4.3 Drilling Program Description

4.3.1 Access Route and Well Siting Selection Criteria

Proposed well site siting and routing of the access road will be determined by the following criteria:

- Satisfy technical requirements of the drilling program;
- Utilizing existing access where possible;
- Utilizing ice roads along channels of the Mackenzie River for primary access;
- Minimize total area of terrain disturbance by utilizing areas of minimal vegetation;
- Avoid sensitive or unique habitats for plants and animals;
- Avoid any known archaeological or paleontological sites; and
- Avoid important site-specific cultural features and traditionally important lands.

As previously mentioned, Petro-Canada will choose between the well site and access route alternatives, having considered all of the above criteria and options. The nine well site options and access roads are represented in Figure 2.

4.3.2 Access Route and Wellsite Construction

Petro-Canada is proposing an access road width of 15 m. Learnings from last year show that the 10 m road width is not manageable throughout the entire winter due to snowbanks and drifting that encroached on the usable width of the road. The length of each access route extending from the channels of the Mackenzie River to each proposed wellsite location is outlined in Table 3, and detailed on the 1:50,000 scale program maps included in the map pocket.

TABLE 3

PROPOSED ACCESS ROUTE LENGTHS

Access Route to Wellsite	Length (m)	Area (ha) based on 15.0 m Access Route Width
Kurk Preliminary Wellsite Locations		
J – 48	± 1765	± 2.65
C – 59	± 2125	± 3.19
B – 09	± 1021	± 1.53
K – 09	± 361	± 0.54
M – 49	± 3611	± 5.42
Napartok Preliminary Wellsite Locations		
N – 03	± 1172	± 1.76
A – 56	± 2526	± 3.79
A – 56	± 931 (alternate route)	± 1.40
F – 29	± 483	± 0.72
B – 12	± 2886	± 4.33
B – 12	± 466 (alternate route)	± 0.70

The surface of the access roads and winter drilling lease(s) will be prepared together using the same equipment and procedures. Access route and wellsite construction will begin once the ground surface is frozen and has adequate snow cover. Should any vegetation clearing be required at the site, willows will be cut with either a brush cutter or a hand cutter, leaving approximately 20 cm of aboveground vegetation in tact. The removed vegetation tops will be spread evenly on the site. A track machine such as a Nodwell or Bulldozer, will then be used to pull a rubber-tired drag (comprised of three flat-lying rubber tires cabled together) over the surface to enhance frost penetration. The access route will then be flooded with water. A water truck, sitting on the riverbank adjacent to land access, will pump water from the river onto the access road. Once there is sufficient ice cover to support the water truck, it will work toward the lease spraying water to build up more in front of it. In this fashion, the construction crew will start working with one truck, and build up to 6 trucks.

The winter drilling location(s) will have the same dimensions as last season's M-15 well with a slightly smaller dimension for the sump; a 150 meter x 150 meter rig pad with an attached 100 meter x 80 meter camp pad, a 60 meter x 50 meter fuel storage pad, a 50 meter x 80 meter sump area (this is for a 20 meter x 50 meter sump plus a 15 meter perimeter for a spoil pile), and a detached 30 meter x 30 meter helipad. Drawing 1 illustrates the typical summer wellsite plan layout. The total wellsite footprint area will also be increased accordingly as per the area of the access route as outlined in Table 3. An airstrip has not been added into these calculations.

4.3.3 Airstrip

Each of the proposed wellsite locations has reasonable access to river channels where an ice airstrip will be constructed (Figure 2). The airstrips will be approximately 500 meters in length, built to the appropriate thickness by flooding the ice. A generator and airstrip lighting will be supplied. The location selected will also include a helicopter landing pad located near the wellsite, comprised of a 30 m x 30 m flooded ice pad.

4.3.4 Water Requirements

Water usage requirements for the program are based on needs for well site(s) and access construction, during drilling operations, and for camp water uses. Water usage requirements for this program are also based upon learnings from last season's M-15 drilling operation. The construction phase may at times require large volumes of water for flooding ice roads and ice pads, with anticipated withdrawal volumes of 400m^3 per day for approximately 20 days. Water will be withdrawn from the river that the access is located on, or where the access last meets the river for land construction. The drilling rig will require water for the mud system and cementing operations, plus small quantities for routine activities. Quantities are typically less than 50m^3 per day and infrequently spike to as high as 200m^3 in one day. The rig camp use is fairly uniform at less than 50m^3 per day. Water required for drilling operations and camp uses will be drawn from a larger nearby lake of adequate size to ensure that drawdown rates are minimized.

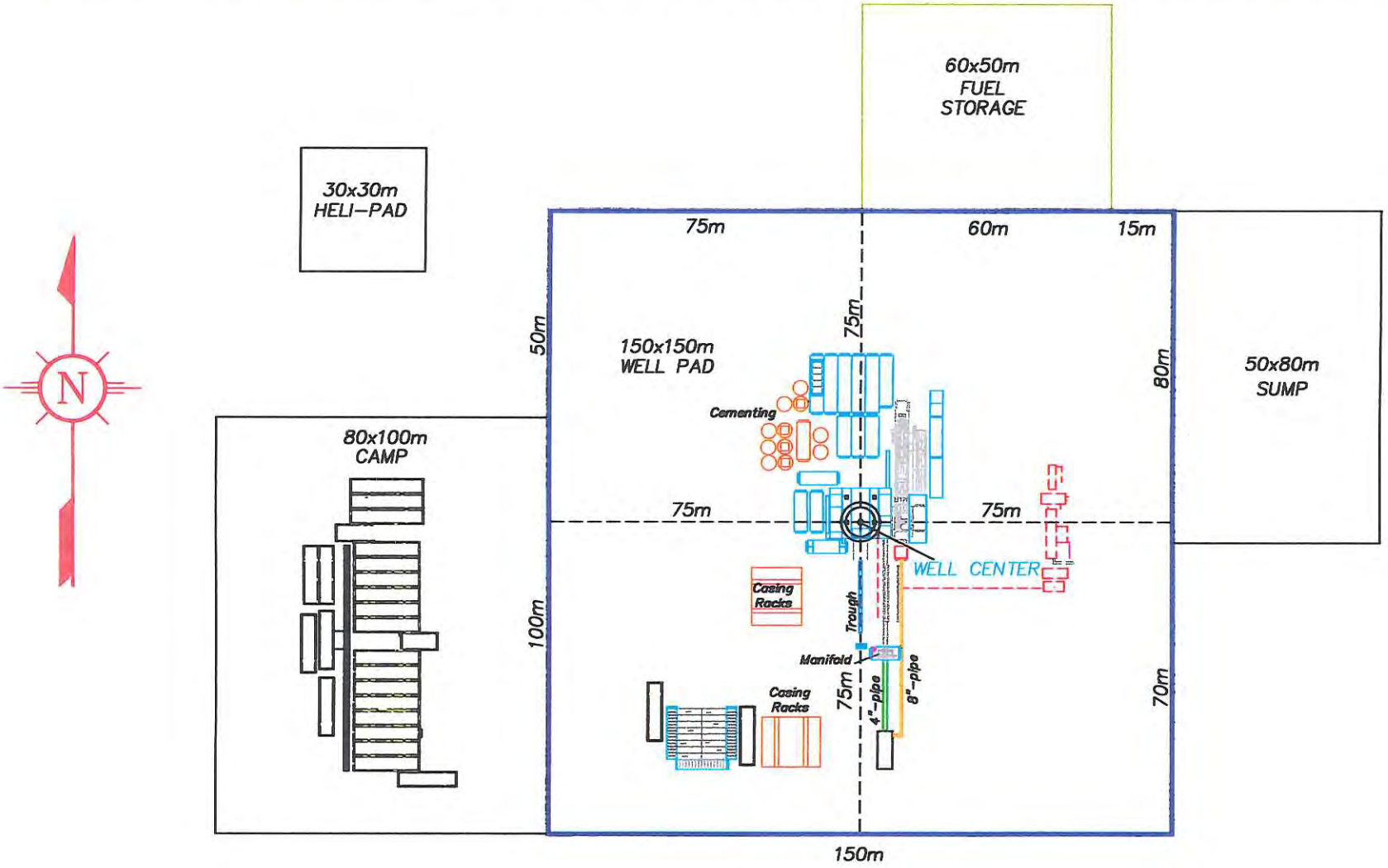
To ensure that fish are not negatively affected during water withdrawal, intake hoses will be equipped with screens in compliance with DFO Freshwater Intake End of Pipe Fish Screen Guideline (1995) to prevent the impingement or entrainment of fish. The suction foot will be suspended one foot below the ice/water interface.

TABLE 4

DRILLING AND CAMP WATER REQUIREMENTS

Activity	Volume
Wellsite and Access Construction	Up to 400 m3/day
Drilling mud	<50 m3/day – 200 m3/day
Camp requirements	< 50 m3/day

Note: Camp water usage is based on maximum occupancy at the camp. This number is an overestimate.



LEGEND

FUEL STORAGE SHOWN THUS. . . . . ○

CEMENTING SHOWN THUS. . . . . ○

4" PIPE SHOWN THUS. . . . . —

8" PIPE SHOWN THUS. . . . . —

NOTE: TYPICAL SITE LAYOUT MAY VARY SLIGHTLY BASED ON SITE CONDITIONS.

PETRO-CANADA

DRAWING #1
TYPICAL WINTER WELLSITE LAYOUT

MACKENZIE DELTA, N.W.T.

50 0 50 Metres

DRAWN :	SCALE:	DATE :	JOB NO. :
KP	1:1500	08/07/01	13244–TYP–WIN

INUKSHUK
Geomatics Inc.
300–6940 FISHER ROAD S.E.
CALGARY, ALBERTA T2H 0W3
PH (403) 253–8101
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Email calgary@inukshuk.com

REVISION NOTES

REV. NO.	DATE	DESCRIPTION	BY
1	AUG.20/2001	ADD LEGEND	KP
2	AUG.22/2001	ADD NOTE	KP

4.3.5 Drilling and Mud Program

Petro-Canada proposes to drill the well site(s) in the Mackenzie Delta using a KCL (potassium chloride) drilling mud system. The KCL system is a mixture of potassium chloride, bentonite, and XC polymer. The use of saline inhibitive muds is primarily restricted to areas where water sensitive formations are exposed for prolonged periods of time or where water sensitive producing formations are encountered.

The well lithology for the site options shows that hydratable shales and clays are present and that there is a high probability of an unstable wellbore. The addition of KCL to a water based mud system in concentrations of 2 to 7% (3% has been recommended) by weight will provide superior inhibition in comparison to a fresh water drilling fluid system. The mechanism is as follows. The K+ ion acts as an inhibitor because of its small ionic size and low hydration energy. The K+ ions can penetrate the clay lattices and becomes tightly fixed by attractive forces. This results in binding of the clay sheet together and reduction in the tendency of the clay to swell. Potassium ions are more effective than sodium or calcium ions for this purpose because of the smaller size.

Data derived from the Geological Survey of Canada, and used by Petro-Canada, indicates that permafrost will be present down to 65 - 75 m depth. The challenge of drilling through permafrost is to keep the wellbore in gauge for successful cementing. A warm circulating drilling fluid (0°C or above) through the permafrost will have the tendency to thaw or erode the permafrost and cause instability due to the large amounts of gravel and downhole debris. The larger the washout through this section the more difficult it will be to drill in terms of hole cleaning and problems. It will also increase cement volumes required to cement the casing and reduces the ability of a successful cement job due to poor mud removal. The additions of KCL will enable the drilling fluid to maintain a temperature of -1.5°C (3%) without freezing, thus having minimum thawing effect on the permafrost. Also, if the well remains static for longer periods of time, the addition of KCL will decrease the likelihood of the drilling fluid freezing in the mud tanks and freezing in the upper section of the hole.

There is the potential of encountering methane hydrates down to 550 m. The possibility of liberation of gas from methane hydrates increases with higher drilling fluid temperatures. If this occurs, well control becomes complex. The use of KCL will minimize this potential by allowing freezing point depression of the drilling fluid. The use of KCL will also minimize accretion and bit balling. Bit balling will sometimes occur if drilling through hydratable shales and clays with an insufficiently inhibitive fluid. The cuttings tend to be sticky in nature and will clump together around the bit and wellbore. This makes drilling new hole slow and difficult. KCL will help minimize the hydration of the cuttings and thus help prevent accretion from occurring.

Large diameter drilling holes such as 444.5 mm (17-1/2") can be difficult to clean with drilling fluids due to very low annular velocities at maximum pump rates. Therefore, increasing the mud viscosity is required to provide sufficient hole cleaning characteristics. Additions of KCL to freshly hydrated bentonite will increase the viscosity and yield point temporarily to provide increased hole cleaning efficiency. The KCL mud system is generally used in the arctic as KCL lowers the freezing point and

allows the use of cold mud to reduce thermal damage to permafrost. The proposed Napartok well will be approximately 2500 m deep, and the Kurk well will be up to 4000 m deep.

The use of a mud cooler will be utilized on top hole and surface holes to keep mud as close to the freezing point as possible to mitigate against permafrost melting. Permafrost retention will also be aided by the use of a refrigerated conductor pipe.

4.3.6 Drilling Waste Disposal

Petro-Canada has incorporated techniques into the drilling process designed to minimize the volume of waste. Centrifuges are used to help use the mud systems for longer periods of time, and a mud cooler is used to help minimize hole size and reduce the volume of the active mud system.

The winter drilling location(s) will use a sump (very similar to M-15), excavated into the ground by small explosive charges, to a dimension of 20 m wide x 50 m long x 5 m deep. The spoil pile will be placed around the perimeter of the sump, consisting of approximately 5000 cubic meters of displaced material. The intent is not to completely fill the 5000 cubic meter sump with fluids, but to fill less than one quarter of it (1250 cubic meters which meets anticipated sump usage). This allows Petro-Canada the ability to minimize environmental impact upon completion of the sumps useful life by employing a mix/bury/cover strategy to sump abandonment. The exact location of the sump will be reflective of the typical wellsite layout schematic represented in Drawing 1.

4.4 Operating Phase

4.4.1 Base Camps

Petro-Canada will utilize the 60-person Arctic class Akita camp that is paired with Akita-Equtak Rig 60. (Drawing 1). The logistics base for the drilling operations is located at Swimming Point and utilizes the existing camp facilities.

4.4.2 Solid Waste Management

The rig camp will be equipped with an incinerator. Solid refuse will be incinerated daily to prevent the attraction of nuisance animals. Non-combustible material will be trucked to Inuvik for proper disposal at the landfill site.

4.4.3 Wastewater Treatment

It is Petro-Canada's intent to treat all wastewater to a level that it is safe for discharge to the ground surface. Wastewater from the rig camp will be treated using an Eco-Tech treatment system. The Eco-Tech system was also used last year, however, learnings from last year were used to make improvements

such as an added primary holding tank, an added grease trap, as well as other adjustments to the waste treatment system.

As an operational alternative to treatment and discharge of wastewater to the land surface, a sump would be used. A 12 m x 20 m sump, 5 m deep with a 10 m perimeter for spoil pile would be utilized.

4.4.4 Fuel Storage

A total of 7.5 million litres of fuel will be required to support Petro-Canada's winter and summer Drilling/Construction/Service rig activities. The total volumes specified below include a 7% capacity buffer to allow for expansion. This fuel will be stored with placement as follows:

- 2.3 million litres (ML) of fuel will be sent to the Swimming Point tank farm (4 x 0.5 ML tanks to be installed early August, 0.3 ML in existing capacity);
- 1.5 ML to be placed at Swimming Point in 8 x .16 ML tanks plus 4 x 0.064 ML tanks - these tanks will be used for storage at the rigsite, but due to storage needs will initially be used at Swimming Point
- Possibly one fuel barge (approximately 0.5 – 1 ML) located at Napartok (Figure 2); and
- 2 - 3 barges at Avarnuk Channel (near last years barge site) to hold the remaining fuel (approximately 3.25 ML).

4.4.5 Other Materials Storage

A number of chemical compounds will be used during drilling operations. A list of chemicals is provided in Appendix A. The drilling rig can hold up to 300 m^3 of drilling fluids including the 40 m^3 premix tank. There will be water storage on site for drilling activities and camp contingency. There will be several days worth of fuel storage on the winter drilling location(s) for contingency if fuel is unable to be delivered to the site.

4.4.6 Testing and Flaring

The summer drilling program may include a full testing program, as approved by the NEB, which will involve flow periods meant for hydrocarbon evaluation. Drill stem tests will be stopped either upon determination of well results, or once a finite fluid volume is obtained. Fluid volumes will be minimized once the test results are determined.

Resulting from testing of the well and depending on content, produced fluids will either be:

- Burned on the flare stack;
- Burned with the aid of an incinerator;
- Re-injected back into the well bore (with appropriate NEB approval); or
- If, at such time, all of these options prove to be insufficient, off-site disposal will be considered.

*4.4.7 Personnel Required**

Construction
32 equipment operators
7 Supervisors

Drilling
16 rig crew
5 – 8 office staff
10 – 20 support staff
5 – 8 camp catering staff

Total Personnel: up to 91
*Approximate numbers of personnel

4.4.8 Equipment Required

Construction
3 to 7 Water Trucks with approximately 15m³ capacity
2 to 3 Tandem Axle Plow Trucks complete with Highways type roll blade
1 to 2 single axle plow trucks complete with highways type roll blade
2 to 4 - one ton trucks with front mounted highways type roll blade and rear mounted ice auger
1 to 2 graders complete with snow wing and v-plow (ie Caterpillar 140H)
2 to 3 Loaders (ie Caterpillar 950 or 966) complete with loading forks, buckets, blade, v-plow, and snowblower
Hydraulic Excavator (ie Hitachi 300) complete with digging bucket and clean-out bucket
Possibly 1 Nodwell

2 to 3 Crawler Tractors (ie Caterpillar D6M, Caterpillar D7H, Caterpillar D8R
1 seven-person hovercraft

Drilling
1 to 2 front end loaders (ie 250 Komatsu & 380 Komatsu)
2 multipurpose flatbed trucks with attachments for water tank, vacuum tank, etc.
1 - 25 ton picker truck

Akita-Equtak Drilling Rig #60 with associated camp

Oilfield service equipment rentals, as required

Sattelite dish and communication system

Light towers

All accessory and support equipment, water tanks, boiler, pipe racks, etc.

4.4.9 Clean-up

Upon completion of the drilling program, the wells will be capped and suspended or permanently abandoned. All equipment, survey stakes and construction debris associated with the operations will be disposed of upon completion of drilling. The only permanent facility planned is the wellhead. It is planned that the wellhead will be above ground level, and appropriately marked, staked, and signed as per NEB regulations.

5.0 ALTERNATIVES AND CONTINGENCIES

Petro-Canada is currently planning to drill one or two of nine (9) potential wellsites as possible alternatives for the summer drilling program. The final well site may be located within a 1000 m radius of the conceptual locations, with the finalized well location pending interpretation of last years seismic data. The proposed wellsite locations and proposed access routes are represented in Figure 2.

Alternatives and contingencies for wastewater disposal have been provided in Section 4.3.3. These include treatment and disposal of wastewater to the land surface, or disposal to a wastewater sump.

Commencement of construction of the access road and drilling is contingent on the complete freezing of the active layer. In the event of delays to the freezing of the active layer, Petro-Canada will delay start-up of their operations.

6.0 CUMULATIVE EFFECTS

Cumulative effects refer to impacts that result from past, existing and imminent projects and activities. This broad interpretation of cumulative effects under the *Canadian Environmental Assessment Act* includes both environmental and socio-economic considerations. The socio-economic interactions are more fully discussed in Section 8.0 Traditional and Other Uses. The causal agents of cumulative effects may include one or more of the following: multiple activities, activities in more than one locale and recurring or ongoing activities. The bounding for the cumulative effects assessment has been adapted to address spatial overlap of the impacts of previous, current and future activities and temporal overlap of current activities and impacts that spatially coincide with, or are in the vicinity of, the proposed program.

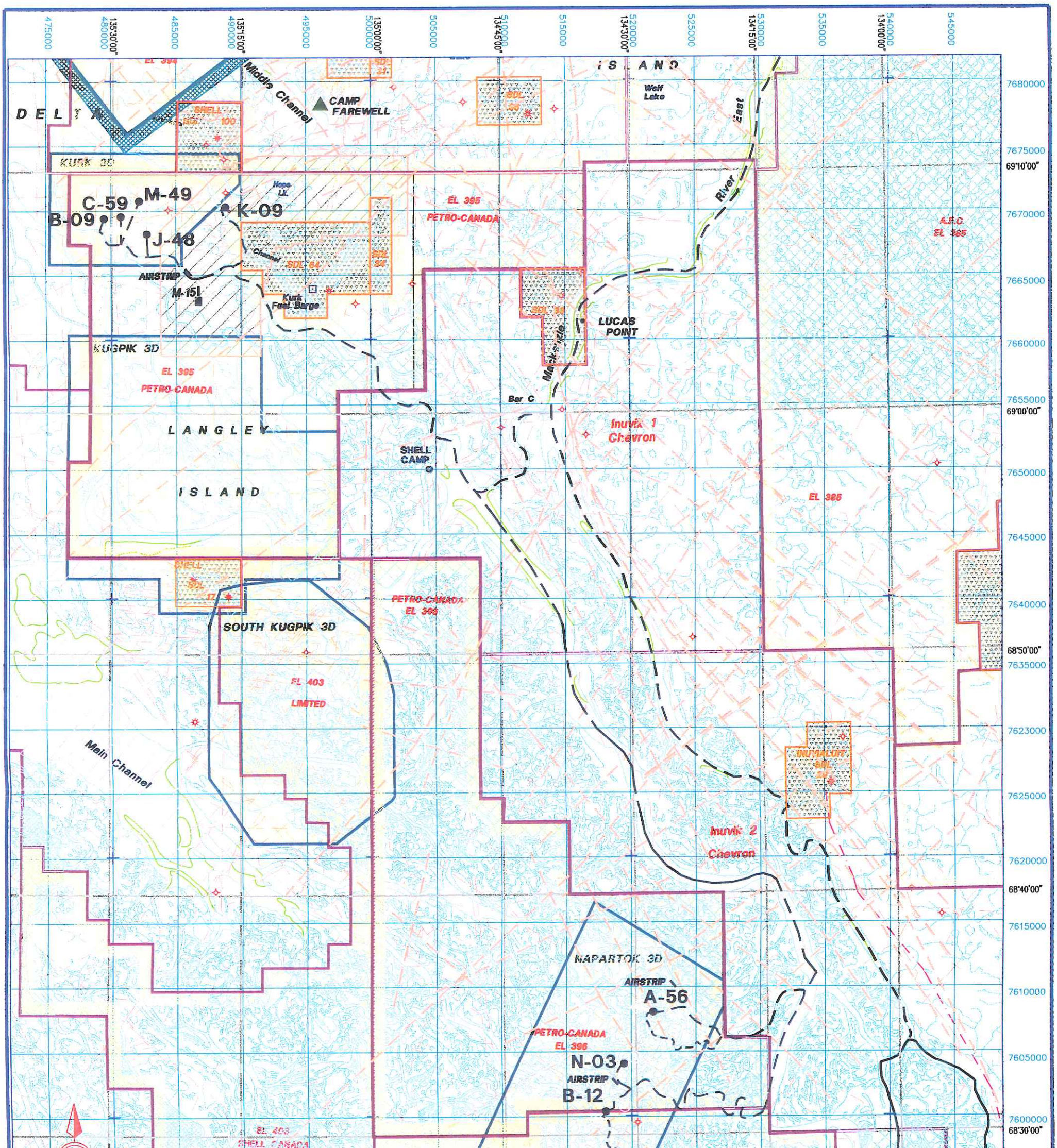
As an initial assessment of the cumulative effects associated with the Petro-Canada drilling program, the study area was based upon the sub-regional footprint of cumulative effects for the proposed drilling program of 32,100 m^2, including the rig pad, camp pad, storage pad, sump area and detached helipad. This program is scheduled to take place in the Winter 2001/2002 time period. The significance, extent, duration, magnitude, and residual effects criteria used in this section are defined in Section 12.0, Proposed Mitigation and Anticipated Environmental Impacts.

6.1 Past, Current, and Imminent Activities

Since the 1960s, the most extensive, non-traditional land use that pre-dates current and future projects is seismic exploration. The Joint Secretariat obtained and mapped data from the National Energy Board to depict historic seismic activity throughout the Mackenzie Delta, nearby islands and the Beaufort Sea for the period of 1965 through to 1992. Seismic activity between 1992 and 2000 has not been compiled and mapped. The update and verification of the past seismic data will help to eliminate data gaps and reduce uncertainty regarding the extent of past activities. Additionally, the biophysical and heritage inventories currently underway will provide additional and more sophisticated information to assess cumulative

effects. Petro-Canada's proposed program lies within a region of moderate intensity seismic exploration. Spatial and/or temporal overlap of past activities and current planned projects of known location are shown in Figure 3.

Approved activities occurring within the vicinity of Petro-Canada's proposed program include: a biophysical inventory for the Producer's Group (Exxon Mobil, Imperial Oil Resources, Shell Canada Ltd., and Gulf Canada Resources Ltd.) and a biophysical and heritage inventory and aquatics survey for the Operator's Group (AEC West Ltd., Anderson Resources Ltd, BP Canada Energy Company, Burlington Resources Canada Energy Ltd., Chevron Canada Resources, Gulf Canada Resources Limited, Petro-Canada, and Shell Canada Ltd) as well as a Cape Bathurst Caribou study and Grizzly Bear Denning survey by RWED. The field seasons for the biophysical, heritage and aquatics studies will be completed before the proposed program is set to begin. Impacts from the sampling program coincide with the project due to repeated aircraft overflights and landings. On the ground, non-intrusive methods were used and are unlikely to have created an additive stress to the landscape although caribou may experience some stress in association with collaring according to local people. Shell's West Channel remediation is expected to be complete in the fall of 2001 and AOGS airstrip expansion at Swimming Point is expected in the fall of 2001. Additional oil and gas activities will take place on or in the vicinity during the winter of 2001/2002. Proposed programs currently before the EISC or in planning stages include the seismic activities of the research activities of the Operator's Group, the quarry for Petro-Canada and an airstrip expansion for AOGS at Swimming Point. Spatial and/or temporal overlap of the projects identified above is illustrated in Table 5 and Figure 3.



LEGEND

- PROPOSED DRILL SITES
- PROPOSED ACCESS ROADS
- 3D SEISMIC PROGRAMS BY OTHER OPERATORS
- PREVIOUS 2D SEISMIC PROGRAMS BY OTHER OPERATORS
- PREVIOUS 3D SEISMIC PROGRAMS BY OTHER OPERATORS
- PREVIOUS HISTORICAL SEISMIC FROM 1965 TO 1992
- BASE CAMP SHOWN THUS
- EXPLORATION LEASE (EL) BOUNDARY
- EXISTING WELLSITE SHOWN THUS
- IKHIL GAS PIPELINE

PETRO-CANADA

FIGURE 3

CUMULATIVE EFFECTS OF OIL AND GAS ACTIVITIES IN THE VICINITY OF THE PROPOSED PROJECT

MACKENZIE DELTA, N.W.T.

SCALE : 1 : 300 000

Nuvaquit Environmental & Geotechnical Inc.

INUKSHUK Geomatics Inc.

DRAWN : B.T.	JOB NO. : 12115–MAP1 PC–DRILL–2001–2002–FIG2A
DATE : AUG 17, 2001	REV NO: 0

TABLE 5

OTHER CURRENT AND IMMINENT LAND USE ACTIVITIES WITHIN THE PROJECT VICINITY

Proponent	Activity	Distance from Project Area* (km)	% Overlap of Petro-Canada Drilling	Temporal Overlap (Y/N)	Duration	Areal Extent	Magnitude of Cumulative Effect
Current Projects							
Operators Group	Biophysical/ Heritage Inventory	0	< 1%	N	Summer 2001 – Fall 2001 Short term	Subregional	Low
Operators Group	Aquatics Study	4.5	0 %	N	Summer 2001 Short term	Subregional	Low
Producer's Group	Biophysical Group	<1	0 %	Y	Summer 2001 – Winter 2001 Medium term	Subregional	Low
RWED	Grizzly Bear Denning Study	0	< 1%	Y	Summer 2001 Short term	Subregional	Low
RWED	Cape Bathurst Caribou Herd Satellite Tagging Program	0	< 1%	Y	Year-round, Multi-year Fall 2001 – Winter 2004 Medium term	Subregional	Low
Alaskan Producers Group	Biophysical Survey	0	70 %*	Y	Summer 2001 – Summer 2002 Medium term	Subregional	Low
Shell	West Channel Remediation	40	0 %	N	Summer - Fall 2001 Short Term	Subregional	Low
Imminent Projects							
Japex	Drilling	43	0 %	Y	Winter 2001/2002 Short term	Subregional	Low-moderate
AEC	Burnt Lake 2D Seismic	30	0 %	Y	Winter 2001/2002 Short term	Subregional	Low
AEC	Iomatkotak 2D Seismic	61	0 %	Y	Winter 2001/2002 Short term	Subregional	Low

Proponent	Activity	Distance from Project Area* (km)	% Overlap of Petro-Canada Drilling	Temporal Overlap (Y/N)	Duration	Areal Extent	Magnitude of Cumulative Effect
AOGS	Swimming Lease Extension and Airstrip Expansion	36	0 %	Y	Fall 2001 Medium – Long term	Subregional	Moderate
Chevron	Ellice, Mallik, Langley Seismic	4	0 %	Y	Winter 2001/2002 Short term	Subregional	Low
Chevron	Ogruknang, Inuvik 2D, Tumma Seismic	9.5	0 %	Y	Winter 2001/2002 Short term	Subregional	Low
Petro-Canada	Nuna 3D Seismic Program	45	0 %	N	Winter 2001/2002	Subregional	Low
Petro-Canada	Swimming Point Quarry	36	0 %	Y	Fall 2001 Medium term	Local	Moderate
Petro-Canada	Napartok/ Kurk Drilling	0	0 %	Y	Winter 2001/2002 Short term	Local	Low-moderate

* Distance from project area at nearest point.

6.2 Valued Ecosystem Components

The Valued Ecosystem Components (VECs) for this program are resources or environmental features determined to have specific legal, scientific, cultural or aesthetic value according to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), the Inuvialuit as published in Community Conservation Plans or local people as identified during community consultation. VECs in the project area have been identified as Bluenose-West caribou herd, critical wildlife habitat for migratory birds, and important harvesting areas for goose.

6.3 Additive and Synergistic Effects

RWED has initiated a Bluenose-West/Cape Bathurst caribou herd satellite tagging program, which has received financial support from the The Operators. The study will provide information on caribou locations during the winter months to better understand habitat use in order to assess effects of exploration activities on the herd. Access routes created for drilling operations, potentially near the Napartok drilling location, could enhance access for traditional harvesting and permitted hunting by Inuvialuit beneficiaries and residents or non-residents holding permits for the Bluenose-West/Cape Bathurst caribou in commonly used harvesting areas (see Section 8.0-Traditional and Other Land Uses). To minimize the additive effect of increased access, Petro-Canada will minimize new access development to avoid the potential for altering hunting success. The cumulative effects on the habitat for selected

VECs is considered subregional in extent, and low in magnitude, given that the Bluenose-West/Cape Bathurst herd is rarely found in the project area.

The most significant cumulative effects of concern relates to disturbance of migratory birds upon their arrival in the delta. Air traffic associated with other research at other times of year may create an additive effect leading to avoidance of the area by some species, and potentially some direct mortality by virtue of helicopter activity. Brant and geese are especially sensitive to helicopters (Ward et al 1999). A rapid response and quick resumption of normal behaviour has been noted for snow geese although there are seasonal differences in recovery time with disturbance in the fall contributing to behavioural response considerably longer than in the spring (Belanger and Bedard 1989). Established flights lines, the advice of an Inuvialuit Environmental Monitor as well as proper orientation of operations staff regarding these concerns will help to minimize the impacts of air traffic. The cumulative effects are considered sub-regional in extent, short-term and low in magnitude. Noise is also a concern in relation to the drilling activities. However snow geese, and ducks, important subsistence species, tend to habituate to low level noise after period of two-three days. The long-term effect of repeated, intensive exposure remains poorly understood.

Direct impacts of Petro-Canada's proposed drilling program, in combination with other projects in the study area, will likely be restricted to breaking/cutting shrubby vegetation in limited locations. These impacts are expected to be local and medium-term in nature. Preliminary results from consultation with local elders suggest that the recovery time to natural growth rates for willows cut back or walked down is a couple of years, provided no root damage and further perturbation by local people occurred (Inuvialuit Elders, Pers. Comm.). This clearing activity could reduce nesting habitat for interior dwelling birds. The vegetation in the Napartok drilling location is characterized by short willow; and the vegetation in the Kurk drilling location is characterized by sedge and grasses, thus the cumulative effects are considered subregional, and low during winter operations (Table 15). The re-growth period could further be extended if access for subsistence use, recreation or other activities became dependent on the corridors created by access to the drilling area thus contributing to the ongoing breakage of new shoots critical to re-growth.

Discussions regarding Cumulative Effects Assessment have been initiated with the Joint Secretariat and industry representatives, on how to best quantify the cumulative impacts of development within the Mackenzie River Delta on a regional scale over a longer time frame. The EIRB and EISC are cooperating with Kavik-Axys Ltd. to prepare guidelines for quantitatively assessing cumulative effects (Chernoff, Pers. Comm.). Workshops to provide guidance on the application of the guidelines are expected prior to this winter's operating season. These workshops, coupled with the biophysical inventory, will help to build the capacity for quantitatively assessing ecosystem quality and the cumulative effects of oil and gas activities.

Residual cumulative effects from this project are predicted to be low in magnitude and local in extent. If seismic results are positive in surrounding areas, future operations within the project vicinity may include more seismic exploration, exploratory well sites and eventually, development of gas resources. Future

development will be planned with consideration of environmental impacts and appropriate mitigative measures.

AEC, Anadarko, Anderson, AOGS, Chevron, Gulf, Petro-Canada, and Shell are all expected to seek approvals for projects within the next year. The scope, work plan, timeline for these projects and thus, their contribution to cumulative effects cannot be determined at this time.

7.0 LOCATION

Petro-Canada's Kurk/Napartok Winter 2001/2002 drilling program is located on Crown lands. The potential Kurk sites are located within EL 395, approximately 105 km northwest of Inuvik. The potential Napartok sites are located within EL 395 or 405, approximately 39 km northwest of Inuvik. The potential wellsites to be selected from and associated access routes are indicated in Figure 2, with the one or two well locations to be drilled, as determined in September or October following interpretation of seismic data. The latitude and longitude of the nine proposed wellsites are:

TABLE 6

LOCATION OF PROPOSED KURK-NAPARTOK DRILLING SITES

WELL REFERENCE	STATUS	LOCATION
Kurk Preliminary Wellsite Locations		
J – 48	New	69°07'30" N – 135°25'58" W
C – 59	New	69°08'13" N – 135°29'01"W
B – 09	New	69°08'08" N – 135°30'57" W
K – 09	New	69°08'39" N – 135°16'52" W
M – 49	New	69°08'52" N – 135°26'54" W
Napartok Preliminary Wellsite Locations		
N – 03	New	68°32'59" N – 134°31'24" W
A – 56	New	68°35'08" N – 134°28'01" W
F – 29	New	68°28'19" N – 134°36'24" W
B – 12	New	68°31'01" N – 134°33'33" W

8.0 TRADITIONAL AND OTHER LAND USES

Petro-Canada's proposed program falls within the Tuktoyaktuk, Inuvik and Aklavik Conservation Planning Areas as defined by the respective Community Conservation Plans (TCCP, IICCP and AICCP 2000). The community conservation plans identify two management categories of lands (C and D) that coincide with the proposed project area. These categories are:

> Category C: Lands and waters where cultural or renewable resources are of particular significance and sensitivity during specific times of the year. These areas shall be managed so as to guarantee the conservation of the resources.
>
> Category D: Lands and waters where cultural or renewable resources are of particular significance and sensitivity throughout the year. These areas shall be managed so as to eliminate, to the greatest extent possible, potential damage and disruption.

The proposed program area is situated within or adjoins three Special Management Areas. The location of these areas is explained in Table 7, and their significance is discussed below. Mitigative measures are discussed in Section 12.0, Proposed Mitigation and Anticipated Environmental Impacts.

TABLE 7

SPECIAL MANAGEMENT AREAS WITHIN OR NEAR THE PROJECT AREA*

Site Number And Protective Status Category	Name	Location Description	Location In Relation To Project
304C	Spring Goose Harvesting	Islands in the western portion of the Mackenzie River Estuary, from eastern Richards Island along the coast, including all of the Tuktoyaktuk Peninsula, to Mason River Estuary, and the Husky Lakes. Other areas include sections of the Miner River, Anderson River and Gossley Lakes.	Overlaps with both Kurk and Napartok wellsite options.
312C	Fall Goose Harvesting	All of the coastline from Yukon/Alaska border in the west, to the Mason River in the east, including sites on Anderson River and Crossley Lakes.	Overlaps with both Kurk and Napartok wellsite options.
718D	Central Mackenzie Estuary	Lands and waters defined by the eastern edge of Mackenzie Bay, bordered to the south by Reindeer Channel, with the eastern border as Main Channel, with an extension along the East Channel.	Overlaps with both Kurk and Napartok wellsite options.

* AICCP, IICCP and TCCP, 2000

Petro-Canada's proposed program area coincides with important wildlife habitat, the Central Mackenzie Estuary (718D). The Central Mackenzie Estuary is a concentration area for beluga. The area also provides a transit area between Shallow and Kugmallit bays for local people. The region is used extensively by feeding anadromous coregonids and provides overwintering and nursery areas for a variety of fish. (IICCP 2000).

Petro-Canada's proposed drilling program also coincides with important traditional harvesting areas. The region is extensively used to harvest goose in the spring and fall (304C and 312C). This harvesting activity lies outside winter operations and is unlikely to be affected by drilling activities. If habitat is affected by winter activities, species availability for harvesting would be similarly affected beyond the operational period.

Assessing the level and permanency of the impacts of the proposed project is made difficult by a lack of comprehensive analysis illustrating the intensity of traditional harvesting of various species, by season and by location. The Joint Secretariat has data for Harvest Studies conducted throughout the area and would like to analyze the available data to determine the intensity of traditional harvesting. However, the continued uncertainty regarding the future of the Harvest Study has delayed further analyses (Slack, Pers. Comm.).

Consumptive (hunting and fishing), nature and adventure tourism is quite limited. Some activity has been noted in nearby portions of the Mackenzie River departing from Inuvik (NWT Arctic Tourism 1998). There is sport hunting and wildlife viewing associated with the caribou herds nearby (AICCP, IICCP, and TCCP 2000). Cabins are situated along the river valley and several cabins are located within the vicinity of the proposed Napartok wellsite. Table 8 provides information on the Northwest Territories Hunting Regulations for non-land claim beneficiaries (RWED 1999). These hunting areas extend beyond the boundaries of the proposed program area so the occurrence of some species (e.g., polar bear) within the proposed program area is unlikely.

TABLE 8

SEASONS FOR PERMITTED HUNTING AND HARVESTING

Species	Hunting Area	Season	
Barren ground caribou	I/BC/06	Residents:	August 15 – November 15
		Non-Residents:	August 15 – October 31
		Non-resident Aliens:	August 15 – October 31
Moose	I	Residents:	July 25 – April 30
Polar Bear	I/PB/03	Residents:	December 1 – May 31
		Non-Residents:	December 1 – May 31
		Non-resident Aliens:	December 1 – May 31
Wolf	I/WF/05	Residents:	August 15 – May 31
		Non-Residents:	August 15 – May 31
		Non-resident Aliens:	August 15 – May 31
Wolverine	G	Residents:	July 25 – April 30

Since the Petro-Canada drilling program will be conducted during the winter months, impacts to the traditional harvest of fish and wildlife will be minimized although access to common hunting areas may require crossing the proposed program area. Petro-Canada has undertaken consultation with local Hunters and Trappers Committees to inform them of ongoing exploration activities that may impact their traditional activities, and solicit comment in that regard. Special management areas within or near the vicinity of the project area are shown in Figure 4.

Inuvialuit Environmental & Geotechnical Inc.

Special Management Areas Surrounding or Adjacent to Proposed Project Area

Scale 0 10 20 Kilometres

Sources: Maps of Mackenzie Delta 107C and Aklavik 107B; TCCP 2000

Legend:

302C, 303B, 304C, 305C, 316C, 711E, 310C, 728D, 315C, 311C, 716CE, 712C, 715C, 704C, 309C, 706D, 307C, 323C, 308C, 718D, 720DE, 725D, 705D, 314C, 701B, 702B, 312C, 723C, 719C, 714CDE, 729D, 306C

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Figure 4

9.0 DEVELOPMENT TIMETABLE

Table 9 provides the proposed schedule for the Petro-Canada Kurk/Napartok Winter 2001/2002 drilling program. Petro-Canada is proposing to commence groundwork in December 2001.

TABLE 9

DEVELOPMENT SCHEDULE

Project Activity	Estimated Time Frame
Planning	Ongoing
Ice Access and Lease Construction	November 2001 – January 2002
Mobilization to Kurk	January 2002
Camp Set-up	January 2002
Well Drilling (Kurk)	January – February 2002
Move to Napartok	February 2002
Well Drilling and Possible Testing	February – March 2002
Move to Summer Location	April 2002
Final Clean-up	Dependant upon ice conditions.

* Time lines given in the above table are approximate and subject to change depending upon variables such as weather or ice thickness on proposed routes of travel.

10.0 NEW TECHNOLOGY

The drilling operation will use standard industry practices and technology, and no new technologies will be utilized. These options have been selected because of their successful track record in the north.

11.0 ENVIRONMENTAL OVERVIEW

11.1 Methods

The baseline information provided in this report was synthesized from existing literature, field surveys conducted during summer 2001, a field reconnaissance conducted by the the Operators and personal communications with local experts, regulatory agency representatives and knowledgeable professional biologists. This information was augmented by informal discussions with local residents regarding Traditional Ecological Knowledge. Literature was collected from community reports obtained from the Joint Secretariat in Inuvik, and from the Arctic Institute of North America library, located at the University of Calgary.

A summary of the physical and biological character of the region was then adapted specifically to the proposed program to fully assess design-related issues and suitable mitigation. The physical descriptions include the physiography and geology, hydrology and climate. The species descriptions provided below

highlight the life cycle and habitat requirements that could be vulnerable to specific interactions with the proposed program for only those species that are deemed important to local peoples based on Community Conservation Plans and through community consultations, along with COSEWIC listed species.

11.2 Physiography and Bedrock Geology

The Kurk drilling area of the proposed Petro-Canada Kurk-Napartok winter drilling program is located in the Tuktoyaktuk Coastal Plain Ecoregion of the Southern Arctic Ecozone, with the Napartok drilling area located in the Mackenzie Delta Ecoregion of the Taiga Plains Ecozone. The Tuktoyaktuk Coastal Plain Ecoregion covers the outer Mackenzie Delta (including Richards Island and Big Lake Delta Plain) and Tuktoyaktuk Peninsula bordering the Beaufort Sea (ESWG 1995). The Mackenzie Delta Ecoregion covers the lower two-thirds of the Mackenzie Delta bordered by the Richardson Mountains to the west and the Caribou Hills to the east. The geology of the region is variable due to differences in the extent of glaciation events.

There are two main landscape types in the Tuktoyaktuk Coastal Plain Ecoregion. The first is associated with the active delta plain, and consists of low-lying (i.e. less then 4 m above sea level) deltaic sediments incised by a network of meandering channels and lakes (Todd and Dallimore 1998). These landforms include active alluvial channels, estuarine deposits and wetlands. Wetlands cover 25-50% of the area. They are classified as lowland polygon fens, both the low- and high-centre varieties (ESWG 1995). Numerous tundra polygons have been identified on Big Lake Delta Plain, and are characteristic of poorly drained areas and former lake bottoms (Taylor et al. 1996). The second landscape type consists of broadly rolling uplands, generally 30 m above sea level, that have been modified by glacial and perigrlacial processes (Todd and Dallimore 1998). Discontinuous morainal deposits mantle much of the area, except near the coast where fine-textured sediments cover the surface. Occurring less frequently are outwash aprons of crudely-sorted sand and gravel, and raised beach ridges along the shores of preglacial lakes. The resulting undulating terrain is studded with innuerable lakes and ponds. Pingos, some very large, also form unique features in the landscape (ESWG 1995), although no pingos are evident from current topographic maps in the vicinity of the proposed Petro-Canada program area.

In addition, the region is underlain by continuous permafrost with sediments often containing excess ice (i.e. they would be supersaturated with water if they melted) in the form of ice veins, lenses, wedges and massive ice (Mackay et al. 1972). Deformation in the form of folding or faulting occurs locally in the sediments and associated ice layers, and is thought to have resulted from glacial ice-thrust (Mackay et al. 1972).

The Quaternary surficial geology of the outer Mackenzie Delta consists of Holocene deltaic and floodplain sediments from the modern surface of the Mackenzie Delta and the Big Lake Delta Plain, typically composed of interbedded silts and silty sands, and often ice-rich in the upper 30 m (Todd and Dallimore 1998). The Tertiary strata of the region are rarely exposed in outcrop. The most extensive outcrops are found in the Caribou Hills, comprising a diversity of delta plain sediments representing rapid fluctuations between terrestrial and marine paleoenvironments (Parsons and Norris 1999). The surficial

geology of the Tuktoyaktuk Coastal Plain reflects the fact that the most recent glaciation did not extend over much of the northernmost part of the area, with older Wisconsinan deposits dominating, and some younger Holocene lacustrine deposits occurring mainly in thermokarst basins (Taylor et al. 1996). Sediments in the Tuktoyaktuk Coastal Plain are predominantly composed of late glacial till or glaciofluvial sand and gravel (Todd and Dallimore 1998).

The Mackenzie Delta Ecoregion is a complex area of peat-covered deltas and fluvial marine deposits. The present delta is unique for its multitude of lakes and channels. Wetlands extend over 50% of the ecoregion, and are characteristically polygonal peat plateau bogs with ribbed fens (ESWG 1995). The Taiga Plains feature typically subdued relief consisting of broad lowlands and plateaus incised by major rivers, the largest of which show elevation differences of several hundred metres (ESWG 1995). Low-lying deltaic sediments, often less than 4 m above sea level, are typical of the Napartok drilling area of the proposed program (Todd and Dallimore 1998). The nearly level to gently rolling plain is underlain by horizontal sedimentary limestone, shale, sandstone and conglomerates, and is covered with organic deposits, and to a lesser degree, with undulating to hummocky fluvioglacial, marine and lacustrine deposits (ESWG 1995). Holocene alluvial deposits and floodplains are common along the major river systems, including braided networks of abandoned channels (Taylor et al. 1996).

Several glaciation events in the region have left behind glacial moraine areas of deposited sand, gravel and boulders. These features occur in various forms and thicknesses, such as elongated ridges (eskers and drumlins) and undulating and low-relief hills (ESWG 1995). The Taiga Plains Ecozone is underlain by extensive discontinuous permafrost with low to medium ice content, and is characterized by sparse ice wedges (ESWG 1995).

The hydrocarbon-bearing sequence of the outer Mackenzie Delta and Tuktoyaktuk Peninsula has been identified as an upper layer of weakly consolidated to unconsolidated sandstone and conglomerate, and includes the uppermost Quaternary sediments of the area. Underlying this is a layer of primarily fine-grained siltstone and shale. The boundary between the two layers marks a widespread regional erosional surface (unconformity). To the east of the Mackenzie River Middle Channel a break in the unconformity between sequences occurs, resulting in difficulties in describing the subsurface (Todd and Dallimore 1998).

11.3 Soils

Soils of the proposed Petro-Canada program area have resulted from prolonged cryoturbation, low temperatures, and low permeabilities in the mostly fine-textured soils (Timoney et al. 1992). Regosolic Static and Gleysolic Static Cryosols with Organic Cryosols developed on level fluvioglacial, organic, and marine deposits are the dominant soils of the Mackenzie Delta Ecoregion. These soils are underlain by an extensive layer of discontinuous permafrost. The soils of the Mackenzie Delta are relatively infertile and macronutrients may be largely unavailable to most plants (Pearce et al. 1988). The dominant soils of the Tuktoyaktuk Coastal Plain Ecoregion are Organic and Turbic Cryosols developed on level to rolling organic, morainal, alluvial, fluvioglacial and marine deposits (ESWG 1995). These soils are underlain by a continuous layer of permafrost and are often water-logged due to impeded drainage. The organic soils

found in the eskers of this ecoregion are generally shallow, highly acidic and nutrient-poor. The mineral soils are also poorly developed and often frozen (ESWG 1995). The low organic matter content of these predominantly mineral soils is associated with low levels of biological activity, limiting the soil capacity to recover quickly from anthropogenic disturbance and pollution (Stonehouse 1999).

The depth of the active layer (i.e. the portion of soil that thaws seasonally) varies greatly with the angle of exposure to the sun, the degree of shading, the texture of the soil and the water content of the soil (Mackay 1995). In well-drained sand or gravel, the seasonal thaw may be relatively deep, whereas in wet peaty soils the summer thaw penetrates only a short distance (Porsild and Cody 1980). Poorly-drained soils overlying ice wedges are associated with unique physical processes, such as active frost churning that modifies both soil and parent material, and vertical cracking of the soil that results in the inflow and subsequent freezing of water fingers and provision of an additional moisture source to the soil upon thaw (Brown 1967).

Hummocks are the most abundant soil microrelief feature of the Tuktoyaktuk Coastal Plain Ecoregion, and are particularly evident in the environs of Inuvik (Mackay 1995). Over this area, hummocks are generally composed of fine-grained frost-susceptible soils that have been upwardly displaced, and range from those that are completely vegetated (earth hummocks) to those with bare centres (mud hummocks) (Mackay 1980). This process of soil displacement is most active during the summer thaw period (Mackay 1980). Sedge dominated vegetation communities are usually found in the depressions surrounding hummocks (Mackay 1995). Hummocks found in the program area are very stable, and may persist for several thousands of years. Thermal disturbance to hummocks causes a loss of the mound form, however regeneration of hummocks has been observed (Mackay 1980).

11.4 Permafrost

Permafrost is defined as sediments which remain below 0°C for two or more years (Taylor et al. 1996). In the Mackenzie Delta, permafrost is discontinuous with low to medium ice content, while in the Tuktoyaktuk Coastal Plain permafrost occurs beneath all terrestrial and many subaqueous areas. The permafrost layer often lies just a few centimetres below the surface and acts as a dam that stops the downward flow of water. Consequently, the soils are often waterlogged or frozen, even though there is little precipitation. The widespread occurrence of continuous permafrost in the area raises concerns for development, as ice-bonding in the soil matrix can dramatically alter the physical, geophysical and engineering properties of frozen sediments (Todd and Dallimore 1998).

Ice-rich soils are maintained by extensive vegetation cover. The top layer of vegetation provides a thermal barrier that acts as protection against permafrost degradation. However, these soils are susceptible to permafrost degradation as a result of erosion and increased temperatures. Vehicle and equipment traffic and soil excavation can disturb the surface layer and degrade the permafrost (UMA 1999). Considering the implementation of mitigative measures and careful project timing, permafrost should be protected.

In the Southern Arctic Ecozone, permafrost thickness increases rapidly from the delta to the Tuktoyaktuk coastlands, with thicknesses increasing from 50 m to 500 m over just a few kilometres (Todd and Dallimore 1998). In the Holocene Mackenzie Delta, maximum permafrost thickness is less than 100 m, increasing to maximums of 500 m and 750 m in the Big Lake Delta Plain and the Pleistocene Tuktoyaktuk Coastal Plain, respectively (Taylor et al. 1996, Todd and Dallimore 1998). Areas that experienced submersion tend to have a horizontally persistent unfrozen zone (talik) within the main permafrost body, while sections that experienced brief or no submersion, such as the Tuktoyaktuk Peninsula, display more laterally variable ice-bonding, with talik completely absent (Todd and Dallimore 1998).

Permafrost characteristics are determined by the duration of submersion and the duration and time of subaerial exposure of the ground. It is generally agreed upon that most of the Tuktoyaktuk Peninsula escaped glaciation during the late Wisconsinan (the interval of the last ice sheet) (Mackay et al. 1972). The great thickness of permafrost in this area is consistent with prolonged exposure to subaerial temperatures during Wisconsinan times (Taylor et al. 1996). The Tuktoyaktuk Peninsula contains numerous lakes formed through the melting of the upper portion of the underlying permafrost layer.

In all areas where permafrost is prevalent, permafrost-related processes such as solifluction and soil creep, ice wedge formation, frost shattering of boulders, pingo formation and the heaving of areas formerly covered by water bodies, have a major effect on shaping the landscape (Rampton and Bouchard 1975). Repeated freezing and thawing of these soils creates features on the surface that include cell-like polygons, bulging hummocks, and bare mud boils where the soil is so active that no plants can take root. Intense frost heaving often splits apart the underlying bedrock and forces large angular boulders to the surface (ESWG 1995).

A number of factors influence the mean annual ground surface temperatures, including past glaciation events, climate change, sea level variation, proximity to heat sources such as rivers, channels or lakes, the formation of seasonal ice in areas of standing water, and the effects of vegetation (Taylor et al. 1996, Todd and Dallimore 1998). Thaw of ice-rich permafrost typically results in varying degrees of ground subsidence, collapse of hummocky microrelief, addition of thaw water to the bottom of the active layer and rapid growth of water-loving vegetation such as sedges, alders and willows.

11.5 Hydrology

The Tuktoyaktuk Coastal Plain is strewn with a large number of typically shallow, interconnected lakes that drain into the southern Beaufort Sea through small streams that freeze to the bottom in winter. These lakes cover 30 to 50% of the surface area of the Tuktoyaktuk Peninsula (Ramlal et al. 1994), and are often connected by ephemeral streams. The lakes of the area, known as thermokarst lakes, were predominantly formed through local melting of the uppermost part of the underlying permafrost layer, and subsequent settling of the ground (Dome et al. 1982a). Few lakes in this area were formed by glacial action. While these lakes are generally shallow (few exceeding 3 m in depth), they play a significant role in the ecology of the coastal plains, supporting populations of fish, waterfowl and mammals, and providing storage for water, sediment and pollutants (RWED 1999).

Lakes on the Tuktoyaktuk Coastal Plain tend to remain ice-covered for around 250 days a year, with freeze-up generally occurring in September or October and break-up occurring in late June (Bond and Erickson 1985, Bigras 1990). Break-up on the peninsula is caused by melting, as opposed to flooding of the ice by a warmer water body, as in the Mackenzie Delta. The slower process of ice melting and the lack of a flood regime on the Tuktoyaktuk coastal and tundra lakes contribute to greater year-to-year variability in measured physical properties, such as temperature, pH, and conductivity, compared to lakes of the Mackenzie Delta (Fee et al. 1988). Precipitation and evaporation are the main controls over lake water level. Some lakes lose more water to summer evaporation than is received through precipitation, causing them to have a negative annual water balance (Bigras 1990).

Streams in the coastal plains region begin to flow in mid June, several weeks before the landfast sea ice breaks up, thereby contributing to the freshwater corridor produced by the Mackenzie River along the coast of the Tuktoyaktuk Peninsula that is used by both migratory freshwater and anadromous fish (Bond and Erickson 1985). Water levels in the lower reaches of the creeks can rise substantially due to storm surges, despite the low tidal activity measured at Tuktoyaktuk (Chang-Kue and Jessop 1992).

The Mackenzie River is the longest river in Canada, flowing northwest over a stretch of 1700 km from its headwaters in Great Slave Lake to its mouth at the Beaufort Sea (Bigras 1990). The poorly formed levees of the estuarine Mackenzie Delta were formed largely from sediments transported by the Mackenzie River over the last 13,000 years. The southwest sector of the delta also receives sediment from the Peel and Rat rivers. The delta is active and builds forward into the Beaufort Sea during the open water season from June to October (Bigras 1990).

The delta is a dynamic complex of lakes and ponds, islands and tidal flats, braided channels and oxbows. The Mackenzie River is the main driving force, introducing large amounts of water, sediment and energy to the delta. The major channels appear largely unchanged in the last century, with the Middle, East, and West channels primarily controlling the hydrologic regime of the delta lakes (MRBC 1981). However, the main channel water level regimes vary significantly over the north-south and east-west extent of the delta due to changes in levee heights, ice jamming and inflow to the delta (Marsh and Hey 1989). The hydrologic regime is the primary factor controlling vegetation and wildlife habitat in the area (MRBC 1981) and the productivity of the delta ecosystem (Marsh and Hey 1989). Flooding of the Mackenzie River, precipitation, and evaporation control the water levels of approximately 25,000 delta lakes. Changes in these controlling factors particularly affect sensitive high elevation lakes; without flooding, these lakes would dry up rapidly. Spring flooding of the delta by the Mackenzie River adds sediments and nutrients to the lakes (Marsh and Lesack 1996). While these lakes are generally shallow (few exceeding 3 m in depth), they play a significant role in the ecology of the delta, affecting the distribution of permafrost, supporting populations of fish, waterfowl and mammals, and providing storage for water, sediment and pollutants (RWED 1999).

The greatest hydrological activity on the delta occurs over the period from early May to September, encompassing the initial rise of water level and flooding of delta lakes, the spring peak, and the summer period, with fluctuating water levels. A remarkable feature of the water level regime in the delta is the

consistency of the timing of the spring flood from year to year. It generally occurs over a 20 day period from late May to early June (Marsh and Hey 1989).

Water levels in the Mackenzie River and adjoining channels vary dramatically with climatic changes and ice regimes. Spring break-up in the delta is the most dynamic and important hydrological event of the year, dominating the hydrologic regime of delta lakes (Bigras 1990). A short-term rise in water level occurs with initial freeze-up, followed by low levels persisting for the remainder of winter. The water levels then rise rapidly due to snow-melt in the southern part of the delta and from ice jams in the main channels of the delta (Marsh and Hey 1989). Depending on the strength of local ice jams during the spring break-up period the peak water levels can last from 3 to 45 hours (Bigras 1990). Once the ice jams fail there is a downstream surge of floodwater, and lake levels begin to drop rapidly (Bigras 1990). The Mackenzie Delta lakes store large volumes of water during the spring break-up period (Marsh and Hey 1989). The magnitude of the spring flood varies greatly from year to year, and as a result not all lakes are flooded annually (Marsh and Hey 1989). Whereas the spring break-up period is dominated by snow-melt runoff and ice jamming, the summer period is mainly controlled by rainfall runoff (Marsh and Hey 1989). During summer, water levels may rise in response to rainstorms upstream and along the delta, and some lakes may be flooded again during these rain-induced peaks (Marsha and Hey 1989). Some lakes lose more water to summer evaporation than is received through precipitation, causing them to have a negative annual water balance until flooding occurs (Bigras 1990). Water levels in the northern portion of the delta may also change due to tidal activity and storm surges of the Beaufort Sea (RWED 1999). Storm surges result from wind stress on the water surface, causing a strong net displacement of water and resulting in either a rise or fall of the water surface. The largest storm surges occur during the open water season, but surges have also been observed during the ice-covered period (Marsh and Schmidt 1993). During winter the lake-connecting channels are generally filled with ice and snow, preventing water movement between the main channels and most of the delta lakes (Marsh and Hey 1989). The shallow lakes are ice covered for up to 8 months of the year (Bigras 1990).

The flooding of lakes in the Mackenzie Delta is controlled by four basic factors. The first is the water level regime of the delta distributary channels. The second is the nature of connecting channels joining a lake to a distributary channel. The third factor is the distance of the lake from a distributary channel. The fourth factor is the elevation of the lake relative to the distributary channels. The frequency and duration of lake flooding varies with elevation, with annual flooding of lower elevation lakes occurring for relatively long durations, and infrequent flooding of higher elevation lakes for shorter periods of time (Marsh and Hey 1989).

Lakes of the delta can be considered either connected or perched, depending on their geomorphic or hydrologic characteristics (Bigras 1990). A connected lake is one with a well-defined, water-filled channel connecting it to the main delta channel from break-up to freeze-up. These lakes are constantly interchanging water with delta channels and the lake level is similar to the distributary channel throughout the open water period. A perched lake is one that is not directly connected by a channel, is isolated atop levees, and is cut off from other lakes and channels except during flooding (Bigras 1990). The hydrologic regime of connected lakes is more complex than perched lakes due to the connection to the main delta channels. Discharge through distributary channels is responsible for the majority of the annual water loss

rather than evaporation (Bigras 1990). Due to present climatic and hydrologic conditions most perched lakes are flooded with a frequency of between 2 and 10 years and only have a slightly negative water balance between floods (Marsh and Lesack 1996). Connected lakes do experience occasional summer flooding as a result of high flow events or storm surges (Bigras 1990).

11.6 Climate

The Tuktoyaktuk Coastal Plain and Mackenzie Delta Ecoregions are classified as having a low arctic ecoclimate. The climate is largely controlled by the movements of cold maritime arctic and continental arctic air masses. The mean annual temperature is approximately –9.5°C to –11.5°C, with a mean summer temperature of 4.5°C to 8.5°C, and a mean winter temperature ranging from –24°C to –26.5°C, for the Tuktoyaktuk Coastal Plain and Mackenzie Delta Ecoregions respectively (ESWG 1995). Winters in this area tend to be quite long as there is an approximately two month period during which the sun does not rise above the horizon. During this period very cold conditions prevail and may last for several weeks at a time.

When temperatures reach such lows, the ability of the air to contain moisture is limited and very little precipitation falls. Precipitation mainly falls as rain, and while it is highly variable in the coastal and delta regions, there is a general increase in amount of precipitation from the coast southwards. The mean annual precipitation for the Tuktoyaktuk Coastal Plains and Mackenzie Delta ranges from 125-200 mm to 200-275 mm respectively (ESWG 1995). Areas modified by open water tend to receive the most precipitation during summer and autumn before freeze-up, while areas further inland have a higher frequency of precipitation during autumn and winter (Dome et al. 1982a). Thunderstorms seldom occur in the area (Dome et al. 1982a).

Snow and freshwater ice persist for six to eight months of the year. When the sun begins to rise above the horizon (January), the increased amounts of heat dissipate the high-pressure centre and storms prevail. By June most of the snow has melted, though lake ice may persist until July. The mean annual number of frost-free days varies from approximately 12 to 15 days on the coast, compared to about 50 days at Inuvik (Dome et al. 1982a).

The normal airflow direction over the region is westerly in summer and northwesterly in winter, with potentially severe weather resulting from deviations in this pattern (Dome et al. 1982a). Winds are often influenced by local topography and vegetation cover. Considerable variation can therefore occur over this region, particularly between coastal and inland areas. Generally, the wind strength and duration decrease from the coast southwards. While high-pressure centres are dominant, low-pressure systems moving across the Beaufort Sea mainly in January and March produce blizzard conditions along the coast and within the Mackenzie Delta. Spring progresses gradually from south to north with a distinctive eastward movement of the high-pressure system. Spring is also typified by increased precipitation moving from northern Alaska through the Mackenzie Valley. As a result of ice break-up along the coast during late spring and early summer the climate changes from arctic to more maritime (Dome et al. 1982a).

The proximity and influence of the Beaufort Sea is evident in lowered air temperatures and frequent coastal fogs during the summer months (Haag and Bliss 1974). Arctic air masses generated from the pack ice are moderated during transit across open water, and further warming occurs as the air travels across the Tuktoyaktuk Coastal Plain, resulting in increased precipitation in this area. In autumn the dominant airflow direction shifts, becoming easterly, and temperatures fall with freeze-up and the advance of arctic air (Dome et al. 1982a). In the delta and coastal areas, the extent of reduced visibility due to advection fog, ice fog, steam fog, ice crystal haze, blowing snow and whiteouts, varies with season and location (Burns 1974 *in* Dome et al. 1982a). Advection fog is most common during the summer, whereas the most common forms of visual obstruction in the winter are steam fog, ice crystal haze, blowing snow and whiteouts (Dome et al. 1982a).

11.7 Vegetation

Permafrost limits soil productivity by cooling the soil and creating waterlogged conditions in the thawed active layer near the soil surface (Stonehouse 1999). Plant communities in the arctic therefore are relatively simple and dominated by a few species that are well adapted to poor soil conditions and the harsh climate.

No distinct succession of plant species is observed on the tundra of the Tuktoyaktuk Coastal Plains, due to the relatively infrequent occurrence of natural disturbances, such as fire, that create places for plants to grow (Wein 1976). Germination from seeds or vegetative growth is minimal, and depends heavily on both site and temporal characteristics (Bell and Bliss 1980, Hobbie and Chapin 1998). Therefore, plant recruitment becomes an opportunistic process (Svoboda and Henry 1987).

Plant diversity is relatively limited on the tundra. The major community type on the tundra is dwarf shrub-heath, which covers 77% of the vegetated surface, while tussock tundra covers 14%, sedge meadows 6%, and lake-edge communities only 3% (Hernandez 1973). The dwarf shrub-heath community is dominated by dwarf birch (*Betula nana*) smooth willow (*Salix glauca*), crowberry (*Empetrum nigrum*), lingonberry (*Vaccinium vitis-idaea*), northern Labrador tea (*Ledum palustre decombens*), mosses and lichens. Sedge meadows are dominated by *Carex* spp., mosses, and lake-edge communities. Corns (1974) also identified low-shrub heath as a dominant community type on hilltops throughout the Tuktoyaktuk Peninsula. Due to lack of snow accumulation on windswept hilltops, this community type is generally quite dry.

Where raised-centre polygons occur, moist conditions in the depressions between polygons result in vegetation that is generally richer than that of the well-drained areas, especially when there is standing water in the depressions (Corns 1974). The depressions are dominated by alpine bearberry (*Vaccinium uliginosum*), leatherleaf (*Chamaedaphne calyculata*), stiff sedge (*Carex bigelowii*), dwarf bog rosemary (*Andromeda polifolia*), and a carpet of sphagnum moss. In very wet depressions, species such as pendent grass (*Actophila fulva*), water sedge (*Carex aquatilis*) and tall cotton grass (*Eriophorum angustifolium*) are found. Dwarf birch, cloudberry (*Rubus chamaemorus*), Labrador tea (*Ledum palustre*), and lingonberry grow primarily on the high points of land.

The Forest Management Institute (FMI) (1974) identifies two main vegetation community types: 1) high and low shrubs; upland; and good drainage, and 2) low shrubs, moss, lichen and grass; variable to flat terrain; and poor drainage. In both upland and lowland tundra communities soil moisture is the most important environmental influence on vegetation (Sheard and Geale 1983). Plants typically establish in openings on moss or lichen mats, or in desiccation cracks where moisture levels are most constant (Bell and Bliss 1980). Soil characteristics related to depth of the permafrost layer are the second most important influence on vegetation (Sheard and Geale 1983).

The Mackenzie River Delta is a northward extension of the boreal forest due to the warming influence of the Mackenzie River, and therefore has a relatively rich flora compared to the adjacent tundra (Gill 1973). There is a distinct succession of plant species that result on the Delta, which is initiated by flooding.

Five successional stages are represented with increasing distance from river channels, distributaries, and tributaries (Gill 1973). The first stage, which is closest to the water, occurs when water horsetail (*Equisetum fluviatile*) colonizes freshly deposited sediments. It is replaced further inland by a *Salix-Equisetum* association, in which felt leaf willow (*Salix alaxensis*) forms the canopy and common horsetail (*Equisetum arvense*) makes up the understorey. These early stages of succession are maintained by frequent flooding.

After the *Salix-Equisetum* association builds up to a maximum height through alluviation, it is replaced inland by a *Populus* association (Gill 1973). The *Populus* association consists of a Balsam poplar (*Populus balsamifera*) overstorey, with an understorey of willow spp. (*Salix alaxensis*, *S. glauca*, *S. pulchra*, and *S. arbusculoides*), and an herb layer consisting of alpine hedysarum (*Hedysarum alpinum*), arctic bearberry (*Arctostaphylos rubra*), wormwood (*Artemesia tilesii*), and *Equisetum arvense*. Inland from the *Populus* association are low areas caused by channel shifting. These low areas are moist, and the vegetation therefore undergoes some changes to form the decadent *Populus* association. In this association, the poplars die because the soils are too wet, whereas the number of willow species increases (*Salix alaxensis*, *S. abrbusculoides*, *S. richardsonii*, *S. glauca*, and *S. barclayi*). The herb layer includes *Equisetum arvense* and cottongrass (*Eriophorum angustifolium*). There is also a thin moss layer made up of golden moss (*Tomenthypnum nitens*), sickle moss (*Drepanocladus uncinatus*), and erect-fruited iris moss (*Distichium capillacem*).

Lastly, the *Picea* association forms well above flood levels, and farthest from the water (Gill 1973). The Picea association consists of a white spruce (*Picea glauca*) overstorey. It is associated with an understorey of green alder (*Alnus crispa*), smooth willow (*Salix glauca*), shrubby willow (*S. arbusculoides*), diamond-leaf willow (*S. pulchra*), *S. alaxensis*, Richardson's willow (*S. richardsonii*), and Barclay's willow (*S. barclayi*). The herb layer is dominated by *Arctostaphylos rubra* and large-flowered wintergreen (*Pyrola grandiflora*), and also includes *Hedysarum alpinum*, valerian (*Valeriana capitata*), alpine bearberry (*Arctostaphylos alpina*), prickly rose (*Rosa acicularis*), and one-flowered pyrola (*Moneses uniflora*). There is also a thin layer of mosses including *Tomenthypnum nitens*, feathermoss (*Hylocomium splendens*), *Drepanocladus uncinatus* and *Distichium capillaceum*.

Spruce forests are long-lived, with more than half the trees being older than 200 yrs (Pearce et al. 1988). However, when the trees do eventually senesce and die, they are rarely replaced by other spruce trees. The insulating effect of the vegetation, which has built up over centuries, decreases soil temperatures

making it too cold for spruce trees to germinate (Hobbie and Chapin 1998). Consequently, the areas once occupied by spruce forests are colonized by a cold tolerant, tundra-like community of plants to become open spruce/lichen-heath or spruce/bog woodlands (Pearce et al. 1988). Maintenance of spruce forests requires some sediment deposition from flooding, which is unlikely given its height above flood level (Pearce et al. 1988).

A similar vegetation pattern exists as the Mackenzie Delta empties into the Beaufort Sea. Flooding becomes more prevalent closer to the sea, and consequently the vegetation there rarely reaches late successional stages. The inner delta is dominated by spruce forest. In the northern parts of the inner delta there is a shrub zone (dominated by *Salix* spp.). The outer delta and seaward alluvial islands are home to hardier, flood resistant plants.

When there are fires, the mineral soil is exposed, resulting in higher soil temperatures. There is, in turn, an increased probability of tree recruitment because of the more desirable soil conditions made possible by the higher temperatures (Stonehouse 1999). However, there is typically an increase in deciduous trees at the expense of spruce trees (Landhäusser and Wein 1993).

Six plant species of national significance are found in the Mackenzie Delta region (McJannet et al. 1995), and may occur in the Kurk or Napartok drilling areas (Table 10).

TABLE 10

VEGETATIVE SPECIES OF SIGNIFICANCE FOUND IN THE VICINITY OF THE PROPOSED PROJECT

Common Name	Latin Name	Phytogeography	Habitat	NCR[1]
Pussytoes	*Antennaria friesiana*	Arctic-alpine	Alpine ridges and snowbeds.	N3T1
Mustard	*Braya pilosa*	Arctic	Sandy seashores.	NX
Pondweed	*Potamogeton subsibiricus*	Aquatic	Still waters.	N2
Goose grass	*Puccinellia poacea*	Arctic	Riverbanks, flood plains and tidal flats.	N1
Buttercup	*Ranunculus pallasii*	Arctic-alpine	Coasts and estuaries	N2
Willow	*Salix ovalifolia* var. *arctolitoralis*	Arctic	Sand beaches and terraces.	N2T2

Notes:

1. The Nature Conservancy Ranks
   - Canada Rank (N): national status
   - Taxon Subrank (T): applied if a taxon is a subspecies or variety
2. The degree to which a species is imperiled is rated on a scale of 1 – 5 (from extremely rare to abundant), with X indicating the species is extirpated or extinct.

11.8 Wildlife

11.8.1 Mammals

The habitats in and around the proposed program area support a wide variety of mammals including arctic fox, caribou, grizzly bear, polar bear, wolf, moose, wolverine, beaver, and muskrat, among others. A number of these species are important to local subsistence harvesters as well as recreational users. Inuvialuit Wildlife and Environmental Monitors will be present during the program to help manage potential wildlife conflicts as the program progresses. Mammal species of significance, because of their sensitivity or importance for subsistence, are listed in Table 11 if they are potentially found in the general vicinity of the program area.

TABLE 11

MAMMALS OF SIGNIFICANCE FOUND IN THE VICINITY OF THE PROPOSED PROGRAM

Species	Habitat	Program Interaction	COSEWIC [1]
MAMMALS			
Arctic fox[2] (*Alopex lagopus*)	Widespread above treeline and coastal areas. Herschel Island to Shallow Bay, Kendall and Hooper Islands, parts of the Tuktoyaktuk Peninsula, and from Cape Dalhousie to Bathurst Peninsula.	Open tundra and coastal areas, including denning areas, in northern extent of program, particularly the Kurk drilling area.	Not listed
Beaver[2] (*Castor Canadensis*)	Shallow lakes and streams of the Tuktoyaktuk Coastal plain, Mackenzie Delta lowlands. Restricted in Beaufort Sea coastal areas to selected river valleys with significant woody vegetation.	Shallow lakes and streams in either drilling area with significant woody vegetation.	Not listed
Caribou[2] (*Rangifer tarandus*)	Hornaday, Brock and Horton Rivers area for calving, winter habitat northeast of Inuvik. Upland habitats with abundant lichen cover.	Cape Bathurst herd range nears western extent of program area.	Not listed
Grizzly bear (*Ursus arctos*)	Prefers open areas of alpine tundra, subalpine mountains or subarctic tundra. Richards Island, Kugaluk River, delta.	Critical denning habitat north of Caribou Hills located just east of Kurk program drilling area.	Special Concern
Muskrat[2] (*Ondatra zibethicus spatulatus*)	Mackenzie Delta, Mackenzie River Valley, coastal Beaufort region. Lakes and ponds with aquatic vegetation where water does not freeze to the ground.	Lakes and ponds of either drilling area.	Not listed
Polar bear (*Ursus maritimus*)	Southern broken edge of the arctic ice pack. Less use of delta region during summer and fall.	Landfast ice extent of both drilling areas as well as denning habitat within vicinity of the Kurk area.	Special Concern
Wolf[2] (*Canis lupus arctos*)	Treeline-tundra transition zone. Bluenose caribou wintering range. Caribou Hills.	Variable and infrequent.	Data deficient
Wolverine (*Gulo gulo*)	On tundra between treeline and arctic coasts. North Slope, Cache Creek, Sheep Creek, Big Fish River, Foothills west of Aklavik. Relatively few in delta.	Infrequent, natal dens in rocky scree slopes or large snowdrifts in either drilling area.	Special Concern

Notes:

1. Committee on the Status of Endangered Wildlife in Canada 2001.
   Special Concern = A vulnerable species because of characteristics that make it particularly sensitive to human activities or natural events.

Data deficient = A species for which there is insufficient scientific data to support status designation.
Not listed = A species which does not appear in COSEWIC documentation.

2. Species are included due to their listing in Community Conservation Plans as species of interest or declining in population.

Caribou (*Rangifer* spp.)

Three subspecies of caribou are found in the Inuvialuit Settlement Region: barren ground caribou (*Rangifer tarandus groenlandicus*), Grant's caribou (*R. t. granti*), and Peary caribou (*R. t. pearyi*). Barren ground caribou are the most abundant of these subspecies, and three distinct populations have been identified based on the location of their calving grounds: Bluenose-East, Bluenose-West, and Cape Bathurst. The proposed program area is in the vicinity of the Cape Bathurst range, bordering on its western extent.

The Cape Bathurst herd ranges eastward from Parsons Lake, northward to the north tip of Bathurst Peninsula, westward to the west bank of Bathurst Peninsula, and southward to the vicinity of Lost Reindeer Lakes (southeast of Inuvik) (RWED 1999). The combined population of these herds was estimated at 88,000 to 106,000 individuals in 1992 (AICCP, IICCP, and TCCP 2000).

Caribou are highly migratory, and migration routes are well established. In spring, cows lead the herds northward from wintering habitat in the boreal forest to calving grounds and summer ranges on the coastal tundra (Dome et al. 1982b). The migration tends to follow frozen lakes and rivers, as well as open, snow-free uplands and eskers (CWS 2000a). Important calving areas include the Brock, Hornaday, and Horton rivers (AICCP, IICCP, and TCCP 2000), located to the east and outside the proposed program area. Calves are born between late May and early June, and although only one calf tends to be produced per cow, healthy caribou are able to reproduce every year. Intensive grazing starts shortly after calving and continues throughout the summer. Herds move to mating grounds in October, and then return to the boreal forest. These herds overwinter north, east, and southeast of Inuvik (AICCP, IICCP, and TCCP 2000). In general, females and juveniles overwinter near the tree line, whereas males move farther into the forest (CWS 2000a).

While large-scale, semi-annual movements to calving and wintering grounds are somewhat predictable, the precise movements of caribou for the remainder of the year are extremely variable. Areas with thousands of caribou one year may have none the next (Case et al. 1996). This is likely in response to the availability of food and the extent of predation (Case et al. 1996). There is, however, high calving ground fidelity (Case et al. 1996, CWS 2000a).

Arctic Fox (*Alopex lagopus*)

The Arctic fox is widespread in northern Canada and are commonly found above treeline in tundra, forest-tundra, and often near coastal areas (Martell et al. 1984). Throughout most of their range, arctic fox are terrestrial animals; however, foxes from Arctic coastal populations generally move onto the nearshore landfast ice during winter (Dome et al. 1982a). In the Mackenzie Delta region Arctic fox are associated with coastal areas from Herschel Island to Shallow Bay, Kendall and Hooper Islands, parts of the Tuktoyaktuk Peninsula, and from Cape Dalhousie to Bathurst Peninsula (Martell et al. 1984). During

spring and summer they occupy areas near terrestrial denning sites, remaining there during the relatively snow-free period from May until August (Dome et al. 1982a). Den construction occurs in areas of early snow melt where soils are well drained and stable (Martell et al. 1984). Important known denning sites in the coastal Mackenzie Delta region includes the coast of Richards Island (Dome et al. 1982a).

Movements and fluctuations of coastal populations are related to the availability and abundance of prey species and appropriate denning sites (Macpherson 1969, Banfield 1974, Dickinson and Herman 1979 *all in* Dome et al. 1982a). Arctic fox may move great distances over the course of the year in response to low food supplies in customary hunting areas. In the southern Beaufort Sea region a regular migration occurs from Banks Island out to the sea ice in winter, with a return in the spring. Similar migrations occur off the outer Mackenzie Delta and Tuktoyaktuk Peninsula, at times in mass movements (Martell et al. 1984).

While historically a common species along the coast, the size and density of the Arctic fox population in coastal areas of the Beaufort Sea has not been documented (Dome et al. 1982a). The population status of Arctic fox can vary from year to year, and tends to display a cyclical relationship to prey abundance (CWS 1990). The size of weaned litters to be directly proportional to food availability (Martell et al. 1984). In particular, those populations depending mainly on lemmings as a food source exhibit a 'crash' and 'peak' cycle every three to four years in response to the lemming population cycle (CWS 1990). One estimation of the population following a crash was approximately 0.086 fox per square kilometre (Banfield 1974 *in* Dome et al. 1982a), while during years of peak lemming populations hundredfold increases in fox numbers are not uncommon (CWS 1990).

Arctic fox are mainly solitary until they form breeding pairs in mid February to late April, when mating takes place (Dome et al. 1982a). As landfast ice is at or near its maximum winter extent during this time, it can be assumed that courtship and mating often occurs offshore on landfast ice. Mating pairs then move onshore to occupy dens often excavated the previous summer, generally found in light, stable, sandy soils in river banks, eskers, or small hillocks (Banfield 1974 *in* Dome et al. 1982a). Litters of 8 to 20 young are born between mid May and mid June (TCCP 2000). In years of low prey abundance, the breeding season may be late or missed entirely (Banfield 1974 *in* Dome et al. 1982a). The weaned litter emerges from the den around mid July, and are abandoned by both parents by mid August (Banfield 1974 *in* Dome et al. 1982a).

Arctic foxes are highly opportunistic and are known to scavenge on the sea ice on the remains of seal carcasses killed by polar bears (CWS 1990, Dome et al. 1982a, Banfield 1974 *in* Dome et al. 1982a). While lemmings, Arctic hares, and ptarmigans are also available to hunt during the winter season, carrion plays a more important role in their diet. They also predate heavily on den-dwelling ringed seal pups in the spring (CWS 1990, Dome et al. 1982a, Banfield 1974 *in* Dome et al. 1982a). Foxes inhabiting coastal regions also hunt for fish, including burbot, Arctic cod, salmon, and char, as well as small marine animals and birds. During the summer coastal Arctic foxes live primarily on lemmings and other voles, fish, shorebirds and their eggs

Grizzly Bear (*Ursus arctos*)

There are three distinct populations of grizzly bears in the Inuvialuit Settlement Region: arctic coastal, arctic mountain, and barren ground. Both arctic coastal and barren ground grizzlies are found in the vicinity of the proposed program, residing year round, albeit in low densities. Particularly important habitat for these populations includes Richards Island, located just to the northeast of the proposed program area (TCCP 2000). The proposed program area also falls within the vicinity of critical denning habitat of the Richards Island-Tuktoyaktuk Peninsula range, which includes the area extending along the northernmost portions of Caribou Hills to the coast (TCCP 2000) (see Table 7, Section 8.0, Traditional and other Land Uses). The proposed Kurk drilling area falls within the Inuvik Grizzly Bear Management Area while the Napartok drilling area falls within the Aklavik-Inuvik Management Area.

Grizzly bears require large areas for feeding (Knight 1977). Grizzly bears are omnivorous; primarily feeding on vegetation but taking advantage of higher energy food sources when available (AICCP, IICCP, and TCCP 2000). They generally thrive best when anthropogenic disturbances are minimized (Knight 1977). Habitat structure is very important for territory selection. In all parts of their range, grizzlies prefer open or semi-open forests (Dome et al. 1982a). In contrast, dens are found in association with thick vegetative cover, particularly willow and alder, as this likely provides structural stability and aids in snow accumulation above the den (Harding 1976, Martell et al. 1984). Denning areas are quite specific and are usually found on banks of lakes, creeks, or rivers (Harding 1976, Martell et al. 1984), and occasionally in pingos or snowdrifts (Harding 1976). Grizzly bears typically den from October to May (AICCP, IICCP, and TCCP 2000). They breed in June and July, and females have a pair of cubs every four to five years (AICCP, IICCP, TCCP 2000).

Moose (*Alces alces andersoni*)

Moose are generally solitary, commonly ranging throughout the boreal forest and occasionally the forest-tundra transition zone and tundra areas (Kelsall 1972 *in* Dome et al. 1982a). During the spring, moose follow the river valleys to the Arctic Coastal Plain (Ruttan and Wooley 1974) where calving occurs in May or early June. Here, moose remain until late September, at which time breeding occurs (TCCP 2000). A single calf is typically born per female, although mature cows may have two calves (TCCP 2000).

Winter habitat is extremely important for moose because during this time they live off of fat reserves accumulated over the summer months (Gasaway and Coady 1974 *in* Dome et al. 1982a). Early successional-stage vegetation, such as that found in riparian areas or recently burned areas (willows, birch, alder), provides good quality winter moose habitat (Dome et al. 1982a). The bulk of their diet consists of shrub twigs, especially willow and riparian vegetation (Dome et al. 1982a). As such, burns that stimulate the regeneration of deciduous shrubs are very important as moose rely on young deciduous vegetation in both summer and winter. River valleys and associated floodplains provide the best year-round habitat, and are particularly important in winter (Watson et al. 1973).

The Mackenzie Delta region has been classified as poor winter range because of frequent flooding, deep snow, and lack of shelter from wind, however, areas along Holmes Creek and the lowlands adjacent to the

East Channel of the Mackenzie River are important moose habitat (Prescott et al. 1973b *in* Dome et al. 1982a). The quality of moose winter range is generally poor east of the Mackenzie Delta, encompassing habitat along the Miner, Kugaluk, Moose, Smoke, and Anderson Rivers (Prescott et al. 1973b *in* Dome et al. 1982a). The fast-flowing braided streams and rivers on the west side of the Mackenzie River provide optimum winter habitat because the annual torrents of meltwater and ice scour the banks and floodplains which keep the riparian vegetation at an early successional stage (Watson et al. 1973).

Muskrat (*Ondatra zibethicus spatulatus*)

In the ISR, muskrats occur in particular concentrations in the Mackenzie Delta and coastal Beaufort region, and along the Mackenzie River Valley (Dome et al. 1982a, 1982b, TCCP 2000). This species is likely most abundant in standing water habitats of the upper Mackenzie Delta and adjacent areas (Dome et al. 1982a, Martell et al. 1984). An intermediate number of muskrat pushups on Richards Island have been recorded (Slaney 1974a *in* Dome et al. 1982a).

Muskrats burrow into the banks of lakes and streams in areas where aquatic plants are accessible for food and building materials (Dome et al. 1982a, 1982b, Jelinski 1989). While muskrats are not migratory animals, seasonal differences in habitat use do occur. In the spring and summer virtually all suitable waterbodies are occupied (Westworth 1977). Severe climate in the arctic restricts the number of waterbodies suitable for muskrats (Dome et al. 1982a). The optimum depth of water required to support muskrat in winter is between 1.2 m and 3 m (Hawley 1974 *in* Dome et al. 1982a). Prior to the onset of winter, muskrats relocate to areas of deeper water, and burrow in higher, steeper banks (Dome et al. 1982a). This shift appears to maintain the accessibility of food, and allows muskrats to forage on high-energy roots and rhizomes of submerged aquatic vegetation, thereby increasing overwinter survival. Muskrats are able to swim considerable distances under the ice to reach foraging areas. The winter range is often extended by the construction of pushups, which are small mounds of vegetation and mud built over holes in the ice that afford cover for feeding (Dome et al. 1982a, 1982b, Martell et al. 1984). During the spring muskrats are highly mobile, feeding on submergent aquatic vegetation (Jelinski 1989).

Wolverine (*Gulo gulo*)

The distribution of wolverines is circumpolar in tundra and tundra-taiga zones (Landa et al. 1998). The species occurs at low densities and is a solitary resident of tundra, boreal forest, and mountainous regions (Banci and Harestad 1990). In the ISR, wolverines are found at low population densities throughout the tundra (Martell et al. 1984, Wilson et al. 2000, CWS 2000b). Wolverines are also found throughout the year in the forests of the Mackenzie Delta region (Martell et al. 1984) and along the Mackenzie Valley (Dome et al. 1982a, 1982b). Winter sightings have been made along the coast of Franklin Bay and east of Cape Bathurst (Martell et al. 1984).

While not considered migratory, the wolverine periodically roams over large areas in search of food (Wilson et al. 2000), and has been known to travel up to 45 km per day through dispersal corridors (TCCP 2000). Wolverines remain active both day and night throughout the year (CWS 2000b), and in the north may be active for 3 to 4 hour long periods between rests (TCCP 2000). Males are typically more mobile than females (Wilson et al. 2000), and are known to use larger home ranges than resident females

(Landa et al. 1998). During spring and summer, males expand their home ranges and become increasingly active, which results in the overlapping of home ranges with several females in an apparent breeding strategy (Banci and Harestad 1990). Although wolverines are highly mobile and maintain large home ranges, most individuals exhibit fidelity to discrete areas, particularly their natal site (Wilson et al. 2000). Movement patterns, home range size, and density estimates have not yet been made for the wolverine populations in the ISR (TCCP 2000).

Wolverine dens range in complexity, from temporary rest beds to natal dens with extensive tunnel systems (Lee and Niptanatiak 1996). Natal dens on the tundra are often associated with rocky scree slopes and large snowdrifts (Lee and Niptanatiak 1996), habitat that is abundant throughout the ISR. Caves, rock crevices, fallen logs, holes in the snow, and burrows are also used for shelter (TCCP 2000). Breeding occurs between April and October with a peak in mid summer. Following delayed implantation, young are born in late winter and spring. Most females breed annually, but do not necessarily produce young every year (Banci and Harestad 1988, CWS 2000b).

Wolverines have a varied diet that includes small mammals, roots and berries (Banci and Harestad 1988, 1990, TCCP 2000, CWS 2000b). The wolverine will scavenge carrion from kills of wolves and bears (Clarkson and Liepins 1993), ungulate carcasses being the principal food item (TCCP 2000).

Beaver (*Castor canadensis*)

Beavers are at the northernmost limit of their range in the Mackenzie Delta region (Hawley and Aleksiuk 1974 *in* Dome et al. 1982a). Beaver activity has been observed between the East Channel and Husky Lakes (Slaney 1974a *in* Dome et al. 1982a), likely in shallower lakes and streams of the Tuktoyaktuk Coastal Plain. The Mackenzie Delta lowlands are considered to be of intermediate quality habitat for beaver (Dennington et al. 1973 *in* Dome et al 1982a). Beaver habitat in Beaufort Sea coastal areas to the west and east of the Mackenzie Delta region is restricted to a few river valleys, and is considered to be poor to insignificant in quality (Dennington et al. 1973 *in* Dome et al. 1982a).

Beaver habitat suitability is determined by the physical characteristics and the dominant vegetation communities of an area (Slough and Sadlier 1977 *in* Dome et al. 1982a). Beavers will only colonize slow moving streams and rivers, as fast flowing water may wash away dams and food caches (Banfield 1974, Standfield and Smith 1971 *both in* Dome et al. 1982a). They usually live in streams that have gradients less than 6%, and are most successful in wide valleys with meandering streams and rivers (Retzer et al. 1956 *in* Dome et al. 1982a). Creeks and small rivers are often dammed to create deep ponds with stable water levels (Banfield 1974, Retzer et al. 1956 *both in* Dome et al. 1982a), allowing continuous access to food caches and transport routes during freeze-up. Rivers with widely fluctuating water levels and significant ice scour of shorelines in spring are considered poor beaver habitat (Nash 1951 *in* Dome et al. 1982a). Preferred lake habitat is shallow with gently sloping shores that support aquatic and terrestrial vegetation (Hall 1971, Standfield and Smith 1971 *both in* Dome et al. 1982a). Prime habitat is found in marshes and ponds with appropriate food supplies.

Beavers construct nesting dens in the form of riverbank burrows or lodges, for shelter and protection against predators. Beaver dams built in subarctic wetlands will alter the hydrologic landscape by creating ponds and diversion channels. Dams can last for years, during which they perpetuate the new drainage pattern they have created (Woo and Waddington 1990).

A family consisting of five or six individuals may require half a hectare of dense poplar trees for its winter food supply (CWS 2000c). In mid to late August, beavers start to accumulate material into a food cache for the winter. These caches are partially submerged rafts of branches and saplings anchored close to their dens (Martell et al. 1984). The presence of alder, willow, and aspen is the most important factor in predicting beaver use of an area (Slough and Sadlier 1977 *in* Dome et al. 1982a).

Beavers are monogamous and remain together following breeding (Martell et al. 1984), which occurs in the water during late winter (February and March) (TCCP 2000). After spring breakup, three or four kits are born in May or June following a 100-day gestation period. At birth, kits are well-furred, have teeth cut, and can see, walk and swim, remaining in the lodge for at least one month (CWS 2000c).

Polar Bear (*Ursus maritimus*)

The polar bear is circumpolar in distribution and ranges in Canada from the pack ice of the Arctic Ocean and High Arctic Islands to southern James Bay (Stirling et al. 1984 *in* Olson et al. 1984, Dome et al. 1982a). In the Canadian Beaufort-Amundsen Gulf region there are two relatively discreet polar bear populations; one associated with the west coast of Banks Island and the other with the mainland coast (Dome et al. 1982a). From freeze-up in the fall to breakup in the spring, polar bears are generally restricted to areas with sea ice, although they prefer areas with suitable combinations of pack ice (preferably relatively free of snow cover), open water, and land (CWS 1992). Following breakup, the distribution of polar bears is often governed by prevailing winds causing drifting of the ice (Martell et al. 1984). Bears concentrate along offshore ice adjacent to series of leads and on unstable ice (Martell et al. 1984). A study looking at Canadian Beaufort data from 1971 to 1979 showed that during the winter and spring, most adult males, non-breeding females, females with yearlings and two year olds, and subadults preferred the ice floe edge and areas of moving ice with $7/8^{th}$ or more ice cover (Stirling et al. 1975, Stirling et al. 1981 *both in* Dome et al. 1982a). This is likely due to the accessibility of seals in these areas. In contrast, adult females with cubs-of-the-year preferred stable landfast ice with deep snow drifts along the pressure ridges (Stirling et al. 1981 *in* Dome et al. 1982a).

Pregnant females use coastal lands in the winter for denning sites. Primary denning areas in the Canadian Beaufort Sea include coastline from Kay Point to Kugmallit Bay (TCCP 2000), the west and south coasts of Banks Island, and to a lesser extent, the west coast of Victoria Island, while the coastal mainland is used infrequently (Stirling et al. 1975, 1981 *in* Dome et al. 1982a). In addition, a study by Stirling et al. (1981 *in* Dome et al. 1982a) showed one maternity den on the ice offshore of Richards Island. The Kurk drilling area of the proposed program lies within the near shore denning habitat as outlined in the Tuktoyaktuk Community Conservation Plan (2000). Denning on pack ice is known to occur in the Alaskan part of the Beaufort Sea (Martell et al. 1984, Lentfer 1975 *in* Dome et al. 1982a). During late

March or early April, females and their new cubs are found on landfast ice, preying on ringed seals (Dome et al. 1982a).

While there is some evidence that one large Canadian population, on Baffin Bay, may be declining in size, other Canadian populations are thought to be stable (CWS 2000d). During the period of 1972 to 1974 an estimated 1700 to 1800 polar bears occurred in the Canadian Beaufort Sea and Amundsen Gulf (Stirling 1978 *in* Dome et al. 1982a). More recent (1998) population surveys of the ISR polar bear management areas estimate 1800, 1200 and 230 polar bears in the Southern Beaufort, Northern Beaufort and Viscount-Melville Sound populations, respectively (TCCP 2000). The Viscount-Melville Sound population is thought to be recovering (CWS 2000d). It has been demonstrated that population fluctuations of polar bears in the Canadian Beaufort Sea-Amundsen Gulf region have been caused by changes in the distribution and abundance of ringed seal (Stirling 1978 *in* Dome et al. 1982a). The current goal of the ISR is to maintain the local polar bear populations at a sustainable level (TCCP 2000)

Mating occurs during April to May, and at times in June, when polar bears are out on the pack ice hunting seals (CWS 1992). Females may successfully breed at 4 years of age, but it is more common for breeding to occur at 5 years of age (TCCP 2000, Martell et al. 1984, Dome et al. 1982a). Delayed implantation occurs, and gestation lasts from 228 to 254 days after mating (Lentfer 1980 *in* Dome et al. 1982a, Banfield 1974 *in* Dome et al. 1982a). Females give birth to litters of 1 to 4 cubs every 3.6 years on average (CWS 2000d), although the reproductive potential of bears in the Delta region varies with nutritional state. Maternal dens are usually excavated in snow banks on coastal hillsides or, less commonly, on the sides of pressure ridges of ice, and occupied by pregnant females for 160 to 170 days from early November through to late March or early April (Dome et al. 1982a, Banfield 1974 *in* 1982a). Cubs are born in December and January, emerging from the den in the spring, and usually remain with their mothers for 1 to 2 years. Starting in mid November, non-breeding females and adult males spend 115 to 125 days and 50 to 60 days respectively in hibernation (Banfield 1974 *in* 1982a).

As breakup continues through the spring and early summer, the polar bears move with the ice to hunt seals more effectively (Stirling et al. 1984 *in* Olson et al. 1984). During the summer months polar bears feed upon shoreline carrion, fish, mussels, crabs, sea stars, and the eggs and nestling young of waterfowl and seabirds (Banfield 1974 *in* Dome et al. 1982a).

Wolf (*Canis lupus*)

In the ISR, wolves occur in forested and tundra habitats and are closely associated with various species of ungulates, including caribou, moose, muskoxen and sheep (Banfield 1974 *in* Dome et al. 1982a). A wolf research program undertaken by RWED in the Western Arctic from 1987-1993 indicated that wolves also commonly occur in the Caribou Hills (Clarkson and Liepins 1989), located to the southeast and within the vicinity of the proposed program area.

Wolf packs establish well-defined territories when the predominant prey species is non-migratory (Mech 1970, Peters and Mech 1975 *both in* Dome et al. 1982). During the winter, packs often hunt over long distances along ridges, trails, seismic lines, lakeshores, and frozen lakes and rivers (Mech 1970, Peters

and Mech 1975 *both in* Dome et al. 1982a). During the summer, wolves typically restrict their movements, frequently returning to pup-rearing areas. Wolves that live within migratory caribou ranges prey primarily on caribou and do not appear to be territorial, moving as required to remain with the caribou herds (Heard and Williams 1992). Studies in northern areas have indicated that other prey items include beaver, small mammals, snowshoe hares, birds, and vegetation (Theberge and Cottrell 1977, Stephenson 1978 *both in* Dome et al. 1982a).

A wolf pack usually consists of a pair of breeders and their young offspring (Mech 1999). Wolf pups are born in dens in late May and early June, and are able to move with the pack in late August (Heard and Williams 1992). The pack functions as a unit year-round. As the offspring begin to mature, they disperse from the pack when they are as young as 9 months of age. Most disperse when they are 1-2 years old, and few remain in the pack beyond 3 years of age (Mech 1999).

11.8.2 Birds

Very few species of birds are adapted to overwinter in the Mackenzie Delta Region. The vast majority migrate into or through the area to nest, raise young, moult, and accumulate fat reserves, and then migrate south in the fall to overwinter in other regions (Martell et al. 1984). Migrating species are not likely to be found in the program area during the time proposed, as they generally move south for winter by early September and do not generally arrive in spring until mid May. Birds that may overwinter in the area include the snowy owl and gyrfalcon, as well as both species of ptarmigan found in the ISR. Bird species of concern, because of their sensitivity or importance for subsistence, are listed in Table 12, if they are potentially found in the vicinity of the program area.

TABLE 12

BIRD SPECIES OF SIGNIFICANCE FOUND IN THE VICINITY OF THE PROPOSED PROGRAM

Species	Habitat	Program Interaction	COSEWIC [1]
WATERFOWL, SHOREBIRDS AND PASSERINES			
Black brant[2] (*Branta bernicla nigricans*)	Coastal meadows, freshwater shore or tidal pools, or on small islets. Outer Mackenzie Delta Islands and Tuktoyaktuk Peninsula.	Limited to transient periods of migration and impacts to habitat.	Not listed
Canada goose[2] (*Branta canadensis*)	Small islands in ponds, lakes, streams, or rivers. Nesting in outer Mackenzie Delta, western delta for moulting.	Limited to transient periods of migration and impacts to habitat.	Not listed
Lesser snow goose[2] (*Chen caerulescens caerulescens*)	Kendall Island during nesting, bays, estuaries, and ocean during migration	Limited to transient periods of migration and impacts to habitat.	Not listed
White-fronted goose[2] (*Anser albifrons frontalis*)	Tidal flats, high or dry terrain near lakes or rivers. Outer Mackenzie Delta, Tuktoyaktuk Peninsula.	Limited to transient periods of migration and impacts to habitat.	Not listed
American wigeon[2] (*Anas americana*)	Dry areas, south of the treeline, extending away from water. Mackenzie Delta, Old Crow Flats, Richards Island, Anderson Deltas.	Limited to transient periods of migration and impacts to habitat.	Not listed

Species	Habitat	Program Interaction	COSEWIC [1]
Long-tailed duck[2] (*Clangula hyemalis*)	Coastal and tundra ponds during summer; large lakes, bays, estuaries, and ocean during migration.	Limited to transient periods of migration and impacts to habitat.	Not listed
Mallard[2] (*Anas platyrhynchos*)	Polynas and leads on open water, nearshore forested areas of the Mackenzie Delta.	Limited to transient periods of migration and impacts to habitat.	Not listed
Northern pintail[2] (*Anas acuta*)	Shallow freshwater floodplain lakes, estuaries, and streams in open areas with low vegetation.	Limited to transient periods of migration and impacts to habitat.	Not listed
Scoters[2] (*Melanitta spp.*)	Dense cover areas including forested and shrubby areas with 200 m of water. Mackenzie Delta east to Bathurst Peninsula.	Limited to transient periods of migration and impacts to habitat.	Not listed
Red-throated loon[2] (*Gavia stellata*)	Coastal and tundra ponds during summer; large lakes, bays, estuaries, and ocean during migration.	Limited to transient periods of migration and impacts to habitat.	Not listed
Yellow billed loon[2] (*Gavia adamsii*)	Arctic tundra on large lakes or in backwater areas of flooded rivers.	Limited to transient periods of migration and impacts to habitat.	Not at risk
Tundra swan[2] (*Cygnus columbianus columbianus*)	Lowland tundra near, or on islands, in ponds, lakes and slow-flowing rivers, near sheltered tidal waters. Kendall Island Migratory Bird Sanctuary, main channel of the Mackenzie Delta.	Limited to transient periods of migration and impacts to habitat.	Not listed
Sandhill crane[2] (*Grus canadensis*)	Coastal tundra including areas around Shallow Bay.	Limited to transient periods of migration and impacts to habitat.	Not at risk
Eskimo curlew[2] (*Numenuis borealis*)	Formerly bred in the tundra and woodland transition zones of the Mackenzie District.	Low potential though generally unknown.	Endangered
Shorebirds (*Phalaropus spp., Calidris spp.*)	Coastal and tundra marshes during summer, bays, estuaries, and ocean during migration	Limited to transient periods of migration and impacts to habitat.	Not listed
Passerines	Wide variety of migratory and nesting habitat. Primarily areas of woody vegetation, less commonly in coastal plains or tundra.	Limited to transient periods of migration and impacts to habitat.	Not listed
RAPTORS			
Bald eagle[2] (Haliaeetus leucocaphalus)	Forested areas near waterbodies, including the inner Mackenzie Delta. Nests in trees and occasionally cliffs.	Limited to transient periods of migration and impacts to habitat.	Not at risk
Golden eagle[2] (*Aquila chrysaetos*)	Mountain forests and open grasslands; can be found in any habitat during migration. Willow River, Fish Creek, First Creek, Mackenzie delta.	Limited to transient periods of migration and impacts to habitat.	Not listed
Gyrfalcon[2] (*Falco rusticolus*)	Arctic tundra and rocky cliffs near water, nests in cliffs and occasionally trees. Richardson Mountains.	Nearshore tundra areas with rocky cliffs in either drilling area,	Not at risk
Peregrine falcon (*Falco peregrinus tundrius*)	Coastal areas, nests on cliffs and occasionally trees, hunts over open tundra habitats. Richardson Mountains.	Limited to transient periods of migration and impacts to habitat.	Special Concern
Rough-legged hawk[2] (*Buteo lagopus*)	Coastal areas with suitable cliff nesting habitat. Richardson Mountains and Herschel Island.	Limited to transient periods of migration and impacts to habitat.	Not listed
Short-eared owl (*Asio flammeus*)	Prairies, grassy plains or tundra in the summer. Tundra areas of the Mackenzie Delta.	Limited to transient periods of migration and impacts to habitat.	Special Concern

Species	Habitat	Program Interaction	COSEWIC [1]
Snowy owl[2] (*Nyctea scandiaca*)	Coastal areas. Open tundra during breeding. Prefers to nest on elevated ground.	Open tundra near high points of land, erratics or rock promontories in either drilling area.	Not listed
GROUND BIRDS			
Rock ptarmigan[2] (*Lagopus mutus*)	Coastal areas and open tundra, forested areas east of the Anderson River in winter. Remain in burrows in snow during winter, emerging mid-day to feed	Onshore areas in either drilling area.	Not listed
Willow ptarmigan[2] (*Lagopus lagopus*)	Widely distributed throughout forest and tundra areas. Remain in burrows in snow during winter, emerging mid-day to feed.	Onshore areas in either drilling area.	Not listed

Notes:

1. Committee on the Status of Endangered Wildlife in Canada 2000.
   Endangered = A species facing imminent extirpation or extinction.
   Special Concern = A vulnerable species because of characteristics that make it particularly sensitive to human activities or natural events.
   Not at risk = A species that has been evaluated and found to be not at risk.
   Not listed = A species which does not appear in COSEWIC documentation.
3. Species are included due to their listing in Community Conservation Plans as species of interest or declining in population.

11.8.2.1 Migratory Birds

Various species of waterfowl, raptors, and shorebirds utilize the Mackenzie Delta and environs as migratory staging and nesting grounds. Waterfowl migrating into the Mackenzie Delta region use staging areas in the spring for resting and feeding. Depending on the location of their overwintering areas, waterfowl may reach the Delta area by inland or coastal migratory routes. Most species of waterfowl and raptors arrive at their nesting grounds by early June (Johnson and Herter 1989). Tundra swans (*Cygnus columbianus*) begin to arrive on nesting grounds in mid May (Stewart and Bernier 1989). Mallards (*Anas platyrhynchos*) arrive in the area from mid to late May (Johnson and Herter 1989). Loons (*Gavia* sp.) and white-fronted geese (*Anser albifrons frontalis*) begin to arrive in late May and early June (Dome et al. 1982a, Bailey et al. 1933 *in* Johnson and Herter 1989). Some migratory raptors may move into the area relatively early in the season, including golden eagles (*Aquila chrysaeto*) in mid-March (Savage 1985).

Many species of shorebirds migrate through the Mackenzie Delta and Beaufort Sea during spring and fall. Concentrations of several species can be found feeding together in coastal bays, estuaries and nearshore Beaufort Sea during late summer prior to southward migration (Hawkings 1987, Alexander et al. 1988, 1991, Johnson and Herter 1989). The Eskimo Curlew (*Numenuis borealis*) has been designated as 'endangered' by COSEWIC and has been unofficially sighted only occasionally in recent years in the woodland zones of the Mackenzie Delta (COSEWIC 2001).

Waterfowl generally start to move to staging areas in preparation for fall migration by about mid-August (Martell et al. 1984). Some migratory bird species do not leave the area until most waterbodies are frozen in late September (Johnson and Herter 1989). The migration of white-fronted geese from the area is gradual, beginning possibly as early as mid August and continuing until late September or early October (Barry 1967 *in* Dome et al. 1982a). Mallards are one of the last migratory birds to leave the Mackenzie Delta with records of fall sightings into late September (Johnson and Herter 1989). Some migratory

raptor species also leave the area relatively late, with Bald eagle and Rough-legged hawk migrating in mid-September to October (Campbell and Davies 1973 *in* Dome et al. 1982b, Johnson and Herter 1989).

11.8.2.2 Overwintering Birds

A few bird species remain in northern areas throughout the winter, often moving locally in response to availability and abundance of food (Dome et al. 1982a). Raptors that remain in the ISR year-round with potential habitat in the proposed program area include gyrfalcons and snowy owl (Fleck 1981, Savage 1985, Martell et al. 1984). Groundbirds that overwinter in the area include both species of ptarmigan found in the region.

Gyrfalcon (*Falco rusticolus*)
The gyrfalcon resides in the ISR year-round and its breeding range includes the northern Mackenzie District (AOU 1983 *in* Johnson and Herter 1989). They are a fairly common resident species on cliffs, rocky outcrops and river bluffs (Garner and Reynolds 1986 *in* Johnson and Herter 1989). Gyrfalcons nest much earlier than most other raptor species with pair formation occurring as early as February or March (Platt 1976b *in* Dome et al. 1982a, Roseneau et al. 1981 *in* Dome et al. 1982b). The winter range of the gyrfalcon in North America includes the majority of its breeding range, especially for adult birds and during years of abundant prey (AOU 1983, Palmer 1988 *in* Johnson and Herter 1989).

Snowy Owl (*Nyctea scandiaca*)
The snowy owl winters in all types of habitats, however the species prefers open rangeland, prairie or tundra environments where a commanding view of the landscape may be achieved. The snowy owl breeds in the islands of the Arctic Archipelago and from the northern coastlines of the Yukon to Labrador (CWS 1991). Individuals who do not spend the entire winter in the tundra begin the northward migration to the arctic breeding grounds in February and March (CWS 1991). Nests are located on high points of land, erratics or rock promontories and are basically a shallow, unlined scraping in the substrate. The family group stays together the entire summer and the fall migration (if the particular individual/group is migratory) ensues in late September and early October (Salter et al. 1980 *in* Dome et al. 1982b , Garner and Reynolds 1986, Smith 1973 *both in* Johnson and Herter 1989).

Ptarmigan (*Lagopus spp.*)
Two species of ptarmigan are common in the Delta area: willow ptarmigan (*Lagopus lagopus*), and rock ptarmigan (*Lagopus mutus*). Both species form flocks in late summer, and by late fall groups of males will separate from the larger flocks as the ptarmigan move to local wintering areas. Willow ptarmigan generally move further from their nesting areas than do rock ptarmigan. During the winter, ptarmigan remain in burrows in the snow, venturing outside for only a few hours of light around mid-day. They feed on a wide variety of plants in the summer, with decreased consumption in the fall (Martell et al. 1984).

Willow ptarmigan are widely distributed throughout forest and tundra areas. The species is found primarily on dry shrub and polygon tundra in summer, but will also nest in forest-tundra and relatively

open forested areas. In late April and early May, willow ptarmigan move from tall willow wintering areas to upland shrub tundra. In winter, the species feeds almost exclusively on willow buds and maintains this diet throughout May (Martell et al. 1984).

Rock ptarmigan are restricted to tundra, being commonly found in open tundra and coastal areas during the summer months. In winter, the species feeds mostly on birch buds. The spring diet of the rock ptarmigan is more varied than that of the willow ptarmigan, probably due to early snow melt in exposed locations on the tundra (Martell et al. 1984).

11.8.3 Fish

A large number of fish species occur within the freshwater and marine environments of the mainland western Arctic. Fish species of concern, because of their sensitivity or importance for subsistence, that are found within the vicinity of the proposed program are listed in Table 13. Species discussed include those with known overwintering habitat within the vicinity of the proposed program or area that the program may affect.

TABLE 13

FISH SPECIES OF SIGNIFICANCE FOUND IN THE VICINITY OF THE PROPOSED PROGRAM

Species	Habitat	Spawning Period	COSEWIC [1]
FRESHWATER			
Arctic cisco[2] (*Coregonus autumnalis*)	Mackenzie River and estuary, tributaries to the Mackenzie (spawning habitat - inland lakes).	Fall	Not listed
Arctic grayling[2] (*Thymallus arcticus*)	Kugalak River, coastal rivers of North Slope. Occasionally Richards Island.	Spring	Not listed
Broad whitefish[2] (*Coregonus nasus*)	Several overwintering areas in East Channel and Whitefish Bay. Tuktoyaktuk Harbour, Mason Bay, Mallik Bay, Shallow Bay, streams of Tuktoyaktuk Peninsula, spawning throughout the Mackenzie system.	October, November	Not listed
Burbot[2] (*Lota lota*)	Mouths of creeks. Winter and spring may be abundant in fresh or brackish waters of Kugmallit Bay's coastal embayment.	January – March	Not listed
Deepwater sculpin (*Myoxocephalus thompsoni*)	Habitat preferences are not known. Spawning areas are not known.	May and June	Threatened
Inconnu[2] (*Stenodus leucichthys*)	Mackenzie River and estuary (rearing habitat). Turbid lakes on Richard Island throughout summer, Mallik and Mason Bays.	Late September – early October	Not listed
Lake trout[2] (*Salvelinus namaycush*)	Outer delta lakes (including minor channels) with high oxygen levels, a good connection to adjacent water bodies, small to moderate volumes available and poor to moderate water quality.	Fall	Not listed
Lake whitefish[2] (*Coregonus clupeaformis*)	Lakes and large rivers, brackish coastal waters	Late September	Not listed

Species	Habitat	Spawning Period	COSEWIC [1]
Least cisco[2] (*Coregonus sardinella*)	Mackenzie River and estuary, tributaries to the Mackenzie (spawning habitat), inland lakes. Inner Shallow Bay / Niakunak Bay and Kugmallit Bay are important overwintering and nursery areas.	Early October	Not listed
Northern pike[2] (*Esox lucius*)	Tributaries, creeks and shallow lakes in Mackenzie delta.	Early spring	Not listed
SALTWATER			
Arctic cod[2] (*Boreogadus saida*)	Within Mackenzie estuary.	Late fall, winter	Not listed
Pacific herring[2] (*Clupea spp.*)	Mackenzie River and estuary, tributaries to the Mackenzie, inland lakes.	Late June	Not listed
Dolly Varden[2,3] (*Salvelinus malma*)	Fish Hole, Rat River, Big Fish River, Fish Creek, Babbage River, Peel River, Shingle Point, occasionally travel the Mackenzie near Inuvik and Aklavik. Travel from stream to stream along the Beaufort Coast.	August, early September	Not listed
Fourhorn sculpin (*Myoxocephalus quadricornis*)	Lakes and streams of the Arctic archipelago.	May and June	Special Concern

Notes:

1. Committee on the Status of Endangered Wildlife in Canada 2000.
   Threatened = A species likely to become endangered if limiting factors are not reversed.
   Special Concern = A vulnerable species because of characteristics that make it particularly sensitive to human activities or natural event
   Not listed = A species which does not appear in COSEWIC documentation.
2. Species are included due to their listing in Community Conservation Plans as species of interest or declining in population.
3. Historically, fish of the genus Salvelinus caught along the Beaufort Sea coast have been identified as Arctic char (Salvelinus alpinus). Haas and McPhail (1991) note that Dolly Varden char (*Salvelinus malma*) are formally separated from the Arctic char complex.

Fish populations are most sensitive to environmental disturbance during spawning, incubation, emergence, rearing, overwintering and migration (Dome et al. 1982a). Overwintering success of any fish species in the arctic is influenced primarily by the amount of overwintering habitat available and the quality of the habitat in terms of its ability to support fish. Many of the water bodies in the arctic coastal plain are too shallow to support fish during the winter when ice depth can approach 2 m. Fish that remain in water that is less than 2 m deep after ice formation will likely perish (Reynolds 1997 *in* Truett and Johnson 2000). Increased survival rates are seen in species that feed in warm, shallow water during the summer and overwinter in deeper water (Truett and Johnson 2000).

In the context of this section, the term "anadromous" refers to fish that either spend most of their lives in the sea and migrate to freshwater to spawn (i.e. salmon and Arctic cisco) or to fish that migrate from freshwater to the sea, or vice versa, regularly at some definite stage in their life cycle for purposes other than spawning (i.e. Dolly Varden and least cisco).

Burbot (*Lota lota*)

Commonly known as 'loche', burbot is a freshwater species also found in brackish coastal waters, ranging from Herschel Island to Atkinson Point, with concentrations in the Kendall Island area (Percy 1975, Martell et al. 1984) located just to the northeast of the program area. This species generally prefers deep

lakes (Martell et al. 1984). They are bottom-feeding predators, consuming sculpins, other burbot, smelt, and mysids on the coast (Percy 1975). The burbot spawns in late fall and early winter under the ice of lakes and rivers (Martell et al. 1984, TCCP 2000). In addition, estuarine coastal and nearshore marine areas have been identified as burbot overwintering habitat (Sekerak et al. 1992), including Middle Channel located to the east and in the vicinity of both program drilling areas. In late winter and early spring, burbot move into tributary rivers before continuing on to deeper water in the summer, including the fresh or brackish waters of Kugmallit Bay (TCCP 2000).

Inconnu (*Stenodus leucichthys*)

Inconnu, commonly known as 'coney', are the largest member of the whitefish family. The species is often anadromous, making long migrations between freshwater and coastal areas, however exclusively freshwater populations do reside in some lakes (TCCP 2000). The preferred spawning habitat is characterized by gravel substrate in relatively shallow, fast-flowing, and clear water. Spawning usually occurs in late September, approximately 2 to 3 weeks prior to the average date of first ice formation. Important wintering habitat for both immature and mature inconnu in the lower Mackenzie Delta area includes the main channels and deeper parts of the outer delta, including some unnamed lakes and channels in the vicinity of the proposed program area, as well as coastal embayments, and larger lakes of the inner delta. It is unclear if inconnu also overwinter in rivers (Howland et al. 2000).

Least Cisco (*Coregonus sardinella*)

Commonly known as 'big-eyed herring', least cisco are much less migratory than other anadromous species, and tend to remain nearer the mouth of the Mackenzie River than do Arctic cisco or Dolly Varden char, but they do disperse as far west as Herschel Island (Percy 1975, Griffiths et al. 1975, Kendel et al. 1975 *in* Dome et al. 1982a, Bond and Erickson 1987, 1989) and eastward along the Tuktoyaktuk Peninsula (Lawrence et al. 1984, LGL 1990). The older and larger cisco tend to disperse the farthest, although least cisco are generally associated with the plume of their natal river (TCCP 2000). They feed on mysids, amphipods, and insects in areas near fresh water (Bendock 1977, Craig and Haldorson 1980 *both in* Dome et al. 1982a). The least cisco returns to the Mackenzie River in August at which time the mature spawners move upstream to spawn (Dome et al. 1982a). Overwintering occurs in freshwater habitat in the lower reaches of the delta for the majority of the population (Dome et al. 1982a). However, some non-spawners have been captured under the ice in areas such as Kugmallit Bay, the outer Mackenzie Delta, and the Tuktoyaktuk Peninsula (Galbraith and Hunter 1975, Fenco and Slaney 1978 *in* Dome et al. 1982a). Identified least cisco overwintering habitat within the vicinity of the proposed program include lakes on Langley Island and associated channels (Sekerak et al. 1992).

Northern Pike (*Esox lucius*)

The northern pike is primarily a freshwater fish, found in the warm waters of shallow lakes and bays or quiet rivers. Northern pike are found throughout the Mackenzie Drainage area and likely most of the Eastern Coastal Drainage area. In addition, pike frequent the brackish coastal waters near the mouths of rivers off Tuktoyaktuk Peninsula and Richards Island (Martell et al. 1984). Northern pike spawn in the spring following ice melt, about mid June to early July. Spawning mainly occurs in heavily vegetated marshes, lakes and river floodplains (Scott and Crossman 1973). Following spawning, pike generally

remain in shallow, warm waters for the duration of summer. Mature pike feed mainly on small fish, including small pike, and on small mammals and invertebrates. Pike move out of shallow waters to wintering habitats during the period between mid August and freeze-up, often concentrating at the mouths of creeks in November and December. They require deep channels and lakes for overwintering (Martell et al. 1984), such as Middle Channel and number of unnamed lakes within the vicinity of the proposed program area (Sekerak et al. 1992).

11.9 Cultural and Historic Resources

Cultural and historic resources include the physical traces of culture and societies as well as the current resources utilized by local people. Heritage sites recognized by Federal agencies are considered. These sites include: archaeological sites, historic structure sites, traditional trails, campsites, berry picking areas, sacred or medicinal plant picking areas, burial sites, ceremonial sites, traditional hunting grounds, and places associated with traditional names or legends.

11.9.1 Methods

Baseline information provided in this report was synthesized from existing archival records, maps and air photos held in databases with the Prince of Wales Northern Heritage Centre in Yellowknife. Field reconnaissance was completed in the Summer of 2001 through helicopter transit and foot inspection to geo-locate known sites, determine the extent of each site, and to assess the extent and magnitude of previous development activities.

11.9.2 Known Archaeological and Cultural Resources

This project is situated in the lowland delta environment of the Mackenzie River Delta. Hydrological processes in the form of fluvial erosion through changes in water levels and stream flows disrupt vegetation cover leading to extensive landscape modification. This, in turn, decreases the likelihood that heritage resources will survive, as well as contributing to their decreased visibility on the landscape.

11.9.3 2001 Field Season: Update on Archaeological and Cultural Resources

Extensive ground truthing in the summer of 2001 in the vicinity of the proposed well sites to examine for the presence of any cultural resources that may be sub-aerial (exposed on the surface) was completed, but no new sites of a cultural or archaeological nature were recorded.

11.9.4 Summary

Based on data accumulated from archival records, and maps, combined with a through field examination completed in the summer of 2001, no archaeological or historical sites will be impacted with the drilling operations. However, should an archaeological site be discovered during drilling operations, the site will be flagged and the appropriate agencies notified. Access roads, however, to the wells were not examined, as this information was not available at the time of the field survey. Because of the low potential of finding archaeological sites within this localized environment, the likelihood of impacting any sites in the development of the access roads is minimal. For full mitigative strategies, please refer to Section 12.5.

12.0 PROPOSED MITIGATION AND ANTICIPATED ENVIRONMENTAL IMPACTS

The wellsite locations have been selected to minimize impacts on the environment and land users. However, the potential exists for environmental impacts to occur during construction, drilling, and completions phases of the program. Potential environmental impacts were identified through public consultation, a review of existing literature and maps, and a field reconnaissance of the project area. During the field reconnaissance, no major concerns were identified.

Potential environmental impacts resulting from the construction of the well sites and access roads may include: damage to permafrost; minor drawdown of water bodies; temporary alteration of vegetation and thus wildlife habitat; and increased access to areas commonly used for traditional harvesting or hunting by virtue of new road creation.

The following section and Table 15 identify: how potential environmental and socio-economic impacts could arise during the seismic program; recommended mitigative measures to avoid or mitigate the potential impacts; and the significance of the residual impacts. The assessment criteria and definitions used in assessing the significance of each potential impact are provided below.

The proposed drilling program is localized and will be conducted during the winter months. It is predicted that the use of proposed mitigative measures by Petro-Canada and their contractors, and completion of the program during winter will result in no significant residual impacts.

12.1 Methods

As detailed in Section 11.0 Environmental Overview, the following procedures and resources were utilized to determine environmental concerns which may be encountered during the course of this project:

- Review of existing literature and maps
- Community consultation
- Field reconnaissance
- Personal communications

12.2 Implementation of Mitigation Measures

The goal of this section is to facilitate implementation of required and suggested environmental mitigation measures. It is important that the mitigation measures outlined in the project description are adhered to by the operator, the contractors, and the subcontractors.

12.2.1 Communication, Responsibility, and Environmental Monitoring

Identification and communication of sensitive areas, assigning responsibility for ensuring that mitigative measures are implemented or adhered to, and environmental monitoring are key components in ensuring that that program is operated in an environmentally responsible manner. Suggested measures to achieving compliance with the measures outlined in this project description and in permits are as follows:

- Responsible parties (for instance, the Drill Crew Supervisor) should be required to sign an indication of having read and understood Table 15 in this Project Description.
- Responsible parties should ensure that the crews (drilling, road construction crew) understands the components of Table 15 which are directly related to tasks they will be performing.
- Meetings (startup meetings and subsequent tailgate meetings) should be held and signatures of those in attendance should be gathered. Meetings should focus on environmental concerns which may be encountered during upcoming tasks and should also address areas where improvement can be made.
- The Monitors should take an active role in meetings, providing guidance and inspiring an environmentally responsible work ethic. Daily meetings can provide an opportunity for the environmental monitor to communicate concerns about observations in the field and to provide positive feedback about practices that are successful in mitigating impacts.
- The program supervisor should be in daily or twice daily contact with the Environmental Monitor to ensure that the Monitor is aware of the status of operations and to assist the Monitor in acquiring knowledge about all phases of drilling operations. An established relationship between the Monitor and operational staff will facilitate communications in the event of an environmental incident.
- Maps/diagrams indicating areas of environmental concern should be posted in a visible and accessible location (rig shack, mess trailer).
- All crew members should be required to sign an indication of having viewed and understood the maps/diagrams as they related to areas where they are working or driving.
- Terminology which leaves room for subjective interpretation should be clarified. For instance, what is meant by "frozen ground conditions" is something that can be measured when in doubt. Subjective judgment calls (and over-enthusiasm for quick production) can otherwise result in adverse consequences.

12.2.2 Role of the Environmental Monitor/Wildlife Monitor

A qualified Inuvialuit Environmental Monitor will be utilized to provide supervision to ensure that mitigation measures are implemented and that environmental and wildlife concerns are addressed as encountered. The Monitor will have an appropriate combination of training, experience, and knowledge of the local area to be successful in this role (specifics concerning the monitor/monitoring will be

consistent with approval requirements). It is important that the roles and responsibilities of the Monitor be clearly understood. The Monitor will prioritize her/his supervision activities according to which tasks may have a higher potential to cause adverse environmental impact. It will also be the Monitor's responsibility to document relevant information for the ILA, INAC, and the operator. Based on community comments during the consultation process, periodic relay of information back to the communities should also be conducted, in a manner to be determined with the ILA.

An Inuvialuit Wildlife Monitor will be employed for the duration of the program to mitigate impacts to wildlife in the vicinity of the program and to handle interactions between wildlife and crews or equipment. The Wildlife Monitor will have knowledge of the local area and experience handling firearms. The Wildlife Monitor should attend daily meetings and should communicate wildlife sightings or environmental concerns to the Environmental Monitor.

12.2.3 Identification of Workspace Boundaries and Areas of Environmental Concern

To ensure that ground disturbance does not occur in areas outside of the lease and access right-of-way (ROW) boundaries, it is crucial to identify the boundaries.

- Lease and ROW boundaries will be clearly identified with survey stakes and signage.
- Signage will display contact information that will include a 24-hour contact number.
- The Operator, with assistance from the Monitor, will flag areas where environmental concerns warrant avoidance (for instance, where the permafrost is deemed to be particularly sensitive, areas where wildlife habitat is of concern, and areas where vegetation should not be disturbed). The flagging will be a colour other than that used for lease and ROW boundaries, and will be made known to all crew members during startup meetings and subsequent meetings.
- Areas where heritage resources have been identified will be staked or flagged if located in close proximity to the project area.
- Warning signs will be posted as indicated in Table 15 where traplines are present. All trappers will be notified of the proposed project by the operator.

12.3 Potential Impacts and Mitigation

The environmental concerns and mitigation measures addressed in this section were deemed as being of particular significance in association with this drilling program.

12.3.1 Permafrost and Soils

In order to minimize impact to permafrost and soils, the dimensions of the surface lease will be limited to what is required to accommodate equipment and ensure safe working conditions (lease, camp, sump, and

access dimensions are detailed in Section 4.0). Once the ground surface is frozen and has adequate snow cover, construction of the drilling pad and access route will begin. A track machine, such as a Nodwell or Bulldozer, will be used to pull a rubber-tired drag over the ground surface to enhance frost penetration. The access route will then be flooded with water. A water truck, sitting on the riverbank adjacent to land access, will pump water from the river onto the access road. Once there is sufficient ice cover to support the water truck, it will work toward the lease spraying water to build up more in front of it.

The creation of a 40 cm thick ice pad under the drilling rigs will minimize disturbance by heavy equipment to the underlying soil and permafrost. However, the additional layer of ice changes the freeze-thaw cycle such that ice road and ice pad thaw depths may take several years to return to pre-impact levels (Noel and Pollard *in* Alaska Department of Natural Resources 1999). The use of ice however is a notable improvement over previously-used more permanent methods.

This will take place only under frozen ground conditions in order to limit soil disturbance which may otherwise result from uprooting. Any vegetation removal which may be required prior to site preparation will be conducted under the guidance of the Monitor.

Soils will not be disturbed with the exception of sump excavation. If deemed necessary, sumps will be lined with clay or a synthetic material. Drilling fluid levels will be maintained at least 1.5m below the original ground elevation. This allows Petro-Canada to minimize environmental impact upon completion of the sumps useful life by employing a mix/bury/cover strategy to sump abandonment.

12.3.2 Aquatic Resources

Petro-Canada will require large volumes of water for road building, pad building, and drilling operations on this program. Petro-Canada proposes to withdraw water from the river that the access is located on, or where the access last meets the river for land construction. For drilling operations and camp uses will be drawn from a larger nearby lake of adequate size to ensure that drawdown rates are minimized. To protect aquatic wildlife, Petro-Canada will place screens according to DFO guidelines on their intake hoses to prevent impingement or entrainment of fish.

12.3.3 Access

Traffic will be heaviest during mobilization and demobilization, but will be restricted to the primary ice road along the Mackenzie River, access roads to the wellsites and water withdrawal points. All new access is temporary and will be constructed of snow and ice. Traffic will be restricted at all times to the ice roads.

12.3.4 Vegetation

Few studies of human disturbance in the Arctic have documented long-term impacts to vegetation from winter disturbance. In general, the highest recovery of vegetation following disturbance occurs on sites

that are initially minimally impacted (Emers et al. 1995). The most visible impacts to vegetation communities result from changes to the physical environment (e.g. exposed soil and increased thaw depth). These are discussed separately.

The well site is situated in an area of predominantly shrubby vegetation including alder and willow, with spruce distributed more sparsely. Ice roads and ice pads help minimize impacts on the vegetation. However, experience related to oil and gas projects in environments along the Beaufort Sea in Alaska have noted impacts of ice roads and pads on vegetation. The increased moisture resulting from melting ice is slow to dissipate as a result of poor evapo-transpiration in cool northern climates and affects regeneration, with certain species recovering faster after summer melt than others (Alaska Department of Natural Resources 1999). These effects will be local to the drill pad and ice road areas.

Construction of the drill pad and overland access roads will begin when the ground is frozen and has sufficient snow cover. Low ground-pressure tracked vehicles will be used for surface preparation, and a compacted snow cover of approximately 25 cm will be laid down ahead of tracked vehicles to minimize impact to vegetation. During surface preparation, shrubs extending beyond the snow cover will be walked over by a cat equipped with mushroom shoes. A minimum blade height of 20 cm above the ground will be maintained to avoid topsoil scalping, leaving the organic layer intact to stabilize soil and promote vegetative regrowth. Impacts associated with this activity are restricted to the aboveground woody material, leaving root systems intact. Provided that the peat layer is not removed, natural revegetation occurs quickly with little change to the original species composition (Hernandez 1972). A study of regeneration following severe caribou browse in the high Arctic showed willow regrowth of 30 cm in one season (Henry and Gunn 1991).

Areas of dense shrub will be avoided to the extent feasible, while considering other environmental constraints of the area (e.g. setback distance from waterbodies). Where these areas are unavoidable due to erosion-prone slopes, and/or altering the access road or drill pad location may compromise crew safety, shrubs will be cut using a brush mower mounted on a cat, to a height where walking over with equipment is possible. Cleared vegetation and snow will be windrowed within the surveyed area and not pushed into standing vegetation or undisturbed areas. A rubber-tired drag attached to a tracked Nodwell or bulldozer will then be dragged over the surface, followed by flooding of the area by water. Frozen ground conditions, snow cover and tracked vehicles will minimize impacts to vegetation communities. In addition, overland travel of personnel and transport of equipment will be restricted to ice access. The above mitigation measures are believed by community elders to be effective in minimizing impacts (Frank Cockney, Pers. Comm.).

Where forest or woodland areas cannot be avoided, trees may be cut down to the snow pack level using chainsaws. Regeneration of spruce trees in the delta is very slow (Hernandez 1972), and seed production, germination, and seedling growth are limited to very specific conditions (Pearce et al. 1988). A community of willow, moss and bearberry (*Arctostaphylos*) would likely reestablish the area following clearing (Hernandez 1972). Coniferous tree species, such as spruce, will be avoided whenever possible.

Although not anticipated to be an issue, where vegetated areas cannot be avoided, willows may be cut using brush cutters or hand cutters, leaving approximately the bottom 20 cm of vegetation and all roots intact. Cut material will be spread evenly over the site and frozen in place through the flooding procedure. Regeneration of spruce trees in the delta is very slow (Hernandez 1972), and seed production, germination, and seedling growth are limited to very specific conditions (Pearce et al. 1988). A community of willow, moss and bearberry (*Arctostaphylos*) would likely reestablish the area following clearing (Hernandez 1972). Coniferous tree species, such as spruce, will be avoided whenever possible.

If clearing is required, care will be taken to ensure that there is no disturbance to the organic mat. Clearing will be limited to areas within the surveyed lease site. On access roads, shrubs and willows will be walked over to leave root systems intact. Frozen ground conditions, snow cover and tracked vehicles will minimize impacts to vegetation communities.

12.3.5 Wildlife

Impacts to wildlife are expected to be limited to temporary habitat alteration and sensory disturbance due to noise. Increased traffic may have the potential to increase the probability of direct mortality due to collisions with wildlife. Petro-Canada and their contractors will abide by speed limits set for the program access. Drilling sumps will be fenced to prevent wildlife from falling into the sumps. Attraction of nuisance wildlife to camp locations will be mitigated by daily incineration of camp wastes.

Project timing has been scheduled to avoid potential wildlife interaction during critical periods, such as migration. Environmental and wildlife monitors will identify any environmental and wildlife concerns during program operation and ensure that mitigation measures are implemented.

Disturbance of denning grizzly bears is expected to be minimal during this program. Bears generally select dens 1 to 2 km from human activity, and seem to tolerate most activities that occur more than one kilometre from the den (Linnell et al. 2000). Activity in closer proximity to denning bears has been shown to cause variable responses (Harding and Nagy 1977, Reynolds et al. 1983, Jalkotzy et al. 1997). Some bears tolerate disturbance even inside the den, although bears may abandon dens in response to activity within this zone, especially early in the denning period. Grizzly bear dens are not easily identified without the assistance of telemetry data (Ian Ross, Marsha Branigan pers. comm.). The RWED grizzly bear study will begin to provide information that can be used to assist operators in minimizing their impact to grizzlies. The potential impact of industrial winter operations within grizzly bear denning areas is that activities may inadvertently approach them very closely. Given an estimated population density of four bears per 1000 km^2, the possibility of encountering a grizzly bear in the program area is very low.

Caribou are highly migratory and follow well-established migration routes. Herds migrate north in the spring to calving grounds and summer range on the tundra. Migration occurs over open habitat types, which are affected minimally by winter activity. Drilling activities and associated access are expected to have negligible effects on caribou migration.

Moose prefer shrubby habitat of the delta. The proposed project is at the outermost portion of this habitat type, and therefore drilling activities and associated access are expected to have negligible effects.

Due to the large home ranges and elusive nature of wolves, interaction with wolves in the project area is expected to be minimal. Wolves follow caribou herds into their overwintering habitat below the treeline and are unlikely to be found in the outer delta habitat during program operations.

The withdrawal of water from lakes in the area may potentially alter the hydrological regime and decrease fish habitat. The selection of large, shallow lakes that are not known to overwinter fish will mitigate for this. Further mitigation to fish and fish habitat is discussed in *Aquatic Resources* below. Lakeshore nesting habitat for shorebirds and waterfowl may also be altered by water withdrawal from lakes. Direct impacts to shorebirds and waterfowl will be minimal as interaction with the program will be localized and limited to transient periods of migration.

Habitat destruction is an important factor in determining survival rates in raptors, and in the ISR, ground-nesting raptors are at higher risk for nesting habitat destruction. Species such as the northern harrier, which nest in marshy areas, are vulnerable to impaired breeding success due to wetland disturbance (Brown and Amadon 1968). Linear disturbance, such as the construction of access routes, may degrade habitat for ground nesters such as short eared owls and snowy owls and may also displace important prey species for certain raptors.

12.3.6 Cultural Resources

The type of mitigative measures taken for archaeological sites are dictated by their viability in the context of the development project (Prince of Wales Northern Heritage Centre 2001: 3). Mitigation strategies consist mainly of avoidance of impact through maintaining a 30 m buffer zone; the protection of the resource by constructing physical facilities; or, the scientific investigation and recovery of information from the resource by excavation. It is important to note that mitigation activities should be initiated as far in advance of the construction of the development as possible.

TABLE 14

SIGNIFICANCE CRITERIA

	AREAL EXTENT
Local:	Impacts are limited to the drilling rights-of-way and camp.
Subregional:	Impacts may extend beyond the limits of the rights-of-way and camp, but are limited to within 1 km of the rights-of-way and camp.
Regional:	Impacts may extend beyond 1 km from the rights-of-way and camp.
	MAGNITUDE
Negligible:	No discernible impact.
Low:	Impacts would be restricted to a few individuals or only slightly affect the resource or parties involved; factors related to species' population levels would not be affected.

TABLE 14 Cont'd

Moderate:	Impacts would affect many individuals or noticeably affect the resource or parties involved; factors related to a species' population levels would be affected to a degree that a change within natural limits of variability will occur; impacts would be socially tolerated.
High:	Impacts would affect numerous individuals or affect the resources or parties involved in a significant manner; factors affecting species' population levels would be altered to a degree that a change beyond natural limits of variability will occur.

DURATION

Immediate:	Impact duration is limited to less than two days.
Short-term:	Impact duration is longer than two days but less than one year.
Medium-term:	Impact duration is one year or longer but less than ten years.
Long-term:	Impact duration extends ten years or longer.

FREQUENCY OF OCCURRENCE

Isolated:	Occurrence confined to specified period.
Accidental:	Occurs rarely over assessment period (*i.e.*, life of the project).
Occasional:	Occurs intermittently and sporadically over assessment period.
Periodic:	Occurs intermittently but repeatedly over assessment period.
Continuous:	Occurs continually over assessment period.

PROBABILITY OF OCCURRENCE

Low:	Unlikely.
High:	Likely.

LEVEL OF CONFIDENCE

Low:	Based on incomplete understanding of cause-effect relationships and incomplete data pertinent to project area.
Moderate:	Based on good understanding of cause-effect relationships using data from elsewhere or incompletely understood cause-effect relationships using data pertinent to project area.
High:	Based on good understanding of cause-effect relationships and data pertinent to project area.

PERMANENCE OR REVERSABILITY

Reversible in short-term:	Impact can be reversed in less than one year.
Reversible in medium-term:	Impact can be reversed in 1 year or more, but less than 10 years.
Reversible in long-term:	Impact can be reversed in 10 years or more.
Irreversible:	Impact is permanent.

RESIDUAL IMPACT BALANCE

Positive:	Net benefit or gain to the resource or affected party.
Neutral:	Neither a positive nor negative impact; or positive and negative impacts are balanced.
Negative:	Net loss to the resource or detriment to the affected party.

RESIDUAL IMPACT SIGNIFICANCE

Significant Adverse Effect:	High probability of permanent or long-term residual effect of high magnitude on ecological, social, or economic sustainability that cannot be technically or economically mitigated or compensated.
Significant Positive Effect:	High probability of permanent or long-term positive residual effect of high magnitude on ecological, biological, social, or economic sustainability.
Unknown:	Potential significance cannot be defined with existing information or knowledge.
Not Significant Adverse Effect:	All other negative effects.
Not Significant Positive Effect:	All other positive effects.

TABLE 15

POTENTIAL ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS, MITIGATION AND RESIDUAL IMPACTS

Concern/Impact	Mitigative Measures	Areal Extent	Magnitude	Duration	Frequency	Probability	Confidence	Reversibility	Residual Impact Balance	Residual Impact Significance
1. Permafrost										
1.1 Disturbance of permafrost	.1 Surface area utilized will be minimized to avoid disturbance of permafrost outside the wellsite and camp leases and/or off the 15 m wide access road. .2 Except during sump construction, permafrost areas will not be disturbed. .3 Machinery will be strictly confined to the surveyed area to minimize terrain disturbance. .4 Access roads and the lease site will be flooded with water to create an ice layer of sufficient thickness to insulate the permafrost and protect it from degradation. .5 Equipment mobilization / demobilization and drilling operations will occur during winter to mitigate soil disturbance and permafrost degradation. .6 Access roads will not be constructed until the active layer of the soil is frozen. .7 Casing of the well will be installed in accordance with the Canada Oil and Gas Regulations including: Permafrost casing will be cemented from the shoe of the casing to the surface.	Local	Low	Short term	Isolated	Low	High	Reversible in short term	Neutral	Not significant

Concern/Impact	Mitigative Measures	Areal Extent	Magnitude	Duration	Frequency	Probability	Confidence	Reversibility	Residual Impact Balance	Residual Impact Significance
2. Terrain and Soils										
2.1 Disturbance to the soil profile (i.e. soil loss, compaction, admixing)	.1 Clearing of the site will be completed under frozen ground conditions limiting soil disturbance caused by uprooting. .2 Construction of an rig pad, access roads and lease site will mitigate soil compaction from the drilling rig and associated equipment. .3 Access roads will not be constructed until the active layer of the soil is frozen.	Local	Low	Short term	Isolated	Low	High	Reversible in short term	Neutral	Not significant
2.2 Disturbance to drainage	.1 The well sites will not be located within a drainage feature. .2 The well sites will not be located downhill from perennial snow accumulation areas or snow banks. .3 Snow bridges or ice roads will be constructed across drainage or waterbodies. Only clean snow and/or ice will be used for drainage crossings. .4 Drainages will be left free of debris. .5 Any clearings will be re-contoured to restore natural cross drainages .6 Surface drainage ditches will be reclaimed to original condition. V-notching of snow bridges will be performed upon completion.	Local	Low	Short term	Low	Low	High	Reversible in short term	Neutral	Not significant
3. Vegetation										
3.1 Loss of vegetation communities	.1 Mobilization and demobilization will take place in winter and utilize an ice access, therefore minimizing effects to existing vegetation. .2 Cleared vegetation and snow will be windrowed within the surveyed area and not pushed into standing vegetation or undisturbed areas.	Local	Low	Medium-long term	Occasional	Low	Moderate	Reversible in long term	Neutral	Not significant

Concern/Impact	Mitigative Measures	Areal Extent	Magnitude	Duration	Frequency	Probability	Confidence	Reversibility	Residual Impact Balance	Residual Impact Significance
	.3 The access road will be developed along the Mackenzie River and on ice access routes. .4 Where new access road is required, it will entail compacting snow and building an ice layer. Roads will be restricted to a 15 m width.									
4. Wildlife										
4.1 Disturbance to wildlife	.1 Intake hoses will be equipped with screens to prevent impingement or entrainment of fish. .2 The sump will be fenced to prevent wildlife from accessing the sump.	Local	Low	Immediate-short-term	Isolated	Low	High	Reversible in short term	Neutral	Not significant
5. Aquatic Resources										
5.1 Erosion of stream banks and destabilization of slopes	.1 Snow ramps will be designed to minimize erosion and/or destabilization of slopes. .2 Tracked units and dozers equipped with mushroom shoes will be used to reduce the possibility of surface disturbance. .3 A 100 m buffer of undisturbed ground between the well site boundary and watercourses or waterbodies will be maintained.	Local	Low	Short-medium term	Isolated	Low	High	Reversible in medium term	Neutral	Not Significant
5.2 Possible damage to fish habitat and spawning sites	.1 Excavated fill, waste material, or debris will not be disposed of in waterways. .2 No materials will be stored on any ice surface of a water body or within 30 m of such a water body. .3 Water intake from waterbodies will utilize screens on intake hoses to prevent damage to stream or lake bottoms and to prevent the entrainment of fish.	Local	Low	Immediate	Accidental	Low	High	Reversible in short term	Neutral	Not significant

Concern/Impact	Mitigative Measures	Areal Extent	Magnitude	Duration	Frequency	Probability	Confidence	Reversibility	Residual Impact Balance	Residual Impact Significance
	.4 Water for construction, drilling, and camp use will be collected at permitted sites. .5 Drawdown of water sources will be minimized through the selection of lakes of appropriate size, and by drawing from the Mackenzie River.									
5.3 Introduction of oil, fuel or other pollutant to waterbody	.1 The campsite and associated facilities (i.e. kitchen, sanitary waste sumps, solid waste site) will be located a minimum of 100 m from the ordinary high water mark of any permanent waterbody or watercourse, where feasible. .2 Liquid fuels and oils will be stored in a closed system during transportation. .3 Liquid fuel will be contained in a closed and properly vented container and will be located at least 25 m from the well. .4 All fuel storage will have secondary containment with the volume of containment being 15% greater than the capacity of the largest fuel container. .5 Fuels or hazardous materials will not be stored within 100 m of a waterbody, where feasible. .6 Petro-Canada will minimize fuel storage volumes on site by transporting fuel to the work site on an as needed basis from fuel barge locations and Swimming Point base camp. .7 Hydraulic hoses and couplings, fuel tanks, and other potential sources of contamination will be inspected prior to working on-site.	Regio nal	Moderate	Immediate - medium term	Isolated	Low	High	Reversible in medium-term	Neutral	Not significant

Concern/Impact	Mitigative Measures	Areal Extent	Magnitude	Duration	Frequency	Probability	Confidence	Reversibility	Residual Impact Balance	Residual Impact Significance
	.8 Any mobile equipment will be refueled and serviced a minimum of 100 m away from waterbodies, where feasible. .9 Drilling units will be equipped with a system capable of collecting any waste oil from the oil sumps on the unit. .10 The well-head will be equipped with a blow-out preventer system and be installed in accordance with the Canada Oil and Gas Drilling Regulations. .11 Spills will be recovered immediately and the location, type of pollutant and volume unrecovered recorded. .12 Spills will immediately be reported to Petro-Canada's Environmental Coordinator, and the Inuvialuit Land Administration. All accidental spills will be reported to the NWT Emergency Spill Response Line (867-920-8130) and to John Korec, the Environmental Assessment Officer with the National Energy Board (403-292-6614). Petro-Canada's Emergency Response Plan will be implemented in the event of a spill. .13 Spill areas will be treated in-situ where appropriate. .14 Personnel will be trained in spill response procedures and equipment use.									
5.4 Disposal of drilling waste in sumps	.1 Drilling fluid sumps will be located a minimum of 100 m from the ordinary high water mark of any permanent water body or stream, where feasible.	Local	Low	Short term	Accidental	Low	High	Reversible in medium term	Neutral	Not Significant

Concern/Impact	Mitigative Measures	Areal Extent	Magnitude	Duration	Frequency	Probability	Confidence	Reversibility	Residual Impact Balance	Residual Impact Significance
	.2 The sump will be located on the high side of the lease and sufficient space will be left for expansion of the original sump if required. .3 Drilling fluid levels will be maintained a minimum of 1.5 m below the level of the immediately adjacent original ground. .4 The sump will be constructed to contain 0.5 m^3 per metre of hole drilled. .5 If there is no alternative but to construct the sump in a pervious material, sump will be lined with either an artificial liner. .6 Well site personnel will be familiar with the properties of the mud types available and only use drilling additives of chemically known composition. .7 Records will be kept of the quantities and types of mud additives used, in case post-abandonment leakage problems occur. .8 Sumps will be monitored regularly so that any required corrective measures can be immediately implemented. .9 Snow fences will be used to prevent snow from accumulating in the sump and to prevent wildlife or personnel from falling in. .10 Sump will be properly abandoned at the end of the operating season.									

Concern/Impact	Mitigative Measures	Areal Extent	Magnitude	Duration	Frequency	Probability	Confidence	Reversibility	Residual Impact Balance	Residual Impact Significance
	.11 In the event there are sump problems leading to potential release of untreated toxic material into the environment the following three options will be considered: • Drilling will be suspended; • The existing sump will be enlarged or a supplementary sump will be constructed. • Fluids from the sump will be dewatered. Applications to dewater sump fluids will only be considered in special circumstances and only for treated fluids. • Supplementary sumps will be constructed immediately adjacent to the existing sump with a wall separating the two. A ditch will be dug to connect the two sumps.									
5.5 Disposal of other associated waste	.1 Combustibles and non-combustibles will be segregated. .2 Camp wastes will be incinerated with a force-fired incinerator daily. .3 Incinerator residue will be disposed of at an approved facility. .4 Non-combustible materials will be hauled to Inuvik for proper disposal at the landfill. .5 Solid wastes will not be disposed of in the drilling fluid sump. .6 All waste fuel, oil or lubricant will be collected in a closed system separately and will be transported and properly disposed of off site.	Local	Low	Short term	Accidental	Low	High	Reversible in medium term	Neutral	Not significant

6. Interference with Other Land Uses										
6.1 Possible conflict with wildlife harvesting in the area	.1 Public consultation with all local communities has been undertaken and is ongoing to notify communities of drilling operations and timing. .2 Post construction warning signs will be placed on access routes.	Local	Low	Short term	Isolated	Low	High	Reversible in short term	Neutral	Not Significant
7. Archaeological, Historical or Palaeontological Sites										
	.1 A 30 m buffer between camp facilities, including roads, and culturally important sites will be maintained. .2 Should any archaeological or palaeontological sites be discovered during construction or operations, work will be suspended at that location until permission is granted by the appropriate Inuvialuit organizations. Notification shall be provided in writing within 2 days.	Local	Low	Short term	Accidental	Low	High	N/A	Neutral	Not significant
8. Abandonment and Restoration										
	.1 Non-combustible solid wastes will be removed from the site. .2 Drilling sump fluids will be disposed of using the total containment method. .3 The sump will be capped with a layer of freshwater to dilute the salt content of the sump fluids and ensure that the sump remains frozen.	Local	Low	Short term	Isolated	Low	High	Reversible in short term	Neutral	Not significant

	.4 Before backfilling the sump, the frozen fluids will be tested to ensure they are sufficiently frozen to support the weight of the backfill material without rupturing. .5 A compacted cap of a minimum 1.5 m of soil material will be placed over the sump. The cap will overlap the sump edges. .6 Material excavated during sump construction will be used as the cap material and contoured to promote vegetation growth and allow natural migration of permafrost on to the site.									

13.0 EMERGENCY RESPONSE PLANS

In the event of an emergency, Petro-Canada's Emergency Response Plan (Appendix B) will be followed, and the NEB and INAC will be contacted immediately. In the event of a spill, the Fuel and Oil Spill Contingency Plan will be followed (Appendix B) and INAC, NEB and NWT Emergency Spill Response Line will be notified immediately as outlined in Table 15.

Petro-Canada is active in the development of a spill coop within the region. Petro-Canada and Anderson Exploration Ltd. (Anderson) will operate under a Mutual Aid Agreement. This agreement will provide assurances to both parties that in the event of an incident of significance, each company will be available to the other to provide assistance in terms of equipment, personnel and expertise. Petro-Canada will work with Anderson to develop and deliver appropriate spill training to key personnel.

14.0 CLEANUP, RECLAMATION, DISPOSAL, AND/OR DECOMMISSIONING PLAN

Upon completion of the drilling program, the wells will be capped and temporarily or permanently abandoned, and the wellsite, campsite, and fuel storage facilities will have the surface scraped to pick up all contaminated or stained ice & snow. This scraped material will be hauled by gravel truck or sealed container to Inuvik or an approved disposal site. All equipment, survey stakes and construction debris associated with the operations will be disposed of upon completion of drilling. The sumps, once covered may be revisited the following winter should maintenance work be required. The only permanent facility planned is the well. It is planned that a wellhead will be the only surficial facility erected. Petro-Canada and their contractors will adhere to all applicable regulations and guidelines.

15.0 OTHER ENVIRONMENTAL ASSESSMENT

IEG (formerly Inuvialuit Environmental Inc.) prepared a previous environmental assessment for Petro-Canada's Mackenzie Delta Kurk and Kugpik Winter 2000/2001 Seismic Program, and the Petro-Canada Mackenzie Delta Winter 2000/2001 Napartok Seismic Program. These Project Descriptions are on file with the EISC and NEB. Several assessments written for past developments within the vicinity of the project area were previously approved, and a number of environmental assessments for proposed projects within the vicinity of the project area will be submitted for approval.

16.0 COMMUNITY CONSULTATION

Petro-Canada initiated public consultation with the communities potentially affected by the proposed drilling program on July 30, 2001. Government representatives were also informed of the proposed project. This consultation has provided the opportunity for Petro-Canada to present the program to the various groups, obtain information on the area from local residents, and hear concerns raised during the community meetings.

In order to reduce the number of project related meeting the community representatives are requested to attend, Petro-Canada coordinated with Chevron Canada Resources to arrange community consultation meetings that would present the upcoming projects of both companies at that time. Petro-Canada presented the details of five proposed projects: the Kurk/Kugpik summer 2002 drilling program, the Kurk/Napartok winter 2001/2002 drilling program, the Titalik 2D/3D seismic program, the Napoiak 2D program, and the Ogeoqueoq 2D/3D seismic program. Mettings were held August 14th through 17th in the communities of Aklavik, Inuvik and Tuktoyaktuk to discuss issues of concern and mitigative measures to be adhered to during the projects. At the meetings, project information was presented to the various individuals and groups, and input related to issues, concerns or questions were invited. A schedule of meetings is provided in Table 16. The issues raised during community consultation meetings that relate to the proposed Petro-Canada drilling projects are listed below in Table 17, as arranged by specific area of interest.

TABLE 16

COMMUNITY CONSULTATION MEETINGS

Date	Consultation Group	Location
August 14, 2001	Aklavik Hunters and Trappers Committee	Aklavik Council Chambers
August 14, 2001	Aklavik Community Corporation	Aklavik Council Chambers
August 14, 2001	Aklavik Public Meeting	Aklavik Council Chambers
August 15, 2001	Inuvik Hunters and Trappers Committee	IRC Building Boardroom
August 15, 2001	Inuvik Community Corporation	IRC Building Boardroom
August 16, 2001	Tuktoyaktuk Hunters and Trappers Committee	Tuktoyaktuk HTC Office
August 16, 2001	Tuktoyaktuk Public Meeting	Tuktoyaktuk Council Chambers
August 17, 2001	Inuvialuit Land Administration	ILA Boardroom (Inuvik)
August 18, 2001	Inuvialuit Regional Corporation	Teleconference

TABLE 17

COMMUNITY CONSULTATION ISSUES AND RESPONSES

Community	Proponent
Environment	
The Environmental and Wildlife Monitors have not been informing the community on what is happening on the programs, only ILA.	We recognize the information gap. We will work closely through the community to provide updates on the programs and establish a closer liaison to allow the ILA to contact the community more frequently.
The quality of the ice roads should be improved over last year.	There were problems with the ice roads last year. We will continue to test the ice thickness on the roads to ensure it is adequate.
There is some concern with the re-fuelling process. There were some fuel and oil spills that occurred last year.	For our operations, one person does the refueling. Our refueling equipment also has locking devices. Any spills over one litre are reported to the proper authorities.

TABLE 17 Cont'd

Community	Proponent
Perhaps the summer drilling program will affect beluga breeding.	Beluga breeding areas are about 30 km away from the proposed summer drill site. In addition, the rig is very quiet. It is a closed and insulated structure so noise is reduced considerably.
Roads need to be marked better.	There will be signage on the roads that they are private property and to use at your own risk. The Department of Transportation was to put signage in place. We will liase with them to ensure that it is done.
In the past there have been conflicts between roads and skidoo trails. The snow gets piled up along the road, and when a snowmobile comes to it at right angles, it can be dangerous.	Attention will be paid to avoiding hazardous conditions along snowmobile trails.
Contracts/Training/Employment	
Inuvik and Tuktoyaktuk are getting all the work, contracts, jobs and Aklavik is being left out. The communication between the ILA and the Human Resources person in the community is insufficient.	We are sympathetic as to the allocation of jobs and contracts. We will communicate your concerns to the ILA. Quite a few employees at Swimming Point are from Aklavik. Our plane also gives direct service of pick-up and drop-off between Swimming Point and Aklavik.
Are there any opportunities for training?	We make every effort to hire locally, and although the work is seasonal, we can use all the people possible. There is a specific need for labourers, mechanics and welders, and we have had difficulty finding individuals with those skills. We will communicate closely with Sharon Stewart (Aklavik HR) to see that these needs are met.
Three apprentices completed 9 months of training, but need a job to fulfill their apprenticeship.	We will make every effort to liase with the Aklavik Human Resources person.
Are there opportunities for contracts?	If someone has heavy equipment that is needed for a program, the individual has to be proactive and position the equipment.
Some people don't want to go south for training.	Unfortunately, the training services that are provided are not always nearby, and may require some training to be done down south. Petro-Canada in liaison with Aurora College to identify individuals with specific skills. Petro-Canada also donated $100,000 worth of casing to a drilling training program in the area.
Program Details	
Are these wells directional?	No, they are all vertical wells. Petro-Canada will drill 2 wells for sure, maybe 3. If it is a 2-well program, they will both be shallow wells. If it is a 3-well program, 2 will be shallow wells, and one well will be deep.
How deep will the deep well be?	That is proprietary information at this time.
How many people will be on the drill rig?	About 60 people on the rig, and 60 people on the service rig for M-15 after Anderson is done with the service rig.
There were a few accidents on some programs last year.	There were a few accidents last year, but not on Petro-Canada's operations. Our plane was used to medi-vac 2 people from other accidents. We always have the helicopter on standby at Swimming Point.
What does Petro-Canada do if there are any accidents or incidents?	There is a debriefing after the incident, then an incident report is written up. The report is scrutinized and recommended actions are suggested and acted upon at that time. When a safety report is generated, it is taken very seriously.
There was a hovercraft used around Inuvik that was very noisy.	They are a bit noisy. We will only be using the hovercraft for about a week until the ice is thick enough, so probably in early to mid-November. We will be doing monitoring and testing at Swimming Point coming to Inuvik for a training program in September. You can come by at this time to look at it and hear it.
Was last years well successful?	The service rig will be on site, and flaring will be done. We will know at that time if the well is successful or not.
Is flaring dangerous?	It is flared into tanks, which is harmless. We will not be flaring

TABLE 17 Cont'd

Community	Proponent
	directly into the atmosphere.
What do you know about the reserves in the area?	Estimates are 6 trillion cubic ft. of reserves in the area. The reserves have to be proven to justify a pipeline.
A summer well is not typical for the area.	That is true, but Shell drilled a well into Spring back in the 1970's.
How do you ensure a safe drilling operation?	The highest technology has been used in the design of the well. In addition to early indicators obtained from monitoring equipment, there are redundancies in the equipment, such as a 4 component BOP stack, and 2 ways to shut off the well. During the winter operation people are welcome to come out and view the rig and program.
Will there be a dike around the wellsite?	Yes, there will be a dike.
What is the long term plan?	It is too early to anticipate that now.

17.0 PERSONAL COMMUNICATIONS

Inuvialuit Environmental & Geotechnical Inc. wishes to acknowledge the following people for their assistance in supplying information and comments incorporated into this report.

Chernoff, Eric. EIRB Secretary, Joint Secretariat – Inuvialuit Renewable Resources Committees, Inuvik, NT.

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Slack, Todd. GIS Specialist, Joint Secretariat, Inuvik, NT.

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APPENDIX A

LIST OF CHEMICAL COMPOUNDS

INVENTORY April 09/01

MATERIAL CODE	PRODUCT NAME	ORIGINAL QTY	U of M	UNIT SIZE	TOTAL UNIT QTY	Swimming Point BALANCE ON HAND	Rig BALANCE ON HAND
0	NO ITEM						
1	ALCOMER 74P	1	C-CAN	15 KG	40	0	40
2	BARITE - BULK BOXED - 1.36 MT	742	C-CAN	1.36 MT	742	584	37
3	BARITE - SACKED	68	C-CAN	40 KG	5100	150	3225
4	BICARB	1	C-CAN	22.68	75	0	70
5	CALCIUM CARBONATE SUPERCAL	1	C-CAN	25 KG	80	80	
6	CALCIUM CARBONATE O (MEDIUM)	2	C-CAN	25 KG	160	160	
7	CALCIUM CARBONATE 325 (FINE)	1	C-CAN	25 KG	80	80	
8	CAUSTIC SODA	4	C-CAN	22.68 KG	240	180	58
9	CELLOPHANE / CELLOFLAKE	4	C-CAN	11.34 KG	200	150	50
10	CI-40	5	TOTE	1000 L	5	0	1
10-A	CI -40	48	PAIL	20 LT	48	0	27
11	CITRIC ACID	1	C-CAN	25 KG	50	0	34
12	DEFOAM-X	2	TOTE	1000 L	2	1	0.5
12-A	DEFOAM - X	45	PAIL	18.93 LT	45	45	
13	DESCO CF	2	C-CAN	11.34 KG	160	160	34
14	DRILL-XT	4	TOTE	1040 L	4	2	1
15	IDCAP D	5	C-CAN	25 KG	250	0	10
16	IDLUBE XL	9	TOTE	1000 L	9	9	
17 *	KELZAN XCD	3	C-CAN	25 KG	105	0	165
18	LIGNITE	3	C-CAN	22.68 KG	200	150	50
19	LIME	1	C-CAN	20 KG	36	36	
20	MIX II FINE	4	C-CAN	11.34 KG	144	144	36
21	MULTI SEAL	1	C-CAN	18.14 KG	30	30	
22	PRIMASEAL COARSE	1	C-CAN	18.14 KG	30	0	30
23	KWIKSEAL FINE	1	C-CAN	18.14 KG	30	0	30
24	PIPELAX W	4	TOTE	1040 L	4	4	
25	POLY PLUS DRY	2	C-CAN	22.68 KG	80	80	
26	POLYPAC REG	1	C-CAN	22.68 KG	40	140	43
27	POLYPAC UL	2	C-CAN	22.68 KG	80	0	37
28	POTASH	26	C-CAN	25 KG	1664	504	210
29	SAPP	1	C-CAN	22.68 KG	60	60	
30	SAWDUST	7	C-CAN	18.6 KG	350	200	90
31	SODA ASH	1	C-CAN	22.68 KG	40	0	17
32	STARPAK / THERMPAK D	8	C-CAN	22.68 KG	400	150	20
33	UNTREATED BENTONITE (GEL)	12	C-CAN	40 KG	420	70	85
34	WALNUT FINE	1	C-CAN	22.68 KG	35	0	35
35	WALNUT MEDIUM	1	C-CAN	22.68 KG	40	40	
36	X-CIDE 207	1	C-CAN	2.72 KG	102	60	52

* 160 Kelzan shipped to rig

APPENDIX B

EMERGENCY RESPONSE PLAN
OIL POLLUTION EMERGENCY PLAN

EMERGENCY CONTACTS

CONTACT	LOCATION	PHONE NUMBER
RCMP	Inuvik	(867) 777-2935
AMBULANCE	Inuvik	(867) 777-4444
HOSPITAL	Inuvik	(867) 777-2955
FOREST FIRE	Inuvik	(867) 777-3333 or (24 hr) 1-800-661-0800
NWT EMERGENCY SPILL RESPONSE LINE	Yellowknife	(867) 920-8130
NATIONAL ENERGY BOARD	Calgary	(403) 299-2792
CANADIAN HELICOPTERS LTD.	Inuvik	(867) 777-2424
PETRO-CANADA CONTACT	Swimming Point	(867) 777-4942

PETRO-CANADA OIL AND GAS

MACKENZIE DELTA PROJECT

EMERGENCY RESPONSE PLAN

COPY NO:_____

AUGUST, 2001

MANUAL DISTRIBUTION **2001-08**

MANUAL #	ASSIGNED TO	LOCATION
1,2,	Corporate Security (Betty Lou Kinton)	14 PCCW
3,4	Drilling Operations (Linda Lee)	26 PCCW
5,6	ES&IH (Anne Downey) (Tim Taylor)	19 PCCW
7	Graeme Phipps	26 PCCW
8	Peter Haverson	26 PCCW
9	Bill Roeske	26 PCCW
10	Art Congdon	26 PCCW
11	Larry Krusel	26 PCCW
12	Jack Kercher	26 PCCW
13	Don Thompson	26 PCCW
14	Wally Shtand	26 PCCW
15-25	Field Operations (Mike Prichuk)	Delta
26-28	NEB	Calgary

1. INTRODUCTION

2. REPORTING PROCEDURES

3. EMERGENCY TEAMS

4. EMERGENCY DESCRIPTIONS

5.0 EMERGENCY RESPONSE TEAM DUTIES

6. EMERGENCY TELEPHONE CONTACTS

7. SAFETY EQUIPMENT LIST

9. REPORT FORMS

Petro-Canada's Emergency Response Plan (ERP) is a living document and accordingly is subject to a Continuous Improvement process. This August 2001 version replaces the January 2001 version and all copies of the later plan should be destroyed.

Prior to the drilling season commencing, this ERP will undergo at least one more review. Petro-Canada has a number of process underway that will be reflected in the ERP:

- Petro-Canada has taken the lead in forming a Joint Venture with other oil and gas companies operating in the Mackenzie Delta to establish an Oil Spill Coop. A planning meeting for this coop will occur on September 18, 2001 in Inuvik, NWT.
- Petro-Canada will be installing spill kits in its vehicles. The design of these kits is not currently finalized.
- Additional spill response equipment will be positioned in Petro-Canada's operating area, beyond that equipment listed in the ERP. This equipment has not been specified at this time.
- Spill Response training is being evaluated for Northern workers.
- An emergency response exercise is planned for the Mackenzie Delta region. Details have not been finalized.

INTRODUCTION

The Mackenzie Delta Project Emergency Response Plan is intended to define the authority and general procedures for response to an emergency that may develop during the drilling, completion, workover or abandonment of Petro-Canada operated wells in the Mackenzie Delta area of the Northwest Territories.

The Emergency Response Plan outlines procedures for notification of the personnel and equipment to handle any emergency which may develop. The plan describes a system for rapid communication of essential details of the emergency to personnel having direct responsibility for implementing corrective action. Responsibilities within the emergency organization are outlined and an integration of the job positions and functions are shown on the organization charts.

All personnel directly involved with the Company operations including both operator and contractor personnel shall become familiar with this Emergency Response Plan. Supervisory personnel shall know and understand their responsibilities and co-ordinate their response action in conjunction with their staff and contractor personnel. Response action shall also be co-ordinated in conjunction with other detailed procedures and safety and security manuals where applicable.

EMERGENCY DEFINITION

An emergency is defined, for the purpose of this plan, as any potential or real developing situation that may result or results in serious injury, loss of life, property damage, or impact on the environment which calls for immediate action to control and mitigate the problem.

FIGURE 1.1
GUIDELINES FOR IDENTIFYING THE TIER LEVEL OF A RESPONSE
(FROM PETRO CANADA MAJOR EMERGENCY RESPONSE PLAN TIER II & III)

Tier I Local Response	Tier II SBU Response	Tier III National Response
• Self-contained, and • Short duration (<24 hours), and • Local resources sufficient, and • No significant customer impact, and • No regulatory threat, and • No strategic issues result, and • Local management can solve	• Off-site resources required, or • Medium duration (24 – 72 hours), or • Local media coverage, or • Significant impact on crude or product supply, or • It is an oil spill for which the Response Organization has been activated, or • It is a third party emergency which affects the Company image, or • Potential for regulatory threat, and • Within SBU financial ability, and • SBU management can solve	• Beyond the SBU resources, or • Major financial impact, or • Major impact on crude or product supply, or • Prolonged involvement (>72 hours), or Significant Federal/Provincial regulatory effect, or • External to Canadian SBU activities, or • Significant security threat, or • A concern for the shareholders, or • National media coverage, or • Could have critical impact on Company image

EMERGENCY ORGANIZATION

In the event of an on-site emergency as defined in this Emergency Response Plan, the Senior Petro-Canada Representative On-Site will notify the Superintendent and additional staff from Petro-Canada, and any other contractor or mutual aid individuals as appropriate and warranted by the nature of the emergency, to establish an "Emergency Organization". In the event of an off site emergency the Superintendent and the Drilling Manager would be responsible for establishing the emergency team. Should the emergency become too large to be dealt with by the Drilling and Completions Department the Petro-Canada Major Emergency Response Plan will be activated to help deal with the situation.

PETRO-CANADA MAJOR EMERGENCY RESPONSE PLAN (TIER II & III)

The Major Emergency Response Plan (MERP) describes how a major incident response operation will be managed to a level appropriate to the scale of the incident. This plan identifies the management system and personnel necessary to effect a response to emergencies that are beyond the resources of a local (Tier I) team. It identifies the steps to escalate to a SBU team (Tier II) and a National and/or crisis response team (Tier III). The plan applies to all types of emergencies within Canadian and international operations. Figure 1.1 of this section illustrates the main criteria, which help to define the tiered level of response.

Several positions in this plan also have duties in the MERP. They are:

MacKenzie Delta Project Department Emergency Response Plan (Tier I)	Major Emergency Response Plan Tier II & III
VP Exploration & Int'l (Graeme Phipps)	Incident Commander
Drilling Manager (Peter Haverson)	Deputy Incident Commander
Drilling Superintendent (Bill Roeske)	Operations Section Chief
Completions Superintendent (Art Congdon)	Operations Section Chief
Superintendent (Spike Leriger)	Contractor Supervisor
Superintendent (Al Reid)	Contractor Supervisor
Drilling Engineering Advisor (Jack Kercher)	Planning Section Chief
Logistics Superintendent (Don Thompson)	Logistics Section Chief

Note: These Tier II&III positions are on the Petro-Canada Oil & Gas Major Emergency Team For drilling, completions and other downhole events.

EMERGENCY OPERATIONS CENTRES/COMMUNICATION PROCEDURES AND EQUIPMENT

Key company personnel, upon notification of an emergency (if required), will report to their respective offices which will serve as "Emergency Operations Centres" for communication and co-ordination of all activities relative to the emergency. The Senior Petro-Canada On-Site Representative's Office at the drilling site, the main office at the Swimming Point Base Camp, and the Drilling & Completions Office, 26th floor, P.C.C.W., are designated as the main Emergency Operations Centres.

If the emergency warrants, the Corporate Crisis Management Centre (17 PCCW) may be utilized. Access to this room may be gained by phoning (403) 296-3000. This room is equipped with extra outside phone lines and has other specialized communications equipment. Copies of all current Petro-Canada emergency response plans are located in this room.

The following equipment and materials should be situated at the Emergency Centres:

A) A communication system of telephones, cell phones, radios, etc. to ensure direct communications between all parts of the emergency organization.

B) Petro-Canada and other pertinent Operator Emergency Procedure Guides.

C) Information regarding operation of emergency control equipment.

D) Technical support information outlined in operations manuals, clean-up procedure manuals, disposal guidelines, and so on.

E) Copies of government regulations and other documents which are relevant to the emergency.

F) Maps showing topography, facilities, roads, residents and hazardous areas.

G) Telephone numbers of key company, contractor and government personnel.

SAFETY IN AN EMERGENCY SITUATION

The safety of personnel responding to an emergency situation is a priority item. Under no circumstances should anyone jeopardize their own safety when responding to an emergency. Actions such as dangerous driving or speeding are not advised. Personnel should be aware of fire, releases of toxic chemicals and/or explosion hazards in an emergency and conduct their activities accordingly. Fatigue may affect judgement and reflexes. Provisions should be made for relief if fatigue may become a factor in responding to an emergency. Good communication is important for responding to an emergency. Personnel should ensure their actions, intent and location are made known to someone, preferably their Supervisor.

MACKENZIE DELTA PROJECT DESCRIPTION

The DRILLING & COMPLETIONS DEPARTMENT is responsible for the drilling, completion, workover and abandonment of all Petro-Canada operated wells in the Mackenzie Delta area.

Petro-Canada will has an ongoing commitment to conducting drilling and testing exploration operations.

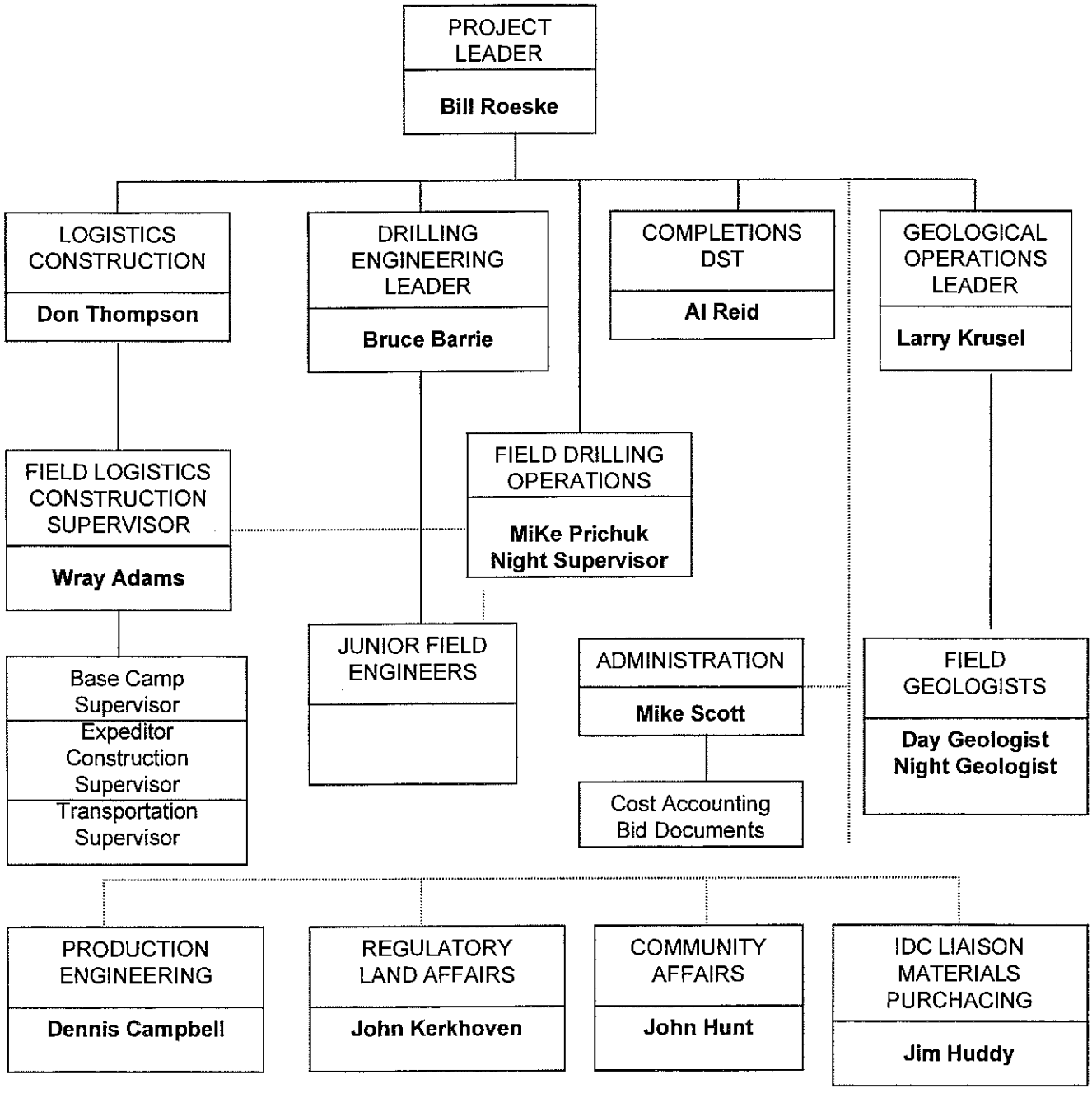
A base camp will be established at Swimming Point on the west side of the Mackenzie River to support all Petro-Canada operations in the area.

Due to the transient nature of these projects the men and equipment located at each site are kept at a minimum required to safely conduct operations. It is likely that for any major emergency extra men and equipment would be required to assist the site personnel to resolve the problem and return the situation to normal.

Communications on these projects will consist of:

- Microwave phone systems located at Swimming Point and the rig for both voice and data.
- Satellite phones at the rig for both voice and data.
- VHF repeater system for coverage of the entire project area.

PETRO-CANADA MACKENZIE DELTA DRILLING & COMPLETIONS



Note: There are three major activities involved in this project:

1) **The completion of well Kurk M 15**
2) **Drilling sites using rig Akita Equtak 60**
3) **The Swimming Point Base Camp**

The Senior Petro-Canada Representative with control of the site of the incident will be the initial On Scene Commander. The non-affected sites will provide support to the emergency site.

SENIOR PETRO-CANADA REPRESENTATIVE ON-SITE (On Scene Commander)

A) Receives the initial report of an emergency and communicates the nature and details of the emergency to all necessary on-site personnel and provides immediate attention to the protection of life.

B) The Senior Petro-Canada Representative On-Site (if necessary) will activate the Emergency Response Plan and contact the Superintendent for response or standby assistance. The Senior Petro-Canada Representative On-Site, in consultation with the Superintendent, will determine the initial response level required to control the emergency and to isolate the public from danger. This determination will be based on the following criteria:

- No potential danger to off-site persons or property. The emergency can be controlled by personnel on-site.
- No immediate danger is yet apparent, but potential danger exists to justify notifying outside services (police, fire department, emergency organizations, regulatory agencies) of the potential danger and keeping them informed of the situation.
- Safe operating control has been lost, causing or potentially causing hazard to project personnel, property, the public or the environment.

C) Make initial contact with the N.E.B, as required by regulations and make them aware of the situation.

D) Except for brief statements of fact, news media personnel at the site should be referred to the Petro-Canada Communications Department (refer to "Media and General Public" in this section).

E) Ensure accurate record keeping for all events and activities and assist in the preparation of all reports regarding the emergency.

FIRST CONTACT LEVEL (Superintendent)

A) Obtain all pertinent facts and ensure a record of the information is kept and recorded on the appropriate report forms.

B) Assist the Senior Petro-Canada Representative On-Site in deciding what immediate action is required. Determine if Calgary based employees or other outside assistance is required.

C) Relay the information regarding the emergency to the Second Contact Level (Drilling Manager).

D) If contractor or service company personnel are involved, contact the local contractor representative.

E) Begin mobilization of required Petro-Canada personnel and outside assistance as required.

F) Obtain internal and external approvals before resuming operations (especially where death or serious injury has occurred).

SECOND CONTACT LEVEL (Drilling Manager)

A) Relay information regarding the emergency to the Third Contact Level (Vice-President, Exploration and International) and send out a "Major Loss Announcement".

B) Mobilize Calgary based personnel if required.

C) Contact the NEB and keep them informed and up to date on the situation.

D) Ensure that contractor's head office is notified if contract personnel are involved.

E) Ensure contact with the media is co-ordinated through Communications (Consult with the Vice-President, Exploration and International).

F) Mobilize support from other Petro-Canada departments as required (eg. EH&S, Security, Aviation, HR, Legal).

G) Contact other operators and arrange mutual aid support where necessary.

H) In cases involving serious injury or death, ensure that next of kin are informed on a timely basis. Provide support to next of kin wherever possible.

I) Provide support to field emergency teams as required.

THIRD CONTACT LEVEL (Vice-President, Exploration and International)

A) Keep the senior officers of the company informed and up to date on the situation.

B) Act as the main company spokesperson for any "high profile" situation requiring a public spokesperson. Contact Communications for assistance with this duty.

C) Ensure that all the resources required to control and mitigate the situation are made available to the emergency teams.

NOTIFICATION - NEXT OF KIN

If a serious accident occurs it is most important that the next of kin of a deceased or seriously injured person be notified as early as possible.

Death should never be presumed: first aid must be administered until a doctor arrives and examines the person. Upon completion of medical report by a doctor, next of kin must be advised in person by the person's supervisor at the scene or his designate and where possible, in the presence of the appropriate clergy. If the next of kin does not reside within the vicinity of the accident, notification should be routed through the Head Office of the company the person works for.

For Petro-Canada personnel the Human Resources Department and the Drilling Manager will have responsibility for contacting next of kin. For contractor or service company personnel the local representative of that company will have responsibility for insuring that the company head office and the next of kin are notified. The Petro-Canada Drilling Manager will monitor and assist to ensure information reaches next of kin on a timely basis.

MEDIA AND GENERAL PUBLIC

Preferably, all external reporting will be carried out with the assistance of Communications. The Senior On-Site Petro-Canada Representative may make brief statements of fact regarding the emergency after consulting with Communications. The Vice-President, Exploration and International will act as the main public spokesperson with the assistance of Communications.

STATUTORY REPORTS

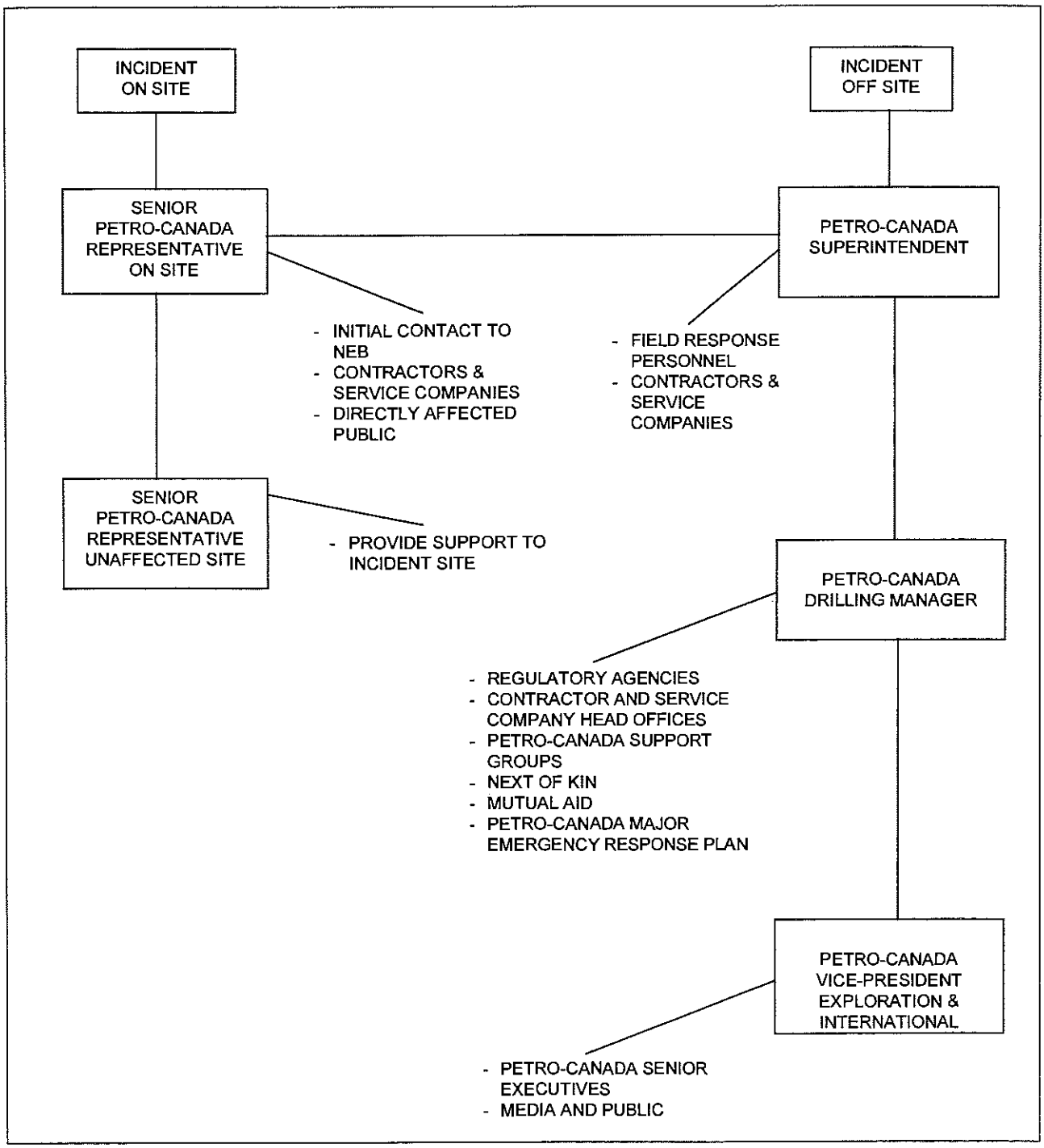
Where a written report is required under federal or provincial legislation only specific facts that describe the emergency should be disclosed. The report should not express an opinion as to how the incident occurred nor who was responsible for its occurrence, since a report is compellable in a court of law in the event of litigation.

In serious cases the report should be reviewed, prior to submitting the report, by the Legal Department.

PRIVILEGED REPORTS

A privileged report is not compellable in a court of law if it is prepared for the purpose of assisting the Legal Department in any existing or contemplated litigation. Emergency personnel, in consultation with the Legal Department, shall determine the need for a privileged report, and no other written report, other than reports made pursuant to a statute shall be prepared unless otherwise directed by the Legal Department.

EMERGENCY COMMUNICATIONS FLOWCHART



In response to an emergency the Petro-Canada Drilling & Completions Department will have up to four teams organized and ready to handle any situation. The exact make up of each team and which teams will respond to an emergency will be decided, initially, by the Senior Petro-Canada Representative On-Site and the Superintendent in charge of the operation.

The four teams and their make up for a maximum emergency (i.e. a major spill, major camp fire or a blow out which is a threat to the public) are outlined on the following chart. Duties of the team members are outlined in Section 5.

EMERGENCY RESPONSE TEAMS

DRILL SITE RESPONSE TEAM

- **Senior Petro-Canada Representative On Site**
- Other Petro-Canada Personnel
- Contractor Rig Manager
- Rig Crew
- Bear Monitor
- Service Personnel

SWIMMING POINT RESPONSE TEAM

- **Senior Petro-Canada Representative On Site**
- Camp Supervisor/Expeditor
- Construction Supervisor
- Transportation Supervisor
- Bear Monitor
- Base Camp Crew
- Construction Crew

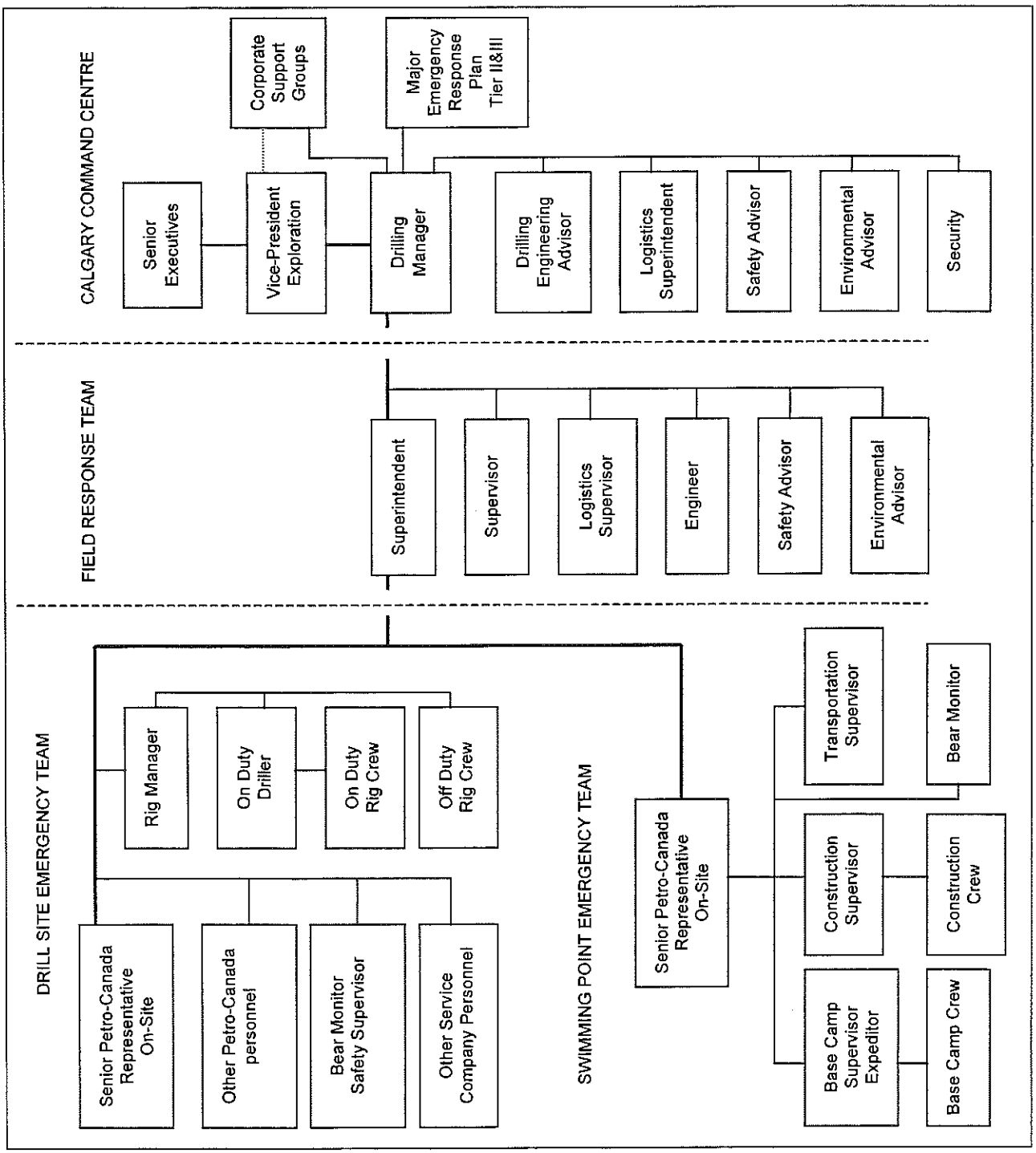
FIELD RESPONSE TEAM

- **Superintendent**
- Supervisor
- Logistics Supervisor
- Engineer
- Safety Advisor
- Environmental Advisor

CALGARY COMMAND CENTRE

- Vice-President Exploration
- **Drilling Manager**
- Supervisor Drilling Engineering
- Logistics Superintendent
- Safety Advisor
- Environmental Advisor
- Security (Telephone Co-ordinator)

MACKENZIE DELTA PROJECT EMERGENCY RESPONSE ORGANIZATION



CORPORATE SUPPORT

In addition to the Response Teams there are several Corporate Departments which can supply support to the Drilling & Completions Department.

Corporate Security - (403) 296-3000

The 296-3000 number is Petro-Canada's prime emergency number. Security has emergency contact lists which they will use to contact the persons required to activate any of the Petro-Canada emergency response plans.

Security will contact Aviation and arrange for pilots and aircraft to fly emergency teams to the area of the emergency.

Security will supply personnel to secure the Calgary Command Centre (17 PCCW) and will arrange for special security services at the emergency site if required.

Aviation

(403) 296-1000 during business hours, outside business hours call Security at (403) 296-3000. Aviation will arrange for aircraft to fly emergency teams to the emergency area. Aviation should also be contacted if equipment such as helicopters or spotter planes are required at the emergency site.

CORPORATE SUPPORT (Continued)

Surface Land

Surface Land is responsible for negotiating land use agreements for all surface lands acquired by Petro-Canada Operations both in normal and emergency conditions.

Communications

All communications with the public or the media should be cleared through the Public Affairs Department and the Vice-President, Exploration before being released, (see Media and General Public in section 2). Communications will supply personnel to both the Calgary Command Centre and the emergency site if required.

Other departments which could supply assistance in an emergency include Materials Management, Risk Management, Legal, and Human Resources.

INJURY/FATALITY

IMMEDIATE EMERGENCY DUTIES

- Any person who discovers or witnesses an injury accident will immediately notify their supervisor, the medic and the Senior Petro-Canada Representative On-Site

- The Senior Petro-Canada Representative On-Site will:

- Initiate rescue and first aid activities

  - Be sure rescue and first aid personnel are aware of hazards such as, H_2S, fire/explosion, asphyxiation, falling, etc. and that they have the proper PPE to protect themselves.

  - Do not move seriously injured persons before medical aid arrives unless it is necessary to protect them from further harm.

  - Never assume an injured person is dead. Until a medical doctor has examined the injured person and declared him dead, first aid efforts must continue.

- Notify ambulance or other appropriate transportation and have them dispatched to the site.
  Note: A medic and ambulance will be located at both Swimming Point Base Camp and the Rig.

- Notify the local hospital and give them any available information. Update them if more information on injuries and condition of victims becomes available.

- If a fatality or serious injury has occurred, initiate notification of next of kin (see Notification - Next of Kin Section 2).

IMMEDIATE EMERGENCY DUTIES (continued)

- Notify Calgary office of situation and keep them up-to-date(see Section 2 - Reporting Procedures).
- Report the accident to the required regulatory authoritiesRCMP, NEB, etc.).
- If contractor or service company personnel are involved ensure that their office is informed.
- Isolate the area of the accident and leave the area undisturbed until investigations have been completed and approval has been given to resume operations.

  The Chief Conservation Officer from the NEB must give approval before restart of operation.
- Ensure that records are kept of all investigations, that the names and addresses of all witnesses are recorded and that all company and regulatory reports are completed and distributed.

VEHICLE ACCIDENT (Project Vehicles)

IMMEDIATE EMERGENCY DUTIES

- Notify Supervisor, Medic and Senior Petro-Canada Representative On-Site.
- Initiate rescue and first aid measures.
- Report accident to Petro-Canada Calgary office.
- Report accident to local authorities as required (RCMP).
- If a contractor or service company vehicle is involved ensure that their office is informed of the situation.
- Conduct investigation and complete all required company and government reports.

FIRE/EXPLOSION

IMMEDIATE EMERGENCY DUTIES

- Sound alarm (Rig Horn, Activate Camp Fire Alarm, other pre-arranged signal)
- Evacuate as necessary.
- Notify Supervisor, Medic and Senior Petro-Canada Representative On-Site.
- Establish search and rescue procedures.
- Direct all workers to report to mustering area (Site Office or Camp) and take personnel head count.
- Shut down all equipment and shut off fuel lines and electrical power at source.
- Ensure administration of first aid to injured personnel.
- Proceed with fire control.
- Do not fight fire, after rescue operations are complete, unless you are sure that the fire can be safely put out with the equipment and personnel available. If it is felt that the fire cannot be safely extinguished use the equipment and personnel available to keep the fire from spreading until additional equipment and personnel arrive.
- Call out specialised service companies as required.
- Notify Calgary office of the situation and keep them up-to-date.
- Notify the NEB as required by the Canada Oil & Gas Occupational Safety & Health Regulations.
- If contractor or service company equipment is involved, ensure that their office is informed.

- Establish controls to prevent secondary losses:
  - barricades
  - roped off area
  - security guards
- Identify clear and precise signals of communications before returning to work.
- Post Event Planning
  - Survey damaged area to determine total damage.
  - Isolate damaged equipment.
  - Prevent further damage.
  - Erect temporary shelter if necessary.
  - Check integrity of equipment to be returned to operation (e.g. x-ray, ultrasonic, pressure testing, etc.).
  - Monitor equipment as per temporary conditions.
  - Prioritise equipment to be repaired.
- Investigate and record information for the preparation of necessary company and government reports.

UNCONTROLLED GAS RELEASE

This section of the plan is designed to deal with unplanned or uncontrolled releases of H_2S gas during well operations. It can also be used for releases of sweet gas.

Note: H_2S is not anticipated in the Mackenzie Delta Area.

PLAN IMPLEMENTATION PROCEDURES

The plan will be implemented using the following Emergency Levels. Normally these Levels will be implemented in sequence, however, if the initial problem is of a large magnitude the plan can be initiated at any level.

Emergency Level One (Potential Emergency):

Description

The H_2S formations are open to the wellbore and an abnormal drilling/completion problem has occurred that has the potential to lead to a well control problem. There is no immediate hazard to the public, as there is no release of H_2S gas, and the situation can be controlled by on-site personnel and equipment. The following conditions could constitute a Level 1 Emergency:

- Continuous gas cut mud with uncontrolled lost circulation
- Controlled well kick
- Any abnormal drilling/completion problem with the potential to affect well control

Response

- Alert the Response Team Members (Company, contract and NEB personnel) required to implement the plan.
- Establish an Emergency Zone (EZ) and inform all persons in the zone of the potential emergency situation.
- **Note: At this level evacuation of the EZ is a voluntary action.**
- Alert and mobilise emergency support services and equipment as required.

Emergency Level Two (Emergency Situation):

Description

Signals that response to an imminent or current release of sour gas is necessary. Indications are that, while the problem will most likely be resolved in the short term, immediate action should be taken to protect the public.

Response

- Inform the Response Team Members previously contacted of the change to a Level 2 Emergency
- Notify EZ occupants and request evacuation of the area, provide assistance as required.
- Establish roadblocks to restrict access into the area.
- Assemble the ignition equipment.

Emergency Level Three (Serious Emergency):

Description

Occurs when well control is unlikely in a short time period by on-site personnel and equipment, and the situation poses an immediate hazard to the public.

Response

- Inform the Response Team Members of the change to a Level 3 Emergency.
- Perform surveys of the EZ to verify evacuations have been competed.
- Verify isolation of the EZ.
- Continue air monitoring downwind of the wellsite.
- **Ignite the H_2S flow if the ignition criteria have been met.**

ISOLATION (ROADBLOCKS)

The hazard area is the area surrounding an H_2S release where a potential hazard to the public or project personnel exists. Isolating the area shall be accomplished by posting security sentries and establishing roadblocks.

Procedures

If a Level 2 Emergency is declared, a sentry shall be stationed at the wellsite entrance to restrict entry of unauthorized personnel. The Rig Manager will place the Off-Duty Crew (designated roadblock personnel) on standby.

If the situation escalates to a Level 2 or 3 Emergency, designated roadblock personnel shall be mobilised to establish roadblocks to isolate the EZ/affected area.

The hazardous area resulting from a hydrogen sulphide release is dependent upon the nature of the release, the volume of the gas escaping and meteorological factors such as wind direction, wind speed and atmospheric stability.

The affected area will be cordoned off by roadblocks manned by contractor employees.

AIR MONITORING

During implementation of the plan air quality monitoring for hydrogen sulphide (H_2S), and sulphur dioxide (SO_2), if ignition of the gas release has taken place, shall be conducted on the wellsite and throughout the Emergency Zone using handheld detectors and fixed sensors.

IGNITION

The Senior Petro-Canada Representative On-site has the authority to direct ignition of the release. If time permits, the decision will be made in consultation with Senior Company officials and the Government.

Ignition Criteria

The H_2S flow will be ignited if the well is experiencing an uncontrolled flow of H_2S gas at surface and public safety cannot be assured because:

- Evacuation of the public within the EZ/affected area has not been accomplished and air-monitoring data indicates H_2S levels in excess of 15 ppm for a 15-minute average or 20 ppm for a 3-minute average in unevacuated areas.

  Or

- Air monitoring is not taking place due to unforeseen circumstances such as bad weather or communications breakdown.

Ignition Procedure

Ignition of sour gas release should only take place once the criteria has been met, and not before all of the on-site personnel have been accounted for and have been safely relocated to an upwind area.

Two Ignition teams shall be formed as follows:

TEAM 1 (PRIMARY) - On-Duty Drilling Supervisor and Safety Supervisor
TEAM 2 (BACKUP) - Rig Manager and Driller

The following procedure is to be used as a guide for igniting the gas flow:

- Assemble equipment, and brief the ignition teams at an upwind safe area. Each person shall be wearing breathing apparatus, Fire Retardant Clothing, and ear protection. They shall carry an explosive meter, a personal H_2S monitor, and remain in visual contact with each other at all times.

Ignition Procedure (Continued)

- The backup team shall man the safety lines.
- Firing of the flare gun should be done from a prone position or from behind a protective object.
- Ignition shall be implemented from the maximum upwind range of the flare gun which is 45-60 metres. Shells shall be shot towards the sour gas release in such a manner that ignition will occur at the furthest outside edge of the gas plume.
- Approach the gas flow from the upwind side checking that an explosive mixture does not exist in the immediate area.
- Fire the flare gun and ignite the gas flow when at the correct range.
- If possible, remain on standby at the ignition site to re-ignite the sour gas release, if required.
- Contact air-monitoring personnel with confirmation of ignition to ensure monitoring of SO_2 emissions is taking place.

RE-ENTRY PROCEDURE

After an emergency situation has been determined "under control" by Petro-Canada staff and appropriate government agencies, a decision will be made to resume work and allow the public to return to the emergency zone. The Petro-Canada Superintendent and the Drilling Manager, in consultation with government authorities, will collectively agree on safe levels of monitored air contaminants and ensure adequate and complete equipment repair has taken place before this decision is made.

MISSING OR OVERDUE PERSONNEL/VEHICLE OR AIRCRAFT

IMMEDIATE EMERGENCY DUTIES

- If employee or aircraft has failed to routinely "report-in" notify the immediate supervisor and Senior Petro-Canada Representative On-Site.
- Organise and dispatch search teams.
- Contact outside help if requiredRCMP, Search and Rescue).
- Search team should be prepared to discover possible accident victim:

  1) Upon discovery initiate rescue and administer first aid as required, and,

  2) Initiate evacuation and transportation as required.

- Notify Calgary office of situation and keep them up-to-date.
- Maintain contact with search and rescue team.
- Record information for preparation of reports.

Note: **A tracking system will be in place for all personnel and transportation working away from the main camps.**

HAZARDOUS MATERIAL RELEASES

SPILL CONTINGENCY PLAN

For any spill, the following steps should always be followed:

- Ensure that all personnel are safe. If any one is injured they should be evacuated to medical assistance.
- It is Petro-Canada's Senior On-Site Representative's responsibility to call-out additional help and inform the Superintendent of the event.
- All spills should be reported to the NWT Spill Hot Line (867-920-8130). Paper copy of report should be faxed to the Spill Line and to the Chief Conservation Officer in the NEB offices in Calgary.
- First responders should be aware of spilt material's properties and required safety procedures. MSDS for commonly used materials are available On-Site and electronically.
- The source of the spill should be shut off and isolated. The spill should be contained as quickly as possible.
- For spills larger than 100 litres at the fuel barge, either landing strip or on the ice road, the large spill response equipment kit should be called out. The spill response materials include power generators and lights, which will be needed at the site.

For specific spills the following should be used:

Equipment Through Ice

During travel on ice roads a small risk of vehicles falling through ice exists. Procedures for testing ice will be in place to minimize the risk. Should a vehicle penetrate the ice:

- Safety of personnel on ice is of primary importance. An ice monitor should be appointed.
- An event report should be created for any instance where equipment goes through ice. In the unlikely event that any fuel is spilt during the recovery of the vehicle, it should also be reported as a spill.
- Primary means of spill recovery is through vacuum truck from the drill site. Prior to using the vacuum truck, ice safety should be ascertained

Spills to Snow and Ice

- The predominate risk for spilled product will be during the winter months. This season has the highest level of activity.
- Winter spills present a lower risk of environmental damage than do spills during other seasons. Snow makes an excellent absorbent and the frozen ground acts to prevent downward movement of contaminate. Ice and frozen tundra can provide a solid base to operate heavy equipment from (which would not otherwise be available during spring and summer). Source 1997 Spill Containment and Clean Up GNWT
- When examining the spill site to determine extent of cleanup, in winter the following relationship might be used: 1:1 ratio for barrels spilt to square metre of spill area (200 litres to 1 square meter).
- For spills that are not witnessed, staining on snow or ice provides a useful indicator of the spill extent. Snow around the spill stain should be probed for diesel under the snow cover.

Snow

For spills in snow, after the source is controlled:

- Use shovels or front end loader to build a berm to halt flow of liquids(shovels are available at spill kits at the fuel barge, drilling site and Swimming point). Avoid damage to underlying tundra.

- For large spills, tarps should be used to line the face of the berm (tarps are available at spill kits in Swimming Point and the drill site).

- Contaminated snow should be excavated to open 1 cubic metre totes (or empty barrels). Totes and barrels are available at Swimming Point, Fuel Barge and at the Drill site. When full the containers should be relocated to Swimming Point. The snow will likely dilute the diesel below the dangerous goods flash point. However, prior to shipping, an analytical test of flash point must be completed and reviewed with GNWT Transportation to determine if a hazardous waste manifest is required. If a hazardous waste manifest is not required, a Petro-Canada manifest should be used to track the wastes.

- For large spills, a dump truck and loader may be used to clean-up contaminated snows. Contaminated snow should be taken to Inuvik for containment in tanks. Care should be used that the loader does not scrap the tundra. Use hand shovel to scrap snow from ground to protect tundra.

- Sorbents should be used on free liquids. Also, sorbent should be used if all spilt material cannot be cleaned entirely. Sorbent materials are available in Swimming Point, Drill Site and at the fuel barge.

- Contaminated sorbents should be placed in totes and moved under Petro-Canada manifest to Swimming Point.

Ice

For spills on ice, after the source is controlled:

- An ice monitor should be appointed to ensure full safety.
- A spill to ice will likely occur on the ice roads. Spill response equipment should be sourced from Swimming Point or the Drill site.
- Any free fluids should be absorbed with snow or sorbent materials available in spill kits.
- Contaminated sorbents should be placed in totes and moved under Petro-Canada manifest to Swimming Point.
- An alternate means of stopping the flow of a spill is to use a chainsaw to cut a shallow intercept channel into the ice.
- Ice that has absorbed spilt materials should be removed to secure storage. If left in place, spilt materials will contaminate flowing water in spring.

Damaged Containers

- Aviation fuel, lubricants, and other chemicals are stored on the drill site and support locations, like the airstrip, fuel barge and may also be transported on support vehicles. To prevent spills barrels should be stored on secondary containment wherever possible.
- Empty drums should be stored at an angle on their sides, so that precipitation does not enter them.
- A container may become damaged by falling off a vehicle or by other mechanical damage. The contents of any damaged drum should be transferred immediately to another container. If contaminates have entered fluid, barrel will be considered a waste.

- For helicopter fuel that is spilt while the helicopter is on duty for Petro-Canada, it is Petro-Canada's responsibility to ensure that the spill is reported. If the helicopter company is reporting the incident, a copy of the report should be filed with Petro-Canada.

- Damaged empty containers must be triple rinsed prior to disposal at a landfill. Preferred disposal is through metal recycling.

- Empty drums may fall under TDG, depending on original contents. Check supplier labels first prior to returning drums or sending them for disposal.

Container, Truck or Tank Overflows

A fuel spill while transferring fuel from storage to tank to vehicle or from a tanker truck to the tanks, is the most likely type of spill to occur. Prevention is important. Consider:

- Using drip trays under the main fuel connections

- Using sorbent pads under fuel transfer operations

- Maintain constant attention during fuel transfer operations

- Understand tank gauging operations prior to transfer of fuel

- Ensure fuel truck has a small pail of absorbents and scoop type shovel

Spill Reporting Requirements

- All spills and gas releases must be reported to the NWT 24-Hour Spill Report line (867-920-8130). The spill should be reported within 24 hours of the event occurring. The NWT Territories Spill Report should be completed and faxed to the **Spill Line (FAX = 867-873-6924)** within that same period. If some information is unavailable, like cause, send the form anyway. Provide faxed updates, as information becomes available.

- The National Energy Board is the lead agency for spills occurring in the drilling program. NEB's Environmental Assessment Officer for spills is available at phone 403-292-6614, FAX 403-292-5876, (Alternate FAX number is 403-292-5875)

- For all other spills a call must also be made to the NEB Environmental Assessment Officer within 24 hours.

- While the NEB is the lead agency, other agencies like Department of Fisheries may become involved. The NWT 24-Hour Spill Report line will forward copies of the spill report to these agencies, you may decide to provide courtesy copies directly.

- All spills should also be reported into Petro-Canada's event reporting system. Information may be entered directly from the NWT Spill Report into the system, or you may elect to send the Spill Report to the EH&S department for entry.

- The NEB leaves all spill events open until environmental impact has been resolved.

Waste Management of Residual Materials

Waste manifests can be found at Swimming Point and at the Drilling Rig

- Used oil is considered a hazardous waste. However, if shipped to a used oil recycler in the NWT, it does not need a federal waste manifest, but does require a Petro-Canada waste manifest for tracking (Verbal confirmation – Donald Helfrick, Hazardous Waste Specialist, GNWT).

- If used oil is shipped to Edmonton for recovery, a federal waste manifest is required.

- Used lube oil filters should also be treated as a hazardous waste and shipped, using a federal waste manifest, to Edmonton on a back haul for recycling.

- Spent batteries are considered a hazardous waste. A federal manifest should be used when transporting batteries. Batteries can be taken to Inuvik landfill for deposit at recycling depot or on a backhaul to Edmonton.

- Spent glycol is not considered a hazardous waste. However, a Petro-Canada manifest should be issued to transport spent glycol. The best waste disposal is to ship to Edmonton for recycling.

- Diesel fuel mixed with spill materials will be considered a hazardous waste. Because of contaminates, it will not be possible to reuse as fuel without conditioning. Several facilities exist in Alberta that condition diesel.

- Contaminated fuels are likely considered hazardous and should be shipped using a federal manifest.

- Domestic wastes should be incinerated using the camp incinerator.

- Petro-Canada standards require all waste receivers used by Petro-Canada to be audited. Check the approved list for current status. If your intended waste receiver is not on the list, call the Environment, Health and Safety Department to arrange an audit prior to shipping wastes.

PROCEDURES - CHEMICALS

- Refer to the Emergency Response Guide for Dangerous Goods, Canutec Current Edition and the MSDS (Material Safety Data Sheets).

- Chemical spills of significant volume, that would require emergency response procedure as outlined in the Liquid Hydrocarbon Spills Section would include:

1) Acids
2) Glycol
3) Drilling fluids
4) Brine water.

FACILITY DESCRIPTIONS

SWIMMING POINT

- The fuel storage system at Swimming Point will consist of two 159 m^3 diesel fuel tanks, two 64 m^3 jet B tanks and one 32 m^3 gasoline tank along with associated pumps and piping. The tanks will be located in a lined berm system with at least the capacity of the largest tank plus 10%(design capacity is 740 barrels – 4653 M^3).

- In August 2001, the capacity will be expanded at Swimming Point with four additional 500 M3 tanks for Diesel. The tanks will be located in a bermed compound of similar design to the existing tank farm.

- Additionally Swimming Point will temporarily hold the tanks and fuel destined for the drilling and completions rig sites. These will be contained in a lined berm system with at least the capacity of 110% of largest tank.

DRILLING RIG (Akita Equtak 60) AND COMPLETIONS RIG

- Four 64 m^3 tanks for diesel fuel storage will be located in a lined berm engineered system with a minimum capacity of 83.2 M^3 (largest tank plus 10% of the aggregate volume). An additional eight 160 m3 storage tanks will be located in a lined concrete berm with a minimum capacity of 110% of the largest tank. Initially these tanks will be located at Swimming Point until the start of the drilling and completion operations.

- The surface mud system on the rig will consist of three open top tanks with a total capacity of 310 m^3. A sump will be located near the tanks to contain any discharge from the drilling mud system. The main section of the well will be drilled with a 4% KCl polymer mud system.

FUEL STORAGE BARGES (River Channels)

- Three NTS barges will be tied up to deadmen located onshore at **Kurk at 69° 04.53" N 135° 09.28"W in the Avarnuk Channel**. These barges will hold an aggregate of 3,250 m^3 of diesel fuel.

- An additional barge will be moored at Napartok at 68° 30.30" N 134° 16.30"W. This barge will hold up to 950 m^3 of diesel fuel.

- Supplies of absorbent material will be stored at each site to clean up small spills. Heavy equipment including back hoes, dozers, and graders will be available in the area to contain and clean up larger spills. There will be no booms stored at any of the sites while the river is frozen. Spill response equipment is being evaluated for the operations during open water.

DANGEROUS ANIMAL ENCOUNTERS

IMMEDIATE EMERGENCY DUTIES

- Encounters with large animals, which are a danger or interfering with operations, are to be reported immediately to the supervisor.

- The Bear Monitor will be mobilised to the incident site to deal with the situation.
  Note: Bear Monitors will be located at the Swimming Point Base Camp and at the Rig Camp.

- Project personnel will not attempt to deal with any dangerous animal encounters on their own.

EXTREME WEATHER

- No personnel will leave either main camp without checking the weather forecast to ensure that they can safely complete their trip.
- There will be a tracking system in place to monitor all personnel working away from the base camps.
- All transportation will be equipped with emergency survival gear, VHF radios and mobile phones.

SECURITY BREACHES

IMMEDIATE EMERGENCY DUTIES

There are several events which would be considered to be under the category of security problems. Some of the more likely ones are:

1. Theft
2. Vandalism
3. Unauthorized persons (trespassing)
4. Bomb Threats
5. Extortion Attempts

In all cases, except minor events under 1, 2 and 3 above, Field Personnel should not try to handle the situation on their own.

- First contact should be made with Local police.
- Contact management in Calgary and pass all information to them and to Corporate Security (296-3000).
- Co-operate with and assist the local authorities as required.
- Keep Calgary management and Corporate Security informed of developments.
- Keep record of events.

Note: **For more serious events Corporate Security may dispatch assistance to the site or arrange for help.**

PROCEDURES - BOMBS/PHONE CALLS

Threatening Contacts (Bomb Threats)

Note: This is a procedure for handling threatening telephone calls which suggest bombs or other such devices may have been placed on Petro-Canada property. It covers what to do in case of such threats from the standpoint of communications, search and disposition.

- If a bomb threat call is received every effort should be made to elicit as much information as possible and relay this promptly to the Senior Petro-Canada Representative On-Site.

- The Senior Petro-Canada Representative On-Site will contact the Superintendent. A decision on whether or not to evacuate and/or close down a building or operation will be made by the Superintendent in consultation with management and security contacts. This will be done with regard to the nature of the threatening call and an appraisal of the personnel and physical situation at the site.

- An immediate search of the suspected area or areas will be ordered by the Senior Petro-Canada Representative On-Site to be carried out with the co-ordination of management.

- If a suspicious device is located, a minimum evacuation distance of 100 metres will be established. The device will not be touched and outside experts will be brought in to properly dispose of it. Continue the search and do not assume that there is only one device.

- In the event that evacuation becomes advisable, remain calm and when evacuating, remove personal property such as brief cases, lunch containers, and purses to reduce confusion during search.

- If the result of the search is negative, based on confidence in the search, time lapsed and history of any previous calls, the Superintendent and Senior Petro-Canada Representative On-Site may decide to reoccupy and resume normal operations, assuming an evacuation had been made.

- Whether or not public information is released will be determined by Management in Calgary. Such information, if released, would be handled by the Communications Department.

Receiving Threatening Phone Calls

- If you receive a threatening phone call, listen carefully, be calm and courteous and do not interrupt the caller. When the caller has completed his initial message, try to draw the caller into giving as much specific information as possible. Write down all that is said as accurately and completely as possible.

- Pay particular attention to the voice of the caller. If someone else is nearby when the call is received, motion with hand signals for the other person to also listen to the call.

- Notify the Senior Petro-Canada Representative On-Site as promptly as possible, giving him the written record of the call and remain available to provide additional information about the call if required.

PROCEDURES - THEFT

- The unauthorized removal of equipment, tools, materials, product or other Company property is considered theft. All employees are requested to maintain an awareness of the actions of non-regular personnel on Company sites to reduce or eliminate the loss of Company property.

- Any employee suspecting theft of Company property should immediately notify his supervisor who will in turn contact the Senior Petro-Canada Representative On-Site. The Senior Representative On-Site, in consultation with the Superintendent and Corporate Security, will determine if law enforcement agencies are to be notified.

PROCEDURES - UNAUTHORIZED PERSONS

If unknown or unauthorized persons are observed on a Petro-Canada drilling site the following procedures should be adhered to in approaching individuals.

- When approaching the unknown person, ask for his name, what he is doing on Petro-Canada property, and if he has permission to be On-Site. If he states he has permission, inquire from whom in order that you may verify the authority granted.

- If the individual is found to be unauthorized, ask him to leave the site immediately, escort him off the site and report the incident to the Senior Petro-Canada Representative On-Site.

- If the unauthorized person refuses to leave or acts in a belligerent manner, advise him that assistance for his removal will be sought from local law enforcement officers and then retreat to a safe area. Do not get drawn into physical conflict.

- From a safe distance, continue to monitor the activities of the unauthorized person and report the incident to the Senior Petro-Canada Representative On-Site. The Senior Petro-Canada Representative On-Site will dispatch additional backup personnel to the scene and contact the local police for assistance.

THIRD PARTY EMERGENCIES

IMMEDIATE EMERGENCY DUTIES - THIRD PARTY EMERGENCIES

Duties outlined in this section should follow the basic procedures outlined in the manual:

Injury/Fatality
Vehicle Accident
Fire Explosion
Uncontrolled Gas Release
(Sweet/Sour/N.G.L.)
Missing or Overdue
Personnel/Vehicle or Aircraft
Hazardous Material Releases
Security Breaches

- Where Petro-Canada has a legal duty to respond, it shall respond immediately in accordance with Petro-Canada emergency plans to the extent required by law.
- Where Petro-Canada has no legal duty to respond, but whenever public perception of the name of Petro-Canada is involved in any way, and prompt response is not forthcoming from others, Petro-Canada will respond to the extent required to control and contain the emergency and eliminate danger to the public.
- When Petro-Canada has no association with the emergency, Petro-Canada will respond when requested by government authority, the public or industry without prejudice.
- All emergencies will be reported internally and externally in accordance with procedures set out in this manual.

EMERGENCY RESPONSE TEAM DUTIES

TEAM	POSITION	ALTERNATE
DRILL SITE	**SERVICE COMPANY PERSONNEL**	

DUTIES

For All Emergencies

1) Notify immediate supervisor and Senior Petro-Canada Representative On-Site.

2) If necessary shut down operation.

3) Ensure personnel are clear of emergency area (use breathing apparatus or other PPE if necessary).

4) Follow instructions of Supervisor and the Senior Petro-Canada Representative On-Site.

Safety Supervisor
For All Emergencies

1) Act as rescue team leader for on-site emergencies.

2) Act as lease security co-ordinator.

Bear Monitor
Dangerous Animal Encounters

1) Act as team leader to deal with all animal contacts.

TEAM	POSITION	ALTERNATE
DRILL SITE	**DRILLING OR WELL SERVICING CREW**	

DUTIES

For All Emergencies

1) Notify immediate supervisor and Senior Petro-Canada Representative On-Site.

2) If necessary shut down operation and secure well.

3) Ensure personnel are clear of emergency area (use breathing apparatus or other PPE if necessary).

4) Follow instructions of Supervisor and the Senior Petro-Canada Representative On-Site.

5) Control access to the area of the event until it has been investigated and it has been declared safe to re-enter the area.

Injury/Fatality

1) Initiate Rescue and First Aid Activities.

2) Isolate and control access to the area of the accident.

Vehicle Accident

1) Act as search and rescue team.

Fire Explosion

1) Act as fire fighting first response team.

Drilling Crew Duties (continued)

Uncontrolled Gas Release

1) On duty crew act as well control team.

2) Off duty crew; man roadblocks; conduct downwind monitoring; act as evacuation team for EZ.

Hazardous Materials Release

1) Control source of spill.

2) Act as initial response team to isolate and control spill.

TEAM	POSITION	ALTERNATE
DRILL SITE	**Rig Manager**	On-Duty Driller Off-Duty Driller

Duties

For All Emergencies

1) Notify Senior Petro-Canada Representative On-Site and immediate supervisor of situation and actions taken.

2) Assign drilling crews to duties as required.

3) Assist in the call-out and direction of required emergency men and equipment.

4) Ensure drilling crews are adequately trained to undertake emergency duties.

5) Ensure that events involving his own personnel are properly reported to Petro-Canada and regulatory authorities.

TEAM	POSITION	ALTERNATE
DRILL SITE	**Senior Petro-Canada Representative On-Site**	Night Supervisor Rig Manager On-Site Geologist

DUTIES

For All Emergencies

1) Report emergency to Superintendent and decide on initial response requirements. Contact Swimming Point for support.

2) Report the situation to the NEB.

3) Take charge of all communications and general organization of company and contractor personnel in the area.

4) For all on-site emergencies, establish control of the affected area and maintain security.

5) Keep company officials up-to-date on activities and changes in the area of the emergency.

6) Ensure that an accurate written account is kept of all events and activities related to the emergency.

7) For all on-site events ensure that proper re-entry procedures are established and followed to prevent further loss after the emergency is under control.

8) Participate in event investigations and reviews.

9) Ensure that all company and government reports are completed and delivered on a timely basis. Co-ordinate this activity with the Drilling Superintendent.

10) Act as company spokesperson at the lease with assistance from the Public Affairs department.

Senior Petro-Canada Representative On-Site Duties (continued)

11) Provide support to emergency teams at Swimming Point as required.

Injury/Fatality

1) Arrange search and rescue and first aid activities.

2) Arrange for transportation of injured to hospital.

3) Contact receiving hospital and keep them informed of the situation until casualties arrive.

4) Contact NEB, (and RCMP for fatalities) (see section 4.0, Code 1).

5) If Petro-Canada personnel are involved, initiate notification of next of kin through the Drilling Manager (section 2.0).

6) If contractor or service company personnel are involved, contact their local office and have them notify next of kin.

7) Ensure that the site of the accident is not disturbed until government (NEB Chief Conservation Officer) and company officials give clearance to resume operations.

Vehicle Accident

1) Contact RCMP and inform them of the accident.

Fire/Explosion

1) Arrange search and rescue activities.

2) Arrange fire control activities.

3) Contact service companies for assistance as required.

Senior Petro-Canada Representative On-Site Duties (continued)

Uncontrolled Gas Release

1) Decide on initial alert stage (section 4.0).

2) Evacuate unnecessary personnel from the lease area.

3) Inform NEB of situation.

4) Arrange roadblock crews and downwind monitoring crews as required by emergency stage.

5) Call-out service companies and contractors as required to handle the emergency.

6) Evacuate and isolate hazard areas as defined by downwind monitoring.

7) Evaluate the need to ignite the gas release using criteria set out in section 4.0, page 9. If circumstances permit, consult with Petro-Canada Head Office and NEB before igniting the well.

8) Lead well ignition team if this action is required.

9) Arrange for relief crews where emergency is likely to last for more than 12 hours.

10) Lead well control team.

Missing Personnel, Vehicle or Aircraft

1) Inform RCMP. Also inform search and rescue for missing aircraft.

2) Supply search and rescue personnel as required by Superintendent.

Senior Petro-Canada Representative On-Site Duties (continued)

Hazardous Material Release

1) Ensure that all persons involved are aware of the properties and dangers of the spill material.

2) Assign personnel to shut off the source of the spill and to isolate and contain the spill.

3) Call-out service companies and contractors as required to contain and clean up the spill.

Dangerous Animal Encounters

1) Dispatch Bear Monitor to site and provide support as required.

Security Breaches

1) Inform RCMP and Petro-Canada Corporate Security of the situation and keep them up-to-date.

2) Follow guidelines in section 4.0.

TEAM	POSITION	ALTERNATE
SWIMMING POINT	**BASE CAMP CREW**	

DUTIES

For All Emergencies

1) Notify immediate supervisor and Senior Petro-Canada Representative On-Site.

2) Ensure personnel are clear of emergency area.

3) Follow instructions of Supervisor and the Senior Petro-Canada Representative On-Site.

4) Control access to the area of the event until it has been investigated and it has been declared safe to re-enter the area.

Injury/Fatality

1) Initiate Rescue and First Aid Activities.

2) Isolate and control access to the area of the accident.

Vehicle Accident

1) Act as search and rescue team.

Fire Explosion

1) Act as fire fighting first response team.

Hazardous Materials Release

1) Control source of spill and act as initial response team to isolate and control spill.

TEAM	POSITION	ALTERNATE
SWIMMING POINT	**CAMP SUPERVISOR**	

Duties

For All Emergencies

1) Notify Senior Petro-Canada Representative On-Site and immediate supervisor of situation and actions taken.

2) Assign crews to duties as required.

3) Assist in the call-out and direction of required emergency men and equipment.

4) Ensure crews are adequately trained to undertake emergency duties.

5) Ensure that events involving his own personnel are properly reported to Petro-Canada and regulatory authorities.

TEAM	POSITION	ALTERNATE
SWIMMING POINT	**Senior Petro-Canada Representative On-Site**	Camp Supervisor Construction Supervisor

DUTIES

For All Emergencies

1) Report emergency to Superintendent and decide on initial response requirements. Contact Rig Site for support.

2) Make an initial report to the NEB of the situation.

3) Take charge of all communications and general organization of company and contractor personnel in the area.

4) For all on-site emergencies, establish control of the affected area and maintain security.

5) Keep company officials up-to-date on activities and changes in the area of the emergency.

6) Ensure that an accurate written account is kept of all events and activities related to the emergency.

7) For all on-site events ensure that proper re-entry procedures are established and followed to prevent further loss after the emergency is under control.

8) Participate in event investigations and reviews.

9) Ensure that all company and government reports are completed and delivered on a timely basis. Co-ordinate this activity with the Logistics Superintendent.

10) Act as company spokesperson at the lease with assistance from the Public Affairs department.

Senior Petro-Canada Representative On-Site Duties (continued)

11) Provide support to emergency teams at the Rig Site as required.

Injury/Fatality

1) Arrange search and rescue and first aid activities.

2) Arrange for transportation of injured to hospital.

3) Contact receiving hospital and keep them informed of the situation until casualties arrive.

4) Contact NEB (and RCMP for fatalities) (see section 4.0, Code 1).

5) If Petro-Canada personnel are involved, initiate notification of next of kin through the Drilling Manager (section 2.0).

6) If contractor or service company personnel are involved, contact their local office and have them notify next of kin.

7) Ensure that the site of the accident is not disturbed until government (NEB Chief Conservation Officer) and company officials give clearance to resume operations.

Vehicle Accident

1) Contact RCMP and inform them of the accident.

Fire/Explosion

1) Arrange search and rescue activities.

2) Arrange fire control activities.

3) Contact service companies for assistance as required.

Senior Petro-Canada Representative On-Site Duties (continued)

Missing Personnel, Vehicle or Aircraft

1) Inform RCMP. Also inform search and rescue for missing aircraft.

2) Supply search and rescue personnel as required by Superintendent.

Hazardous Material Release

1) Ensure that all persons involved are aware of the properties and dangers of the spill material.

2) Assign personnel to shut off the source of the spill and to isolate and contain the spill.

3) Call-out service companies and contractors as required to contain and clean up the spill.

Dangerous Animal Encounters

2) Dispatch Bear Monitor to site and provide support as required.

Security Breaches

1) Inform RCMP and Petro-Canada Corporate Security of the situation and keep them up-to-date.

2) Follow guidelines in section 4.0.

TEAM	POSITION	ALTERNATE
Field Response	**Superintendent**	Supervisor

DUTIES

For All Emergencies

1) Receive call regarding the emergency and consult with the Senior Petro-Canada Representative On-Site to decide on initial response level and required resources.

2) Report emergency to Drilling Manager

3) Mobilize Field Response Team Members as required.

4) If required, proceed to emergency site and take command of the field operations. If not required to go to the field, assist Drilling Manager with his duties.

5) Lead incident investigation team.

Injury/Fatality

1) Ensure prompt reporting of serious accidents and accidents with serious potential to NEB Chief Conservation Officer (section 4.0).

Superintendent Duties (continued)

Missing Personnel/Vehicle or Aircraft

1) Organize and dispatch search teams. Maintain contact with search teams and coordinate their activities.

Hazardous Material Releases

1) Call-out additional spill response materials if required.

Security Breaches

1) Contact Corporate Security and co-ordinate all activities through them.

TEAM	POSITION	ALTERNATE
Calgary Command	**Drilling Manager**	Vice-President Exploration Superintendent

DUTIES

For All Emergencies

1) Report emergency to the Vice-President, Exploration and International.

2) Contact all Calgary based personnel and activate the Calgary Command Centre if required.

3) Arrange air or other appropriate transportation for the field response team if required.

4) Contact the NEB and keep them up-to-date on the situation. Ensure that all required reports are produced on a timely basis. Co-ordinate this activity with the on-site supervisors.

5) Contact other Petro-Canada departments for support as required.

6) Contact other companies and mutual aid groups for any outside assistance required.

7) Contact contractor or service company head offices if any of their personnel or equipment are involved in the emergency.

8) Assist and support the field response and on-site teams as required.

9) Inform the Major Emergency Team (MET) Incident Commander and co-ordinate activation of the Major Emergency Response Plan if required.

Drilling Manager Duties (continued)

Injury/Fatality

1) If Petro-Canada personnel are involved, initiate and carry out notification of next of kin (section 2.0). If contractor or service company personnel are involved, ensure that the contractor has carried out proper notification.

2) For Petro-Canada personnel, ensure that next of kin are assisted in any way possible to deal with the situation.

Uncontrolled Gas Release

1) If the on-site team has time to inform the Calgary Command Centre team the Drilling Manager will make the final decision on igniting the well if it is deemed necessary.

TEAM	POSITION	ALTERNATE
Calgary Command Team	**Vice President, Exploration International**	

DUTIES

For All Emergencies

1) Inform the senior officers of the company and keep them up-to-date on the situation.

2) Act as the main company spokesperson for any "high profile" situation.

3) Ensure that all the company resources required to control and mitigate the emergency are available to emergency teams.

DRILLING & COMPLETIONS EMERGENCY CONTACT LIST

24 HOUR COMPLETIONS FAX:296-4642
24 HOUR COMPLETIONS FAX:296-7446 (Logs Only)
MODEM PHONE: 264-6584

24 HOUR DRLG. & GEOLOGY FAX: 296-3740
24 HOUR DRLG. & GEOLOGY FAX: 296-5073
24 HOUR GEOLOGY OPS.FAX: (Logs Only)296-8260

24 HOUR EMERGENCY # SECURITY: 296-3000

TITLE	NAME	OFFICE #	HOME #	CELLULAR
V.P. EXPLORATION	GRAEME PHIPPS	6-7451		
DRILLING GROUP LEADER	PETER HAVERSON	6-3163		
LEAD DRILLING SUPERINTENDENT	BILL ROESKE	6-6795 6-3011Rig	239-1625	651-8932 C
Drilling Superintendent	Spike Leriger	6-6801 6-3016 Rig	948-7027	540-8434 C
Lead Drilling Supervisor	Mike Prichuk	TBA	556-8089	803-8358 C
Drilling Engineer	Marc Lemay	TBA	236-1565	
LOGISTICS SUPERINTENDENT	DON THOMPSON	6-6799	281-3684	860-9186 C
Logistics Supervisor	Chris Schulze	6-3314	226-5814	816-6301 C
	Barry Peterson			
LEAD COMPLETIONS SUPERINTENDENT	ART CONGDON	6-6812 6-3021 Rig	293-4790	651-8935 C
Completions Superintendent	Allan Reid	6-6811 6-3013 Rig	239-6759	651-8933 C
Completions Supervisor	Gary Helinsky	6-6806 6-3023 Rig	938-5127	860-0450 C
Completions Supervisor	Bob Barvir	6-6813	280-4170	540-4506 C
Completions Programmer	Dustin Brodner	6-4539	242-6359	651-3386 C
ENGINEERING ADVISOR	JACK KERCHER	6-6818	289-3343	860-9187 C
Engineer	Bruce Barrie	6-4081	241-1228	

DRILLING & COMPLETIONS EMERGENCY CONTACT LIST

TITLE	NAME	OFFICE #	HOME #	CELLULAR
GEOLOGICAL OPERATIONS	LARRY KRUSEL	6-8211	215-7126	540-1401 C
Geological Operations	Sam Quantz	6-6810	215-7128	540-1001 C
Geological Operations	Wade Harris	6-3604	215-7130	803-1433 C
Environmental	Tim Taylor	6-7770	281-4919	816-2679 C
Safety	Wally Shtand	6-3627	246-1304	615-2210 C
Community Relations	John Hunt	6-5309		
Land & Regulatory Affairs	John Kerkhoven	6-6345		
Support	Sue Schoenthaler	6-6793	274-0064	
Support	Janine Jacobson	6-6359		
Support	Cathy Vitale	6-4647		
Support	Linda Lee	6-6854		
SUPPLY CHAIN MGMT.	Jim Huddy	6-3280		
CONTRACTORS:				
Akita Drilling – Rig	Rob Hunt	292-7979	239-9419	
Nowsco – Cement	Don Shuell	6-3177	640-1400	
MI – Fluids	Ismael Musa	6-5797	209-1850	804-0359 C
Schlumberger – Logging	Terry Eichinger	6-5797	932-5524	819-9322 C
Baker Hughes – Directional	Greg Szutiak	6-4804 BHI 537-3454	730-0489	617-8049 C 661-8650 P
Baker Bit Optimization	David Folmer	6-4020	270-9408	540-0060 C
Summit	Keith Dow	232-6066		
Stream Flo	Bill Karran	269-5531		
Environmental	Tim Taylor	6-7770	281-4919	816-2679 C
Well Control Specialist	Key Safety & Blowout Control	1-866-347-3911		

NORTH CONTRACTOR CONTACTS

Company	Contact	Location	Number
Canadian Helicopters	Dispatch	Inuvik	(867) 777-2424
Akita Drilling Rig #60	Doug Kennedy Gordon Seabrook	Nisku	(780) 955-8746
Arctic Oil & Gas Services	Jim Guthrie (President)	Inuvik	(867) 777-8701
Rigstar Communications	Scott Smith	Calgary	(403) 243-0600
New North Networks	Tom Zubko	Inuvik	(867) 777-2111

EMERGENCY CONTACTS

	Location	Number
RCMP	Inuvik	(867) 777-2935
Ambulance	Inuvik	(867) 777-4444
Hospital	Inuvik Switchboard Fax	(867) 777-2955 (867) 777-8000 (867) 777-8062
Forest Fire	Inuvik	(867) 777-3333 (24hr.)1-800-661-0800
NWT Emergency Spill Response Line	Yellowknife	(867) 920-8130
NEB	Calgary	(403) 292-4800

National Energy Board Regulatory Contacts

NAME	POSITION	NUMBERS
Rick Fisher	Drilling Specialist	Bus: (403) 299-2798 Res: (403) 220-0893
Rick Turner	Operations Inspector (Occupational Safety & Health)	Bus: (403) 299-3868 Res: (403) 257-0840
Chris Knoechel	Operations Engineer	Bus: (403) 299-3866 Res: (403) 241-0047
Andrew Graw	Operations Engineer	Bus: (403) 299-2790 Res: (403) 547-3073
John Korec	Environmental Assessment Officer (Spills)	Bus: (403) 292-6614 Res: (403) 275-6256
Tod Collard	Environmental Assessment Officer	Bus: (403) 299-2769 Res: (403) 256-1902
Terry Baker	Chief Conservation Officer	Bus: (403) 299-2792 Res: (403) 239-5032
John McCarthy	Chief Safety Officer	Bus: (403) 299-2766 Res: (403) 240-2354

Calgary Main Office: (403) 292-4800
Fax: (403) 292-5876

SPILL REPORTING - 24 HOUR SPILL LINE: (867) 920 8130

John Korec, Environmental Assessment Officer: Office: (403) 292-6614
Home: (403) 275-6256

Hazardous occurrences (as prescribed under Section XVI of the *Canada Oil and Gas Occupational Safety and Health Regulations)* are to be reported to the N.E.B. immediately. The N.E.B. also requires immediate notification of any accident or incident requiring medivac.

NWT GOVERNMENT

Agency	Contact	Location	Number
Environmental Protection	Ken Hall Manager	Yellowknife	(867) 920-6476
Minerals Oil & Gas	Doug Mathews Director	Yellowknife	(867) 920-3214
Resources Wildlife & Economic Development	Ron Morrison Regional Superintendent	Inuvik	(867) 777-7286

FEDERAL GOVERNMENT

Agency	Contact	Location	Number
INAC	Rudy Cockney District Manager	Inuvik	(867) 777-3361
INAC	Rob Walker Resources Management Officer	Inuvik	(867) 777-3361

EQUIPMENT LISTS EMERGENCY RESPONSE (WELL CONTROL)

Key Safety and Blowout Control – Response Apparatus, On call Basis

Description	Quantity
Fire Truck Pumper Units	2/1
Command Escort Unit	1
Blowout Tool Unit	1
Escort Emergency Response Unit	1
Service Vehicle	1
Breathing Air Protection Trailer	1
Paramedic Ambulance Service	1
Road Block Personnel	As required
Tank Truck Service	4
Vacuum Truck Service	1

Other Equipment (first 24 hours)

Description	Quantity
Camp/Accommodation facilities	60 men
Water Tank trucks	4
400 BBL Water storage tanks c/w timbers	10
Tank suction manifold	1
Well site office shacks	5
Generator	6
Portable light towers	6
Hot oiler unit	1
Boiler (100 HP minimum)	1
Dozer, D9 Ripper/D8 Winch	2 each
Trakhoe 245	1
Welding Trucks	4
Building material: Steel, Sheet metal, etc.	As required
Crane Rough Terrain, 25 ton	1
Fuel Bulk truck	1
Surface control equipment	As required
Crane, Track, 250 Ton	1

SURVIVAL KITS

Personal Arctic Emergency Kit

These items to be in a sealed case

Item	Number	Remarks
Candles	6x8 hrs.	
Candle holder	1	
Mylar blankets	3	Large space blankets
Aluminum foil	1 roll	
Tent	1	Small 2man popup in bag
Matches, windproof	2 packages	In waterproof case
Flint and striker	1	
First aid kit	1	#1 kit in soft case
Flares & mini gun	3 flares	
Signal Mirror	1	
Whistle	1	
Chemical lights	5	
Aluminum pot	1	Small
Cups	2	
Spoons	2	
Knife	1	
Snare wire	25 feet	
Parachute cord	25 feet	
Toilet paper	1 roll	
Food pack	2000 calories	4 freeze dried food, 10 pkgs. Coffee, 20 pkgs. Tea, 20 pkgs. Coffee mate, 20 pkgs. Sugar, 10 pkgs. Hot chocolate, 10 pkgs. Salt.
Playing Cards	1 deck	

SURVIVAL KITS (continued)

Vehicle Emergency Equipment

To be contained in vehicle tool box

Item	Number	Remarks
First aid kit	1	Number 1 kit in hard case
Road flares	1 set	Reflector type, triangles
Fire extinguisher	1	10lb BC, low temperature type
Jumper cables	1 set	At least 12 feet long
Tow strap	1	25 –30 ft, chains hooks and clevis separate
Rope	25 feet	Small, nylon
Flat mouthed shovel	1	
Gasoline antifreeze	3 bottles	
Axe	1	Medium size
Saw	1	Small fold up Swede saw
Hand tools	1 kit	Multi driver, lineman pliers, 12" crescent wrench, claw hammer
Flash light	1	

Notes:

In addition to the equipment in this kit all vehicles must have an appropriate jack and wheel wrench.

Small 2 wheel drive vehicles and all large trucks should also carry tire chains.

SPILL CLEAN UP KITS

The spill kit provisions are currently under review and are expected to be more comprehensive by January 2002.

Fuel Barge - Small Spill Response	*Comments*
Placed at barge	For cleaning up small spills at fuel transfer site.
Aluminum shovel (scoop)	
Sorbent – loose (5 gallon pail)	
I Cubic metre tote	

Notes:

Drill Rig - Small Spill Response	*Comments*
Small truck based	For use during drilling operations at drill site
6 Aluminum shovels (scoop)	
Large impervious tarp	For temporary storage of waste
Sorbent – socks (2 bale/bbl)	
Sorbent – pad (4 bale/bbl)	
Sorbent – loose (3 bale/bbl)	
I Cubic metre tote	
Documentation Kit	

Notes:

- **Sorbents** should ideally be stored in barrels for protection. In event of emergency the barrels can be used as waste bins. If sorbents are not stored in barrels an equivalent volume of empty containers should be provided.

SPILL CLEAN UP KITS (continued)

Swimming Point - Winter based major spill response	***Comments***
Large truck based	For responding to a larger spill in winter
12 Aluminum shovels (scoop)	
Chain saw (18")	
Portable lights (See light kit list)	
3 Portable generators	
Fuel in CSA approved portable containers	
Safety kit (equipment as listed below)	
Sorbent – socks (15 bale /bbl)	
Sorbent – pad (25 bale /bbl)	
Sorbent – loose (10 bale/bbl)	
Two - I Cubic metre totes	
2 Pick axes	
4 Large impervious tarps	
Tool box	
5 Boxes of XXL Disposable coveralls	
Documentation kit	
5 Boxes of vitron or nitrile gloves (winter lining)	
Diesel Herman Nelson heater	
Lubes	

Notes:

- **Fuel** - predominant fuel type is diesel in drilling operations. Portable equipment should be powered whereever feasible by diesel engines. Consideration in selection needs to be given to start-ability in cold temperatures.
- **Tool Box** should include: 3/8 socket set, crescent wrench (8" and 10"), multi-tip screwdriver , pliers, utility knife, wire cutters flat file, hack saw, claw hammer, ball

peen hammer, chainsaw file and screwdriver, pipe wrench (18", 24"), tin snips, allen wrench set, duct tape, tie wire, electrical tape.

HAZARDOUS OCCURRENCE INVESTIGATION REPORT
N.W.T. SPILL REPORT
TELEPHONE/EVACUATION CONTACT LOG
H_2S/SO_2 DETECTION RECORD
ROADBLOCK CONTROL LOG
EVACUATION CENTRE REGISTRATION LOG
INCIDENT/EVENT LOG

SCHEDULE I
(SUBECTION 16.4(3))

HAZARDOUS OCCURRECE
INVESTIGATION REPORT

TYPE OF OCCURRENCE

☐ Fire / Explosion ☐ Death
☐ Disabling Injury ☐ Emergency Procedure

☐ Other _____
Specify

Department File No./No de dossier du ministère

Regional Office/Bureau régional

Employer ID No./Numéro d'idenfication de l'employer

Employer Name and Mailing Address	Telephone Number	Operator
	Supervisors Name	
	Witnesses	
Site of Hazardous Occurrence	Weather	
ID of Drilling Rig, Drilling Unit, Production Facility, or Support Craft		Date and Time of Hazardous Occurrence

Description of what happened

Description and estimated cost of property damage	Operation in Progress	
Injured Emplyee's Name	Age	Occupation
		Years of experience in occupation
Description of Injury	Sex	Nationality
	Education	Direct cause of Injury

Was training in accident prevention given to Injured employee in relation to duties preformed at the time of the hazardous occurrence?

Yes ☐ **no** ☐ **Specify**

Direct causes of Hazardous Occurrence

Corrective action and date employer will implement

Supplementary preventative measures

Name of person investigating	Signature	Date
Title	Telephone number	
Safety & Health Committee Member or Representative's Name	Signature	Date
Title	Telephone number	
Name of person representing the Operator	Signature	Date
Title	Telephone number	

Lab/Trav 369 (Revised 7/87)

(Continue on reverse if needed)

COPIES 1&2 to **R.S.O., COPY 3** to the **Safety and Health Committee** or **Representative, COPY 4** to the **Employer**

SCHEDULE I
(SUBECTION 16.4(3))

HAZARDOUS OCCURRECE
INVESTIGATION REPORT

TYPE OF OCCURRENCE

☐ Fire / Explosion ☐ Death
☐ Disabling Injury ☐ Emergency Procedure

☐ Other _____
Specify

Department File No./No de dossier du ministère

Regional Office/Bureau régional

Employer ID No./Numéro d'idenfication de l'employer

Employer Name and Mailing Address	Telephone Number	Operator
	Supervisors Name	
	Witnesses	
Site of Hazardous Occurrence	Weather	
ID of Drilling Rig, Drilling Unit, Production Facility, or Support Craft		Date and Time of Hazardous Occurrence

Description of what happened

Description and estimated cost of property damage	Operation in Progress	
Injured Emplyee's Name	Age	Occupation
		Years of experience in occupation
Description of Injury	Sex	Nationality
	Education	Direct cause of Injury

Was training in accident prevention given to Injured employee in relation to duties preformed at the time of the hazardous occurrence?

Yes // no // Specify

Direct causes of Hazardous Occurrence

Corrective action and date employer will implement

Supplementary preventative measures

Name of person investigating	Signature	Date
Title	Telephone number	
Safety & Health Committee Member or Representative's Name	Signature	Date
Title	Telephone number	
Name of person representing the Operator	Signature	Date
Title	Telephone number	

Lab/Trav 369 (Revised 7/87)

(Continue on reverse if needed)

COPIES 1&2 to **R.S.O., COPY 3** to the **Safety and Health Committee** or **Representative, COPY 4** to the **Employer**

N.W.T. SPILL REPORT

(Oil, Gas, Hazardous Chemicals or other Materials)

24-Hour Report Line
Phone (867) 920-8130
Fax (867) 873-6924

A Report date and time	B Date and time of spill (if Known)	C ☐ Original report ☐ Update no._____	Spill number

D Location and map coordinates (if known) and direction (if moving)

E Party responsible for spill

F Product(s) spilled and estimated quantities (provide metric volumes/weights if possible)

G Cause of spill

H Is spill terminated ☐ Yes ☐ no	I If spill is continuing, give estimated rate	J Is further spillage possible? ☐ yes ☐ no	K Extent of contaminated area

L Factors affecting spill or recovery (weather conditions, terrain, snow cover, etc.)	M Containment (natural depression, dykes etc.)

N Action, if any, taken or proposed to contain recover, clean up or dispose of product(s) and contaminated materials

O Do you require assistance? describe: ☐ no ☐ yes	P Possible hazards to persons, property, or environment; eg: fire drinking water, fish or wild life

Q Comments and/or recommendations

FOR SPILL LINE USE ONLY

Lead Agency

Spill significance

Lead Agency contact and time

.....

.....

.....

Is file now closed? ☐ yes ☐ no

Reported by	Position, Employer, Location	Telephone
Reported to	**Position, Employer, Location**	**Telephone**

NWT 1752/1295

N.W.T. SPILL REPORT

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FOR SPILL LINE USE ONLY

Lead Agency

Spill significance

Lead Agency contact and time

.....

.....

.....

Is file now closed? ☐ yes ☐ no

Reported by	Position, Employer, Location	Telephone

Reported to	Position, Employer, Location	Telephone

N.W.T. SPILL REPORT

(Oil, Gas, Hazardous Chemicals or other Materials)

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FOR SPILL LINE USE ONLY

Lead Agency

Spill significance

Lead Agency contact and time

.....

.....

.....

Is file now closed? ☐ yes ☐ no

Reported by	Position, Employer, Location	Telephone
Reported to	**Position, Employer, Location**	**Telephone**

NWT 1752/1295

TELEPHONE/EVACUATION CONTACT LOG

NAME (LIST ALL NAMES IN PARTY)	MAP NO.	CONTACT TIME	ASSISTANCE OR TRANSPORTATION REQUIRED	REMARKS (PARTICULARLY CONTACT INFO. IF NOT GOING TO THE EVACUATION CENTRE

H_2S/SO_2 DETECTION RECORD

Prepared By:	Date:

Time	H_2S/SO_2 Reading ppm	Weather and Wind Contitions			Location of Reading
		Temperature °C	Direction	Speed (km/hr)	

H_2S/SO_2 DETECTION RECORD

Prepared By:	Date:

Time	H_2S/SO_2 Reading ppm	Weather and Wind Contitions			Location of Reading
		Temperature °C	Direction	Speed (km/hr)	

ROAD BLOCK CONTROL LOG

Prepared By:			Date:		
Vehicle Type & License No.	**Name of Driver**	**Number of Passengers**	**Time Entering EPZ**	**Time Exiting EPZ**	**Remarks**

Note: Instruct all residents exiting the EPZ to check in at the Evacuation Centre

EVACUATION CENTRE REGISTRATION LOG

Prepared By:			Date:	
Name (List all names in Party	**Map No.**	**Check In Time**	**Location & Telephone Number Where They Can Be Reached**	**Remarks**

INCIDENT/EVENT LOG

Prepared By:		Date	
Time	**Company or Agency**	**Name**	**Telephone Number**
Notes:			
Prepared By:		**Date**	
Time	**Company or Agency**	**Name**	**Telephone Number**
Notes:			
Prepared By:		**Date**	
Time	**Company or Agency**	**Name**	**Telephone Number**
Notes:			
Prepared By:		**Date**	
Time	**Company or Agency**	**Name**	**Telephone Number**
Notes:			
Prepared By:		**Date**	

INCIDENT/EVENT LOG

Prepared By:		Date	
Time	**Company or Agency**	**Name**	**Telephone Number**
Notes:			

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Time	**Company or Agency**	**Name**	**Telephone Number**
Notes:			

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Notes:			

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Time	**Company or Agency**	**Name**	**Telephone Number**
Notes:			

Prepared By:	Date

INCIDENT/EVENT LOG

Prepared By:		Date	
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Prepared By:		**Date**	
Time	**Company or Agency**	**Name**	**Telephone Number**
Notes:			
Prepared By:		**Date**	

INCIDENT/EVENT LOG

Prepared By:		Date	
Time	**Company or Agency**	**Name**	**Telephone Number**
Notes:			

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Time	**Company or Agency**	**Name**	**Telephone Number**
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Time	**Company or Agency**	**Name**	**Telephone Number**
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Time	**Company or Agency**	**Name**	**Telephone Number**
Notes:			

INCIDENT/EVENT LOG

Prepared By:		Date	
Time	**Company or Agency**	**Name**	**Telephone Number**
Notes:			

Prepared By:		Date	
Time	**Company or Agency**	**Name**	**Telephone Number**
Notes:			

Prepared By:		Date	
Time	**Company or Agency**	**Name**	**Telephone Number**
Notes:			

Prepared By:		Date	
Time	**Company or Agency**	**Name**	**Telephone Number**
Notes:			

APPENDIX C

ECO TECH WASTEWATER TREATMENT EQUIPMENT INFORMATION REQUEST RESPONSE

eco tech
Water Systems Ltd.

20 August 2001

Erin Bradley
Inuvialuit Environmental & Geotechnical Inc.
Bay R, 1338-36th Avenue NE
Calgary, AB
T2E 6T6

Dear Ms. Bradley:

RE: INFORMATION REQUESTED ON ECO TECH WASTEWATER TREATMENT EQUIPMENT

Further to your fax dated August 15th below is the itemized response to your questions retarding Eco Tech's wastewater treatment equipment to be employed within the Mackenzie Delta region this winter.

1. The equipment employed on temporary work camps operating this year is similar in design to that which operated last year. Akita Drilling has purchased three new treatment plants for their expanded operation within the region and ATCO Structures has purchased one small unit. Both of these plants employ primary separation of solids from liquids, aerobic digestion utilizing extended aeration, clarification of digested fluid and finally disinfection of the treated product prior to discharge. The technology being employed is extended aeration. Please let me know if you require a complete process description on these systems.

   All of the systems provided last year are or will shortly be undergoing some modification to increase their storage capacity of raw wastewater and regulate more closely how that volume is delivered to the aerobic segment of the treatment process. Specific details as to the modifications are listed below. All of the new plant have these alterations incorporated into their design.

2. As mentioned above the main modification to the wastewater plants employed last year within the Mackenzie Delta region is one of capacity. Both styles of plants built and supplied by Eco Tech, the rotating biological contactor (RBC) and the extended aeration plant have or will very shortly be undergoing their modifications.

   - Increase holding capacity of primary tank – The primary tanks were increased to have an average holding capacity of 4000 gallons. This allows prolong retention of the raw wastewater within the tank for separation of solids from liquids. This volume increase also provides for the collection or storage of separated solids so the frequency for this tank segment to be cleaned out via vacuum truck will be less than last year.
   - Increase holding capacity of aerated surge tank – The aerate surge tanks have also been increase to approximately 4000 gallons. This increase prevents camp outfall surge events, such as those straddling meal and crew change events from negatively impacting the plants performance as was experienced last year.

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Calgary, AB CANADA
T2P 1A1
Phone: 403-264-9993 FAX: 403-264-9810

- o Incorporate two submersible feed pumps – Two identical feed pumps have been placed within the aerated surge tank. One pump, the low level is plumbed such that a portion of its discharge volume is recycled back into the surge tank. A control valve on the inlet line to the plant from the surge tank allows the operator to set and adjust the flow into the plant depending on number of residents within the camp. The recycle stream assists with pre-aerating the fluid and breaking down solid particles which may have a negative impact on plant performance. The second pump is simply a high level pump and should a surge event produce a volume that engages the high level switch the will discharge to the plant until the level falls below the switch set point. A high level alarm lamp on the plant exterior also will be illuminated when the high level pump is operational.
- o The other change on the wastewater plants is the incorporation of high intensity UV disinfection lamps. This will aid in consistently reducing the coliforms counts below that listed on the permit.

3. Eco Tech currently has only one plant in operation. It is a new plant sold to Akita drilling and in operation at their training center in Inuvik. Samples of the treated effluent has just been collected and are currently in the lab. Results should be available by weeks end.

   Last years results varied significantly. Sample results did illustrate the permit requirement could be achieved but not on a consistent. All of the plants are designed to meet the 30/35 BOD/TSS and Eco Tech is confident that those guidelines can and will be attained on a consistent basis. That being said, Scott Gallupe of DIAND pointed out to me that the permit discharge criteria were more stringent than those issued for the town of Inuvik's lagoon to discharge. He made it quite clear that although he does not issue the permits there could be some leeway provided by the water board for less stringent effluent criteria. Even by the water boards own publish criteria provided we are discharging into the river, an argument could be made less stringent criteria. The anticipated effluent quality on a consistent basis is 45/45.
4. Camp practices do have and have had significant impacts on the plants performance. For example last year at the Petro Canada/Akita Drilling base camp oil and grease concentrations in the treated effluent were some 12 times the permit limit. This was due exclusively to the fact that the camp kitchen was not equipped with a grease trap and the kitchen staff were not informed to prevent cooking grease from entering the grey water discharge system. Excessive oil and grease concentrations can be directly correlated to both BOD and TSS concentrations. To my knowledge not all camps supplied by Akita have been equipped with grease traps on the kitchen drainage lines. One other practice was the deposition of inorganic material into the camp outfall system. Items such as cigarette buts, clothes, plastic bags and sanitary napkins all contribute to elevated levels of TSS as they are inorganic and hence can not be digested by the biology of the plant. A third camp practice noted to have a negative impact on plant performance is cleaning product selection and volume. High concentrations of household bleach was used within several camps last year as a disinfection agent. In significant concentrations, the bleach can destroy the plant biology reducing the digestions efficiency. By the end of the programs most camps had altered both product selection and educated their cleaning staff as to the recommended volume of each product. Eco Tech would be happy to offer suggestions not on specific product brand names but characteristics cleaning agents should have to lessen their impact on the digestion plants. We have also in the past offered to assist in educating cleaning staff on the impact their daily activities may have on the plant's performance.

5. As mentioned above in items 2 and 4 the issues leading to the plants inconsistent output quality revolved around the impacts surge events had on the plants and the impact cleaning staff had on the plants. The issue of surge protection and feeding the plants with a consistent volume over the entire operating day in lieu of "shocking" it with the

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surge volumes have been rectified over the past few months with the inclusion of added retention capacity within the primary and surge tanks. As for camp staff related impacts, I would recommend that all camp kitchen drain lines be channeled into a grease trap sized sufficiently for the number of camp residents as well as cleaning product selection be based on those that are biodegradable, concentrated so less of each product is required and that cleaning staff are sufficiently instructed on their usage. Eco Tech has made it a practice to remind camp kitchen and cleaning staff as to impacts their activities may have on plant performance as well as post signs within the bathroom and kitchen facilities to remind staff and residents that not all materials are acceptable to be put into the camp sanitary outfall system.

I trust you will find the information meets your requirements however if more detail is required please let me know. I can be reached at 264-9993, via FAX at 264-9810 or email at todd.esler@telusplanet.net.

Regards,
Eco Tech Water Systems Ltd.

Todd Esler, P.Eng

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