# 18 Traditional Knowledge and Land Use

Traditional knowledge is important to the Comprehensive Study for the Program to:

- gain knowledge and insights about the local natural environment from local residents with history and experience on the land
- understand the potential effects of the Program on current traditional use activities, resources and sites and to develop, with the help of knowledgeable local people, effective mitigation measures
- inform the technical discipline-specific assessments of potential Program-specific and cumulative effects

In addition to ongoing meetings and consultation activities with communities in the Program area (Section 4: Public Engagement and Consultation), focused traditional knowledge studies, involving Elders, hunters who were sanctioned by the local HTCs, and other community members were conducted. All the interviews for the traditional knowledge studies were conducted by local Inuvialuit beneficiaries and interpreters.

The traditional knowledge study focused on local communities that have patterns of traditional use in or near the lease areas or that may be affected by Program activities. Based on discussions with local community organizations, the communities of Tuktoyaktuk, Inuvik and Aklavik have a long history of traditional use in the lease area, while people from Sachs Harbour, Holman, Paulatuk, Fort McPherson and Tsiigehtchic do not regularly hunt and fish in the lease areas. Accordingly, traditional use interviews were only conducted in Tuktoyaktuk, Inuvik and Aklavik.

Study participants emphasized that traditional harvesting activities are an essential part of Inuvialuit life and culture. While positive aspects of the Program were recognized, communities also had major concerns about effects on the health of the natural environment and the quality of life in communities. Potential impacts of pollution or environmental contamination from, for example, spills, waste disposal, garbage or litter on environmental quality and traditional use were major community concerns. For the same reason, participants feel that it is critical to protect wildlife habitat such as migration corridors, denning, nesting and spawning areas. Participants welcome the employment opportunities that programs such as Devon's will bring, but are equally conscious of the potential negative impacts of increased income, the influx of new people to the communities and the increased absence of wage-earners from daily family and community life. Thus, participants feel that the continued ability to pass on traditional values and skills is as important as job training opportunities.

Most participants appreciated Devon's efforts to consult with community members through the community workshops and the individual interviews conducted for the traditional knowledge study. They would like Devon to continue to communicate with the communities throughout the Program.

Detailed findings of interviews in each community and maps of use areas and habitat observations are provided in the TA Report (KAVIK-AXYS 2004b). Key findings of the traditional knowledge studies are summarized in Table 18-1.

## Table 18-1 Summary of Preliminary Community Issues and Concerns

| Issue or Concern | Community |
|---|---|
| Wildlife and Harvesting | |
| Respect the Community Conservation Plan (CCP) recommendations | All three[1] |
| **Wildlife – Whales** | |
| Disruption of harvest patterns (all whales) | Inuvik, Tuktoyaktuk[2] |
| Disruption of beluga habitat and migration patterns | All three |
| Beluga health and contamination | Inuvik, Tuktoyaktuk |
| Noise impacts to belugas | Inuvik |
| Impacts to sea floor and beluga food | Inuvik |
| **Wildlife – Polar Bears** | |
| Disruption of harvest patterns | Inuvik, Tuktoyaktuk[3] |
| Disturbance of habitat or denning areas | Inuvik, Tuktoyaktuk |
| Safety hazard of bears attracted to drill platforms | Tuktoyaktuk, Aklavik |
| Community quotas and DLP kills | Inuvik, Tuktoyaktuk |
| Noise impacts | Inuvik, Aklavik |
| Role of wildlife monitors in deterring bears | Inuvik |
| **Wildlife – Seals** | |
| Disruption of seal habitat (e.g., breathing holes) and migration | All three |
| Disruption of harvest patterns | Tuktoyaktuk |
| Noise impacts | Aklavik |
| **Wildlife – Fish** | |
| Fish health and water quality | All three |
| Impacts on fish | Aklavik |
| Decline in local herring population | Inuvik, Tuktoyaktuk |
| Verify location of spawning; determine food sources | Aklavik |
| Decline in whitefish and minnow populations | Tuktoyaktuk |
| **Wildlife – Birds** | |
| Disruption of habitat and migration | All three |
| Noise impacts | Inuvik |
| Impact of seismic work on geese | Inuvik |
| Decline in geese population | Tuktoyaktuk |
| **Wildlife – Ungulates[4]** | |
| Change in habitat near EL 420 | Inuvik, Tuktoyaktuk |
| Change in wildlife health | Inuvik |
| Impact of air traffic | Inuvik |
| Change in caribou population and migration | Inuvik |
| **Pollution or Environmental Contamination** | |
| Accidental spills and resulting contamination | All three |
| Importance of maintaining environmental integrity | Inuvik, Aklavik |
| Importance of adequate regulations, emergency response planning and monitoring | Inuvik |
| Cumulative effects | Inuvik |
| **Community and Social Concerns** | |
| Loss of traditional values and skills | All three |
| Avoidance of traditional use sites | All three |
| Substance abuse | Inuvik, Aklavik |

## Table 18-1 Summary of Preliminary Community Issues and Concerns (cont'd)

| Issue or Concern | Community |
|---|---|
| **Community and Social Concerns (cont'd)** | |
| Appreciate Devon's consultation efforts and respect for traditional knowledge | Inuvik, Tuktoyaktuk |
| Human health | Inuvik |
| Strain on community infrastructure and support | Inuvik |
| Money management skills | Aklavik |
| **Employment and Training** | |
| Employment opportunities | All three |
| Access to training | All three |
| Local hiring and hiring of Inuvialuit | All three |
| Value of work experience versus education | Inuvik |
| Employment sustainability | Inuvik |
| **Drilling Platforms** | |
| Platform options | All three |
| Impact of weather and ice on platforms | Tuktoyaktuk, Aklavik |
| Impacts to the sea floor from platforms | Inuvik |
| Air emissions | Aklavik |
| Staging sites | Tuktoyaktuk |
| **Safety** | |
| Overall program | All three |
| Employees | All three |
| Wildlife | Aklavik |
| Ice road | Tuktoyaktuk |
| **Wildlife and Environmental Monitors** | |
| Independent and timely reporting; sharing of results with communities | Inuvik |
| **Climate Change** | |
| Change in weather patterns | All three |
| Ice formation | Inuvik, Tuktoyaktuk |
| Water levels | Aklavik, Inuvik |
| Impact on harvesting activities | Inuvik |
| Erosion and changes to permafrost | Inuvik |
| **Seismic Work[5]** | |
| Clearing and timing | Aklavik |
| Explosions and impact on fish | Inuvik |

**Notes**:
1 The three communities involved in the traditional knowledge interviews were Tuktoyaktuk, Aklavik and Inuvik. When an issue or concern was shared by all three communities, it is simply stated 'all three'
2 Aklavik participants noted that while they do not harvest polar bear in EL 420, that they were aware that the area was used by Tuktoyaktuk and Inuvik residents for polar bear hunting
3 Same comment as note 2
4 Includes comments on local reindeer population
5 Although seismic work is not directly associated with the drilling Program, participants commented on the impacts of seismic activities

Preliminary findings and mitigation measures arising from the traditional knowledge studies have been integrated into the respective discipline assessments. The findings of these assessments, based on western science, indicate that neither the availability of harvest nor harvest numbers will be affected by the proposed Program. Detailed reports of the traditional knowledge studies for Aklavik, Tuktoyaktuk and Inuvik, including an assessment of impacts on traditional use resources, sites and activities, will be completed and reviewed with the communities in fall 2004. These reports will identify residual Program and cumulative effects, with significance determinations from a traditional knowledge perspective. The assessment of potential impacts to traditional use requires the verification of results with study participants to provide confidence in the assessment statements. Copies of the final reports will be provided to each community, as well as to federal agencies and Inuvialuit organizations.

# 19 Heritage Resources

Disturbance or destruction of archaeological sites and artifacts from Program activities was identified as a concern by communities, government agencies and Inuvialuit organizations.

While there are currently no recorded archaeological sites on the offshore islands such as Garry and Pelly, information from the traditional knowledge studies indicates that the outer islands have been used for hunting and fishing camps and that traditional use camps currently exist on Garry, Pelly and Pullen islands. There are no known underwater archaeological sites in the area.

Given traditional use patterns, there is some potential for archaeological sites and artifacts to occur on the offshore islands. Currently recorded heritage resources sites occur on Kendall Island and the small associated island immediately to the west. Traditional land use sites, however, are reported on several offshore islands.

The Program will not require any new onshore facilities. Therefore, there will be no new ground disturbances and its associated potential to affect archaeological resources. The only anticipated nearshore activities are those associated with the mobilization of the SDC at Herschel Island and the potential barge staging sites near offshore islands such as Garry, Pelly, Hooper or Pullen. In both cases, activities will occur offshore and there will be no requirement for any access to shore. Personnel for these operations will not go onshore without appropriate permission. No indirect effects from coastline erosion are expected from Program activities (Section 10: Coastal Processes). Accordingly, it is anticipated that there will be no effect of Program activities on heritage resources near EL 420.

# 20 Land and Resource Use

This section discusses how land (e.g., parks and recreational areas) and resource use (e.g., industrial use such as oil and gas, commercial and recreational uses of fish, wildlife and forests) in the Program area may be affected by Devon's exploration activities. This section focuses on non-traditional uses. Information on Traditional Knowledge, including traditional land and land use is provided in Section 18.

## 20.1 Baseline Conditions

The main non-traditional land and resource uses within the LSA are:

- industrial and commercial activities
- non-traditional resource harvesting
- tourism and recreation
- protected and environmentally significant areas

Visual aesthetics, while not a typical non-traditional land and resource use, contribute to the quality of tourism, recreation, non-traditional resource harvesting and protected area use.

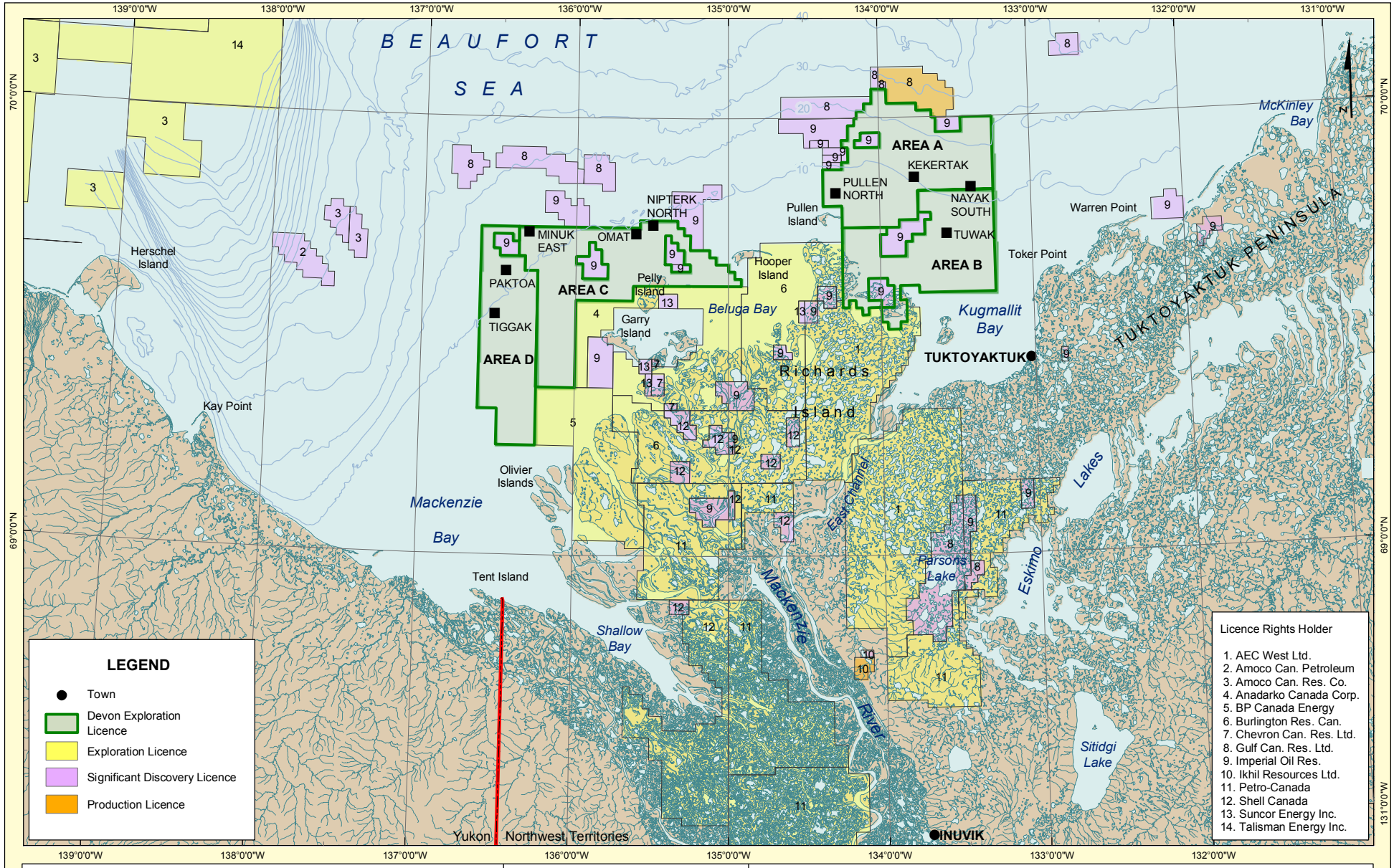
### 20.1.1 Industrial and Commercial Activities

Oil and gas and transportation activities are the main industrial/commercial presence in the area. There are currently 15 Exploration Licences, two Production Licences, and 65 Significant Discovery Licences in the Beaufort Sea-Mackenzie Delta region, although not all of these are presently active (Figure 20-1). Thirteen major oil and gas companies, including Devon, maintain an interest in this area, many of which have initiated 2D and 3D seismic programs.

No oil or gas fields have recently been developed within the Mackenzie Delta-Beaufort Sea region, other than the onshore Ikhil field, north of Inuvik (Eddy 2001; Brackman 2000). There are also three proposals to transport natural gas from the Mackenzie Delta and Alaskan North Slope to market. The Mackenzie Gas Project is furthest along in the approval process, having submitted its Preliminary Information Package (June 2003) and is moving forward with regulatory applications (NEB 2003, Internet site).

Eight privately owned companies provide transportation services near EL 420 (KAVIK-AXYS Inc. 2002a):

- six air charter companies
- one marine transportation company
- one road transportation company




devon

KA036 Devon - Exploration Licences and Significant Discovery Licences in Relation to the Study Area
June 24, 2004

Area of Detail

0 10 20 30 40
Kilometres

Data Sources:
Devon Canada
National Energy Board
National Topographic Series
Projection: Universal Transverse Mercator Zone 8 (NAD 27)

**Figure 20-1**
**Exploration Licences and Significant Discovery Licences in Relation to the Regional Study Area**

Northern Transportation Company Limited operates a coastal community supply vessel through the East Channel of the Mackenzie Delta and Kugmallit Bay between July 1 and October 1 (Fast et al. 1998). Barge traffic consists of ten river tugs that push or tow on average six linked barges and typically transit the Kugmallit Bay area approximately two to three times per week during the summer (KAVIK-AXYS Inc. 2002a). There is also a shipping corridor north of Pullen Island and north of EL 420 (Eddy 2001).

### 20.1.2 Non-traditional Resource Use

Non–traditional land and resource use includes hunting and fishing pursued by residents who are non-beneficiaries of the ISR land claim agreement and tourists.

Game management areas for barren-ground caribou, grizzly bear and polar bear management areas overlap Devon's EL 420 area. There is very little domestic non-beneficiary fishing and no large-scale commercial fisheries operating within the LSA.

Several tourism companies, based in Inuvik and Tuktoyaktuk, operate in the Mackenzie Delta area and a few are known to run tours near EL 420, principally to view wildlife and visit traditional camps with Inuvialuit guides. Little to no independent (i.e., unguided) recreational use occurs in or adjacent to EL 420.

### 20.1.3 Protected and Environmentally Significant Areas

The Program is located in the Aklavik, Inuvik and Tuktoyaktuk conservation planning areas. EL 420 is adjacent to the Beluga Management Plan Zone 1A areas. These areas are important habitat for beluga whales and for traditional harvesting areas (whales are present in the summer and early fall). Zone 1A areas are currently being assessed as a potential marine protected area (MPA) by the Beaufort Sea Integrated Management Planning Initiative (BSIMPI) working group (Fisheries and Oceans Canada 2002, KAVIK-AXYS Inc. 2002). The entire EL 420 area is located within Beluga Management Zone 2 and the Mainland Coastal Polar Bear Denning Area (both category C of the Community Conservation Plan [CCP]). Guidelines for Beluga Management Zone 2 allow industrial activities if they do not adversely affect the conservation of beluga whales and the protection of beluga whale habitat and hunting.

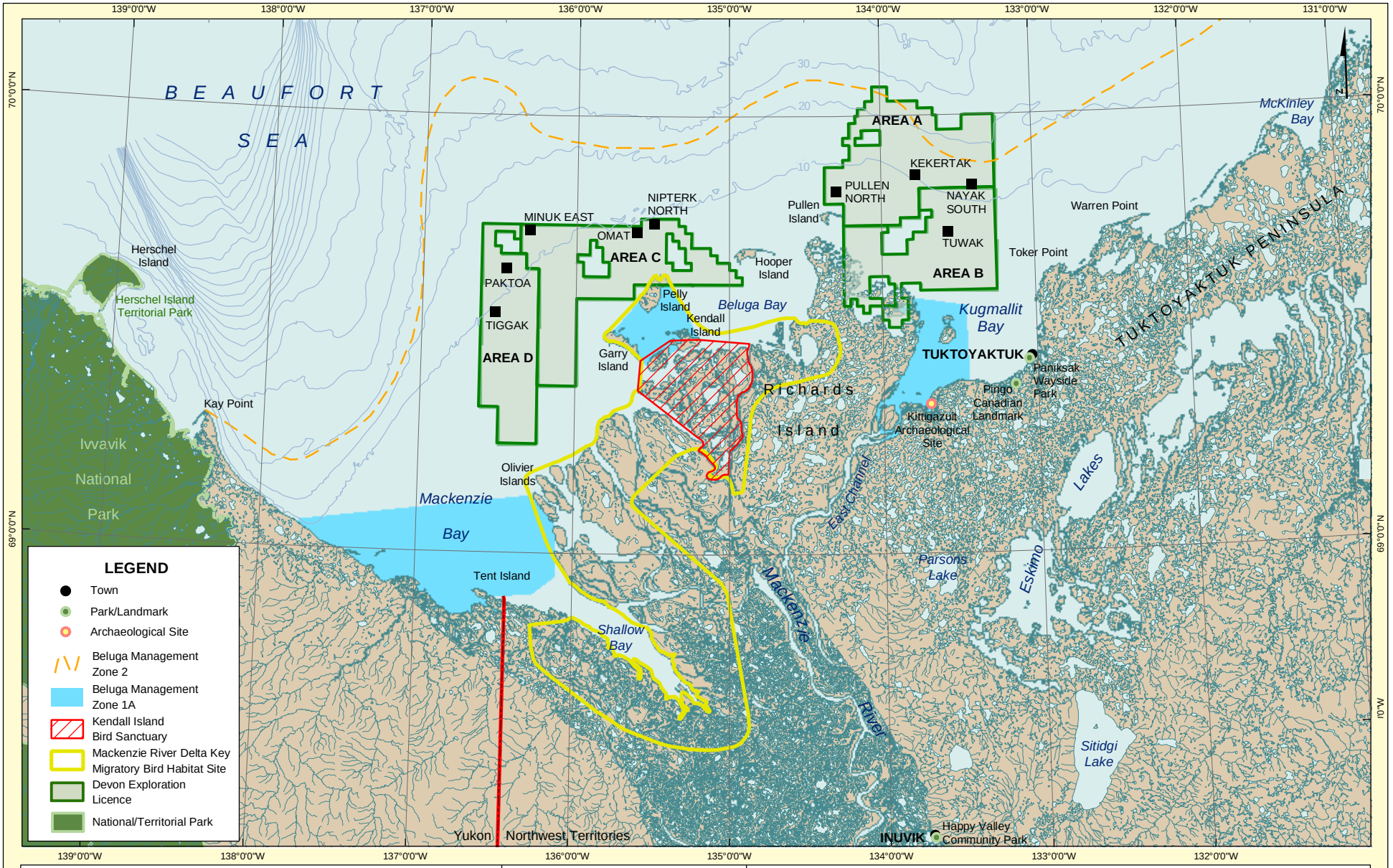
There are several protected areas and areas of significance near EL 420 (Figure 20-2):

- Kendall Island Migratory Bird Sanctuary (category D of the CCP)
- Pingo Canadian Landmark Site
- Herschel Island (Oikiqtaruk) Territorial Park
- Ivvavik National Park
- International Biological Program Site encompassing Garry and Pelly Islands
- The Mackenzie River Delta Key Migratory Bird habitat
- Kittigazuit Archeaological Site

Most of these areas do not lie within the LSA and will not be directly affected by the proposed project.

### 20.1.4 Visual Aesthetics

The area near EL 420 has generally flat topography and possesses few notable visual features. Visual interest is provided by scattered island features in the foreground to the south and the gently rolling landscape of the Mackenzie Delta in the distance.




devon

KA036 Devon - Protected Areas in the Vicinity of the Regional Study Area
August 24, 2004

Data Sources:
Devon Canada
National Energy Board
National Topographic Series
Projection: Universal Transverse Mercator Zone 8 (NAD 27)

**Figure 20-2**
**Protected Areas in the Vicinity of the Regional Study Area**

## 20.2 Impact Assessment

Six VSCs are identified as indicators of Program effects on non-traditional land and resource use:

- oil and gas activities – selected because there is a high potential for future oil and gas development in the Mackenzie Delta and Beaufort Sea area.
- non-traditional resource use harvesting – selected because there is a high level of concern expressed during the Program workshop for potential impacts on these activities
- other industrial and commercial activities (mineral and granular extraction, reindeer herding, commercial transportation, military and coast guard use, other related access and infrastructure)
- tourism and recreation (ecotourism, cultural tours and less structured recreational activities such as boating, hiking, camping, cross-country skiing, off-highway vehicle activities and wildlife viewing)
- protected and environmentally significant areas (various CCP management areas, a migratory bird sanctuary, a migratory bird habitat site, various categories of parks, an International Biological Program site, various recreation areas)
- visual aesthetics – selected because there is currently very little physical structure on the landscape in the vicinity of EL 420, and the Program drilling platforms and rig have the potential to affect the visual quality of the area

The local study area (LSA) for non-traditional land and resource use includes the Eastern and Western Blocks of EL 420 and the area between the two blocks. The majority of the Program activities will occur on the proposed drilling sites within these blocks. The regional study area (RSA) extends from the northern limit of the landfast ice near the four areas of EL 420, south to the community of Inuvik and from Herschel Island in the west, to McKinley Bay on Tuktoyaktuk Peninsula, in the east. This includes all areas potentially affected by platform mobilization and resupply operations. Inuvik and Tuktoyaktuk are included because onshore logistical support activities will be located in either or both of these communities.

With the exception of the CCPs, there is a lack of specific guidelines or scientific thresholds on which to determine the significance of Program effects on land and resource use. Therefore, a qualitative method based on professional judgement and linkages with other disciplines is employed. Program effects on land and resource use were characterized according to criteria in Table 20-1. The assessment of Program effects on visual aesthetics involved a qualitative analysis supported by a viewshed analysis to determine the area within which the drilling platforms and rigs would be visible at each potential drill site.

An effect is deemed significant if it is high magnitude, negative, long term and local to regional. An effect of moderate magnitude is significant if it is negative, long term and regional.

Findings of the impact assessment are summarized in Table 20-2. The level of residual effects (effects remaining after application of mitigation measures) is summarized, based on criteria from Table 20-1.

## Table 20-1 Effect Attributes for Land Resource Use

| | |
|---|---|
| **Direction** | |
| Negative | Effect on VSC conflicts with community resource use plans and priorities |
| Neutral | Effect on VSC has no effect on community resource use plans or priorities |
| Positive | Effect on VSC is aligned with community resource use plans and priorities |
| **Magnitude** | |
| Low | No effect or negligible effect to VSC |
| Moderate | Effect on VSC is detectable, but within a normal range of variation |
| High | Effect on VSC is detectable, but outside normal range of variation |
| **Geographic Extent** | |
| Site specific | Effect on VSC within 1 km of drill platform location |
| Local | Effect on VSC within LSA |
| Regional | Effect on VSC within RSA |
| **Duration** | |
| Short term | Effect on VSC will occur for a maximum of one drilling season or for short intervals throughout the entire drilling Program (e.g., every February) |
| Medium term | Effect on VSC will occur throughout numerous drilling seasons, but not the entire Program, or for moderate intervals throughout the entire Program (e.g., open-water season each year) |
| Long term | Effect on VSC will occur throughout the entire drilling Program |

## Table 20-2 Program Effects on Land and Resource Use

| Potential Effect | Interaction with VEC | Level of Effect[1] | | | | Effect Significance[2] | |
|---|---|---|---|---|---|---|---|
| | | Direction | Magnitude | Extent | Duration | Program-related Effect | Cumulative Effect |
| **Pre-operations and Operations** | | | | | | | |
| Conflicts with oil and gas activities in the area | • No other activities planned in the immediate vicinity of EL 420 during the Program. The Program will not affect access related to other oil and gas activities (e.g., the Mackenzie Gas Project) | Neutral | Low | Local to regional | Medium term | Not significant | Not significant |
| Demands on marine transportation | • Use of existing services for supply barges, platform towing | Neutral to positive | Low | Regional | Medium term | Not significant | Not significant |
| Demands on air transportation | • Use of existing air services in the RSA | Neutral to positive | Low | Regional | Long term | Not significant | Not significant |
| Disturbance of non-traditional hunting activities, reduced success | • Potential disturbance to wildlife from Program activities<br>• Potentially some restrictions on hunting in the vicinity of Program facilities and activities, for safety | Negative | Low to moderate | Site specific | Medium term | Not significant | Not significant |

## Table 20-2 Program Effects on Land and Resource Use (cont'd)

| Potential Effect | Interaction with VEC | Level of Effect[1] | | | | Effect Significance[2] | |
|---|---|---|---|---|---|---|---|
| | | Direction | Magnitude | Extent | Duration | Program-related Effect | Cumulative Effect |
| **Pre-operations and Operations (cont'd)** | | | | | | | |
| Disturbance of non-traditional fishing activities, reduced success | • No significant effect on fish and fishing success expected (Section 14) | Neutral | Low | Regional | Short term | Not significant | Not significant |
| Disturbance of tourism and recreation activities | • Possibly some minor disturbance of tourism activities or a drill site could be a point of interest | Neutral to positive | Low | Regional | Medium term | Not significant | Not significant |
| Disturbance of protected and environment-ally sensitive areas and valued features | • Mitigation measures (activity scheduling, flight paths and elevations, site selection for barge staging areas) will minimize potential interactions | Neutral | Low | Regional | Long term | Not significant | Not significant |
| Degradation of visual aesthetics in viewshed | • Single rig, while visible for up to 30 km, will not generally be visible from areas of concentrated settlement. Only a rig at Tuwak would be visible in Tuktoyaktuk. SDC is most visible and ice island is least visible | Negative | Low to moderate (Tuwak only) | Local to regional | Short to medium term | Not significant | Not significant |
| Degradation of visual aesthetics at drill site | • While the visual effects will be high at the drill sites, very few people will be in the vicinity of the drill site | Negative | High | Site-specific | Medium term | Not significant | Not significant |
| **Closure** | | | | | | | |
| SDC or LTD platform storage conflicting with other resource use activities | • Site selection studies and mitigation measures (activity scheduling) will minimize potential effects | Positive to Negative | Low | Site-specific | Short to long term[3] | Not significant | Not significant |

**Notes:**
1 Based on criteria in Table 20-1
2 Based on criteria in Section 20.2
3 Would occur subsequent to the drilling Program with the duration depending on the storage requirements at the time

In general, there is little overlap between Program activities and non-traditional land and resource use. Key areas of potential interaction include the following:

- **Effects of pre-operations, platform supply and mobilization activities on the Beluga Management Zone 1A areas** - The Beluga Management Zone 1A areas are important areas for wildlife populations and for subsistence harvesting. Guidelines for the conservation of beluga whales and their habitat are being followed on a voluntary basis, but the designation of the Zone 1A areas as a MPA under the *Oceans Act* would provide regulatory authority to enforce guidelines and other conservation measures, including the prohibition of development activities. It is possible that marine and air traffic could be diverted from these areas when whales are present (summer and early fall). Devon intends to transport the SDC or LTD platforms into EL 420 after the peak of the beluga whale hunt to minimize disturbances to hunters and wildlife. Towing vessels will also operate in such a way as to minimize potential disturbance to whale fall migration (i.e., travel at consistent speed on a straight course as described in Section 16: Marine Mammals). If weather or ice conditions were to affect transport activities in any given year, Devon will meet with the local HTCs, the WMAC (NT) and the IGC to determine appropriate mitigative measures to avoid any potential conflicts with whale hunting activities.
- **Effects of operations activities on guided polar bear hunts** - Polar bear hunting is considered to be a traditional land and resource issue since only Inuvialuit are allowed to possess tags for polar bears (Section 18: Traditional Knowledge and Land Use). Devon will meet with the guides to discuss Program schedules and locations and determine appropriate mitigation measures to avoid potential conflicts with hunting activities. Devon will also develop a Wildlife Protection Plan that includes attractants management, monitoring and protocols in response to sightings. As part of wildlife mitigation measures (Section 16: Marine Mammals), Devon will institute a policy to restrict hunting, wildlife harassment and the use of vehicles for non-company related activities. Firearms will be banned, except as authorized to protect employee safety and as required by wildlife monitors. Some community members have expressed a desire to implement a general no hunting zone near Program facilities and activities (Section 18: Traditional Knowledge and Land Use). Although Devon cannot institute or enforce policies outside of the immediate worksite for its projects, Devon will work with the relevant stakeholders (e.g., IGC, HTCs, co-management bodies and RWED) to address this concern in a mutually satisfactory manner. This restricted area for hunting will be small compared to the home range of a polar bear, thus the impact of the drilling operations on polar bear hunting activities or success in the area will be limited.
- **Effect of platforms and drill rigs on visual aesthetics** - The viewshed analysis indicates that the visibility range for the SDC platform and rig (the most visible of the platform options) generally has a radial extent of approximately 30 km for each drill site. A majority of this area of visual disturbance lies within the LSA, although at several of the drill sites parts of the viewshed extend to the Yukon mainland, Richards Island and the Tuktoyaktuk Peninsula. The visibility range for the ice island platform and rig (the least visible platform option) is about 25 km. The ice island platform will be visible only during ice cover, whereas the SDC and LTD platforms will also be visible during open-water conditions. Visibility will vary with weather conditions. The nature of the impact will vary between daylight when all or parts of the structure may be visible and at night, when only the lights may be seen at a

distance. Only at the Tuwak drilling site would a platform be visible from an area of concentrated settlement (i.e., Tuktoyaktuk). Even here, the visual effect of the drilling platforms will be very small in the context of the broader landscape and the duration of effect will be short (one year maximum).

## 20.3 Mitigation Measures

The remote, offshore location of Program activities, the relatively small scale of activities associated with the Program and the winter drilling schedule minimizes the potential for conflicts with non-traditional land and resource use activities in the area. Mitigation measures identified in other sections pertaining to protection of fish (Section 14), wildlife (Sections 15 and 16) and traditional use activities (Section 18) also provide protection for non-traditional use of these resources. Based on the negligible effects of the Program on non-traditional land and resource use, no additional impact mitigation measures are recommended.

## 20.4 Residual Program Effects and Significance

Based on criteria in Table 20-1 and Section 20.2, the residual effects on land and resource use are expected to be not significant.

## 20.5 Cumulative Effects and Significance

Because there are no major concurrent activities planned in the Program area, no significant cumulative effects are expected on land and resource use in the Program area. Potential cumulative effects of the Program and other projects in the region on air and marine transport in the region are discussed in Section 17: Socio-economic Conditions.

## 20.6 Monitoring

Monitoring activities to be conducted for the purposes of checking mitigation effectiveness and impact management pertaining to fish, wildlife, traditional resource use and socio-economic conditions will also address management of effects on non-traditional land and resource use. No further monitoring is recommended.

# 21 Effects of the Environment on the Program

The natural environment can influence or impact an offshore drilling project at any stage. Devon's Program could potentially be affected by a variety of environmental influences, including:

- weather (storms)
- sea ice regime
- seismicity
- seabed stability
- climate change
- corrosion and bio-fouling

## 21.1 Baseline Conditions

EL 420 is exposed to a wide range of environmental conditions. Low air temperatures, variable sea ice cover, and few daylight hours characterize the physical environment of the Beaufort Sea in winter. Summer is characterized by extended hours of daylight, warmer air temperatures, open water and fairly small waves. Factors such as high wind-chill and blowing snow in winter, fog and poor visibility during breakup and freeze-up and storm waves in fall are factors that need to be considered when mobilizing, operating and demobilizing the offshore drilling platforms.

Information on the ice regime in the licence area is described in Section 8: Ice and Physical Oceanography.

## 21.2 Impact Assessment

The effects of the environment on Program activities are described in the following sections and summarized in Table 21-1.

### 21.2.1 Weather and Waves

During the open-water season, Devon will avoid sea-going transport in adverse weather conditions, to the degree possible. Weather and wave conditions will be evaluated and marine operations will be scheduled to optimize safety and efficiency. If weather or ice conditions require operations in open water outside the proposed time frames, Devon will contact the regulatory agencies, the local HTCs and Inuvialuit co-management agencies to discuss revised scheduling requirements. Thus, conflicts will be minimized with any traditional activities and environmentally sensitive areas, mitigation measures identified and approval obtained for revised scheduling. All marine support vessels are designed for conditions in the Beaufort Sea and will be operated by personnel experienced with local marine conditions. Effects of open-water storms on marine mobilization activities are expected to be not significant.

## Table 21-1 Effects of the Environment on the Program

| Potential Effect | Interaction with Program | Level of Effect | Effect Significance | |
|---|---|---|---|---|
| | | | Program-related Effect | Cumulative Effect |
| **Pre-operations** | | | | |
| Open-water storms, unexpected ice conditions in open water | Delay to marine mobilization activities | Scheduling and mitigation (Table 21-2) effectively address potential effects. | Not significant | Not significant |
| | Displacement of mobile drill platforms (SDC, LTD) | Wave conditions capable of causing slight displacements are rare in the area. Slight movements of the SDC or LTD platforms during the open-water would have no effect on drilling operations | Not significant | Not significant |
| **Operations** | | | | |
| Winter storms | Interference with operations, air transport | Storms capable of delaying air transport are infrequent and of short duration. No effect on operations | Not significant | Not significant |
| Ice forces | Displacement of drilling platforms, ice pile up on platform surface | Platform design (ice pad for sliding resistance, adequate free board) will effectively address potential effects | Not significant | Not significant |
| Timing of landfast ice formation and breakup | Shortening the drilling season | Selection of appropriate platform type for drill site ice characteristics will effectively address potential effects | Not significant | Not significant |
| Seismic activity | Reduced platform stability | Platform design for local seismic conditions will effectively address potential effects | Not significant | Not significant |
| Sediment mass movement, permafrost degradation, gas hydrate release | Reduced platform stability | Site geotechnical investigations and Program design (platform design, chilled and weighted muds) will address potential effects | Not significant | Not significant |
| Global warming affecting air temperatures and timing and extent of landfast ice formation | Shortening of the drilling season | Changes beyond current natural variability not expected within Program life span. Program scheduling and platform selection and design to address site conditions and variability in ice conditions will effectively address potential effects. | Not significant | Not significant |
| Corrosion and bio-fouling | Reduced integrity and efficiency of mobile drill platforms | Standard marine maintenance procedures will address potential effects. | Not significant | Not significant |
| **Closure** | | | | |
| No effects | N/A | N/A | N/A | N/A |

The SDC or LTD platform structure may be subject to slight movement (i.e., one to several metres) in very extreme storm waves in late summer or fall. Any slight movements of the SDC or LTD platforms during the open-water period (after their deployment on-site) would have no effect on operations because drilling would not be underway. No significant effects on the SDC or LTD structures are expected from storm waves.

Based on experience with offshore platforms in the Beaufort Sea, drilling operations will proceed regardless of winter storms. All facilities and equipment are designed to withstand and operate effectively in arctic environments. Should a winter storm occur, helicopter and fixed-wing flights or certain on-ice activities (e.g., general site or airstrip maintenance) may be temporarily delayed until the storm subsides. While winter storms may cause temporary operational inconveniences, they will not prevent the successful completion of the mobilization and winter drilling activities. Effects from winter storms on the Program are expected to be not significant.

### 21.2.2 Ice Regime and Climate Change

All three drilling platforms are designed to accommodate anticipated ice forces in winter, including those from normal and extreme ice loading. Industry design codes and standards will be followed and the selected platform type will be designed to withstand horizontal loads caused by ice forces.

Expected ice conditions, variability in these conditions, ice interaction behaviours and ice load levels are reasonably well understood for all the platforms that Devon is considering. Potentially detrimental ice situations will be identified by ice monitoring, ice load measurement and ice event forecasting systems. If apparent risks to safety occur because of particular ice events, precautionary measures will be taken through an ice alert system, including suspension of drilling. In abnormal years, late landfast ice formation or early breakup may shorten the expected drilling season but should not affect the safety of drilling operations. As noted in Section 8: Ice and Physical Oceanography, current information on trends in ice and ocean conditions, as potentially influenced by climate change, do not indicate any changes in the ice or ocean conditions that would affect Program planning or design within the time frame of the Program.

Adverse ice conditions can affect platform mobilization, resupply and demobilization during the open-water season. Devon will employ various environmental monitoring and forecasting systems to support operational decision-making processes, thus allowing them to select appropriate environmental windows that avoid any adverse situations. In addition, marine vessel support for platform mobilization will include ice management capabilities to address any unexpected ice conditions that may arise.

In summary, no significant effects are expected due to the ice regime, other than occasional operational delays. As a result, effects on operations from the ice regime are expected to be not significant.

### 21.2.3 Seismicity

The Beaufort Sea is considered seismically active, although the intensities of earthquakes tend not to be extreme (<4M) and there is no historical evidence of earthquakes having occurred in or around the area of EL 420 (Section 9: Geology, Terrain and Sediments). However, the drill sites could be subject to ground motion from seismic activities. Design criteria for all platform systems will address requirements for seismic conditions in the

area to ensure stability during drilling operations. Hence, effects of seismic activity on the Program are expected to be not significant.

### 21.2.4 Seabed Stability

Potential effects of the sea floor and sub-sea floor environments on the platform are primarily related to potential instability of the platform caused by sediment mass movement. Soft surface sediments, potential permafrost degradation and potential subsurface gas hydrate release might act in concert to increase instability below the drilling platform (Section 9: Geology, Terrain and Sediments).

The use of properly weighted and chilled drilling muds will reduce the potential for gas hydrate release and permafrost thawing, thereby reducing the risk of subsurface slumping. All platform options use a bottom-founded ice platform designed to provide stability during operations based on-site-specific substrate characteristics and predicted ice forces. Effects of seabed stability on the Program are expected to be not significant.

### 21.2.5 Corrosion and Bio-fouling

The possibility of vessel and platform corrosion and bio-fouling (growth of marine organisms on the hull) is accepted as part of operating in saltwater conditions. General precautions to reduce these effects include:

- vessel maintenance
- dry dock hull maintenance
- bilge water monitoring and evacuation
- corrosion inhibitor methods and technologies
- hull and screw cathodic protection for steel subsurface components
- appropriate, regulator approved and commercially available methods to limit bio-fouling and associated bio-corrosion

With standard, regular maintenance of the mobile drilling platforms, effects on the Program from corrosion and bio-fouling are expected to be not significant.

## 21.3 Mitigation Measures

Mitigation measures addressing potential effects of weather, ice forces and unexpected ice conditions are summarized in Table 21-2.

**Table 21-2 Mitigation Measures for Effects of the Environment on the Program**

| Potential Effect | Mitigation Measures |
|---|---|
| Adverse weather and wave conditions affecting platform mobilization, resupply and demobilization | • Regional and local environmental monitoring and forecasting system to support operations decision-making processes<br>• On-site weather and wave monitoring<br>• Program schedule to accommodate variable weather conditions<br>• Consultation with regulatory agencies, the local HTCs, and Inuvialuit co-management agencies, as required, to discuss implications and mitigation for revised scheduling |
| Unexpected ice conditions in open-water season | • Regional and local environmental monitoring and forecasting system to support operations decision-making processes<br>• Marine vessel support with ice management capability |
| Ice forces affecting platform stability | • Ice pad design and in-situ measurements to confirm platform performance<br>• Ice alert systems to support decision making (e.g., suspend drilling if conditions require) |
| Global warming | • Implementation of Devon's policy on management of energy and emissions to minimize consumption of electrical energy, improve fuel economy, reduce losses of saleable products and reduce volumes of flared and vented gases |

## 21.4 Monitoring

Devon will use an environmental monitoring and forecasting system to obtain the necessary information to support operations and the decision-making processes associated with them (Table 21-3). For example, weather and wave conditions will be monitored using both on-site observations and government services. A variety of ice monitoring, measurement and ice event forecasting systems will also be employed to ensure prudent drilling operations in winter ice conditions. Routine observations of ice thickness, ice movement and any new ice rubble will be made throughout operations. Instruments to measure ice forces, foundation deformations and other important aspects of platform performance will be installed and monitored as an integral part of the drilling operation. A small onboard team consisting of a stability engineer and environmental observers will be in place at all times to monitor continuously the ice and other environmental conditions and the overall performance of the drilling platform.

**Table 21-3 Monitoring Programs for Effects of the Environment on the Program**

| Potential Effects | Program Objectives | General Methods | Reporting | Implementation |
|---|---|---|---|---|
| Unexpected ice conditions | • Ice monitoring and event forecasting to support safe operations<br>• Confirm platform performance | Observation and instrumentation to monitor ice thickness, ice movement, ice rubble, ice forces, foundation deformations | Ongoing during ice cover | Devon |

# 22 Accidents and Malfunctions

The discipline-specific assessments presented earlier in this report address effects of routine Program operations. In this section, a variety of possible accidents and malfunctions that could occur during an offshore drilling program is discussed. While such incidents have been uncommon during both onshore and offshore exploration drilling programs in North America and, specifically, in the Beaufort Sea and Mackenzie Delta region (Section 22.1: Spill Incident Statistics), a discussion of accidents and malfunctions is useful in identifying the following risks:

- the types of incidents that may occur during an offshore program using the SDC, LTD or ice island platform
- the probability of such incidents occurring
- Devon's response structure and organization
- the potential environmental effects of accidents and malfunctions
- precautionary measures that have been, or will be, incorporated into the Program to minimize the likelihood of accidents and malfunctions

Depending on the regulatory approval process for the Program under the Inuvialuit Final Agreement (IFA), a separate report (independent of the process defined in the *Canada Environmental Assessment Act [CEAA]*) may be prepared that identifies the technical aspects of a reasonable 'worst-case scenario' and assesses potential environmental effects associated with that scenario. The well blowout described in this section likely incorporates many of the same characteristics as a reasonable 'worst-case scenario'.

## 22.1 Spill Incidence Statistics

Three facts suggest that the likelihood of a spill or blowout is low. First, a recent study on marine oil pollution by the U.S. National Research Council (NRC 2002) indicates that accidental petroleum discharges from offshore exploration and production platforms contribute only 0.07 percent of the total petroleum input to the world's oceans. Second, The spill prevention record is particularly good in the U.S. Outer Continental Shelf where 28,000 wells have been drilled and over 10 billion ($10^9$) barrels2 of oil and condensate have been produced from 1972 to 2000, yet only ten blowouts have occurred that involved any discharge of oil or condensate. The total oil discharged in the ten blowout events was only 751 barrels. In the past, there had been a tendency towards numerous, small spills. Third, with modern technology and practices, the number of small spills has decreased by almost a factor of ten.

Information on gas and condensate blowouts during exploration drilling in the Canadian Beaufort Sea (Gulf Canada 1990; Baker 2004, pers. comm.) and exploration and

2 The petroleum industry usually uses the oil volume unit of petroleum barrel (which is different than a U.S. barrel and a British barrel). There are 6.29 petroleum barrels in one cubic metre ($m^3$). Most spill statistics used in this report are taken from publications that use the oil volume units of petroleum barrels.

production operations off Newfoundland and Nova Scotia up to June 2001 are provided in Table 22-1. To date, no oil blowouts have occurred in the Canadian offshore.

Up to 1990, 85 offshore drilling programs have been completed in the Beaufort Sea (BSSC 1991). No condensate or oil spills have occurred. One shallow gas blowout occurred in the Beaufort Sea in 1989 when drilling with the Kulluk.

As of 2001, only one well blowout had occurred in Atlantic Canada at the Uniake-G72 Well off Sable Island in 1984. This blowout resulted in the release of gas and the loss of about 1500 barrels of natural gas liquids (condensates).

## Table 22-1 Hydrocarbon Blowouts during Exploration and Development in the Canadian Beaufort Sea and Eastern Canada as of June 2000

| Region | No. of Exploratory Wells | No. of Development Wells | No. of Blowouts[1] | Exploration Blowout Frequency | Overall Blowout Frequency |
|---|---|---|---|---|---|
| Beaufort Sea | 85 | 0 | 1 shallow gas[2] | $1.2 \times 10^{-2}$ gas | $1.2 \times 10^{-2}$ gas |
| Newfoundland | 157 | 44 | 0 | 0 | 0 |
| Nova Scotia | 105 | 70 | 1 gas/condensate | $9.5 \times 10^{-3}$ | $5.7 \times 10^{-3}$ |
| Total | 347 | 114 | 2 | $5.8 \times 10^{-3}$ | $4.3 \times 10^{-3}$ |

**Notes:**

1 A blowout is defined as an uncontrolled flow of gas, oil or other well fluids into the atmosphere or into an underground formation.

2 One of the incidents not included here was an encounter of a shallow gas pocket while drilling at the Amauligak wellsite with the Molikpaq drill platform (Baker 2004, pers. comm.). This resulted in a gas flow through the diverter, with some leakage around the flange. This incident does not qualify as a blowout by the definitions used in any of the other databases that were examined and, therefore, has not been included.

Based on available worldwide statistics, the chances of an extremely large (i.e., greater than 150,000 bbl) or very large (i.e., greater than 10,000 bbl) oil or condensate well blowout from exploration drilling are very small – about one in 35,000 and one in 12,000, respectively. There is a one in 5000 chance of having a blowout involving an oil spill larger than one barrel. The chance of a blowout involving gas only is one in 150.

Based on these estimates, it is highly unlikely that a blowout would occur during Devon's Program that would result in any release of oil to environment. Because these estimates do not reflect modern technology or current safety and operational standards, the likelihood of blowout resulting in an oil and gas spill during the Program is even less than indicated by these statistics.

Risks of a blowout will also be minimized by a number of operational aspects for the Program, specifically:

- recent 2D and 3D seismic data for the drill sites, combined with data from existing nearby offset wells, will provide high quality geological information that will allow better prediction of high risk zones and better planning of the drilling Program to minimize blowout risks
- modern drilling technology, including improved mud management systems, will be employed in the drilling Program
- blowout prevention and diversion equipment

Devon intends to construct and test a Super Shear and Seal system referred to as the Alternative Well Kill (AWK) system. The AWK would have to be tested and approved by the NEB before it could be used in the Devon Program.

For the purpose of this Comprehensive Study, the drilling Program does not include the use of the AWK system. The proposed drilling Program is based on the use of conventional well control alternatives, including the use of a relief well on the ice pad adjacent to the main drilling platform.

### 22.1.1 Devon Environmental Incidents

Devon has been active in exploration of the Beaufort Sea and the Mackenzie Delta region since 2000. Exploration activities have included:

- five onshore seismic programs
- one offshore seismic program and an associated bathymetric survey
- two onshore exploration drilling programs (Tuk 2 and Itiginkpak)
- miscellaneous smaller programs (geochemical and geological programs and field trips)

As required by federal and territorial legislation, Devon reports all spill incidents, regardless of size, to the NEB and the Government of the Northwest Territories.

No major spills or accidents have occurred during these various Devon programs. From September 2001 to December 16, 2003, Devon reported eight small spill incidents involving a combined total of 117 L of fluid. The specific products released were:

- drilling mud and fluid
- diesel fuel
- antifreeze
- synthetic oil
- glycol
- biodegradable synthetic hydraulic oil

In all cases, the spills were small and readily contained and were collected with sorbent pads. Only small areas were affected.

## 22.2 Spill Response

### 22.2.1 Frontier Emergency Management Plan

Devon's Frontier Emergency Management Plan (FEMP) provides direction regarding response structure, communication strategies between the Corporate Area Command Team in Calgary and the Incident Command Team on-site, responsibilities and contacts, chains of command, organization structures and notification channels. The FEMP has been used successfully in all wells drilled to date in the Arctic by Devon.

In addition, Devon will develop a Program-specific Spill Contingency Plan that will outline specific response actions to spills and releases of potentially hazardous materials related to pre-operations and operations phases of the Program. This plan will be prepared as part of the DPA and will include:

- key contacts
- initial response and corrective actions to be taken in the event of the spill

- wildlife protection plans, including reconnaissance surveys to track spills and wildlife distributions, methods to deter wildlife from a spill area and actions for recovery and treatment of oiled wildlife
- platform drawings and specifications
- list of available spill response equipment
- planned maintenance schedules
- maintaining a record of oil pollution prevention drills

Prior to commencing the Program, Devon will use a number of approaches to involve responsible authorities, Inuvialuit organizations and other government departments with an expertise or jurisdictional interest in spill contingency planning in the development and review of the FEMP and the Spill Contingency Plan. In particular, Devon would be willing to undertake a desktop exercise involving these agencies and organizations and Devon's contractors to critique the FEMP and ensure appropriate coordinated response procedures.

#### 22.2.1.1 Human Health and Safety

Human health and safety concerns related to accidents and malfunctions normally take precedence over environmental concerns. Information on human safety issues, remedial actions and responses will be detailed in the DPA that will be submitted following the completion of the environmental approval process.

#### 22.2.1.2 Contractors

Devon will ensure and require that contractors have operational and emergency response protocols in place that are consistent with Devon's FEMP, the Program-specific Spill Contingency Plan, Devon's health and safety policies and Program-specific commitments. As part of this requirement, Devon will ensure that contractors have adequate supplies of all equipment necessary to address appropriately accident and malfunctions related to their activities. Specific requirements will be defined for the prevention, containment and contingency response and clean-up for activities that present potential for accidental spills to the environment. These will be developed as part of the DPA.

#### 22.2.1.3 Training

As part of the DPA, Devon will develop an awareness program for all of its staff and contractors, including typical accidents and malfunctions associated with an offshore exploration program and response procedures, including spill clean-up. In addition, awareness and training for all staff and contractors regarding potential blowout events and response procedures will be implemented. This will include clear determination of incident response protocols and responsibilities, as well as relevant emergency drills and exercises. Devon will conduct or request that contractors conduct additional announced or unannounced exercises, based on the risk of the operation and as part of Devon's quality assurance (Devon 2002). Specifics on these programs and requirements will be provided as part of the DPA.

## 22.3 Impact Assessment

Two types of scenarios are examined:

1. Accidental spills (not blowout related) of various liquid and solid products during pre-operations, logistical support and drilling operations. These tend to be small spills on or near the drill platform.
2. Spills of condensates or oil resulting from a blowout during exploratory drilling (note: gas blowouts could also occur but since the released gas would rapidly evaporate, the environmental effects of gas releases are not assessed). As noted in Section 22.1: Spill Incidence Statistics, the chances of a large blowout (greater than 150,000 bbl of oil or gas condensate) are very small (one in 35,000). There is a one in 5000 chance of a blowout releasing more than one bbl of oil or condensate. The well blowout used in this section is considered as a reasonable 'worst-case scenario'.

Volumes of accidental spills are estimated based on historic spill data and storage volume units. Accidental spills could potentially occur during open-water conditions from pre-operations platform mobilization and supply, or during winter ice-cover conditions from drilling, testing and demobilization activities. Materials spilled could range from petroleum-based fuels to various soluble and insoluble materials that will be stored and handled in bulk for drilling operations. To examine the possible range of effects associated with accidental spills, the effects of petroleum-based materials, inert solids, water-soluble inorganics and water-soluble organics on the receiving environment, during both open-water and ice-cover conditions, are assessed.

Effects of hydrocarbon spills from condensate and oil blowout scenarios are also assessed. Because drilling activities will be conducted during ice-cover conditions, effects of blowouts during ice-cover conditions are assessed, in addition to the effects of any residual spill material remaining on the ice after clean-up that may be introduced to surface waters at breakup. Effects are characterized using the same criteria that are used to describe effects of routine operations on individual biophysical and social components in the preceding sections.

### 22.3.1 Accidental Spills

The estimated spill volumes for accidental spills are based on historic data for the Beaufort Sea region (Fitzpatrick 1983; Esso et al. 1989) and other areas (MMS 2003), Devon's operating record and the likelihood of a spill for each type of material. Within each class, the substances included in the assessment of effects were typically those with the largest estimated spill volumes or the substances that presented the greatest risk to the environment within that class.

#### 22.3.1.1 Open Water

Spills during the open-water season are more problematic because they are more difficult to contain and there is greater likelihood that sensitive biota and/or traditional harvesting could be affected. During the open-water season, accidental spills and malfunctions could occur during:

- marine supply shipments to the platforms
- vessel collisions
- equipment failures (e.g., fuel transfer equipment)
- weather-related accidents

While most activities will occur offshore in marine areas, some open-water activities such as barge resupply will also include freshwater and estuarine areas.

For small liquid hydrocarbon spills, the initial response would be to confine, contain and remove all hydrocarbon fuel that is released into the water, as weather permits. A boom and skimmer system might not recover the entire released hydrocarbon product, but could control and retrieve a major portion, depending on the weather conditions at the time of the recovery effort. Sorbent materials would also be used to remove any surface hydrocarbon sheen. Some residual hydrocarbon is expected to be unrecoverable.

Water-soluble products would be expected to enter an aqueous phase in fresh water and sea water and rapidly disperse, depending on the volume of product released. Products that are not water soluble, such as hydrocarbon-based products, would remain on the water surface or sink into the water column, depending on the product density but would not enter an aqueous phase. As noted, hydrocarbon floating on the sea surface would be recovered using booms, sorbents and other means available. Soluble spilled chemicals would be unrecoverable. Dry compound (e.g., mud products) spills into open water are likely to be lost. The material will dissolve and rapidly disperse in fresh water or sea water.

#### 22.3.1.2 Ice Cover

During the winter season, accidental spills and malfunctions could occur in association with:

- materials handling
- maintenance
- equipment malfunctions (e.g., valves, hoses)
- refueling

The configuration of the SDC platform will prevent spills from reaching the ice around the SDC. The LTD is designed for storage of consumables, including fuel, and would help minimize spills reaching the ice surface. While activities on the ice pad for the SDC and ice island platforms could result in spills onto the ice, the ice surface provides a smooth, stable surface for spill containment and removal. For the ice island platform, transport of supplies and materials from the barge staging area to the drilling location also creates the potential for accidental spills and malfunctions associated with vehicle accidents, vehicle malfunctions and leakage.

If spills of these materials were to occur, clean-up activities would include:

- containment of the spills using snow berms or other measures
- recovery of the spilled fluid including snow and ice that has been in contact with material
- removal, storage and disposal of recovered fluids, including snow and ice that is picked up with the released material

For small spills, recovery uses hand tools or sorbents. All recovered fuel, ice, snow and contaminated materials would be placed into an appropriate storage container or tank. Contaminated snow and ice, recovered spill fluids and solids and used sorbents will be stored in dedicated containers at the site until they can be transferred to an appropriate waste receiver.

Effects of spills or accidental releases of products during the open-water season were assessed, using maximum spill volumes, for aquatic biota, birds and marine mammals (Table 22-2). Given the nature of the spilled products, no or very small effects on ice and physical oceanography, coastal processes or geotechnical aspects would be likely. Because the direct effects of potential spills on aquatic biota, birds and marine mammals are expected to be not significant (Table 22-2), effects on traditional resource harvesting or related socio-economic components also are expected to be not significant. Effects of spills during ice-cover conditions are also assessed. Because of the relatively small volumes of materials involved and the opportunity for effective containment and clean-up on the platforms or surrounding ice pads, effects are expected to be not significant (Table 22-2). Preventative measures and clean-up procedures to minimize potential effects of accidental spills are summarized in Table 22-4.

## Table 22-2 Effects of Accidental Spill Scenarios

| Potential Effect | Level of Effect | Effect Significance |
|---|---|---|
| **Product Spills in Open Water** | | |
| Effects of petroleum based spills (e.g., 1000 L diesel fuel) on water and sediment quality | • Under average sea conditions for the summer and assuming 50% clean-up, total hydrocarbon and aromatic hydrocarbon concentrations are predicted to be 0.4 mg/L and 0.15 mg/L, respectively within 12 hours and within a circle with a radius of 500 m. Further evaporation, adsorption and mixing would reduce concentrations to background levels with several more hours<br>• Heavier fractions would settle to the sediments. Assuming a settlement trajectory of about 10 $km^2$, the hydrocarbon flux is estimated to 4 $mg/m^2$ compared to a natural hydrocarbon flux of 1090 $mg/m^2$ | Not significant |
| Effect of inert solids spills (e.g., 100 $m^3$ barite) to water and sediment quality | • Packaged solids would be distributed after package rupture, but small amounts and inert nature result in no significant effect<br>• If the solids are in bulk (as opposed to packaged), sediment deposition is estimated at 3–4 mm within 100 m of the spill site. Natural sedimentation would cover the spill deposit within months | Not significant |
| Effect of soluble inorganics (e.g., 150 kg KCl) on water and sediment quality | • Packaged solids would fall to seafloor and slowly dissolve and would be diluted and dispersed by natural processes.<br>• If the products are in bulk (as opposed to being packaged) and the initial dissolution is highly localized in 100 $m^3$ of water, there would be a transitory increase in salinity of 1.5 parts per thousand, which would rapidly be diluted to background concentrations. | Not significant |
| Effect of soluble organics spills on water and sediment quality | • Due to small anticipated spill volumes, spills would be dispersed and diluted to insignificant concentrations within a few minutes and a few metres of the spill location | Not significant |
| Effects of biocide spills (e.g., 20 kg) on water and sediment quality | • Spills would be diluted to harmless concentrations within a few minutes and a few metres of the spill location | Not significant |
| Effects of spills on aquatic biota | • No toxic effect of hydrocarbons on adult or juvenile fish. No sensitive freshwater or anadromous fish life stages (eggs, larvae) are present in the river, estuary or the vicinity of the drill site locations during pre-operations period. Early life stages of marine species may be present. Effects would be small, site-specific and short term<br>• Potential for localized fish tainting. Mitigation would include closure of affected area and compensation of fishers for lost opportunity<br>• Effects of hydrocarbon spills are not likely to be detectable in the benthic invertebrate community. | Not significant |

## Table 22-2 Effects of Accidental Spill Scenarios (cont'd)

| Potential Effect | Level of Effect | Effect Significance |
|---|---|---|
| **Product Spills in Open Water (cont'd)** | | |
| Effects of spills on aquatic biota (cont'd) | • Inert solids spills on benthic invertebrates would be small, site-specific and short term<br>• No effect on aquatic biota from soluble inorganic or organics spills<br>• Biocide concentrations could inhibit algae growth up to 200 m from spill sites, but short-term exposure reduces effect. Acute toxic concentrations for fish would not occur beyond 10 m and a few minutes. There is a low potential for bioaccumulation of biocides in fish. Effects would be small, site-specific and short term | Not significant |
| Effect of spills on birds | • Low risk of exposure to petroleum slicks due to small area affected and clean-up activity in affected area. Effects are low, local and short term.<br>• Effects of inert solids, water-soluble inorganics, water-soluble organics, and biocides are expected to be negligible, immediate and local | Not significant |
| Effects of spills on marine mammals | • Petroleum slicks could cause irritation of eyes and mucous membranes of whales and seals and potential effects on bowhead baleen, affecting filtering efficiency. Given small size of spill, effects would be low and temporary.<br>• No juvenile seals, which are potentially vulnerable to oiling of fur, will be in the area during pre-operations.<br>• Polar bears are rarely present during open-water season<br>• Effects of a hydrocarbon spill on seals, whales and polar bears are expected to be low, short term and local<br>• Effects of spills of inert solids, water-soluble inorganics, water-soluble organics, and biocides are expected to be negligible, immediate and local | Not significant |
| Effects of spills on traditional harvesting activities | • No significant effects on the abundance or distribution of fish and marine mammal stocks or hunting opportunities are expected<br>• Potential or perceived tainting or fouling effects and effects on traditional use would be addressed by appropriate compensation | Not significant |
| **Product Spills on Ice Surface** | | |
| Effect of small product spills (onto ice) on water and sediment quality and related effects on biota | • No acute lethal effects on adult or juvenile fish, or their larvae (only Arctic cod larvae are expected to be present)<br>• Locally harvested fish species (Dolly Varden, whitefishes, ciscoes) are not likely to be present at this time of year. While Pacific herring may be present, fishing for this species occurs in fall, by which time fish tainting is not expected to be an issue<br>• Effects of an oil spill on fish are small, local and short term<br>• No acute lethal effects on invertebrate zooplankton and benthos<br>• No effects on benthic invertebrates above natural background | Not significant |
| Effects of small product spills on traditional harvesting activities | • All biophysical effects are expected to be localized, low, and short term. Therefore, no significant effects on fish and marine mammal stocks are expected. As a result, no direct effects on hunting opportunities are expected<br>• Potential or perceived tainting or fouling effects would be addressed by appropriate compensation | Not significant |

### 22.3.2 Blowout Scenarios

The potential effects of petroleum-based spills resulting from two blowout scenarios are assessed:

- a condensate blowout
- an oil blowout (unlikely, but a key environmental and social concern)

Details on the condensate and oil blowout scenarios, countermeasures, condensate and oil dispersion, ice movements, and condensate and oil distribution following breakup are based on a report by Envision et al. (2004).

Two scenarios are used to describe the fate, behaviour, countermeasures and ultimate ice disposition resulting from a blowout using the SDC platform at the Paktoa site. The following assumptions are used for these scenarios:

- the drill rig is outfitted with conventional blowout and diversion equipment
- a blowout occurs late in the drilling season (i.e., April 1), from a 12-cm inside diameter drill pipe in the BOP elevated 25 m above sea level on the SDC. This leaves roughly 90 days for clean-up of a spill before breakup of the ice
- it releases $5.5 \times 10^6$ $m^3$/day of natural gas accompanied by 795 $m^3$/day of either natural gas condensates or crude oil
- the blowout ceases after seven days. A 7-day blowout is selected because it is the scenario that produces the most significant spill, as recommended in the 1991 report by Adams Pearson Associates (1991) on Worst Case Scenarios to the Beaufort Sea Steering Committee. In the U.S. Gulf of Mexico, 84 percent of the recorded blowouts lasted less than one week. Additional text and figures on historic blowout durations are included in S.L. Ross Environmental Research Ltd. (2004).
- the SDC will likely be positioned in an east-west orientation with an ice pad approximately 130-m wide on all sides of the platform
- a natural rubble field is formed around the ice pad with a rough width of 50 m to the west, 25 m to the east, 20 m to the north and 15 m to the south

These assumptions provide a conservative approach in examining the fate and behaviour of condensate and oil in the two blowout scenarios. The landfast ice areas affected and deposition rates for condensate and crude oil are calculated, based on these scenarios. The form of oil on the ice after clean-up and at breakup is used as a basis for assessing exposure of VECs and VSCs during the ice cover period and at breakup.

A variety of countermeasures would be employed, focusing primarily on the thicker sections of oil on the ice pad, the fairly flat surrounding ice and, possibly, the natural rubble field around the SDC (Envision et al. 2004). Because the majority of oil will fall either on or close to the flat ice pad, various strategies and techniques could be used to recover the oil, specifically:

- mechanical recovery using loaders and bobcats
- scraping oiled snow and ice into cones to facilitate melting and subsequent burning of the oil
- selective manual recovery of pooled oil
- in-situ burning

- flushing of the ice pad surface
- trenching

All these techniques have been used in arctic environments within landfast ice zones with high degrees of success. Effects of the respective blowout scenarios on VECs and VSCs are discussed below.

#### 22.3.2.1 Condensate Blowout

Because condensate is a mixture of very light (volatile) hydrocarbons, the droplets will evaporate in the air very quickly. It is predicted that about 68 percent of the condensate would evaporate in the air, before the droplets hit the ice pad and the adjacent ice rubble (Envision et al. 2004). After seven days of condensate droplet deposition, most of the condensate will fall near the SDC. After 30 days of evaporation, even beneath snow, the condensate that fell in the outer zones will have completely evaporated. After 90 days, only traces of condensate will remain near the SDC.

Because of the low levels of residual hydrocarbons that would remain on the ice following the blowout and at breakup, residual effects are expected to be not significant, with the exception of effects on air quality (Table 22-3). A short-term (hours to days) exceedance of ambient air quality objectives for volatile organic compounds (VOCs) would be expected during the condensate blowout. This transient, significant effect on air quality would cease at the end of the blowout event, and ambient air quality conditions would return to levels within ambient air quality objectives. While a condensate blowout could have a short term significant effect on local air quality, the likelihood of a condensate blowout of this magnitude is extremely remote. Based on an analysis of worldwide offshore drilling accidents, the predicted frequency of very large (greater than 10,000 bbl) spills from exploration drilling is $8.6 \times 10^{-5}$ per well, or a probability of 1:12,000 (see Section 22.1: Spill Statistics).

#### 22.3.2.2 Oil Blowout

Crude oil is much less volatile than the condensate and contains a significant portion of heavier compounds that are essentially non-volatile. Thus, compared to condensate, much less of the crude oil will evaporate over the 90-day period (available for clean-up on the ice) than for condensate.

Based on modeling (Envision et al. 2004), half of all the oil deposited would fall as larger droplets within 300 m of the platform. Within these zones, the oil would be 1 mm thick or greater. The oil would soak into the snow on the ice and form a dry mulch of oily snow. With a concerted effort to contain and clean up the thicker oil, only about 17 percent of the oil originally discharged is estimated to remain on the ice surface when the landfast ice begins to break up in mid-June.

Once the snow melts in the spring, any oil remaining will be concentrated into melt pools on the ice surface, which would be visible as oil slicks. As the ice breaks up, sheens may be visible on the water surface. Ice floes created by the fragmentation of the landfast ice and spray ice pad around the SDC will spread as they move off towards the northwest. As they move offshore, floes will shed oil through melt pools, candling and by final melting at different times, depending upon the thickness of the particular ice floe area.

The predicted effects of the oil blowout scenario are summarized in Table 22-3. Ambient air quality objectives would be exceeded during the blowout event and during clean up, if

burning of oil on the ice is required. While important from an air quality perspective, these short-term effects on air quality are an unavoidable aspect of blowouts and clean-up to minimize potential effects on the marine environment and biota. In-situ burning has been shown to be of net environmental benefit in most spill situations that are remote from population centres (I. Buist 2004, pers. comm.).

## Table 22-3 Effects of Blowout Scenarios

| Potential Effect | Level of Effect | Effect Significance |
|---|---|---|
| **Condensate Blowout Scenario** | | |
| Effect of a condensate blowout on air quality | • Short-term (hours to a few days) increase in VOCs (above ambient air quality objectives) in the vicinity of the wellsite due to volatilization during and after the blowout event | Short-term significant effect returning to not significant within hours to a few days |
| Effects of a condensate blowout on water and sediment quality and biota during spring breakup. | • Gas condensate lost during a winter blowout would evaporate within 90 days (i.e., prior to spring breakup). No significant effects on water and sediment quality, aquatic biota, birds or marine mammals at breakup<br>• No significant effects on land and resource use, social and economic conditions or traditional use activities during open-water period | Not significant |
| Effects of a condensate blowout on marine mammals | • No overlap of effects with seals or whales<br>• Polar bears may be exposed to hydrocarbons near the drill site with potential sub-lethal or lethal effects by oiling of fur or ingestion. Wildlife monitoring and polar bear management protocols will be implemented to repel bears from the spill area.<br>• Effects are negligible, local and short term | Not significant |
| Effect of a condensate blowout on traditional use during ice cover | • Polar bear hunts may be affected by disturbances associated with blowout response activities or polar bear mortalities affecting hunting quotas. To address potential economic effects of reduced hunting opportunities, Devon will provide appropriate compensation to the affected HTC for any related reduction in hunting opportunities or quotas | Not significant |
| **Oil Blowout Scenario** | | |
| Effects of an oil blowout on air quality | • Short-term (hours to days) increase in VOCs (above ambient air quality objectives) near the wellsite due to volatilization during and after the blowout event<br>• Short-term (several days) increase in $CO_2$, $NO_x$, CO and particulate matter (above ambient air quality objectives) due to burning of spilled oil<br>• Visible smoke plume during burning of oil<br>• Short-term significant air quality effects are required to reduce effects on marine environment and biota at breakup | Short-term significant effect, returning to not significant within hours to weeks (for burning) |
| Effect of an oil blowout on water quality | • Concentrations of dissolved and particulate hydrocarbons in sea water would exceed background concentrations beyond 1000 m of the spill for more than one day; however, concentrations will be well below LC 50 toxicity for even the most sensitive organisms | Short-term significant, but non-toxic effect, returning to not significant within days |
| Effect of an oil blowout on sediment quality | • Hydrocarbons flux to sediments would be a maximum of 900 $mg/m^2$, similar to the natural sediment flux rate of 1090 $mg/m^2$ | Not significant |

## Table 22-3 Effects of Blowout Scenarios (cont'd)

| Potential Effect | Level of Effect | Effect Significance |
|---|---|---|
| **Oil Blowout Scenario (cont'd)** | | |
| Effects of an oil blowout on aquatic biota | • No acute lethal effects on adult or juvenile fish, or their larvae (only Arctic cod larvae are expected to be present)<br>• Locally harvested fish species (Dolly Varden, whitefishes, ciscoes) are not likely to be present at this time of year; Pacific herring may be present, however fishing for this species occurs in the fall by which time fish tainting is not expected to be an issue<br>• Effects of an oil spill on fish are small, local and short term.<br>• No acute lethal effects on invertebrate zooplankton and benthos are expected<br>• No effects on benthic invertebrates above natural background | Not significant |
| Effect of an oil blowout on birds | • Small numbers of pacific loons, surf scoters, white-winged scoters, long-tailed ducks and glaucous gulls that may be present in July might be exposed to sufficient oil to cause mortality from hypothermia. Fewer than 100-200 bird mortalities would be expected. Effects are low, subregional and short term | Not significant |
| Effects of an oil blowout on marine mammals | • Few seals would be exposed to oil in breathing holes or while hauling out on ice near the drill site. Polar bears may also be exposed to oil on the ice.<br>• After breakup, whales may contact small, scattered sheens. Given the very low concentrations of oil, even temporary sub-lethal effects through oiling of mucous membranes, eyes or bowhead baleen are not expected<br>• Effects of an oil spill on marine mammals are low, subregional and short term | Not significant |
| Effect of an oil blowout on traditional use | • Polar bear hunting may be disturbed by spill countermeasures or polar bear mortality. To address potential economic effects of reduced hunting opportunities, Devon will provide appropriate compensation to the affected HTC for any related reduction in hunting opportunities or quotas | Not significant |

At breakup, residual hydrocarbons will enter sea water from drifting ice floes. This will cause elevated dissolved hydrocarbon concentrations in the water column at distances greater than 1000 m from the wellsite, for more than one day (about 0.18µg/L within 5000 $km^2$ [125 km x 40 km]). While this would be a significant effect based on the criteria in Section 11.2: Impact Assessment, the concentrations that will persist are significantly lower than the LC50s for even the most sensitive aquatic organisms. Consequently, the risk of dissolved and particulate hydrocarbons concentrations leading to measurable biotic effects will be very low. While an oil blowout scenario as described could lead to short term and significant, but non-toxic, effects on water quality and short term significant effects on air quality, the likelihood of an oil blowout of this magnitude is extremely remote. Based on an analysis of worldwide offshore drilling accidents, the predicted frequency of very large (greater than 10,000 bbl) spills from exploration drilling is 8.6 x $10^{-5}$ per well, or a probability of 1:12,000 (see Section 22.1: Spill Statistics).

Based on the scenario used for this assessment, the effects of a blowout on aquatic biota, birds or marine mammals is expected to be not significant. No important or long-lasting effects are expected on noise, coastal processes or geotechnical conditions. There is potential to affect traditional harvesting opportunities through direct mortality of polar

bears and disturbance of harvesting activities. Effects on land and resource use, social and economic conditions or archaeological resources are expected to be not significant.

Preventative measures will minimize the probability of accidents and malfunctions during the Program, and spill countermeasures will minimize the potential effects of accidents and malfunctions, should they occur. Because small quantities are typically involved in accidental spills and there is the ability to contain and recover spills on the SDC and LTD platforms, no significant effects are expected during pre-operations activities in open-water conditions. Because operations activities will be conducted during ice-cover conditions, accidental spills can be effectively contained and recovered, with negligible effects on the environment. Similarly, in the highly unlikely event of a blowout during drilling operations, the ice-cover conditions will facilitate recovery of hydrocarbons such that residual environmental effects during ice cover period and following the breakup are expected to be not significant.

## 22.4 Mitigation

As noted in Section 22.2: Spill Response, Devon will develop a Program-specific Frontier Emergency Management Plan (FEMP) and a spill contingency plan as part of the DPA. These plans will address in detail the potential range of operational spills that could occur and appropriate preventative and response measures. Training of relevant staff and contractors, including response drills, will ensure effective implementation of these plans.

General measures for prevention and clean-up of accidental spills and blowouts are summarized in Table 22-4.

**Table 22-4 Mitigation Measures for Effects of Accidental Spills and Blowouts**

| Potential Effect | Mitigation Measures |
|---|---|
| Accidental spills | Preventative Measures:<br>• secure storage with sufficient secondary containment for hazardous materials<br>• regular inspection and maintenance of valves, hoses and materials handling equipment to keep them in good working condition<br>• use of secondary containment, wherever possible, to minimize residual drips and small and large spills.<br>• maintenance of vehicles for ice road transport; transport only under safe driving conditions<br>• regular inspection and prompt repair of leaking or dripping<br>Clean-up Measures:<br>• confine, contain, and remove all hydrocarbon fuel that is released into the water using boom and skimmer<br>• deploy sorbent materials to remove any surface hydrocarbon sheen<br>• contain spills using snow berms or other measures<br>• recover spilled fluid, including contaminated snow and ice<br>• remove and store recovered fluids, including snow and ice for appropriate disposal onshore |
| Condensate and oil blowouts | Preventative Measures:<br>• blowout prevention or alternative well kill, if approved<br>• relief well capability<br>• Spill Contingency Plan<br>• platform deck design will contain and capture of some blowout spill<br>• availability of Hercules transport or heavy-lift helicopter and airstrip to allow prompt delivery of additional response equipment and personnel |

## Table 22-4 Mitigation Measures for Effects of Accidental Spills and Blowouts (cont'd)

| Potential Effect | Mitigation Measures |
|---|---|
| Condensate and oil blowouts (cont'd) | Blowout Spill Countermeasures – smooth ice pad:<br>• mechanical recovery using loaders and bobcats<br>• scraping oiled snow and ice into cones to facilitate melting and burning of the oil<br>• selective manual recovery of pooled oil<br>• in-situ burning<br>• flushing<br>• trenching<br>• tracking of contaminated ice flow and recovery, as feasible |
| | Blowout Spill Countermeasures – ice rubble:<br>• prior to melting, break up of ice rubble to encourage melting and collection of oil residue<br>• enhanced melting to release oil (heated water, dark coloured material on ice)<br>• burn thick pockets of oil in-situ<br>• ditching in ice to collect oil in runoff<br>• flushing of rubble and collection of runoff |
| Potential oiling of birds (ravens) or wildlife from deposition on ice | • as part of the Spill Contingency Plan (Section 22.2: Spill Response), wildlife protection plans (including reconnaissance surveys to track spills and wildlife distributions), methods that will deter birds and wildlife from a spill area and actions for the recovery and treatment of oiled birds will be developed. Plans will be developed in consultation with CWS and other federal and Inuvialuit agencies |
| Polar bear mortality due to oiling or DLP kill with effects on hunting opportunities | • compensation to appropriate HTCs for loss of animal |
| Potential oiling of sea birds from oil residue in water at breakup | • as part of the Spill Contingency Plan, wildlife protection plans (including reconnaissance surveys to track spills and bird distributions), methods that will deter birds and wildlife from a spill area and actions for recovery and treatment of oiled birds will be developed. Plans will be developed in consultation with CWS and other federal and Inuvialuit agencies |

# 23 Summary and Conclusions

## 23.1 Program Scope

The Comprehensive Study Report describes the potential environmental and socio-economic effects of Devon's proposed Beaufort Sea Exploration Drilling Program in EL 420. The comprehensive study is based on the following Program scoping parameters:

- winter exploration drilling operations, within the landfast ice zone.
- exploration drilling at one of 9 potential offshore drill site locations in EL 420
- one exploration well per year in each of the four areas (Areas A, B, C and D) of EL 420, from the winter of 2005-2006 to the winter of 2008-2009
- three potential drilling platform systems, none of which requires dredging support to construct the platform or prepare the seafloor for platform setdown:
  - a converted tanker platform (the steel drilling caisson or SDC)
  - a purpose-built system that will combine a steel caisson and ice pad construction (the landfast tender-assist drill unit or LTD)
  - an ice island platform, which will be constructed on site

Drill site preparation and drilling, well testing and site demobilization will occur from November through to early June, with slight variations within this timeframe for different platform systems. All systems will require some marine vessel support during mobilization in the open-water season (July to October) and air support for personnel and equipment at various times during the year.

## 23.2 Assessment Methods

The base case for environmental and socio-economic assessment is routine operations for the first exploration well to be drilled, assumed to be the SDC platform at the Paktoa site (Area D) in the winter of 2005-2006. Any different or additional effects associated with the following variations on the base case are also assessed, if necessary:

- the other potential platform systems
- the remaining drill sites
- spatial and temporal variations in marine vs. brackish habitat conditions at the respective sites

Mitigation measures for potential effects are identified and any residual Program effects (predicted effects after implementation of mitigation measures) are evaluated and characterized in terms of defined significance criteria for each environmental and social component. Cumulative effects arising from the overlap of residual Program effects with other past, ongoing and reasonably foreseeable future activities are then assessed, and mitigation measures specific to cumulative effects are identified. Remaining cumulative effects are characterized in terms of defined significance criteria.

Effects of accidents and malfunctions are also assessed, including effects of small-scale spills of diesel or other products during routine mobilization and drilling operations, and effects of a hypothetical and unlikely blowout of condensate or oil during exploration drilling operations. Preventative measures and spill response procedures are described. Residual effects, after clean-up, are identified and characterized in terms of defined significance criteria.

## 23.3 Consultative Approach

Devon has been active in hydrocarbon exploration within the Inuvialuit Settlement Region (ISR) as an operator since 2000 and has demonstrated a commitment to building and maintaining strong relationships with the communities and local residents. This continues to involve conscientious ongoing communications with local community members, respect for the specific concerns of Aboriginal peoples, participation in community initiatives, and optimization of employment benefits. Devon's Program also includes proactive pollution prevention and risk management pertaining to health, safety and the environment. Devon's public engagement and consultation program has provided for systematic and progressive involvement of community members in each step of Program planning and assessment including:

- preliminary consultation to determine the best method of involving community members
- issue scoping to define VEC and VSCs and specific questions to be addressed by the comprehensive study
- involvement of local resource users and managers in conducting effects assessments and identification of mitigation measures
- review and discussion of preliminary assessment findings with local community members
- ongoing involvement of key community representatives in development of detailed Program-specific emergency response and environmental protection plans as required for ongoing approvals and permits
- involvement of Inuvialuit wildlife monitors in implementation of Program environmental protection measures and performance monitoring and reporting

## 23.4 Winter Drilling

The Program is based on a winter drilling Program within the landfast ice zone. By drilling in the landfast ice zone, Devon will be operating in a stable, well-understood setting. The longer, more dependable winter drilling season should permit Devon to effectively drill and evaluate any of its potential drill targets. Direct environmental benefits of drilling during the winter in the landfast ice zone include:

- minimal overlap with the migratory fish, bird and mammal populations that normally use the area during summer
- minimal overlap with Inuvialuit hunting activities

- in the unlikely event of an accidental spill of a petroleum product, more efficient and effective containment and recovery of potential accidental spills on the ice surface compared to an open-water environment or broken/moving ice

## 23.5 Study Findings

### 23.5.1 Routine Operations

No significant residual effects of routine operations are predicted. Because of the highly localized and short-term duration of Program effects, the remote location of Program area, and the low likelihood of overlapping effects from other activities in the area no significant cumulative effects are predicted, with one exception. Should the Mackenzie Valley Pipeline Project go ahead, socio-economic effects of that project in the region could overlap with effects of the Program. While the contribution of the Devon Program to such cumulative effects would be small, Devon would willingly participate in any regional initiatives to manage cumulative effects of large-scale hydrocarbon development affecting the ISR.

Highlights of study findings for each environmental and socio-economic component potentially affected by the Program are summarized below.

#### 23.5.1.1 Air Quality

All potential stationary and mobile air emission sources are considered. If gas is found, flaring during well testing would have the greatest potential for effects on ambient air quality. Potential effects of flaring were modeled, using conservative assumptions (maximum potential emission rate and duration of flaring during calm [minimal dispersion] conditions). Flaring emissions are found to be well within ambient air quality objectives (less than 1-2 % of objective levels for relevant air quality constituents), and thus effects of flaring are found to be not significant. Use of equipment with current emission control technologies and regular maintenance will minimize effects of other stationary and mobile emission sources. If well testing is required, Devon will abide by relevant industry standards (e.g., EUB Guide 60, 1999) to minimize potential flaring emissions. No monitoring is recommended.

#### 23.5.1.2 Noise

Effects of noise from drill site construction activities, exploration drilling, flaring, and air, marine and winter road transport activities on ambient sound levels are assessed by modeling the propagation of sound from these sources to potential human receptors. While effects of noise were of high magnitude close to the source, the remote location and transient nature of many of the sources indicated that very few, if any, non-Program related human receptors would be affected by changes in ambient sound levels. Potential effects will be further reduced by timing of activities, selection of transportation routes, and notification of potential receptors (through consultation with HTCs) to minimize noise effects on human receptors in the Program area. As a result, effects of the Program on ambient noise levels are found to be not significant. Liaison with local co-management agencies is recommended to monitor effectiveness of mitigation measures and address any conflicts or complaints.

#### 23.5.1.3 Ice and Physical Oceanography

The effects of a single, mobile exploration platform during each year of the Program on ocean waves and currents or landfast ice formation, break-up or movements would be very localized and of low magnitude and not significant in the context of the natural oceanographic processes and ice regime of the southern Beaufort Sea. No mitigation measures are recommended. Routine observations of ice formations and break-up, ice pressures and waves will be conducted to support Program planning and scheduling, assess platform performance and ensure operational safety. These measurements will also assist Devon in confirming impact predictions.

#### 23.5.1.4 Geology, Terrain and Sediments

Effects of drilling platforms and ice pads and deposition of drill cuttings on sediments are predicted to be not significant due to the localized nature of effects and the pervasive natural effects of annual ice scour and sediment deposition from the Mackenzie River outflows. No unique subsea landforms are known to occur near potential drilling locations. Wellsite surveys will be conducted prior to drilling to identify and avoid any potential drilling hazards or unique landforms (e.g., subsea pingos). Potential effects on seabed stability due to permafrost degradation or gas releases from hydrate bearing sediments will be minimized by Program design, including use of refrigerated KCl drilling mud and a BOP and diversion system to help control any unexpected gas releases. No significant residual Program effects are predicted and no monitoring, other than standard monitoring of drilling operations, is recommended.

#### 23.5.1.5 Coastal Processes

The Program will not have any direct impacts on shoreline areas. Potential indirect effects of drilling platform placement or Program-related marine transport on currents or waves affecting shoreline erosion or sediment deposition would be localized and short term and not significant compared to effects of natural wave energy. Activities associated with potential barge staging for supply of the ice island platform would be away from the shoreline in a shallow, low-energy wave environment and no significant effects on shoreline erosion are predicted. If the ice island platform is used, further evaluation of candidate barge staging areas will include consideration of wave exposure, water depth, sensitive shorelines (e.g., erosion potential) and traditional use, to avoid effects on adjacent shoreline areas and use by local residents. No significant residual effects are predicted and no monitoring is recommended.

#### 23.5.1.6 Chemical Oceanography

The effects of the Program-related waste discharges on water and sediment quality are assessed. Effects of marine discharge of drill cuttings, water-based KCl drilling mud, treated sewage, wash water, brine from the water treatment system and miscellaneous discharges (deck drainage, rig wash water, etc.) are assessed. For water quality, elevated concentrations of naturally occurring (inorganic salts and metals) and non-naturally occurring (drilling additives) contaminants would be localized (within a few hundred meters of the discharge point) and short term.

Based on defined significance criteria, effects on benthic accumulation rates of naturally and non-naturally occurring contaminant in sediments are expected to be not significant with one exception: deposition rates for barium could exceed natural depostion rates up to

1300 metres from the discharge point (Table 11-2). In the Program, barium occurs in the form of barium sulphate (barite), a chemical compound that is non-reactive in the environment (i.e., insoluble and inert). This is the same compound used in digestive track surveys. Although considered a significant effect based on the criteria used for this assessment (Table 11-1), deposition rates beyond 1000 m will approach natural accumulation rates. Bioassays have indicated that KCl drilling fluids can be tolerated by aquatic biota at very high concentrations without toxic effects. Furthermore, effects on sediment within the zone of influence are limited to a very small proportion of available habitat. Subsequent deposition of natural sediments and mixing by natural ice scour processes will disperse and dilute barium and other contaminant concentrations to background levels within a number of years.

Mitigation measures include:

- adherence to Guideline Respecting the Selection of Chemicals Intended to be Used in Conjunction with Offshore Drilling and Production Activities on Frontier Lands (NEB et al, 1999) and Offshore Waste Treatment Guidelines (NEB 2004)
- development and implementation of a Waste Management Plan, as part of the DPA process, including toxicity testing prior to marine discharge
- procurement policies to ensure use of biodegradable soaps and cleaning agents
- optimizing use of drilling mud additives
- solids control and recycling to minimize drill mud volumes

On this basis, no significant residual effects on water quality and sediments are predicted.

With regard to cumulative effects, there is no other known existing or reasonably foreseeable future industrial projects that would overlap the zones of influence for residual project effects during the lifespan of the drilling Program. There is a possibility that residual Program effects could overlap with long-range transport of contaminants via atmospheric deposition, riverine input and ocean currents. The greatest concern regarding LRTAP is the input and bioaccumulation of organochlorine contaminants (e.g., from pesticides). No organochlorine contaminants will be released by the Program.

Two monitoring programs are recommended:

- toxicity testing for waste discharges from the under-ice pipeline, to be developed in consultation with NEB and EC and other affected stakeholders
- monitoring of contaminant levels in benthic sediments at the exploration well site following each winter's drilling program

#### 23.5.1.7 Plankton

Program effects on phytoplankton, zooplankton and ice algae during the winter drilling period are assessed. The mechanisms for effects include changes in water quality and changes in the ice environment (ice pad construction, ice road clearing). Localized, short-term changes in water quality (within 1000 m of the discharge point) due to contaminants and nutrient additions from treated sewage are expected to have no measurable or ecologically meaningful effects on the plankton or ice algae communities. Similarly, alienation of ice algae habitat resulting from ice pad construction would be localized and short term. For the ice island platform option, the habitat loss may be offset by snow clearing on the ice road access, providing increased light penetration and localized increase

in ice algae production. Accordingly, residual Program and cumulative effects are predicted to be not significant and no additional mitigation measures or monitoring are recommended.

#### 23.5.1.8 Benthos

The effects of drilling platforms, ice pads and drilling waste deposition on bottom dwelling organisms are assessed. Benthic habitat would be alienated for one year at each exploration well site. Storage of the SDC or LTD platforms at the end of the Program could result in longer-term alienation of up to 1.8 ha of benthic habitat. Rates of recolonization would be similar to what occurs naturally following ice scouring. A return to pre-Program invertebrate densities at the SDC site may take several years to a decade. The maximum area affected by Program activities would represent a small proportion (0.004 percent or less) of the available habitat near EL 420. Benthic productivity is naturally limited in the Program area due to ice scour, variable salinities and sediment deposition from the Mackenzie River inflows. These limitations to benthic productivity would be greater for the nearshore Pullen and Tuwak drilling locations, than the deeper water sites in the estuarine-marine transition zone. Accordingly, effects are found to be not significant and no additional mitigation measures are recommended. In conjunction with monitoring of sediment contaminant levels at each drilling site following the winter drilling Program, benthic invertebrate sampling will be conducted to monitor benthic community structure and recolonization rates. Devon will consult with DFO in the development of this program.

#### 23.5.1.9 Fish and Fish Habitat

The effects of fish habitat loss and alteration are assessed, resulting from:

- platform placement
- effects of marine waste discharges
- potential fish entrainment due to platform ballasting or water pump intakes for ice road and ice pad construction.

Habitat loss and entrainment during platform mobilization and ice pad construction may affect Arctic and least cisco, rainbow smelt, Pacific herring and Arctic cod. Ice road construction may affect rainbow smelt and Pacific herring at the Pullen North and Tuwak drilling locations. Drilling waste disposal may result in localized effects on Pacific herring, Arctic cod, Arctic and starry flounder and four horn sculpin. If the SDC or LTD platforms were stored at Herschel Island, there would be longer-term alienation of up to 1.8 ha of habitat for Dolly Varden, Arctic and least cisco, rainbow smelt and Pacific herring.

Devon will work with DFO to evaluate appropriate fish screens for water intakes to reduce potential for fish entrainment. Due to their small magnitude, localized and generally short-term nature, Program effects on fish and fish habitat are found to be not significant. Fish entrainment rates will be monitored during ice pad construction to assess effects and improve mitigation measures if possible. Devon is also proposing to conduct a follow-up study of benthic fish habitat utilization at drilling locations during winter, using a drop camera and video surveillance. The objective is to better characterize benthic habitat utilization and confirm accuracy of impact predictions. Details will be developed in consultation with DFO and FJMC.

#### 23.5.1.10 Birds

Program effects on the bird VECs loons, brant goose, sea ducks, moulting ducks and common raven are assessed. Potential effects included presence of platform structures, drill site lighting, marine waste discharges, flaring, atmospheric emissions, and disturbance (including noise) by marine and air transport activities. Only ravens would be affected by drilling activities during winter. Solid waste management (incineration, storage of ash for landfill disposal) will minimize attraction of ravens. Because of the highly localized nature of effects and the adaptability of ravens to human activities, effects are found to be not significant.

Localized effects of routine marine waste discharges will not have a significant effect on feeding habitat for marine birds during open water conditions. Waste treatment measures will minimize the potential for oily residues at breakup affecting marine birds. Disturbances of marine or moulting birds as a result of ship movement during platform mobilization would be localized and transient. Selection of barge staging areas for the ice island option or longer-term storage locations for the SDC or LTD platforms will avoid sensitive shoreline habitat areas. Flight paths for air transport will avoid concentrated nesting areas or sanctuaries during sensitive life stages. Devon will consult with the HTCs, Inuvialuit co-management agencies and the Northwest Territories resource management agencies in selecting barge staging areas and defining flight paths for the Program. Accordingly, residual Program effects on birds are found to be not significant.

An Inuvialuit wildlife monitor will be onsite during all Program activities to monitor bird presence and response to Program-related disturbances and assess the effectiveness of mitigation and protection measures. In addition, Devon is supportive of additional studies with government and co-management agencies to address specific and relevant data gaps concerning bird habitat use (e.g., spring distribution and abundance of sea ducks).

#### 23.5.1.11 Marine Mammals

The Program effects on the VECs beluga whale, subsistence hunt for beluga whale, bowhead whale, ringed seal and polar bear are assessed. Arctic fox may also be present in the Program area in winter, to scavenge on the remains of seals killed by polar bears. Potential Program effects include disturbance from:

- marine vessel movements
- aircraft overflights
- ice road construction and use
- habitat alienation due to platform structures, ice pads, ice roads and barge staging areas
- disturbance from drilling activities
- effects of solid waste disposal and marine waste discharges.

A key mitigation measure will be timing of mobilization activities to avoid peak whale migration periods and the beluga subsistence hunt. Devon will meet with HTCs and appropriate co-management agencies to determine appropriate mitigation measures prior to mobilization. An Inuvialuit wildlife monitor will be onsite during mobilization activities to monitor whale presence and check effectiveness of mitigation measures (maintaining a straight course at slow steady speeds, acceptable flight elevations for air transport). Barge staging areas for the ice island platform options will avoid sensitive habitat areas.

Polar bears and seals will be the species affected by construction and operations activities during ice cover. Small numbers of seals (2-7 animals) will be displaced from the drill site

location and along the ice road corridor for the ice island platform option. Localized effects of marine waste discharges are not expected to adversely affect seals and polar bears. Solid waste management measures will minimize bear attraction and strict protocols for bear monitoring and deterrence at drill sites will minimize the risk of a polar bear kill in defence of life and property. In the unlikely event that a polar bear is killed during Program operations, Devon will compensate the affected HTC for the value of the lost animal. On this basis, residual Program effects on marine mammals are found to be not significant.

Devon is supporting an ongoing ringed seal study, which will provide useful monitoring data concerning the effects of the Program. An Inuvialuit wildlife monitor will be onsite during all Program phases to monitor wildlife presence and response to Program activities and to evaluate the effectiveness of mitigation measures.

#### 23.5.1.12 Socio-Economic Conditions

Program effects are assessed on:

- regional employment
- training and procurement
- population stability
- personal and corporate income and government revenue
- provision of physical infrastructure and community and social services
- individual and family wellness
- traditional economies
- tourism

Effects on regional employment and training and regional procurement were found to be positive with application of mitigation and enhancement measures (e.g., Devon's commitments under their Comprehensive Cooperation and Benefits Agreement). Potential low magnitude negative effects on community and social services and tourism, especially guided polar bear hunts would be addressed by identified mitigation measures:

- Devon's ongoing involvement in local service initiatives such as recreation facilities and the SHARE program
- consultation with community agencies to assess Program effects and mitigation measures
- consultation with RWED, the HTCs and co-management agencies to minimize conflicts with tourism activities and the polar bear hunt
- compensation agreement to address any polar bear kills

Effects on personal and corporate incomes, individual and family wellness and traditional economies could be positive or negative, depending on the degree to which Program-related opportunities are realized by individuals and businesses. Because of the relatively small scale of the program and identified mitigation measures, any potentially negative effects are found to be of generally low magnitude. The Program is not expected to give rise to conditions that would conflict with preferred lifestyles and wellness. Accordingly, residual Program effects are found to be not significant. Effects would be similar for Inuvialuit, Gwich'in and non-aboriginal people, with the exception of potential effects on the polar bear hunt resulting from Defence of Life and Property kills. This effect would be limited to the Inuvialuit in Aklavik, Inuvik and Tuktoyaktuk.

If the Mackenzie Gas Project is approved as described in the Project Description for the Mackenzie Gas Project, activities will overlap with the last three years of the Program. The Program would contribute in a minor way to what is expected to be a significant increase in economic activity and social change in the region due to the Mackenzie Gas Project. In the event that this occurs, Devon would ensure its mitigation and monitoring measures are closely aligned with any regional scale initiatives to manage cumulative effects. Devon's contribution to cumulative effects in this context is not significant.

Devon will monitor internal and relevant territorial data to ensure implementation of socio-economic commitments and evaluate the effectiveness of mitigation measures throughout the Program.

#### 23.5.1.13 Traditional Knowledge

Issues were identified concerning the effects on the health of the natural environment (effects of spills and waste disposal on environmental quality and traditional use resources and activities) and the quality of life in communities (population influxes, absence of wage earners from the home, potential negative effects of short-term increased income). These issues and mitigation recommendations are integrated into the relevant discipline assessments. Detailed assessment reports for traditional knowledge will be reviewed with community members in the fall of 2004. Copies of the final reports will be provided to each community, the federal review agencies and Inuvialuit organizations.

#### 23.5.1.14 Heritage Resources

Program activities will not involve any new onshore disturbances and therefore there are no effects on heritage resources.

#### 23.5.1.15 Land and Land Use

The effects of the Program are assessed on:

- industrial and commercial activities
- non-traditional resource harvesting
- tourism and recreation
- protected and designated environmentally significant areas
- visual aesthetics

In general, there would be very little overlap between Program activities and non-traditional land and resource use, which would give rise to potentially negative effects.

Potential effects on the Beluga Management Zone 1A areas will be addressed through Program scheduling and mitigation measures discussed for marine mammals. If weather or ice conditions were to affect proposed mobilization activity scheduling (and therefore, possibly, affect the beluga hunt) in any given year, Devon would meet with the HTCs, WMAC (NT) and the IGC to determine appropriate mitigation measures, consistent with the management objectives of this zone.

While the magnitude of visual effect of the drilling platform will be high near the drill site, there will be few, if any, non-Program related people near the site during winter. Because the potential drill sites are generally remote from any areas of concentrated settlement, effects on viewsheds were found to be low, with the exception of the Tuwak drill site,

which would be visible in the distance from Tuktoyaktuk for a period of less than a year. The SDC would be most visible and the ice island would be least visible.

Based on these considerations, residual Program effects on land and resource use are found to be not significant. No additional mitigation or monitoring measures are identified.

#### 23.5.1.16 Effects of the Environment on the Program

The Program will be conducted in a well understood environment with proven technologies. Based on considerable operational experience by the oil and gas industry in the southern Beaufort Sea, Program design and operation and established monitoring and safety response procedures will address the potential effects of weather, waves, ice, seismicity, seabed stability and corrosion and bio-fouling. A systematic evaluation of trends in climate and effects on ice and open water regimes in the Program area over the last 11 years did not indicate any changes in ice or ocean conditions that would affect Program planning or design within the time frame of the Program. Accordingly, effects of the environment on the Program are found to be not significant.

### 23.5.2 Accidents and Malfunctions

#### 23.5.2.1 Accidental Spills

Effects of small-scale spills are examined for a range of materials, from petroleum-based fuels to various soluble and insoluble materials that would be stored and handled in bulk for drilling operations. Spill volumes are based on historic spill data and storage volume units. Effects of spills during the open water mobilization period and ice cover platform construction and drilling period are assessed. With identified spill prevention, emergency spill response and clean-up procedures, residual effects on water and sediment quality, fish, birds and wildlife and associated traditional harvesting activities are found to be not significant.

#### 23.5.2.2 Blowout Scenarios

Effects of a hypothetical blowout of either condensates from a gas blowout or an oil blowout during winter drilling (ice cover conditions) are assessed. Worldwide statistics indicate that the chance of a gas blowout is one in 150. The chance of an oil blowout is very small (one in 5000 for a blowout involving more than one barrel of oil). The chances of a blowout involving more than 10,000 bbl of oil or condensate are one in 12,000. Because these statistics do no reflect ongoing improvements in technology and safety and operational standards over the past two decades, the chances of a blowout resulting in an oil or gas condensate spill during the Program would be even smaller. While the risk of a blowout involving a large spill of oil is small, it is a major concern in the local communities.

The two blowout scenarios were based on conservative assumptions, that is, a 7-day blowout, because it produces the most significant spill, as per the Beaufort Sea Steering Committee's publication "*Recommended Philosophy for Development of a Worst Case Blowout Scenario for Wells Drilled in the Beaufort Sea"* (Adams Pearson Associates 1991). The areas of landfast ice affected and deposition rates for condensate and crude oil are calculated. The form of oil on the ice after clean up and at breakup is used to assess exposure of VECs and VSCs during the ice cover period and at breakup.

Due to the ability to effectively contain and clean up spilled products on the ice, residual effects of an oil blowout are predicted to be not significant, based on specified significance criteria, with two exceptions. Introduction of small amounts of residual oil from the ice surface to the water column over a large surface area at break up would result in hydrocarbon concentrations exceeding background levels beyond 1000 m of the spill source for more than one day. However, concentrations will be well below the LC50 toxicity values for even the most sensitive benthic and pelagic organisms. Effects on water quality would be significant but non-toxic for a short period, returning to not significant within days. Mortalities of Pacific loons, surf scoter, white-winged scoters, long-tailed ducks and glaucous gulls could occur if exposure to residual oil at break-up is sufficient to cause oiling and associated hypothermia. Effects are predicted to be low (fewer than 100-200 birds), sub-regional and short term and therefore not significant.

An oil blowout would cause an increase in VOCs above ambient air quality objectives due to volatilization during and after the blowout. Subsequent burning of spilled oil on the ice surface would cause an increase in $CO_2$, $NO_X$, CO and particulate matter above ambient air quality objectives. Significant effects would be short term and localized, returning to not significant within hours to weeks (depending on the duration of the blowout and subsequent oil burning activities). The short-term effects of burning on air quality are required to minimize potential effects on the marine environmental and biota at breakup.

Because condensate is a mixture of very light (volatile) hydrocarbons, the droplets will evaporate in the air very quickly and continue to evaporate from the ice surface after deposition. As a result, only trace amounts of condensate would remain near the platform at break-up. Residual effects on VECs and VSCs are predicted to be not significant with one exception. A short-term (hours to days) localized exceedance of ambient air quality objectives for VOCs would be expected during the condensate blowout. This transient significant effect on air quality would cease at the end of the blowout event and return to not significant within hours to a few days.

Although the blowout scenario assessed would result in some short-term significant effects, the likelihood of an oil or condensate blowout of this magnitude is extremely remote. Based on an analysis of worldwide offshore drilling accidents, the predicted frequency of very large (greater than 10,000 bbl) spills from exploration drilling is $8.6 \times 10^{-5}$ per well, or a probability of 1:12,000.

In summary, in the highly unlikely event of a blowout, effects of an oil or condensate spill would be generally not significant with identified spill control and clean-up measures. Significant effects on air and water quality would be transient and would not result in significant effects on other VECs and VSCs.

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# Appendix A Scope of the Environmental Assessment and Environmental Impact Screening and Review