoid or minimize disturbance;*
    - *minimize the development footprint in habitats known to support Listed species;*
    - *where Listed species are present, schedule activities so as to avoid disturbance;*
    - *implement access management;*
    - *ensure effective reporting and data sharing;*
    - *minimize disturbance from vehicle and air traffic; and*
    - *ensure effective communication with the public; and*
- *identification of monitoring activities that:*
    - *document habitat loss and habitat change;*
    - *document incidents, interactions and mortality; and*
    - *assess effectiveness of access management.*

RECOMMENDATION 10-17

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, prior to the commencement of construction, a plan in relation to wood bison that has been endorsed by the Government of the Northwest Territories and that documents:

- *measures to avoid creation of preferred bison habitat;*
- *a monitoring program to detect wood bison use of the Mackenzie Gas Project's right-of-way; and*
- *a process to develop mitigation measures in consultation with the Government of the Northwest Territories if wood bison start using the Mackenzie Gas Project's right-of-way.*

RECOMMENDATION 10-18

The Panel recommends that the National Energy Board, as a condition of any certificate or approval it might issue in relation to the Mackenzie Gas Project, require the Proponents to file with the Government of the Northwest Territories information they collect from their pre-construction, construction and post-construction surveys and monitoring programs in relation to short-eared owls and rusty blackbirds.

The Panel is of the view that, if the Panel's recommendations are implemented, the Project as Filed would not result in any changes to wood bison and would not likely have significant impacts on short-eared owl or rusty blackbird. The Panel heard no evidence on possible cumulative impacts on these species.

10.10 BIRDS: MACKENZIE VALLEY

The Mackenzie Valley is home mainly to songbirds, upland birds, raptors and shorebirds. Many of the waterfowl species that breed and nest in the Mackenzie Delta are present in the Valley only briefly during migration. Bird habitat in the Project Review Area consists mainly of boreal forest, the large islands of the Mackenzie River and some large lakes. There are no areas set aside for the protection of birds in the Mackenzie Valley. Project components located in the Valley would be the pipeline and associated facilities. The Project as Filed would likely have only limited impacts on these habitats, although there may be concerns with respect to future developments.

10.10.1 PEREGRINE FALCON

EXISTING CONDITIONS

Two subspecies of peregrine falcon, *anatum* and *tundrius*, occur in the Project area. The *anatum* peregrine is a Listed species, is designated as threatened under SARA, and is classified as sensitive on the NWT General Status Ranks. The *tundrius* peregrine is considered of special concern under SARA and as may be at risk on the NWT General Status Ranks. An *Anatum* Peregrine Falcon Recovery Plan is in place, under which the GNWT and the Canadian Wildlife Service conduct population monitoring throughout the Mackenzie Valley every five years. For management purposes and for status assessment, each subspecies is differentiated based on the nesting habitat. The Mackenzie Valley harbours a large portion (20–40%) of the known occupied nests of *anatum* subspecies in Canada and is considered to be the core of its distribution in North America.

Peregrines breed throughout the RSA wherever suitable cliff nesting habitat occurs, with the *tundrius* occurring north of the treeline in the proposed production area and the *anatum* breeding generally south of the treeline in the proposed pipeline corridor. Nest surveys have been conducted since the mid-1960s, and about 80 occupied nests were recorded in the 2000 survey, similar to levels since 1990. Although no comparable data existed in the production area, it is unlikely that peregrines would breed in the production area because of the lack of cliff sites. The Proponents indicated that, along the pipeline corridor, only one known nest site was located within 1 km of the proposed right-of-way, although no baseline habitat surveys were conducted and the Proponents relied on the GNWT's raptor database.

Peregrine mortality is due to larger avian predators. Nestlings can be prey for other birds and mammals. Peregrines arrive from southern wintering grounds in late April and May and leave in late August. Peregrines prey on other birds, mainly shorebirds and waterfowl.

The GNWT indicated that peregrines are not known to nest in the RSA designated for the Anchor Field and gathering system facilities because suitable nesting habitat is lacking. However, the Mackenzie Delta provides good foraging habitat because waterfowl and shorebirds are abundant during the nesting season.

The GNWT's analysis of peregrine falcon and golden eagle nest sites in the RSA for the pipeline corridor indicates that there are 13 peregrine falcon nest sites and 2 golden eagle nest sites within 1 km of the proposed pipeline corridor or other development sites. These sites represent 16% of the known peregrine falcon nest sites in the Mackenzie Valley. Although not selected by the Proponents as a valued component, golden eagles are raptors and are present in the Mackenzie Valley.

PROPONENTS' VIEWS

The Proponents indicated that peregrine falcon nest sites would be avoided wherever possible and concluded that this would reduce much of the potential for effects. They also indicated that some foraging areas could be disturbed, but impacts were considered to be periodic and of short duration. The Proponents assessed the potential impacts of the Project on peregrine habitat availability and mortality. They did not model nesting habitat for peregrine falcons because nest sites for peregrines are well known and, thus, habitat mapping was unnecessary. The Proponents concluded that the potential impacts of the Project on peregrine falcon for both subspecies would be adverse, low in magnitude, local in extent and long-term. The Project was not expected to affect peregrine falcon mortality.

The Proponents committed to developing species-specific protection plans and to limit clearing near critical habitats, including active nest sites, in compliance with regulatory requirements.

PARTICIPANTS' VIEWS AND RECOMMENDATIONS

The GNWT reviewed the Proponents' assessment and mitigations for peregrine falcon (*anatum*). As noted earlier, the GNWT indicated that the number of nest sites within 1 km of the proposed pipeline corridor and other Project activities was higher than estimated by the Proponents. Furthermore, the GNWT indicated that sensory disturbance can result in reduced productivity or nest abandonment as well as habitat loss. The GNWT indicated that such effects can be the result of a single disturbance or multiple disturbances in a single nesting season. For that reason, the GNWT recommended that the primary mitigation strategy should be avoidance of nest sites from ground activities and infrastructure development by at least 1 km. The GNWT further recommended that, to fulfill this mitigation and to comply with section 79 of SARA, the Proponents use historical nest site data and additional future survey data when finalizing the pipeline right-of-way and in locating associated facilities and infrastructure.

Other concerns noted by the GNWT regarding the Proponents' proposed mitigative measures included "clarification of the season that peregrines are sensitive to disturbance, the lack of an aircraft overflight mitigation measure, and the setback distance selected." (J-GNWT-00118, p. 10) The GNWT indicated that the sensitive period for peregrine falcons begins as early as mid-April and extends to September 1. The GNWT suggested that there was uncertainty whether the Proponents had proposed a specific measure to mitigate potential impacts due to aircraft overflights. As a result, the GNWT recommended that a minimum overflight distance of 760 m above ground level be in place over nests during the period of sensitivity.

Based on current literature and professional judgement, the GNWT developed best practices guidelines that restrict activity periods and setback distances for peregrine falcon and other raptor nest sites that are consistent with those used in other jurisdictions. The GNWT recommended that these guidelines be implemented to supplement or enhance the Proponents' mitigation measures in order to adequately protect nesting peregrine falcons and other major raptors and their habitat in the Mackenzie Valley. The restricted activity periods and setback distances for peregrine falcon and other raptor nest sites recommended by the GNWT are set out in the Table 10-2.

The GNWT accepted the Proponents' commitment to develop a protection plan for peregrine falcon in consultation with wildlife management boards, communities and other stakeholders for approval by the appropriate regulatory authorities. The GNWT indicated that the plan should:

- cover all aspects of the Project including anchor fields, gathering systems, pipeline and related facilities and construction activities;
- identify mitigation measures including, but not limited to, those required to document all current and historical nest site locations, minimize disturbance at active nest sites, implement over-flight and set-back restrictions, minimize development footprint in important habitats, schedule activities in relation to peregrine activity/ presence, detect and avoid active nest sites, implement access management, minimize disturbance from vehicle

Table 10-2 GNWT-Recommended Restricted Activity Periods and Setback Distances for Raptor Nest Sites

Restricted Activity Period	Activity	Setback Distance
Peregrine Falcon Nest Sites		
April 15 to September 1	Permanent structures or long-term habitat disturbance (e.g. pipeline right-of-way, road, quarry, campsite, etc.)	1,000 m
April 15 to September 1	Ground and air access	1,000 m
April 15 to September 1	Aircraft overflight	760 m above ground level
April 15 to September 1	Blasting	1,000 m
Bald Eagle and Golden Eagle Nest Sites		
March 30 to July 31	Permanent structures or long-term habitat disturbance (e.g. pipeline right-of-way, road, quarry, campsite, etc.)	1,000 m
March 30 to July 31	Ground and air access	1,000 m
March 30 to July 31	Aircraft overflight	760 m above ground level
March 30 to July 31	Blasting	1,000 m

Source: Adapted from J-GNWT-00118, pp. 11–12

and air traffic, and ensure effective communications and reporting;

- identify monitoring activities including, but not limited to, those necessary to document habitat loss and habitat change, document peregrine activity, incidents, interactions, and mortality, and assess effectiveness of access management;
- identify linkages to regional and national peregrine monitoring programs such as the Mackenzie Valley Peregrine Falcon Monitoring Program; and
- identify and implement processes for oversight and reporting. (J-GNWT-00314, p. 17)

In addition to the restricted activity periods and setback distances noted in the guidelines, the GNWT also recommended that the Proponents:

- Negotiate exception(s) with the GNWT and appropriate renewable resources board, and prepare and implement a site-specific wildlife protection plan, where Project infrastructure cannot be relocated to a 1,000 m setback.
- Conduct pre-construction surveys "for a minimum of 1,000 m on either side of the Project to identify active raptor nests where conflicts between raptors and project activities may occur." (J-GNWT-00118, p. 13)
- Participate in the five-year North American Peregrine Falcon Survey.
- Participate as a partner in the Peregrine Falcon Monitoring Program for the Mackenzie Valley through sharing data, protocol reviews, interaction of experts and, where possible, collaborating on field surveys.
- Work with the GNWT to develop an appropriate environmental effects monitoring program for peregrine falcons (and other raptor species) where potential impacts to this species may occur.

Transport Canada informed the Panel that its *Aeronautical Information Manual* provides information on wildlife, including migratory bird protection, but that compliance with such information is voluntary. Transport Canada also notifies pilots of airspace restrictions from time to time, including Notices to Airmen (NOTAMs), generally for the purpose of aviation safety. These are not issued to restrict airspace over a long term or over large areas. In response to questions about the possible use of NOTAMs for bird protection, Transport Canada advised that NOTAMs "are not the correct mechanism for controlling aircraft activity associated with the Mackenzie Gas Project" and that "NOTAMs are generally advisory in nature and as such are not enforceable." (J-TC-00090, p. 2)

PANEL VIEWS AND RECOMMENDATIONS

The Panel recognizes the requirement to consider any change to a SARA-Listed species or to its residences. The Proponents selected the peregrine falcon as a valued component and, through the course of the hearings, presented mitigation measures for the Panel to evaluate. The Panel considers that the measures proposed by the Proponents together with the additional recommendations provided by the GNWT would provide an effective means to avoid adverse impacts to peregrine falcons, provided that the commitments and recommendations were implemented.

RECOMMENDATION 10-19

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, prior to the commencement of construction, a Peregrine Falcon Protection and Management Plan that includes the following restrictions on Project-related activities or facilities:

Restricted Activity Period	Activity	Setback Distance from Nest Site
April 15 to September 1	Permanent structures or long-term habitat disturbance (e.g. pipeline right-of-way, road, quarry, campsite, etc.)	1,000 m
April 15 to September 1	Ground and air access	1,000 m
April 15 to September 1	Aircraft overflight	760 m above ground level
April 15 to September 1	Blasting	1,000 m

RECOMMENDATION 10-20

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to file, prior to the commencement of construction, a Protection and Management Plan for Raptors, other than peregrine falcons but including bald and golden eagles, that includes the following restrictions on Project-related activities or facilities:

Restricted Activity Period	Activity	Setback Distance from Nest Site
March 30 to July 31	Permanent structures or long-term habitat disturbance (e.g. pipeline right-of-way, road, quarry, campsite, etc.)	1,000 m
March 30 to July 31	Ground and air access	1,000 m
March 30 to July 31	Aircraft overflight	760 m above ground level
March 30 to July 31	Blasting	1,000 m

10.10.2 PROTECTED AREAS FOR BIRDS IN THE MACKENZIE VALLEY

EXISTING CONDITIONS, PARTICIPANTS' VIEWS AND RECOMMENDATIONS

Nature Canada provided documentation on identified Important Bird Areas (IBAs) in the Mackenzie region. IBAs are internationally recognized high-biodiversity sites that provide essential habitat for birds that meet specific criteria and form a network of priority sites for biological conservation. Within the Project Review Area, there are five IBAs and two additional IBAs that fall just outside RSA boundaries. Six of these sites are globally significant:

- Mackenzie River Delta;
- Kugaluk River;
- Lower Mackenzie River Islands;
- Middle Mackenzie River Islands;
- Mills Lake (outside the RSA); and
- Beaver Lake (outside the RSA).

One site, Brackett Lake, is continentally significant.

Nature Canada noted that four Important Bird Areas (Kugaluk River IBA, Lower Mackenzie River Islands IBA, Middle Mackenzie River Islands IBA and Brackett Lake IBA) within the Local or Regional Study Areas of the Mackenzie Gas Project (MGP), or their vicinity, support globally, continentally and nationally important concentrations of migratory birds. To mitigate potential impacts of the MGP on these birds, NC recommended that the Proponents should:

- Limit construction-related activity in and near (within 3.0 km) these IBAs to the period between October 30 and May 1 when migratory birds are not expected to be present.
- Minimize the physical footprint of the MGP within IBAs, including:
    - Compressor stations.
    - Infrastructure necessary to support pipeline construction and operation.
    - Pipeline right-of-way. (J-NC-00028, p. 3)

The Proponents agreed with this recommendation, with variation:

> Construction-related activity will take place during the winter for the pipeline and gathering system and year round for facility and infrastructure sites. Where practical, every effort will be made to minimize sensory disturbance for activity that occurs within 3 km of the Kugaluk River important bird area, Lower Mackenzie River Islands important bird area, Middle Mackenzie River Islands important bird area and Brackett

Lake important bird area, the exception being Mackenzie River barge traffic. (J-IORVL-01040, p. 79)

Nature Canada's final recommendation was that the Proponents: "take into account the significance of the IBAs found within the project study area when considering impacts on birds and bird habitat, mitigation and monitoring activities." (J-NC-00028, p. 16)

In response to questioning, Nature Canada indicated that it would support the completion of the Northwest Territories Protected Areas Strategy because protected areas identified in that process would largely protect the identified IBAs.

PANEL VIEWS

With respect to the Expansion Capacity Scenario and Other Future Scenarios, the Panel is of the view that the Important Bird Areas in the Mackenzie region merit further consideration and attention. In the Panel's view, completion of the Northwest Territories Protected Areas Strategy may be the most appropriate manner in which to provide the protection necessary. This is discussed further in Chapter 11, "Conservation Management and Protected Areas."

10.11 BIRDS: MACKENZIE DELTA

The Mackenzie Delta (or more particularly, that part of it most affected by the Project) is home mainly to waterfowl, shorebirds and marine birds. Their habitat is a low-lying delta that is subject to both marine and riverine influences. The vegetation consists mainly of grasses, sedges and shrubs. Although a substantial proportion of the Inuvialuit Settlement Region has some form of protected area status (including three national parks), the only part of the Mackenzie Delta itself that has any protected status is KIBS, where activities are restricted while birds are present. Two of the Anchor Fields and part of the gathering system would be located within KIBS. Impacts from the Anchor Fields on bird populations would likely be substantially different and almost certainly of longer duration than those arising from the pipeline in the Mackenzie Valley, both for the Project as Filed and for facilities that may be constructed within KIBS or in the vicinity of KIBS that would increase the throughput of the Project above 0.83 Bcf/d.

10.11.1 EXISTING CONDITIONS

Environment Canada considers the Mackenzie Delta to be the most important "key migratory bird terrestrial habitat site" in northern Canada and one of the most important breeding, moulting and staging areas for waterfowl in North America. (J-EC-00136, p. 9) The Delta, an area of more than 14,000 km^2, supports at least 1% of the national population of over 20 migratory bird species. Waterfowl, other water birds, shorebirds and songbirds are present in large numbers during the staging and breeding seasons. Waterfowl arrive from their various wintering grounds via all four continental flyways.

The Delta consists of two parts: the inner or wooded Delta, and the treeless outer Delta. The inner Delta is used by a diverse assemblage of ducks, water birds, songbirds and two species of shorebirds. The outer Delta, containing KIBS and where proposed Project facilities would be located, is of special significance to birds. Within the Mackenzie Delta, the outer Delta is the most important staging and breeding area for geese and swans, and it supports the largest numbers and diversity of shorebirds.

WATERFOWL

Annually, the region hosts an average of 300,000 ducks in June and can contain as many as 750,000 ducks in years of prairie drought. From 1990 to 2004, an average of 1% of the continental population of four ducks species (American widgeon, canvasback, scaup and scoter) were found in the Mackenzie Delta, and at least 1% of eight other species were found in the area in at least one year.

Approximately 350,000 geese and swans concentrate in the area during the fall staging period. In particular, the outer edge of the Delta is used heavily by white-fronted geese, Canada geese and black brant. The outer Delta can contain:

- 20% of the Canadian black brant population;
- 10% of the Canadian lesser snow geese population;
- 10% of the eastern tundra swan population;
- 5% of the short-grass prairie Canada geese population; and
- 5% of the mid-continent greater white-fronted geese population.

Environment Canada has conservation concerns regarding recent waterfowl declines in the western Arctic (black brant), small continental populations (tundra swan and black brant) and present harvest levels (greater white-fronted goose and Canada goose). Environment Canada and the SCC noted that there are international conservation concerns about populations of lesser scaup, northern pintails, long-tailed ducks, and surf and white-winged scoters, all of which have declined internationally over the last 20 years. The SCC also identified the possible conflict of the Project with common and king eiders.

SHOREBIRDS

Environment Canada indicated that the Mackenzie Delta contains some of the highest densities of shorebirds recorded anywhere in North America and provided recent survey data showing more than 132,000 shorebirds using the outer Delta and an additional 31,000 using the middle Delta. The outer Delta contains more than 1% of the North American population of six species. Of special significance is the whimbrel; as the region contains 60% of the North American population, with 4% of the North American population found within KIBS alone. The SCC provided a list of shorebird species within the RSA that were identified for conservation concern by the Canadian Wildlife Service of

Environment Canada in conjunction with stakeholders in the Canadian Shorebird Conservation Plan.

KENDALL ISLAND BIRD SANCTUARY

KIBS was established in 1961 to provide long-term protection for a continentally important colony of lesser snow geese and other migratory birds that breed in the Mackenzie Delta. It is the only legally protected area in the Mackenzie Delta. KIBS covers 623 km^2, approximately 5% of the entire Mackenzie Delta. Bird sanctuaries are managed by Environment Canada under the *Migratory Bird Sanctuary Regulations*. These regulations require operating permits for anyone wishing to conduct development within sanctuary boundaries.

Environment Canada noted the importance of KIBS as critical habitat for waterfowl and shorebirds. KIBS is occupied by birds from early May until mid-October. Compared with other key habitat areas in the Canadian Arctic, particularly high densities of greater white-fronted geese, northern pintails, tundra swans, Arctic terns, sandhill cranes and loons occur in KIBS. A significant snow goose breeding colony located on small islands south of Kendall Island averages 1,120 nesting geese and up to 3,000 individuals, including non-breeders.

During the fall staging period, up to 34,000 geese and swans stage prior to their migration south to wintering grounds. Given the daily turnover in birds, the total number of birds using the area is significantly higher. KIBS also hosts more than 1% of the North American breeding population of Hudsonian godwits and whimbrels.

Although KIBS is a migratory bird sanctuary, this status does not provide complete protection for habitat. KIBS is no longer a pristine environment. Environment Canada provided a description of past development in KIBS, which included more than 1,500 km of seismic surveys and 20 exploration wells. Camp Farewell, operated until 1978 and periodically since then, is Shell Canada's staging and storage facility within KIBS. Regarding future development potential, 10 Significant Discovery Licences associated with gas and oil discoveries have been issued within KIBS to date.

10.11.2 PROPONENTS' VIEWS

The Proponents identified the following valued components as being potentially impacted by Project activities in the Mackenzie Delta, along with their relevant effects pathways:

- Greater white-fronted geese may be most impacted by activity in the outer Delta near the Taglu and Niglintgak production areas by vegetation clearing and from sensory disturbance from boat and aircraft traffic.
- Snow geese would be disturbed during nesting, brood-rearing and moulting in KIBS and along the coast in the outer Delta. If aircraft avoid nesting colonies, disturbance would be low.
- Tundra swans would be mostly affected by sensory disturbance during construction and less so during operations. Of most concern is disturbance from aircraft, barge and boat traffic to nesting pairs during brood-rearing and moulting.
- Scaup would be disturbed and displaced from favoured brood-rearing and moulting areas, especially during construction from aircraft, barge and boat traffic.
- Nesting colonies of Arctic tern could potentially be impacted if they occurred close to construction activities.
- Whimbrel nesting and rearing habitat would be impacted by sensory disturbance and direct habitat loss.
- Disturbance of peregrines would be minimized during all phases of the Project by avoidance of nest sites.
- The nesting and rearing habitat of boreal chickadees and lesser yellowlegs would be impacted by sensory disturbance and direct habitat loss.

The Proponents stated that the amount of habitat that would be lost within KIBS from construction of Project facilities and infrastructure (i.e. the Project footprint) would total about 164 ha, or about 0.28% of the total area of KIBS. Project facilities and infrastructure include the two Anchor Fields within KIBS (Taglu and Niglintgak), the Taglu airstrip and access road, and the 30 m pipeline right-of-way. The Proponents further noted that the affected areas do not have any actual concentrations of waterfowl. The Proponents subsequently revised their estimate of habitat loss slightly. However, a direct comparison with the information in the preceding is not possible due to the way the information was presented.

The Proponents made a number of general and specific commitments related to birds, chiefly regarding scheduling and locating activities to avoid sensitive times and places "where practical," conducting pre-construction surveys to identify active nests, and developing wildlife management and protection plans.

The Proponents assessed individual Project components separately for their impact on bird habitat (but not bird movements or mortality). The only effects pathways they considered were vegetation clearing, altered hunter and predator access, and sensory disturbance. The Proponents did not include gas field subsidence as a possible effects pathway. The Proponents concluded that the impacts of all components and phases of the Project on all bird valued components would be adverse, low in magnitude, local in extent, short-term and not significant.

10.11.3 PARTICIPANTS' VIEWS AND RECOMMENDATIONS

Several participants drew attention to potential impacts on birds and bird habitat in the Mackenzie Delta that, in their view, the

Proponents had considered either incompletely or not at all. These impacts included:

- direct habitat loss due to the Project's footprint and zone of influence;
- habitat loss due to subsidence;
- the Taglu airstrip;
- Project noise standards; and
- increased potential for predation on migratory birds.

HABITAT LOSS

Environment Canada considered that the Proponents had underestimated the extent of habitat loss within KIBS and adjacent areas, and the importance of that habitat to migratory birds.

Environment Canada considered loss of effective habitat to include not only the physical footprint of facilities, but also sensory disturbance from the Project that would effectively reduce or eliminate habitat availability or effectiveness. It stated that it can be reasonably assumed that the impact of the Project on migratory birds would extend beyond the boundaries of the physical footprint and that wildlife habitat near a Project facility should be treated as being lost if it is heavily disturbed by noise or other construction and maintenance activities that prevent animals from settling nearby or reproducing successfully. Environment Canada also stated that the disturbed area around the Project's infrastructure and facilities is termed the Project's zone of influence.

While the Proponents used a zone of influence of 500 m to assess impacts, in Environment Canada's view, assumptions about the size of potential zones of influence are speculative, and their extent probably varies with season and species. Using a zone of influence of 1,000 m, Environment Canada estimated that the number of migratory birds annually impacted during the construction and operations phases could be five times greater than the levels estimated by the Proponents.

Environment Canada estimated that, based on the number of existing Significant Discovery Licences within KIBS, the physical habitat impact would be approximately 1.7 km^2, assuming permanent loss of habitat along the pipeline right-of-ways but not including extraction-induced subsidence. Environment Canada also provided a map that indicated that these Significant Discovery Licences cover a substantial area within KIBS and that depicted Environment Canada's estimation of the cumulative physical and auditory footprint of the Project and induced developments. However, Environment Canada did not provide a numerical estimate of the depicted areas as a percentage of the total area of KIBS.

Environment Canada's management approach to development impacts within KIBS separates the impacts of physical footprint from those of extraction-induced subsidence, while acknowledging that the full extent of the impacts of the latter may not be apparent for decades. Environment Canada's approach, as modified by new information obtained over the course of the Panel's hearings was put forward as follows:

- All activities within KIBS shall be undertaken in a manner that will avoid or minimize the temporary and long-term physical impacts on habitat of those activities.
- Permanent, cumulative long-term physical impacts on habitat that arise from physical works and infrastructure must be kept to less than 1% (6.23 km^2) of KIBS.
- For impact accounting purposes, subsidence-induced flooding will not be included in the account because of temporal and spatial uncertainty relating to the projection of the impacted area.
- The projected extent of subsidence-induced flooding will be addressed through habitat offsets.
- Environment Canada will consider issuing a permit if the anticipated long-term physical impact on habitat of a proposed activity is in accordance with the 1% threshold.
- Environment Canada will consider issuing a permit where the anticipated temporary physical impact of a proposed activity, when added to the latest cumulative long-term impact account, exceeds the 1% limit.

Environment Canada defined "long-term physical impact" as "the physical alteration, disruption, removal, covering, or degradation of habitat, which is not restored through natural process or human assistance to its natural state within three growing seasons." (J-EC-00174, p. 34)

Environment Canada defined "temporary physical impact" as "the physical alteration, disruption, removal, covering, or degradation of habitat, which may be restored through natural process or human assistance to its natural state within three growing seasons." (J-EC-00174, p. 35)

Environment Canada further stated that the 1% threshold could accommodate the projected physical impacts of existing licence holders, who would be able to operate in KIBS subject to appropriate legislation and regulations. However, it stated that there would be no further issuance of licences until the full extent of all habitat impacts was determined. If, at that time, the total impact exceeds 1%, then "new exploration licences may be considered when an enhanced, integrated approach to the management of subsurface and land based resources is in place to assure the sustainable development of the Mackenzie Delta." (J-EC-00174, p. 36)

Environment Canada also drew attention to the Fish Island segment of the Taglu lateral pipeline, immediately east of Taglu and just outside the boundaries of KIBS. It characterized this area as constituting an important wetland habitat. Environment

Canada was concerned that the current routing of the pipeline across Fish Island would create a significant impact to key migratory bird habitats. Its research in 2007 confirmed the high density of breeding and post-breeding birds, some of which were nesting within the proposed pipeline right-of-way. Environment Canada reported that a number of species identified in the EIS, including whimbrel (a valued ecosystem component in the EIS), nested directly on the pipeline right-of-way and, based on radio-tagged birds, moved to small lakes in central Fish Island after breeding.

Based on its review of case studies of pipelines situated in ice-rich permafrost areas, similar to Fish Island, Environment Canada concluded that travel access to construct the pipeline, if restricted to the frozen period of the year, could be carried out with minimal impact on low-lying vegetation. It also reviewed the impacts on vegetation through subsidence from trenching and burying the pipeline, and it visited past exploration sites that have similar vegetation. These site visits and a review of Alaskan studies indicated that ponding and flooding is difficult to avoid but that disturbance did not spread outward from the trench route. Environment Canada concluded that Fish Island is a critical habitat for migratory birds. It also concluded that the Proponents should be able to construct and operate a pipeline through Fish Island with minimal impact on migratory bird habitat if the highest construction standards were employed with exemplary operation, mitigation and monitoring.

Environment Canada's conclusion that the Fish Island route would result in minimum impact on migratory birds was predicated on acceptance of its recommendations for "exemplary" construction practices by the Proponent, as discussed in Chapter 6, "Project Design, Construction and Operations." (J-EC-00173, p. 16) Both Environment Canada and the Proponents expressed willingness to develop such mitigation, where practical and as the Project proceeds, with particular emphasis on the design and construction of the gathering line on Fish Island.

Nature Canada observed that the Proponents calculated habitat loss due to the Project's physical footprint as a proportion of the total area of KIBS, including water. It maintained that habitat loss should have been calculated as the proportion of terrestrial habitat only, which it estimated at 0.49%, not including previous seismic exploration, possible future losses to subsidence or accidents such as spills.

SUBSIDENCE EFFECTS AND HABITAT OFFSETS

Environment Canada considered extraction-induced subsidence to be the greatest long-term impact within KIBS, with the major concern being the loss of terrestrial habitat due to inundation or increased periodic flooding that would interfere with migratory bird use.

The Proponents noted that extraction-induced subsidence would occur gradually over the life of the Project. They also acknowledged that the effect of this would be to inundate some areas of KIBS and that, even where submergence was not complete, rising water levels would change the character of nearshore vegetation. Nonetheless, the Proponents concluded that "there is no evidence that subsidence is likely to have a significant adverse impact on the environment" and that mitigation was neither necessary nor practical. (J-IORVL-01050, p. 111) However, the Proponents committed to work with regulators to establish monitoring and management programs related to potential effects of subsidence.

Because of the uncertainty associated with estimates of Project-induced subsidence and the impacts from that subsidence, Environment Canada, INAC, and the Proponents formed an ad hoc working group to refine their understanding of subsidence effects at Niglintgak and Taglu, with the assistance of independent technical analysis conducted by Environment Canada and Natural Resources Canada. The working group accepted for its purposes the predicted depth of subsidence at the centres of the Niglintgak and Taglu bowls as 0.45 m and 0.38 m respectively, as the "most likely" case. (J-EC-00174, p. 3, 5) Based on these estimates and available information on terrain elevations and seasonal water levels, the working group projected that the amount of habitat area impacted by subsidence-induced flooding would be 140.2 ha at Niglintgak and 617.8 ha at Taglu, for a total of 758 ha.

Average water levels recede throughout the nesting season in the Mackenzie Delta. However, the nest initiation phase is particularly critical to nesting birds. If birds are unable to nest because habitat remains flooded or nest initiation is unduly delayed, there will be no production of young from that habitat for a particular breeding season. A review by Environment Canada of the available information on avian nesting chronology in the region indicated that most birds begin nesting before June 15–20 in any given year. Thus, if land were to remain flooded because of gas field subsidence past June 15–20, breeding habitat would not be available for most nesting species.

Environment Canada stated that its approach to subsidence-induced habitat loss would be to seek replacement habitat by means of a system of offsets, which it described as follows:

- The projected extent of subsidence-induced flooding (7.6 km^2) will be the basis for establishing habitat offsets.
- The quantum of habitat that will be set aside through habitat offsets will be the projected extent of subsidence-induced flooding multiplied by an offset factor consistent with mitigation practices elsewhere in Canada, reflecting a precautionary approach to conservation.
- An offset factor of five (5) has been selected, so that the total area of the offset land is projected to be 38 km^2.
- The location of the offset area(s) will be determined through appropriate consultation with the Inuvialuit, Gwich'in, other governments and government

departments, environmental non-government organizations and industry.

- A consensus agreement will be sought on the location(s) of the offset areas. However, if agreement cannot be reached within three years, the Government of Canada will identify the location(s) after considering the collective input of the stakeholders.
- Offset areas will be managed by INAC under the *Territorial Lands Act*.
- Exploration or subsurface rights will not be issued with respect to the habitat offset area(s). However, exploration activities that would not result in permanent physical impacts (e.g. seismic) may be permitted.
- The habitat offsets will remain in place until it is determined that all or a portion of the offsets will be permanently protected or are no longer required as a precautionary measure. (J-EC-00174, p. 35)

Environment Canada acknowledged that, with this approach, it would no longer require the condition set out in its earlier position that habitat offsets must be established before gas begins to flow from the Project.

Nature Canada questioned why only subsidence-induced habitat loss was being considered for offsets rather than including the full physical footprint of the Project. Environment Canada responded that the physical footprint did not exceed the 1% limit but that the uncertainty regarding subsidence required that it recommend a precautionary approach to offset the potential habitat loss before it happens.

Nature Canada also questioned why seismic exploration may be permitted. In its view, if seismic exploration were allowed and oil and gas were discovered, the developer would require access to the discovery. Environment Canada responded that offset areas will be managed under the *Territorial Lands Act* by INAC, and that the latter has indicated that it will not issue exploration or subsurface rights with respect to those lands under habitat offset areas. Thus, a modest degree of seismic exploration may be allowed to occur around the margins of habitat offset areas to define potential resources under the adjacent parcels of land, but there will be no Exploration Licence or rights issued with respect to the lands under habitat offset areas.

Nature Canada said that it was inappropriate to provide only offsets for the subsidence-induced habitat loss. Its position was that, with subsidence included, the Project would be expected to exceed the 1% habitat loss threshold and that appropriate habitat should be sought to offset the total habitat loss, not just the subsidence-induced loss. Based on this position, Nature Canada calculated that an offset of 69.15 km^2 would be required, rather than the 38 km^2 proposed by Environment Canada. Nature Canada further recommended that an environmental levy should be applied against the Proponents to compensate for the net habitat loss in KIBS.

TAGLU AIRSTRIP

The proposed facilities at the Taglu Anchor Field, within KIBS, include a gravel airstrip and an access road to connect the production facility to the airstrip. Initially, Environment Canada recommended that the airstrip be situated outside of KIBS, in an area with low densities of migratory birds.

Environment Canada and the Proponents held several meetings to discuss their respective positions on the proposed Taglu airstrip, consider alternative means of accessing the site, compare impacts of alternative means and clarify Environment Canada's recommendations. Two options were evaluated: the existing Taglu airstrip proposal and a helicopter-only option, whereby materials and crews would be shuttled by helicopter directly from Inuvik. Environment Canada considered the time periods that birds are in the area, their responses to aircraft, the zone of influence of approaching and departing aircraft, the frequency of flights, and the type of aircraft. After re-evaluating these considerations and in consultation with the Proponents, Transport Canada, INAC, and Environment Canada concluded that:

- The airstrip will result in the permanent loss of at least 8.7 ha of habitat not accounting for space for an apron.
- A helicopter[-]only option would result in a footprint of about 2 ha. There is no apparent need to increase the planned heliport footprint to accommodate the helicopter-only option.
- The relative difference in migratory bird impacts marginally favors the fixed wing option.
- Based on the assessment of both the biological effects and operational considerations, a fixed wing aircraft option could operate in KIBS, subject to specific conditions.
- Either air transportation option will require a precautionary approach which would include operational procedures that are designed to minimize the impact on birds within the Sanctuary, ongoing monitoring and evaluation of impacts to inform the management of project-specific and cumulative impacts, and the application of regulatory controls. (J-EC-00173, p. 9)

Environment Canada recommended that:

- An Air Operations Plan for the Taglu facility must be developed by the Proponent for approval by the appropriate regulatory authorities. The plan must identify the initiatives and procedures which will be undertaken to minimize the impact of aircraft activity on migratory birds. The plan should include, but not be limited to:
    - designation of flight paths into and out of KIBS that minimize impacts on birds;

  - aircraft landing and takeoff procedures designed to minimize impact on birds;
  - minimization/avoidance of flights during critical migratory bird periods (May 10 [to] June 20 and August 25 to September 30);
  - combined (fixed/rotary) flights, when the migratory birds are present, not to exceed 15 flights per week [when] construction and drilling are occurring and 10 flights per week when construction only activities are occurring (2 of 4 years);
  - de-icing procedures and handling of the waste;
  - a process to determine if the aircraft type used during critical periods should be changed based on the results of the implementation of a follow-up and monitoring program including research;
  - awareness training for aviation personnel on the plan;
  - monitoring for compliance with the plan; and
  - [implementation of] the plan [to] ensure that personnel and aircraft safety and emergency response capability are maintained.
- The airstrip should be authorized for use during the migratory bird period (10 May to 30 September) during the initial construction and drilling phase only (not more tha[n] five years from project initiation). A decision respecting decommissioning of the airstrip after the initial construction and drilling phase would be determined by the Government of Canada in consultation with the Proponent and other interested parties. Subject to this decision regarding decommissioning, the airstrip could continue to be used outside the migratory bird season.
- The use of the airstrip and heliport must be restricted to flights related to activities at the Taglu facility and not used as a transfer point for other activities inside and outside of KIBS.
- An airstrip and heliport and associated facilities should be as small as possible and located to minimize the direct loss of bird habitat without compromising design requirements (e.g. flare/well control spacing, etc).
- A follow-up and monitoring program (which may require research), incorporating a pre- and post-monitoring design pre-approved by EC to evaluate the impacts of the airstrip, heliport and aircraft activity on migratory birds and their habitat. The results of the program will inform any subsequent modifications to the Air Operations Plan and future regulatory decisions concerning the use of the airstrip. (J-EC-00173, p. 10)

The Proponents agreed with the first recommendation, with variation:

> An Air Operations Plan will be developed for Taglu, in consultation with appropriate regulatory authorities. The details of this plan will be established during the permitting process as project execution planning progresses. Although Imperial will endeavor to reduce or avoid flights during critical migratory bird periods, the plan must be flexible enough to accommodate increased flights the week before or after these critical periods, in order to manage crew rotations. (J-IORVL-01040, p. 70)

The Proponents agreed with the third recommendation, with variation:

> Imperial agrees with the intent of this recommendation, but is concerned that such restrictive wording might preclude the appropriate use of this infrastructure for collecting scientific research data by others, or for unforseen circumstances. Restrictions on the use of this infrastructure are likely better dealt with by the appropriate regulatory authorities on a case-by-case basis in the future. (J-IORVL-01040, p. 71)

With respect to de-icing procedures and handling wastes, the Proponents indicated that they would have the capability to store, use and contain ethylene glycol at the airstrips. Ethylene glycol is known to be toxic to wildlife. The Proponents further indicated that, although they had not yet worked out the details of the system for managing de-icing products, they plan to collect and dispose of ethylene glycol in the field but not recycle it. Such details would be developed during the permitting phase. In response to questions from the Panel, Environment Canada indicated that ethylene glycol was a substance controlled by the *Canadian Environmental Protection Act* and that there would be containment and collection requirements of some type that would be required by regulation.

PROJECT NOISE STANDARDS

The Proponents stated that noise (chiefly from compressors) emanating from Niglintgak and Taglu would not significantly impact birds in KIBS, given that the zone of influence for noise is within the zone of influence for other impacts (e.g. helipads, airstrips and roads) and that, as a result, no mitigation would be required.

The Proponents, referring to the *Directive 038*, *Noise Control* of the Alberta Energy Utilities Board (EUB; now the Energy Resources Conservation Board), stated that noise level studies have not shown impacts on migratory birds. Therefore, given that there would be no impact, the Proponents saw no need to consider KIBS as a special case. The consultant that had conducted the noise impact assessment for the Project noted that *Directive 038* was the basis for the Proponents' assessment of the effects of facility noise on wildlife. The assessment concluded that wildlife, including birds, would not be significantly affected by noise from the Proponents' facilities. The Panel heard that further mitigation would not be required at the Proponents' facilities in order to protect wildlife either inside or outside of KIBS.

Nevertheless, the Proponents committed to evaluate and apply noise mitigation options in KIBS as the Project proceeds in an effort to reduce noise emissions beyond those required in *Directive 038*, where practical. The Proponents stated that the proposed design for facilities at Taglu and Niglintgak would exceed EUB *Directive 038* standards and that they expected sound levels would approach the levels recommended by Environment Canada. The Proponents are committed to working with Environment Canada to further mitigate noise levels in KIBS as development and operation facility planning proceeds.

Studies reviewed by Environment Canada documented noise impacts on distribution, density, reproduction, productivity and behaviour of migratory birds, although the results varied among species, between different life-cycle periods and under different ambient environmental conditions. Highlights of those studies included:

- compressor station noise impacted forest bird abundance, mate finding and behaviour at noise levels of 51.1 dBA (decibels acoustic);
- highway noise at levels of <40–63 dBA impacted the distribution of birds at distances of <0.1–2.8 km, depending on the species;
- snow geese showed behavioural effects at noise levels above 79 dBA;
- construction and compressor noise averaging 25–68 dBA on Alaska's North Slope resulted in white-fronted geese shifting their nesting 1 km from the source, and in pre-nesting Canada geese, nesting eiders, brood-rearing tundra swans and red-throated loons shifting further away from the compressor station; and
- fall staging snow geese avoided sites by a minimum of 0.8–2.5 km from simulated compressor noise at noise levels of 50 dBA at 305 m.

In its final review of noise regulations, Environment Canada stated that continuous noise emissions would, as measured under the terms and conditions of EUB *Directive 038*, not exceed 50 dBA L_{eq} (equivalent sound level) at 300 metres (40 dBA at 900 m), as measured from the fence line of the facility, for the period when birds are present in KIBS (May 10 to September 30). Environment Canada also stated that it recognizes that the appropriateness, technically and economically, of the proposed regulatory requirement will be further informed when the detailed design and Noise Impact Analysis is available and independently verified, prior to finalizing permit conditions.

With respect to cumulative impacts, Environment Canada also noted the need to require a best management practice for appropriate Project production and transmission facilities throughout the Project area with respect to noise emissions from facilities and aircraft.

INCREASED PREDATION ON MIGRATORY BIRDS

Environment Canada noted that predation is a major cause of nest failure and reduced productivity in Arctic nesting water birds and shorebirds. Experience in other Arctic regions revealed that development facilities provide enhanced perching, nesting and denning habitat, as well as food from garbage and handouts, and not only increase the population size of the predator but increase the predation rate on adjacent local nesting birds. Evidence from installations on the Alaskan North Slope showed that nesting ravens "substantially reduced nest success in a nesting goose colony over 40 km away." (J-EC-00136, p. 42) Environment Canada asserted that the Proponents had underestimated the impact of increased predation and that "the predicted zone of impact [for predation] should be at least a 40 km radius around development nodes." (J-EC-00136, p. 42)

Environment Canada recommended that that the Proponents undertake the following predator control measures within KIBS:

- all wildlife must be prevented from gaining access to solid and liquid waste and other wildlife attractants;
- all structures must be designed to preclude nesting and roosting sites for avian predators or den sites for mammalian predators; and
- orientation for all relevant project personnel should include best practices with regard to waste management and avoiding wildlife. (J-EC-00136, p. 43)

Environment Canada further recommended that the predator control measures it requires for KIBS be applied to all Project facilities.

The Proponents agreed with this recommendation but noted that it is not practical to design all structures to preclude predator nesting and roosting, or den sites. However, the Proponents would, in consultation with Environment Canada, incorporate mitigation measures into their wildlife management plans, where practical, to discourage such predator activities. They also reiterated their commitments on waste management.

10.11.4 PANEL VIEWS AND RECOMMENDATIONS

MANAGEMENT OF KENDALL ISLAND BIRD SANCTUARY

KIBS is the only protected area within the outer Mackenzie Delta, which is one of the most significant wetland complexes in North America and ranks high on a global basis. Environment Canada is committed to maintaining the integrity of KIBS in the face of potentially large-scale hydrocarbon development.

Environment Canada's authority to manage activities in KIBS derives from the *Migratory Birds Convention Act, 1994* and the *Migratory Bird Sanctuary Regulations*. The Act and the regulations were passed by Parliament to enable Canada to fulfill its commitments under the Migratory Birds Convention, an international treaty that commits Canada, Mexico and the United States to protect and conserve bird species that migrate across all three countries. In addition to protecting the species, their nests and their eggs, the 1994 update of the original 1916 treaty includes a commitment of each signatory to:

> use its authority to take appropriate measures to preserve and enhance the environment of migratory birds. In particular, it shall, within its constitutional authority:
>
> - seek means to prevent damage to such birds and their environments…; [and] …
> - pursue cooperative arrangements to conserve habitats essential to migratory bird populations. [article IV]

The *Migratory Bird Sanctuary Regulations* establish bird sanctuaries (of which KIBS is one) and prohibit a person from carrying on "any activity that is harmful to migratory birds or the eggs, nests or habitat of migratory birds, except under authority of a permit." (section 10(1)) The regulations simply authorize the Minister to issue a permit as long as it is "subject to such conditions as in the opinion of the Minister are necessary to protect migratory birds or the eggs, nests or habitat of migratory birds within a migratory bird sanctuary." (section 9(3))

The regulations themselves provide no detail on the management practices to be followed generally in bird sanctuaries, no criteria for determining the circumstances under which a permit will be required, and no procedures to be followed to obtain regulatory approval for activities within a sanctuary. Neither do they prescribe the conditions under which the Minister may grant an exemption to the prohibitions. The overriding principle guiding the Minister in carrying out his or her duty is to ensure that the migratory birds, as well as their eggs, nests and habitat within a sanctuary, are protected.

The Panel acknowledges Environment Canada's efforts to work toward a mutual agreement with the Proponents on a number of key issues pertaining to KIBS and the adjacent Fish Island (including the Fish Island segment of the gathering system), subsidence, the Taglu airstrip and noise impacts. In most cases, differences were resolved.

The Panel recognizes the importance of maintaining the integrity of KIBS as prime bird habitat and has adopted a precautionary approach in making its recommendations. As a general principle, the Panel endorses Environment Canada's view that maintaining the integrity of that prime habitat requires that a higher standard of practice be implemented in protected areas than in unprotected areas, particularly with respect to habitat impacts, noise and other disturbance. In the Panel's view, however, the *Migratory Bird Sanctuary Regulations* as currently written may not provide Environment Canada with the necessary capacity to achieve its objectives.

HABITAT LOSS

The Panel concludes that bird habitat would be lost or reduced in its effectiveness within KIBS and adjacent Fish Island by the footprint and zone of influence of the facilities and pipelines, and from predators attracted to facilities because of increased access and enhanced nesting and feeding opportunities. Although the actual extent of this loss is uncertain, the Panel found Environment Canada's identification of the factors contributing to the loss of effective habitat — and the likely zone of influence of those factors — more persuasive than the Proponents'.

The Panel notes that Environment Canada's approach to managing long-term impacts to KIBS involves two interrelated elements: the 1% threshold for direct physical impacts and habitat offsets for subsidence-induced flooding impacts. The Panel understands that, with respect to habitat loss other than from subsidence, once the 1% threshold is reached, Environment Canada would not permit any further development that would result in permanent physical impacts to the habitat until such time as previously disturbed habitat recovers. The Panel understands that the 1% limit is in effect a "revolving account" so that, as areas were rehabilitated or reverted to their pre-existing ecological function, they would be removed from the account and developers with subsurface rights could be permitted to use the newly available balance up to the 1% limit. Activities resulting in only temporary physical impacts to habitat, which in combination with permanent impacts could total in excess of the 1% threshold, could be permitted. Environment Canada also indicated that the 1% threshold would accommodate the potential permanent physical impacts of other existing Significant Discovery Licences and Exploration Licences within KIBS. The Panel endorses this approach.

The Panel notes Nature Canada's view that habitat loss should be calculated as a proportion of the terrestrial area of KIBS rather than the whole. The Panel did not hear much evidence on the matter but notes that Environment Canada's policy appears to be ambiguous about what area the 1% applies to. The Panel considers that Environment Canada should, for greater certainty, clarify whether its 1% policy applies to land only or to the entire area of KIBS.

The Panel notes that, beyond being informed of Environment Canada's management approach to development impacts in KIBS (as described elsewhere in this chapter), it was not provided with any documentation on Environment Canada's departmental policy. Thus, the Panel is concerned that the protective measures in place for KIBS have not been articulated in a manner that is sufficiently clear and in enough detail to accommodate the competing uses proposed by oil and gas developments within KIBS. In addition, the Panel is not persuaded that the mechanism by which these management measures have been put in place by Environment Canada is sufficiently robust to ensure that

Canada will be able to protect the habitat of migratory birds and uphold its international obligations under the Migratory Birds Convention. Therefore, the Panel finds that the Proponents' activities would be harmful to the habitat of migratory birds within KIBS and would require a permit from the Minister of Environment under the *Migratory Bird Sanctuary Regulations*.

The Panel accepts Environment Canada's conclusion that impacts associated with the Fish Island segment of the Taglu lateral would be kept to acceptable levels provided the Proponents implemented "exemplary" mitigation measures (see Panel Recommendation 6-4).

The Panel also agrees that the approach proposed by Environment Canada to minimize the potential for increased predation on migratory birds, as accepted, with variation, by the Proponents, would be appropriate.

SUBSIDENCE AND HABITAT OFFSETS

Environment Canada took a precautionary approach to the uncertainty surrounding impacts from subsidence. In view of the potential for flooding of nesting habitat, it seeks habitat offsets at a factor of 5 ha offset for 1 ha flooded. Environment Canada indicated that the offsets would be based on actual subsidence effects and that the area offset would be adjusted as required.

The Panel agrees with this approach in principle, although the selection process, land tenure and how these lands would be managed were still undetermined at the close of the Panel's record.

Nature Canada asserted that the total Project footprint, including subsidence-induced flooding, should be the basis of habitat offsets. However, Environment Canada remained committed to initiating offsets when habitat loss exceeds 1% of the total area of KIBS and to recommending offsets for subsidence as a precautionary measure. The Panel considers this to be an appropriate response, particularly given Environment Canada's view that the existing Significant Discovery Licences and Exploration Licences could be developed without exceeding the 1% threshold. Environment Canada's commitment to not issue further Exploration Licences within KIBS until the actual extent of all habitat impacts (infrastructure and subsidence-induced flooding) have been determined provides a reasonable approach to managing impacts within KIBS. Further, the Panel agrees with Environment Canada that subsidence flooding constitutes a direct impact of subsurface extraction of petroleum resources. In the Panel's view, Shell Canada and Imperial Oil should be required to contribute to the costs of identifying and securing habitat offsets with respect to the Project as Filed.

The Panel found, as noted in Chapter 6, "Project Design, Construction and Operations," that extraction-induced subsidence would inevitably occur and would result in the submergence or increased flooding of over 1% of the terrestrial area of KIBS. The Panel notes that the Proponents did not consider subsidence as an effect pathway, nor did they select critical habitat as a valued component. Thus, the Proponents did not directly assess the Project's potential impacts on KIBS. Therefore, the Panel does not accept the Proponents' conclusion that "no likely significant adverse effects on birds or bird habitat are expected as a result of this subsidence." (J-IORVL-01050, p. 107) The Panel concludes that extraction-induced subsidence leading to submergence or increased flooding would result in loss of effective bird habitat, and that the cumulative impacts of future development, if allowed to occur within KIBS, would result in further loss of bird habitat.

The Panel considers that these Project-related impacts on migratory bird habitat would likely be significant and that this habitat cannot be replaced within KIBS. However, the protection of migratory bird habitat outside of KIBS could serve to compensate for habitat loss within it. The Panel accepts that offsets are a form of habitat compensation and notes that compensation is a concept within the definition of "mitigation" in the CEA Act, and that determination of the significance of an impact takes place after application of mitigation measures. The Panel is of the view that the impact of extraction-induced subsidence on migratory bird habitat could be mitigated only by a firm commitment on Canada's part to give force and effect to Environment Canada's proposed approach to habitat offsets.

In the Panel's view, therefore, offsets are required as proposed by Environment Canada. The Panel is also of the view that Environment Canada should create additional habitat offsets at this time, while the opportunity still exists, to protect critical migratory bird habitat in the Mackenzie Delta. Such additions could be included as extensions to the boundary of KIBS or special management zones but, at a minimum, should have development restrictions, including threshold limits. The Panel discusses this further in Chapter 11, "Conservation Management and Protected Areas."

TAGLU AIRSTRIP

Environment Canada and the Proponents assessed alternative means of accessing the Taglu site and agreed that the proposed Taglu airstrip would pose the least adverse effects. The Panel agrees with Environment Canada's assessment that the proposed airstrip is the preferred option and supports its recommendations relating to managing the airstrip.

With respect to managing of de-icing products at the Taglu airstrip, the Panel accepts Environment Canada's assurance that the containment, collection and disposal of de-icing fluids would be required either under regulation or in permits issued to the Proponents. In the Panel's view, the location of the Taglu airstrip in KIBS demands the application of the highest standard of care and responsible management. The Panel expects that, although Environment Canada had not specified the measures in detail by the close of the Panel's record, Environment Canada will require and implement measures that are consistent with standards of care and management that align with its objectives for KIBS.

PROJECT NOISE STANDARDS

The Panel notes that the Proponents and Environment Canada differed on how to implement EUB *Directive 038*. Environment Canada maintains that KIBS should be considered a special case requiring lower noise emission levels than "business as usual." The Proponents indicated that the EUB *Directive 038* target of 40 dBA at 1,500 m is based on the assumption that ambient noise is 35 dBA and, thus, a 5 dBA increase to that level is a permissible sound level for industry. Based on a commissioned study, Environment Canada maintained that the ambient noise level in KIBS was 23 dBA when winds were <10 km/h and 27 dBA when winds were up to 15 km/h. In determining its noise standard, Environment Canada used the higher limit of the ambient levels (30 dBA) and added the 5 dBA (the assumed permissible increase under EUB *Directive 038*) to set a standard of 35 dBA at 1,500 m, which is equivalent to 50 dBA at 300 m.

The disagreement between Environment Canada and the Proponents is related to the ambient noise level and whether the Project's operation in KIBS constitutes a special case under EUB *Directive 038*. The Proponents maintained that the ambient noise level in KIBS is 37 dBA, and, assuming an average of 35 dBA, their facilities would not exceed EUB *Directive 038* standards. They maintained that levels were typically between 20–30 dBA when winds were <10 km/h and 30–40 dBA when winds were 10–15 km/h. Environment Canada maintained that this latter observation indicated that using the 20–30 dBA ambient value was justified, given that the higher values recorded by the Proponents were associated with higher winds and, thus, could be attributed to microphone noise.

The Panel is of the view that KIBS constitutes a special case and recommends that the Proponents design facilities in KIBS that meet or exceed 50 dBA at 300 m from the fence line.

PANEL VIEWS AND RECOMMENDATIONS: PROJECT AS FILED

The Panel notes that all of the assumptions underpinning Environment Canada's policy for KIBS are based on seasonal and temporary activities in critical migratory bird habitat and do not reflect the permanent operations contemplated by the Anchor Fields in the Project as Filed. In the Panel's view, these assumptions may not be adequate for protecting the values of KIBS or migratory bird habitat if the Project were to proceed. Neither would they be adequate if the Expansion Capacity Scenario or Other Future Scenarios related to Significant Discovery Licences in KIBS and the Beaufort Sea were to proceed. Implementation of the Panel's Recommendations 5-1 and 10-1 is an essential element of an approach to managing Project-related impacts on birds. However, in the Panel's view, additional measures would be required, particularly with respect to the potential impacts on birds and bird habitat within KIBS.

RECOMMENDATION 10-21

The Panel recommends that Environment Canada, in relation to resource extractive activities, prepare a plan for compensation that addresses habitat offsets with respect to subsidence-induced habitat loss within the Kendall Island Bird Sanctuary or within any offset areas. The plan must be prepared for review and approval by the Inuvialuit Regional Corporation, the Inuvialuit Game Council and resource managers with responsibility for migratory birds or disposition of rights to lands or resources in the Kendall Island Bird Sanctuary or in potential offset areas, and be finalized within two years of the date of the Government Response to the Panel's Report.

The Environment Canada plan must reflect the following:

- *the principle that habitat offsets will reflect and be based on the projected extent of subsidence-induced flooding within the Kendall Island Bird Sanctuary;*
- *the principle that the quantum of habitat that will be set aside through habitat offsets will be the amount of the projected extent of subsidence-induced flooding multiplied by an offset factor reflecting a precautionary approach to conservation, but not less than a factor of five to one;*
- *the identification of the location of the preferred offset area(s) and the actual areas recommended for offset;*
- *the schedule of fees (on a cost-recovery basis) that will be charged to proponents whose development activities would require lands to be set aside to offset the impact of their activities on migratory bird habitat;*
- *identification of the owners of the surface and subsurface of offset area(s) if the lands are not owned by the Crown; and*
- *the preferred legislative, regulatory or policy mechanism for setting aside and protecting the offset lands and the means for achieving same.*

The plan should apply to the subsidence effects of the Mackenzie Gas Project and to any future developments, to the extent that these may affect the Kendall Island Bird Sanctuary or any offset areas that may have been put in place. Once approved, Environment Canada should make the plan public.

RECOMMENDATION 10-22

The Panel recommends that, within two years of Environment Canada filing its plan as required in Panel Recommendation 10-21, the Government of Canada take the necessary steps to adopt Environment Canada's plan and to put in place legislative and policy measures to implement it, inclusive of:

- *selection of the offset lands that will be withdrawn and the mechanisms by which those lands will be set aside and withdrawn from industrial activities;*
- *the procedures by which land issues with third-party land or rights holders will be settled; and*
- *formal protection of lands selected for offset (including permanent protection or interim protection that will be in place until it is determined that the offsets are no longer required).*

To optimize availability and protection of suitable habitat for migratory birds, formal protection of the offset lands should be completed prior to the National Energy Board granting Leave to Open under any certificate or approvals issued by the National Energy Board for or in relation to the Mackenzie Gas Project.

RECOMMENDATION 10-23

The Panel recommends that, within three years of the Government Response to the Panel's Report, the Governor-in-Council develop and take steps to promulgate regulations specific to the Kendall Island Bird Sanctuary under appropriate legislation for the management of the Sanctuary and offset lands that:

- *are for the purpose of preserving and enhancing the habitat of and environment for migratory birds in accordance with the Migratory Birds Convention;*
- *incorporate the 1% policy that Environment Canada has been implementing thus far;*
- *specify whether this 1% policy applies to the land area only or to the entire area included in the Kendall Island Bird Sanctuary;*
- *prohibit the issuance of subsurface or surface rights in the Kendall Island Bird Sanctuary and offset lands to third parties; and*
- *restrict the activities, if any, that are permitted in the Kendall Island Bird Sanctuary and offset lands.*

RECOMMENDATION 10-24

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to prepare an Air Operations Plan for the Taglu facility. Such a plan must identify the initiatives and procedures that will be undertaken to minimize the impact of aircraft activity on migratory birds. The plan must be developed in consultation with, and to the satisfaction of, Environment Canada, Transport Canada, and other appropriate regulatory authorities and the plan must be in place prior to the commencement of construction. The plan should describe:

- *the goals of the plan;*
- *the measures to be used to avoid, prevent or minimize adverse impacts to migratory birds, their nests, eggs or habitat;*
- *the protocols for use of the airstrip, heliport and associated facilities consistent with the goals of the plan;*
- *the program for monitoring impacts during operations and the responses proposed to address unforeseen effects;*
- *procedures for updating the plan, as required; and*
- *reporting requirements and frequency.*

RECOMMENDATION 10-25

The Panel recommends that the National Energy Board require the Proponents to include a provision in their Environmental Protection Plans that all ethylene glycol or any other fluids used by the Proponents for de-icing purposes for any Project-related activities be contained and recovered for recycling or disposal.

RECOMMENDATION 10-26

The Panel recommends that the National Energy Board, as a condition of any certificate or approvals it might issue in relation to the Mackenzie Gas Project, require the Proponents to design any facilities to be located in the Kendall Island Bird Sanctuary such that noise emissions from those facilities meet or are below 50 dBA at 300 m from the fence line.

The Panel is of the view that, with the implementation of the Panel's recommendations, the adverse environmental impacts on birds and bird habitat in the Mackenzie Delta associated with the Project as Filed would not likely be significant.

PANEL VIEWS: EXPANSION CAPACITY SCENARIO AND OTHER FUTURE SCENARIOS

In the Panel's view, the Expansion Capacity Scenario and Other Future Scenarios would likely result in significant adverse impacts to birds and bird habitat in the Mackenzie Delta. The adoption of a proactive approach to establishing habitat offsets based on conservative assumptions, adding to the protected areas system, and introducing and implementing a formalized regulatory regime are the only ways that those impacts could be reduced to non-significant levels. Further discussion of the approach to enlarging the system of protected areas is provided in Chapter 11, "Conservation Management and Protected Areas."

The Panel accepts the view that KIBS is important and that higher standards are necessary when operating in KIBS. As KIBS covers only a small amount of the important bird habitat in the Mackenzie Delta, it is the Panel's view that, as a precautionary approach in advance of further developments, an expansion of areas to protect birds and important bird habitat is necessary. Furthermore, in considering options for expanding the system of protected areas in the Delta, it is the Panel's view that adopting a more integrated view of the Delta as an ecosystem would be appropriate, as the Delta provides critical habitat to many other species in addition to birds. Further discussion of the need for an approach to creating additional protected areas is outlined in Chapter 11.

With respect to the potential long-term impacts to KIBS, the Panel considers the management approach developed by Environment Canada to be reasonable for addressing both the long-term physical impacts to habitat and subsidence-induced flooding. The Panel endorses this approach and considers that it should be applied in future to any and all future developers operating within the boundaries of KIBS. In the Panel's view, however, Environment Canada's approach is only a limited solution because KIBS does not include all of the sensitive habitat that sustains bird populations in the Mackenzie Delta. It is imperative that a long-term, enhanced and integrated approach to managing subsurface and land-based resources in the Mackenzie Delta be developed. Chapter 11 addresses the need for an integrated approach to habitat protection and an integrated view of the Delta as an ecosystem that provides critical habitat for many species, not just birds.

The Joint Review Panel for the Mackenzie Gas Project was a seven-member, independent body that evaluated the potential impacts of the proposed Mackenzie Gas Project and associated Northwest Alberta Facilities on the environment and lives of the people in the project area. The Joint Review Panel members were (from left to right): Tyson Pertschy, Peter Usher, Barry Greenland, Robert Hornal, Percy Hardisty, Rowland Harrison, Gina Dolphus.

Joint Review Panel
for the Mackenzie Gas Project