13 Benthos

Benthos refers to the benthic (bottom-dwelling) invertebrate community that lives on or in the seafloor. These communities include organisms living within the soft bottom substrates (infauna) (e.g., clams and marine worms, such as polychaetes) and organisms living on the surface of the sea bottom (epifauna) that may be attached to the substrate or mobile (e.g., crustaceans such as mysids, amphipods and isopods). They are fed upon by fish, birds and marine mammals and are therefore important in nearshore coastal food webs. They are also potentially vulnerable to Program-related disturbances.

13.1 Baseline Conditions

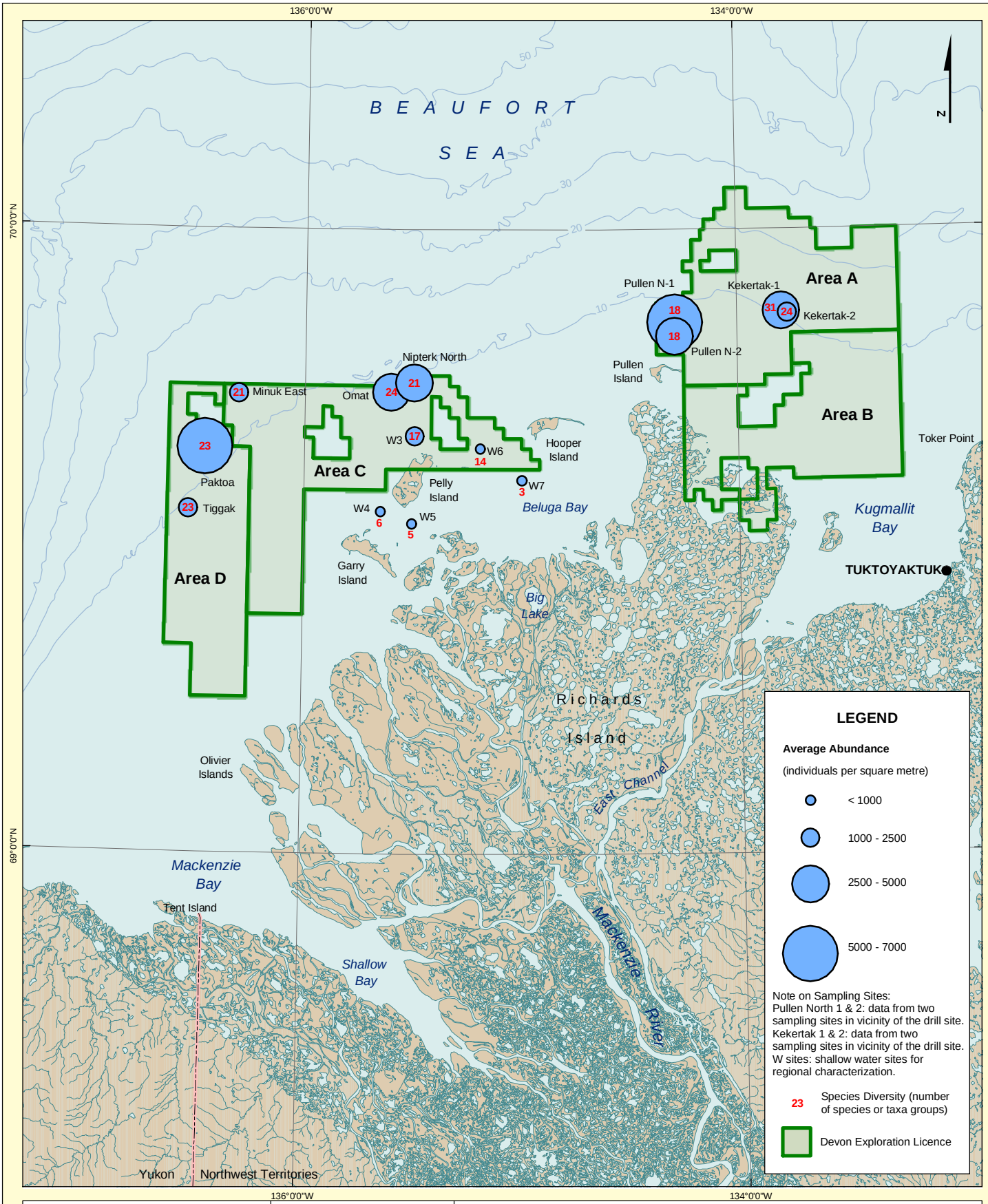
Information on the benthic community was obtained from a review of benthic literature from the 1970s and 1980s, as well as Wong (2000) (which included much of the previous work conducted by oil and gas exploration companies). Baseline benthic surveys were also conducted by Devon near EL 420 (North/South and KAVIK-AXYS Inc. 2004). Results from this survey are summarized in Figure 13-1.

The importance of the benthic invertebrate community as a food source for fish, birds and marine mammals is variable in the region and depends on location, depth and composition of the invertebrate fauna. Benthic communities in EL 420 are generally limited by ice scour, variable salinities and high rates of sediment deposition from the Mackenzie River.

In nearshore embayments that occur along much of the coast, benthic invertebrates are plentiful (Wacasey 1975; Hopky et al. 1994) and form a major food source for anadromous and euryhaline fish species that seasonally occupy these waters (Lawrence et al. 1984). In shallow water and brackish locations farther offshore, benthic fauna are not abundant (Wacasey 1975; North/South and KAVIK-AXYS Inc. 2004), principally due to high rates of sedimentation and resuspension of sediments from wave action. In deeper, more saline (i.e., transition zone) locations, species diversity and abundance of benthic invertebrates increases, and they are presumably fed upon by benthic-feeding species of fish (e.g., eelpouts, eel blennies and lumpsuckers). During bottom trawls conducted in shelf waters at depths ranging from 10–36 m, it was determined that the contents of Arctic cod stomachs contained large amounts of zooplankton species and epibenthic invertebrates such as amphipods and mysids but did not contain infaunal benthic organisms.

In offshore locations similar to EL 420, local fish species do not appear to consume infauna much, and the small size of infauna probably precludes their use by local marine mammals (F. F. Slaney & Company Limited 1976). Diving birds, however, are believed to feed on bivalves in water up to 30 m deep (F. F. Slaney and Company Limited 1976). Epifauna are a significant food item for many of the fish species found in the region (e.g., Arctic cisco, *Coregonus autumnalis*).

Figure 13-2 shows the biomass (dry weight grams per square metre) of zoobenthos by benthic habitat types within the region and demonstrates the generally low biomass conditions that exist in the LSA.



devon

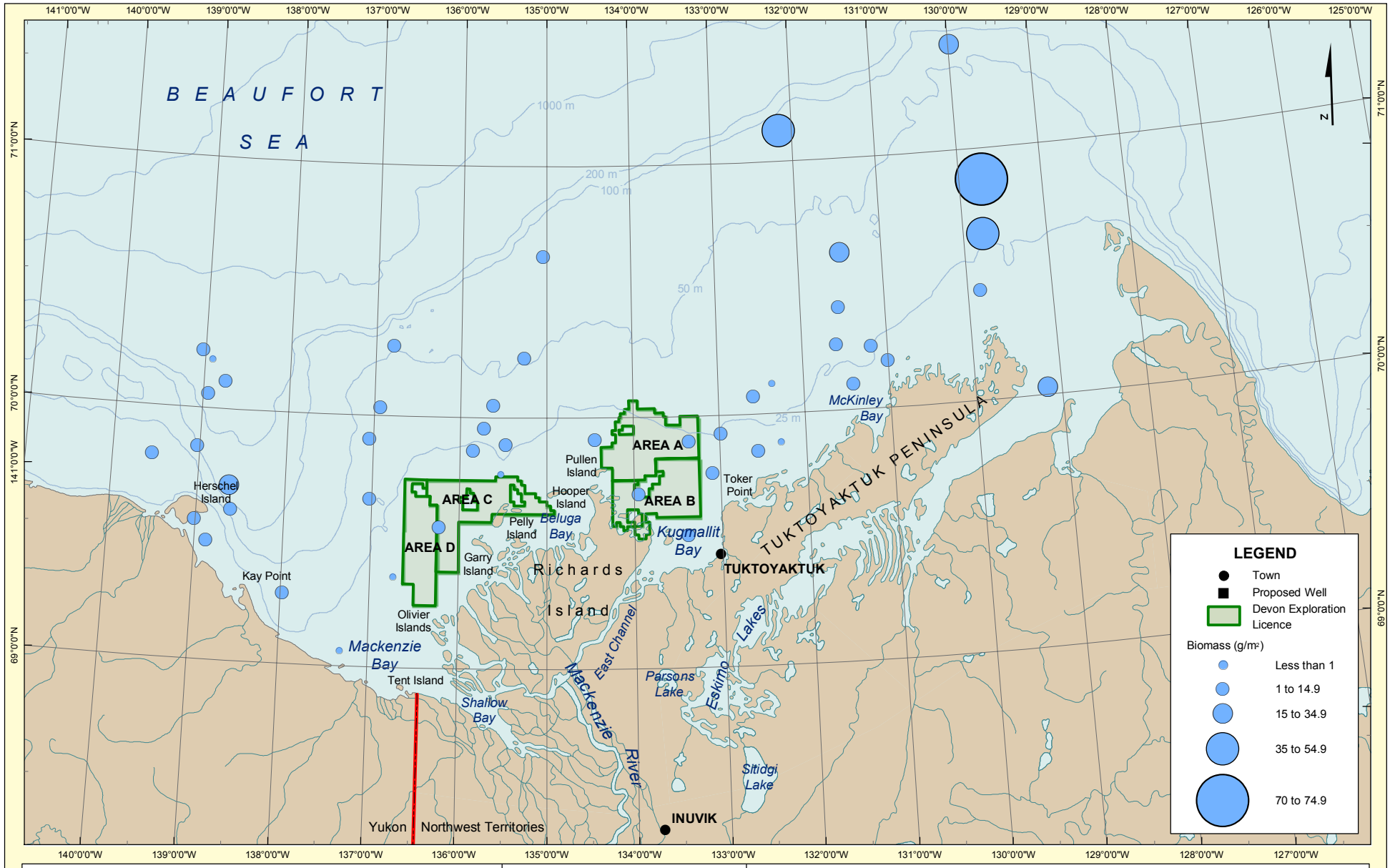
KA036 - Zoobenthos Abundance
August 26, 2004

Area of Detail

0 5 10 15 20
Kilometres

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

Figure 13-1
Average Abundance and Diversity of Zoobenthos from the 2002 Baseline Benthos Survey



devon

KA036 Devon - Biomass
August 18, 2004

Area of Detail

0 20 40 60 80
Kilometres

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

Figure 13-2
Biomass of Zoobenthos from the Southern Beaufort Sea

13.2 Impact Assessment

The assessment of effects of the Program on the benthic community is based on examining the potential pathways and mechanisms by which the Program may affect benthic invertebrates, that is:

- physical disturbances from drilling platform mobilization and setdown on the seabed
- construction of a grounded ice pad
- deposition of drilling wastes on the sediments

Effects were quantified, where possible, in terms of their magnitude, spatial extent and duration (Table 13-1).

Table 13-1 Effect Attributes for Benthos

Magnitude	
Small	No detectable change in benthic invertebrate abundance, but a mechanism for change has been identified
Moderate	A detectable change of less than 20 percent in benthic invertebrate abundance
Large	A readily measurable change in benthic invertebrate abundance (given the natural variability that exists within the benthic community, a change greater than 20 percent is considered readily measurable)
Geographic Extent	
Site-specific	Confined within a 1-km radius of the drill site
Local	Confined within the LSA (EL 420)
Regional	Confined within the RSA (landfast ice zone from Herschel Island to the northeastern tip of Tuktoyaktuk Peninsula)
Duration	
Short term	Up to two years
Long term	More than two years

Program effects on benthic invertebrates are based on predicted effects of waste release on sediment deposition and quality (Section 11: Chemical Oceanography) and an assessment of effects of footprint disturbance (platform and ice pad).

A short-term effect (less than two years) is considered significant if it is:

- large in magnitude and local to regional in extent
- moderate in magnitude and regional in extent

A long-term effect (more than two years) is significant if it is moderate to large in magnitude and local to regional in extent.

The following additional factors are considered in determining significance:

- frequency of occurrence of Program impacts (this may influence the duration of effects)
- reversibility of an effect either through mitigation or population resilience (this would influence the duration of an effect)
- ecological context (i.e., Do known thresholds exist? Are effects ecologically meaningful?)

Effects are summarized in Table 13-2. Mobilization of the SDC in Pauline Cove will expose the 1.8 ha of seabed that was under the MAT for recolonization by benthic species from surrounding areas. Studies of recolonization related to dredging (Heath and Thomas 1984, cited in Wong 2000), indicate that some components of the benthic community may recover to a productive state within a year, but several years may be required to develop a mature community. The net effect of SDC mobilization will be the return of 1.8 ha of benthic habitat to a productive state within a few years.

Table 13-2 Program Effects on Benthos

Potential Effect	Interaction with VEC	Level of Effect[1]			Effect Significance[2]	
		Magnitude	Extent	Duration	Program-related Effect	Cumulative Effect
Pre-operations						
Platform mobilization and setdown	• 1.8 ha of benthic habitat available for benthic colonization at Herschel Island storage site for SDC • Up to 1.8 ha (0.0005% of LSA) benthic habitat temporarily removed by platform setdown • Recolonization could take from several years to a decade	Small	Site specific	Long term	Not significant	Not significant
Ice pad construction	• Up to 12.2 ha (<0.004% of LSA) benthic habitat temporarily removed by ice pad construction. • Less effects on nearshore locations (e.g., Tuwak and Pullen North) due to lower natural benthic productivity.	Small	Site specific	Long term	Not significant	Not significant
Operations						
Waste disposal affecting sediment deposition	• Elevated sedimentation rate within 500 m^2 of discharge • Potential site specific reduction in benthic production for several years	Small	Site specific	Long term	Not significant	Not significant
Waste disposal affecting sediment quality	• No significant changes in sediment metals concentrations • Elevated hydrocarbon deposition within 50 m of discharge (0.05 ha increment to effects of platform and ice pad disturbance) • Potential site specific reduction in benthic production for several years	Small	Site specific	Long term	Not significant	Not significant
Closure						
Platform storage	• Up to 1.8 ha (0.0005% of LSA) benthic habitat temporarily removed from production (LTD and SDC)	Small	Site specific	Long term	Not significant	Not significant

Notes: 1 Based on criteria in Table 13-1
2 Based on criteria in Section 13.2

Placement of the drilling platforms and associated ice pads (up to 12.2 ha), and the deposition of 90 percent of the drilling solids within 50 m of the discharge point, would alienate benthic habitat and eliminate benthic production in that area for one year. The affected areas would be covered with a one-centimetre layer of natural sediments in the following year and benthic communities would begin to recolonize. Over longer periods, because of continued natural deposition and ice scour, affected areas would become indistinguishable from background sediment. 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 from several years to a decade. Hence, effects would be small, site-specific and long term. The area affected represents a small proportion of available habitat in the 400,000-ha LSA (approximately 0.004 percent or less). Furthermore, the productivity of benthic communities in EL 420 is naturally limited by ice scour, variable salinities and sediment deposition from the Mackenzie River. Site-specific effects of the Program on benthic productivity would be small in the context of these overriding, naturally limiting factors (Table 13-2). Therefore, Program effects on benthic invertebrates are expected to be not significant.

At closure, if storage of the SDC or LTD platforms is required, up to 1.8 ha of benthic habitat would be alienated for the duration of platform storage.

13.3 Mitigation Measures

Because no significant effects are predicted with the standard design and treatment procedures to be implemented, no additional impact mitigation measures are recommended.

13.4 Residual Program Effects and Significance

Residual Program effects on the benthic community are expected to be not significant.

13.5 Cumulative Effects and Significance

Residual effects at each site over the four-year period are expected to be not significant. There is no overlap of effects between the four exploratory wells during the four years of the Program and there are no other known existing or reasonably foreseeable future industrial projects (e.g., dredging, exploration drilling and seismic activities) that will overlap or have overlapping effects with the Program. Therefore, cumulative effects on benthic habitat and benthos are expected to be not significant. In addition, because chemical inputs from LRTAP are described as minor compared with local sources (Section 11.5: Cumulative Effects and Significance), cumulative effects on the quality of benthic habitat and benthos are expected to be not significant.

13.6 Monitoring

As noted in Section 11.6: Monitoring, an assessment of contaminant levels in benthic sediments will be completed each year at the location of each previous year's drilling Program. It is recommended that benthic invertebrate sampling also be conducted to assess effects on benthic invertebrate community structure and re-colonization rates (Table 13-3). Devon will consult with DFO on the development of this monitoring program.

Table 13-3 Monitoring Programs for Benthos

Potential Effect	Program Objectives	General Methods	Reporting	Implementation
Waste disposal (elevated rates of sediment and hydrocarbon deposition affecting benthic productivity)	Determine rate and extent of recolonization of affected habitat	• Benthic invertebrate sampling (species composition and abundance) • Comparison with pre-program data • Drop camera observation of larger invertebrates	• To be determined	Devon
Bioaccumulation of contaminants	Determine effect of waste disposal on invertebrate body burden of metals and hydrocarbons	• Measure metals and hydrocarbons in invertebrate tissues	• To be determined	Devon

14 Fish and Fish Habitat

This section examines the potential direct effects of routine Program operations on fish and fish habitat from physical habitat disturbances and changes in water quality associated with the drilling Program.

14.1 Baseline Conditions

Seven fish species were selected as VECs because they are common in the Program area or are important to local harvesters:

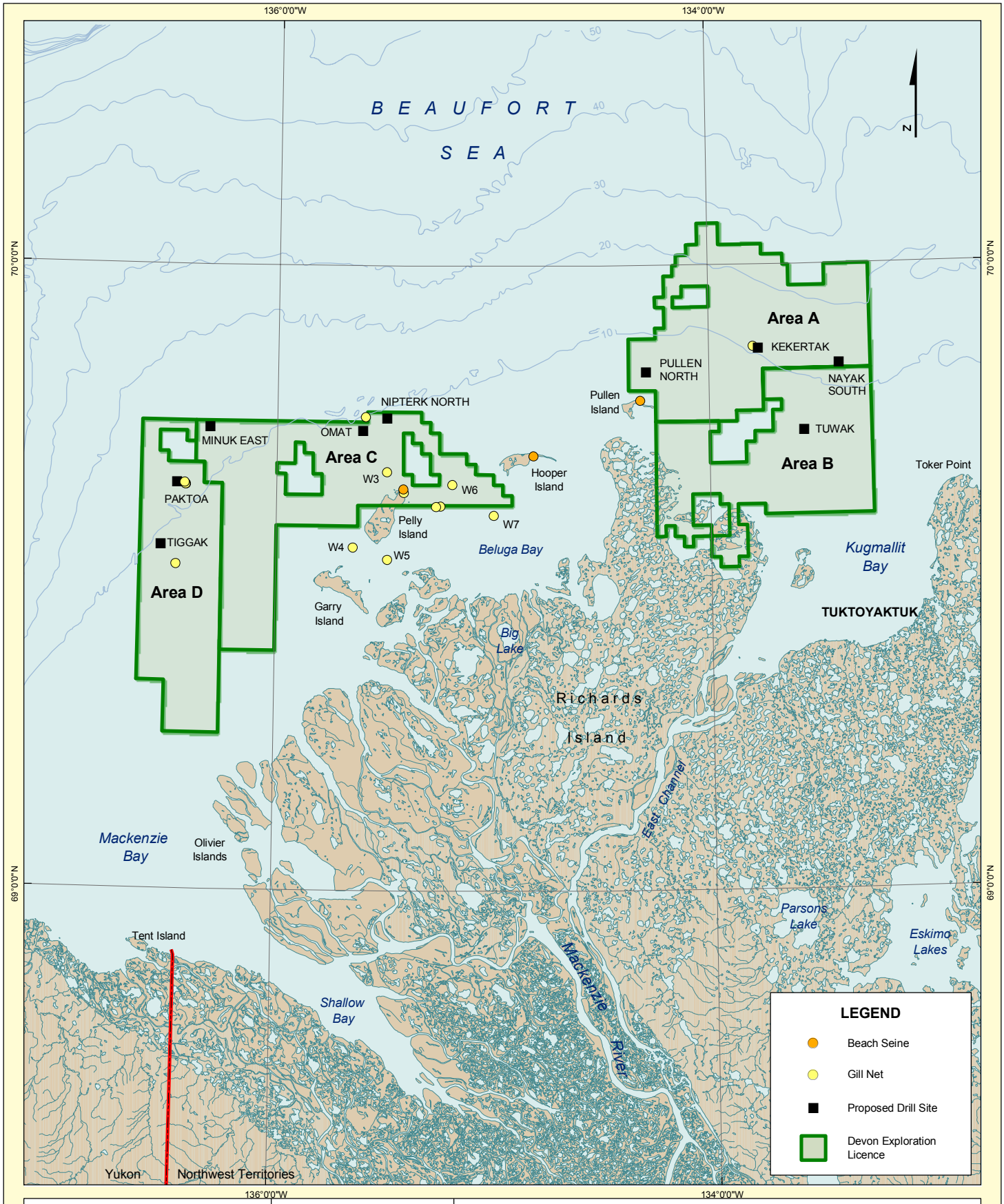
- broad whitefish (*Coregonus nasus*)
- lake whitefish (*C. clupeaformis*)
- Pacific herring (*Clupea harengus pallasi*)
- inconnu (*Stenodus leucichthys*)
- Dolly Varden char (*Salvelinus malma*)
- Arctic cisco (*C. autumnalis*)
- least cisco (*C. sardinella*)

Additional fish VECs were selected as follows:

- Arctic cod (*Boreogadus saida*) – high abundance and ecologically important in the marine environment
- rainbow smelt (*Osmerus mordax*) –important as food for fish, birds and marine mammals in the nearshore environment
- blackline prickleback (*Acantholumpenus mackayi*) – a marine benthic fish of uncertain status and potential vulnerability to disturbance
- fourhorn sculpin, Arctic flounder and starry flounder – benthic fish species abundant in nearshore coastal waters and potentially susceptible to Program effects

Information on fish species and habitat use in the Mackenzie Delta and southern Beaufort Sea was compiled from a considerable volume of literature on the subject. Baseline fish studies were also conducted by Devon near EL 420 (North/South and KAVIK-AXYS Inc. 2004). Sample sites, which were selected in relation to priority drill targets, are shown in Figure 14-1.

Fish distribution near EL 420 is highly dependant on the tolerance of individual fish species to the range of conditions found in the coastal area off the Mackenzie Delta. These zones are described Section 12.1 and shown on Figure 12-1. Many species of interest to local harvesters, such as ciscoes, whitefishes and Dolly Varden, cannot tolerate the sub-zero temperatures that prevail over most of EL 420 in winter. Because most drilling will occur during the January to April period, many of these species are not present during drilling activities. However, as winter progresses, the Mackenzie River discharge displaces the cold, more saline water from the nearshore regions and less saline and cold-tolerant species (e.g., ciscoes and whitefishes) may move outwards from their winter range in the channels of the Mackenzie River Delta. By winter's end (i.e., late May), their distribution may extend seaward to depths of five to six metres. Seasonal distribution patterns of the VECs in the Mackenzie Delta/Beaufort Sea area are summarized in Table 14-1.



devon

KA036 - Baseline Fish Survey
February 26, 2004

Area of Detail

0 5 10 15 20
Kilometres

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

Figure 14-1
Baseline Fish Survey

Table 14-1 Distribution of Valued Ecosystem Component Fish Species in Open-Water and Ice-Covered Conditions

Species	Open-Water Distribution	Ice-Covered Distribution
Dolly Varden	Brackish to marine coastal waters, west of delta	Freshwater tributaries
Arctic cisco	Brackish to marine coastal waters of estuary	Fresher water areas of inner estuary and the Mackenzie River
Least cisco	Similar to Arctic cisco but not likely to extend as far from influence of Mackenzie River	Fresher water areas of inner estuary and the Mackenzie River
Broad whitefish	Narrow coastal band within fresh to brackish water	Freshwater lakes and the Mackenzie River
Lake whitefish	Narrow coastal band within fresh to brackish water	Freshwater lakes and the Mackenzie River
Inconnu	Within fresh to brackish water of central portions of Mackenzie River estuary	Lakes and channels of the Mackenzie River delta
Rainbow smelt	Brackish to marine coastal waters of estuary	Fresher water areas of inner estuary and delta channels and tributaries
Pacific herring	Marine and brackish waters of the estuary	Brackish to marine waters of coastal bays
Arctic cod	Marine regions with occasional presence in nearshore brackish water	Marine coastal waters of the Beaufort Sea
Blackline prickleback	Marine to brackish water. Known distribution limited to Tuktoyaktuk Harbour, Phillips Bay and Wood Bay	Marine to brackish water. Known distribution limited to Tuktoyaktuk Harbour, Phillips Bay and Wood Bay
Starry flounder Arctic flounder Fourhorn sculpin	Marine and brackish waters of the estuary. Only fourhorn sculpin reported in sub-zero marine waters, up to 10 m	Brackish to marine waters of coastal bays

14.2 Impact Assessment

Program effects on plankton and benthic invertebrate communities (Sections 12 and 13) were found to be not significant and, therefore, are not expected to have an effect on fish that feed on plankton or benthos. Potential Program-related effects on fish include:

- direct loss of habitat and decreased productivity (i.e., due to increased siltation) resulting from placement of offshore structures
- direct loss and alteration of habitat as a result of the discharge of drilling waste under the ice
- fish entrainment during platform ballasting and water withdrawal for ice pad and ice road construction

Potential effects are based on interaction of Program activities with VECs and their habitat. Where interactions are possible, potential effects are characterized based on criteria in Table 14-2.

Only effects at a local and regional scale are examined for significance. Site-specific effects are not considered significant. Local and regional effects, both short term and long term, are significant if they are predicted to be large or moderate in magnitude. Effects that are small in magnitude are expected to be significant only if they are predicted to be long term in duration and regional in extent.

Table 14-2 Effect Attributes for Fish and Fish Habitat

Magnitude	
Small	A change in fish population abundance of less than one percent. This magnitude of effect is not likely detectable, but a mechanism for change has been identified.
Moderate	A change in fish population abundance of less than 25 percent and greater than one percent. This magnitude of effect may be detectable with a well-designed, carefully executed monitoring program.
Large	A change in fish population abundance of greater than 25 percent. This magnitude of effect is the minimum that would be readily detectable through monitoring or by a domestic fisher (i.e., readily distinguishable from natural annual variations in catch).
Geographic Extent	
Site-specific	Effects confined within a 1-km radius of the platform site
Local	Affects the LSA (EL 420)
Regional	Affects the RSA (landfast ice zone from Herschel Island to the northeastern tip of Tuktoyaktuk Peninsula)
Duration	
Short term	Less than three years
Long term	Three years or longer, based on species generation time

Program activities will not overlap with habitat for broad and lake whitefish, inconnu, Dolly Varden char, or blackline prickleback; therefore, there will be no effects on these species. Pre-operations activities (platform mobilization, ballasting and water intakes for ice pad construction) may affect Arctic and least cisco, rainbow smelt, Pacific herring and Arctic cod through highly localized losses of habitat and potential for entrainment in ballast water intakes or in pump water intakes for ice pad construction. Ice road construction for the ice island platform will potentially affect rainbow smelt and Pacific herring at the Pullen North and Tuwak drilling locations through highly localized losses of habitat and potential for entrainment. There may also be some localized effects of under-ice drilling waste disposal on Pacific herring, Arctic cod, flounder and sculpin. Table 14-3 summarizes potential effects and level of effects on these VECs.

Table 14-3 Program Effects on Fish and Fish Habitat

Potential Effect	Interaction with VEC	Level of Effect[1]			Effect Significance[2]	
		Magnitude	Extent	Duration	Program-related Effect	Cumulative Effect
Pre-operations						
Physical disturbance from platform mobilization and setdown	Arctic and least cisco: • ballasting of SDC and LTD at Pullen North and Tuwak Rainbow smelt: • ballasting of SDC and LTD at Pullen North and Tuwak Pacific herring: • ballasting of SDC and LTD at all locations Arctic cod: • ballasting for the SDC and LTD at all locations Arctic and starry flounder and fourhorn sculpin: • Platform setdown and ice pad construction at all locations	Small	Site specific	Short term	Not significant	Not significant

Table 14-3 Program Effects on Fish and Fish Habitat (cont'd)

Potential Effect	Interaction with VEC	Level of Effect[1]			Effect Significance[2]	
		Magnitude	Extent	Duration	Program-related Effect	Cumulative Effect
Pre-operations (cont'd)						
Entrainment during ice pad and ice road construction	Rainbow smelt • ice pad construction for all three platforms at Pullen North and Tuwak • ice road construction for the ice island platform at Pullen North and Tuwak Pacific herring • ice pad construction for all platforms at Pullen North and Tuwak • ice road construction for the ice island platform at Pullen North and Tuwak Arctic cod • ice pad construction for all platforms at all locations • ice road construction for ice island at all locations	Small	Site specific	Short term	Not significant	Not significant
Operations						
Waste disposal affecting water quality	Pacific herring • exposure to drilling wastes Arctic cod • exposure to drilling wastes Arctic and starry flounder and fourhorn sculpin • exposure to drilling wastes	Small	Local	Short term	Not significant	Not significant
Closure						
Physical habitat disturbance and alienation	Dolly Varden, Arctic and least cisco, rainbow smelt, Pacific herring if the platform is stored at Herschel Island	Small	Site specific	Long term	Not significant	Not significant

Notes: 1 Based on criteria in Table 14-1
2 Based on criteria in Section 14.2

14.3 Mitigation Measures

Pacific herring, rainbow smelt, Arctic cod, Arctic cisco and least cisco populations in the LSA may experience a small effect because of entrainment of fish into pump water intakes during ice pad and ice road construction. Devon will work with DFO to evaluate appropriate fish screens for water intakes to reduce, to the extent practical, the potential for entrainment of fish from water withdrawal operations (Table 14-4).

Table 14-4 Mitigation Measures for Effects on Fish and Fish Habitat

Potential Effect	Mitigation Measures
Fish entrainment in water intakes for ice pad and ice road construction	• Devon will work with DFO to evaluate appropriate fish screens for water intakes to reduce, to the extent practical, the potential for entrainment

14.4 Residual Program Effects and Significance

Residual Program effects on fish and fish habitat are expected to be not significant.

14.5 Cumulative Effects and Significance

There are no other known existing or reasonably foreseeable future hydrocarbon-related or other industrial activities in the RSA. The only other activity with known direct effects on fisheries that could act cumulatively with Program-related effects in the RSA is ongoing fishing activities. Fishing activity in the RSA could have the potential to place added stress on VEC fish populations that may be affected by the Program. However, Program effects on fish populations (Table 14-3) are of such a small, localized and short-term nature that when combined with the effects of domestic fishing activity, cumulative effects are still expected to be small, short term and, therefore, not significant.

14.6 Monitoring

Monitoring for fish entrainment during construction of the ice pad in the first year of the Program is recommended to obtain information on the potential for fish entrainment at water intakes during ice pad construction (Table 14-5). This would be accomplished by systematically surveying the ice surface during ice pad construction to detect, measure and enumerate any fish that are inadvertently entrained. Detailed methods will be developed in consultation with DFO. In response to observations of fish being entrained, the location of the intake in the water column may be raised or lowered in an effort to reduce entrainment rates.

Table 14-5 Monitoring and Follow-up Programs for Fish and Fish Habitat

Potential Effect	Program Objectives	General Methods	Reporting	Implementation
Fish entrainment in water intakes for ice pad and ice road construction	A monitoring program to: • Assess fish entrainment • Improve mitigation as appropriate (e.g., screening, intake depths)	• Measure number of fish entrained per cubic metre of water used • Adjust depth of withdrawal location as potential mitigation	• To be determined	Devon
Platform footprint disturbance and waste release	A follow-up program to: • Characterize benthic fish habitat utilization at drill sites in winter • Confirm the accuracy of the effects predictions	• Drop camera and video surveillance of benthic fish and fish habitat at drill sites in winter	• To be determined	DFO in collaboration with Devon and Environment Canada

DFO has recommended that a follow-up study be conducted to address data gaps on benthic fish habitat use during the winter. This Program will be conducted by DFO in collaboration with Devon and Environment Canada. It will involve use of a drop-camera to record observations of benthic fish and fish habitat features at the drill site. Information from this study will help to better characterize habitat utilization in winter and to confirm the accuracy of the effects predictions.

15 Birds

This section examines the potential effects of Program activities on bird populations and their distribution in the Program area.

15.1 Baseline Conditions

Five bird species or groups of species were selected as VECs because they would be most vulnerable to Program effects:

- loons – includes four species that nest on freshwater ponds and lakes but do most of their feeding in marine waters. The Canadian Wildlife Service (CWS) uses the red-throated loon as an indicator species in its studies
- brant goose – a marine species that frequents sea coasts and marine waters in the study area
- sea ducks – marine ducks that nest in the area, including common eider, king eider, and long-tailed duck; sea ducks are hunted by residents of the area for subsistence purposes
- moulting ducks – congregate to moult in coastal waters, bays and behind barrier islands and includes white-winged and surf scoters, and greater and lesser scaup; because they are flightless during the moult, these ducks are thought to be particularly susceptible to disturbance and vulnerable to hydrocarbon spills during that period
- common raven – likely to be the only bird that would be found in the vicinity of the drilling operations in winter

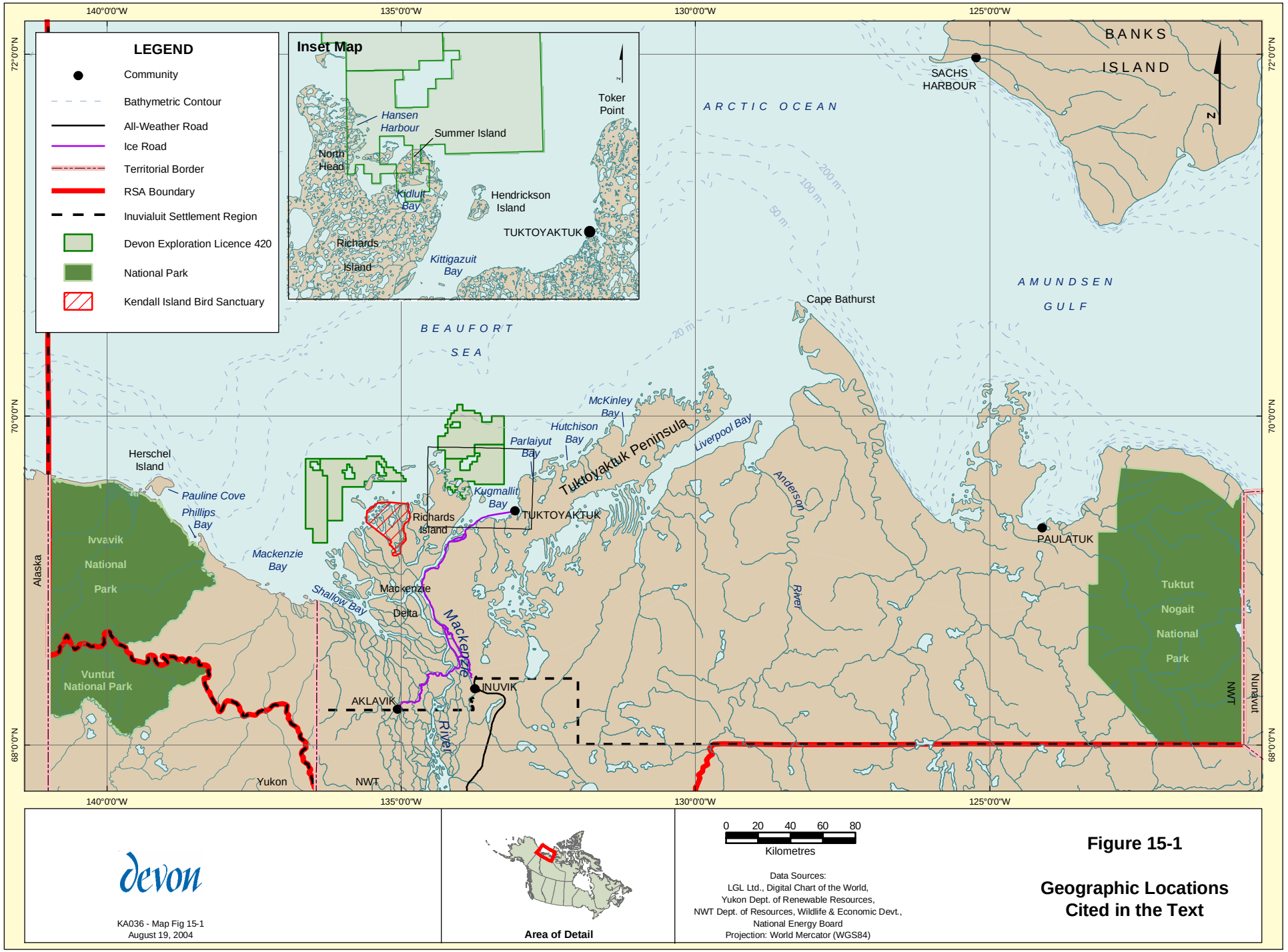
Other common species such as tundra swan, snow goose and greater white-fronted goose that are abundant and are valued by society were not selected as VECs because they are primarily terrestrial and freshwater species that are not dependent upon the marine system.

The local study area (LSA) encompasses all of EL 420, the area between the Eastern and Western Blocks, and the areas between EL 420 and the outer edge of the Mackenzie Delta. This is the area in which most of the open-water activities will occur that could affect marine birds and shorebirds.

The regional study area (RSA) includes all of the marine habitat and coastlines in the area bounded by Phillips Bay in the west, McKinley Bay in the east and out to the 20-m bathymetric contour. This area encompasses all of the important marine bird habitats in the Beaufort Sea region off the Mackenzie Delta that could be affected by Program activities. Figure 15-1 shows the geographic locations of many of these areas.

15.1.1 Loons

Four loon species occur in the region: red-throated loon, pacific loon, common loon and yellow-billed loon.



KA036 - Map Fig 15-1
August 19, 2004

Figure 15-1

Geographic Locations Cited in the Text

Red-throated loons (*Gavia stellata*) use the Beaufort Sea in the RSA throughout the open-water season, from late May/early June through late September. They are common breeders in coastal areas throughout the Beaufort Sea region (Johnson and Herter 1989). Major river deltas (e.g., Babbage and Mackenzie rivers) and offshore leads are important during spring migration (Alexander et al. 1997). After the ice breaks up, red-throated loons frequent nearshore marine waters, especially sheltered bays and lagoons, for feeding, brood rearing, and staging (Alexander et al. 1988). During the surveys conducted by Devon in 2002 (LGL Limited and KAVIK-AXYS Inc. 2004a), the highest numbers of red-throated loons were found in Phillips Bay, along the shoreline of Richards Island, and the islands offshore from the outer Mackenzie Delta.

Pacific loons (*Gavia pacifica*) are common breeders near most of the Beaufort Sea coast, feeding in marine waters during the breeding season and during fall migration (Hawkings 1987; Johnson and Herter 1989; Dickson 1994). However, Alexander et al. (1997) found very few Pacific loons in recurrent offshore leads during spring migration. In the RSA, Pacific loons feed and stage in low densities in Phillips, Parlaiyut, and McKinley Bays and offshore from Toker Point to Hutchison Bay (Alexander et al. 1988; Dickson et al. 1988). During baseline studies, Pacific loons occurred in lower densities in marine areas than did red-throated loons (LGL Limited and KAVIK-AXYS Inc. 2004a).

Common loons (*Gavia immer*) are very uncommon breeders in most of the Beaufort Sea area (Johnson and Herter 1989). Very few common loons were recorded during baseline surveys in late June to early September 2002; most were seen in Phillips Bay (LGL Limited and KAVIK-AXYS Inc. 2004a).

The yellow-billed loon (*Gavia adamsii*) is a circumpolar Arctic loon species that is an uncommon breeding bird in the Beaufort Sea region. It uses marine waters during migration and during the summer (Johnson and Herter 1989). Spring surveys of offshore leads by Alexander et al. (1997) indicated that most yellow-billed loons in the southern Beaufort Sea occurred east of Tuktoyaktuk, off western Banks Island and in the Lambert Channel Polynya (in Dolphin and Union Strait off southwestern Victoria Island). Very few yellow-billed loons were seen during baseline surveys conducted by Devon in 2002. Six were seen in McKinley Bay in June, one near northeast Richards Island in July, and two in Phillips Bay and along the Yukon coast in August (LGL Limited and KAVIK-AXYS Inc. 2004a).

15.1.2 Brant

The brant (*Branta bernicla*) is a circumpolar marine goose that is a common migrant and common breeder in the Beaufort Sea area (Johnson and Herter 1989). Brant nest and rear broods at several sites along the Yukon coast, on islands offshore from the Mackenzie Delta, on Richards Island, and along the Tuktoyaktuk Peninsula (Alexander et al. 1988; Wiebe and Hines in prep.). The tidal flats in Phillips Bay, designated as an Important Bird Area (IBA 2002, Internet site), support globally significant numbers of staging brant in their westward migration (Koski 1977; IBA 2002, Internet site). Small numbers of brant were scattered in the RSA during field surveys carried out for this Program during June to early September 2002 (LGL Limited and KAVIK-AXYS Inc. 2004a).

15.1.3 Sea Ducks

Three sea duck species of interest occur in the region: common eider, king eider and long-tailed duck. During spring in the Beaufort Sea, offshore open-water leads at the edge of landfast ice are very important for several species of waterfowl, particularly common eiders, king eiders and long-

tailed ducks (Johnson et al. 1975; Richardson et al. 1975; Woodby and Divoky 1982; Johnson and Herter 1989).

The common eider (*Somateria mollissima*) is abundant in the Beaufort Sea region (Johnson and Herter 1989). Large numbers migrate through the southern Beaufort Sea in spring on their way to breeding grounds in the central Arctic.

The king eider (*Somateria spectabilis*) is also abundant in the Beaufort Sea region (Johnson and Herter 1989) as they migrate to breeding grounds in the central Arctic. No significant spring concentrations of king eiders have been identified in the RSA. During field surveys carried out for the Program during late June to early September 2002, only small numbers of eiders were present along the Yukon coast, the outer Mackenzie Delta and Richards Island (LGL Limited and KAVIK-AXYS Inc. 2004a).

The long-tailed duck (*Clangula hyemalis*) occurs on Beaufort Sea waters during spring as migrants, during June as non-breeding birds and failed breeders, during July and August as moulting birds and during August and September as staging and migrating birds (Alexander et al. 1988). This species is also an abundant breeder in the Beaufort Sea region (Johnson and Herter 1989). Hutchison Bay and McKinley Bay, both east of the Eastern Block of EL 420, are high-use areas for moulting long-tailed ducks and for moulting ducks in general (Alexander et al. 1988). Moderate-use areas for moulting long-tailed ducks include Phillips Bay, the small bays on the coastline of Richards Island and Parlaiyut Bay to the southwest of Hutchison Bay (Alexander et al. 1988). Baseline field surveys found small numbers in Phillips Bay, along the Yukon coast, the outer Mackenzie Delta and Richards Island during June to September 2002 (LGL Limited and KAVIK-AXYS Inc. 2004a). The long-tailed duck was one of the few species that was observed during surveys of the Eastern Block of EL 420.

15.1.4 Moulting Ducks

Four species of waterfowl that moult in the RSA were considered VECs: greater scaup, lesser scaup, surf scoter and white-winged scoter.

Both greater scaup (*Aythya marila*) and lesser scaup (*Aythya affinis*) occur in the LSA and RSA. However, the greater scaup is the one most likely to interact with the drilling Program. The greater scaup is a common breeder in the Beaufort Sea area (Johnson and Herter 1989). Scaup arrive in the Beaufort Sea region when freshwater water bodies thaw, approximately late May to early June. Greater scaup leave breeding and moulting areas of northwestern Canada by mid-September to late October (Kessel et al. 2002). Scaup moult in several protected bays in the RSA. Small numbers moult in Phillips, Hutchinson and McKinley bays, although flocks in McKinley Bay are large in some years (Alexander et al. 1988; Cornish et al. 1991). Bays on the northeast end of Richards Island, from Hansen Harbour to Kidluit Bay, are important to moulting scaup and large numbers use Parlaiyut Bay, between Toker Point and Hutchison Bay. Baseline surveys conducted by Devon in 2002 found moulting scaup distributed throughout the RSA (LGL Limited and KAVIK-AXYS Inc. 2004a).

Surf scoters (*Melanitta perspicillata*) are common migrants on the Beaufort Sea coast and common breeders in the Mackenzie Delta (Johnson and Herter 1989). White-winged scoters (*Melanitta fusca*) are common migrants along the coast of the Beaufort Sea and common breeders in the forested part of the Mackenzie Delta (Johnson and Herter 1989). White-winged scoters are found in spring floe-edge leads by the thousands in mid- to late-June just west and east of the Mackenzie Delta (Alexander et al. 1997). Scoters are generally uncommon in the RSA until males begin arriving in late June prior to their moult (Alexander et al. 1988). Thousands of scoters then gather in Hutchison and McKinley Bays, and sometimes along the coast between these two bays

(Alexander et al. 1988; Cornish et al. 1991). During the baseline surveys conducted by Devon, surf and white-winged scoters were very common from June through August (LGL Limited and KAVIK-AXYS Inc. 2004a). Scoters were the only group that was common on the offshore transects.

15.1.5 Common Raven

The common raven (*Corvus corax*) is the one bird species that is likely to be present around the drilling operation during the winter. It is a common winter resident in northern communities, such as Inuvik. Small numbers of individuals and pairs were observed during field surveys carried out for the Program in late June to early September 2002 (LGL Limited and KAVIK-AXYS Inc. 2004a).

15.2 Impact Assessment

Impacts are characterized in terms of the following effects on bird habitats and populations:

- change in the abundance or distribution of VECs
- change in the distribution or abundance of the prey species and/or habitats used by VECs
- change in Inuvialuit hunting activities

Because most birds are not present in the Program area during the winter ice-covered period, interactions are only likely to occur during the pre-operations mobilization period and at spring breakup, following winter drilling operations when platforms are in cold shut-down.

The assessment is based on worldwide experience of the response of sea-associated birds to marine and aircraft traffic. Based on this experience, qualitative assessments of the likely risk were made and direction, magnitude, geographic extent and duration of potential effects are characterized using the criteria in Table 15-1.

An effect is significant if it satisfies all of the following criteria:

- the rating for magnitude is high, the extent is regional or subregional, and the duration is medium or long term; a moderate effect would also be significant if it was regional or subregional, and if it was long term
- the VEC displays one or more of the following characteristics: low abundance, high likelihood of interaction with Program, special status or highly valued locally
- impacts cannot be mitigated to the satisfaction of the regulatory agencies or Inuvialuit co-management groups and
- the effect is predicted to remain at closure and continue to adversely affect the VEC

An effect is generally considered not significant if the ratings for magnitude, duration and extent of impact are low and effects can be mitigated to the satisfaction of the regulatory agencies or Inuvialuit co-management groups.

A number of Program activities could affect bird VECs:

- presence of structures
- lights and flaring (assuming natural gas is found and testing proceeds)
- under-ice discharge of drilling mud and cuttings
- under-ice discharge of other fluids and solids
- atmospheric emissions

- marine transport, including noise
- air transport, including noise

Table 15-1 Effect Attributes for Birds

Direction	
Positive	Change in the VEC is perceived as beneficial
Neutral	Change in the VEC is not detectable
Negative	Change in the VEC is perceived as detrimental
Magnitude	
Negligible	Impacts would result in very minimal or no effects on population levels, habitat carrying capacity or both
Low	Impacts would be restricted to a less than 1% change in either or both population levels and habitat carrying capacity, or only slightly affect the subsistence resource involved
Moderate	Impacts would result in a 1% to 10% change in either or both population levels and habitat carrying capacity, or noticeably affect the subsistence resource involved; impacts would be socially tolerated
High	Impacts would result in a greater than 10% change in either or both population levels and habitat carrying capacity, or affect the subsistence resource to an extent that is not socially tolerated
Geographic Extent	
Local	Impacts are limited to the Program footprint or immediate area of the Program activities (within 1 km)
Subregional	Impacts may extend beyond the limits of the Program operations but are limited to the Program vicinity (1 km to 50 km from the Program activities)
Regional	Impacts may extend beyond 50 km from the Program activities to the entire region, defined as extending from Phillips Bay in the west to McKinley Bay in the east
Duration	
Immediate	Impact duration is limited to two days or less
Short term	Impact duration is longer than two days but less than one year
Medium term	Impact duration is one year or longer but less than ten years
Long term	Impact duration extends ten years or longer

Program effects on birds are summarized in Table 15-2. The presence of structures, lights, and flares are expected to have minimal effects on birds. The SDC or LTD will occupy a small area and the effects of lost habitat would be negligible. During the winter, when lights would be most obvious and flaring might occur, the only bird species likely to be present is the common raven. This species readily adapts to the presence of lights in an otherwise dark environment, as evidenced by their presence around towns throughout the north during winter. Similarly, it is expected that very few birds would be affected by late-season flaring (late March to late May). This is because the probability of flaring when birds will be present is low, the duration of flaring periods is brief (hours), there is little darkness during May, and the fatal attraction of birds to lights at night affects primarily songbirds, not the waterbirds that are the primary offshore migrants during May. Therefore, the effects on birds from structures, lights, and flares are expected to be not significant.

The under-ice discharge of drilling muds, cuttings, and other fluids and solids (e.g., grey water, sewage, reverse osmosis reject water, miscellaneous wash water) are not expected to affect birds. Because the drilling waste will be discharged under the ice, there will be no opportunity for over-wintering birds such as ravens to interact with the waste. Given that all cuttings and muds will meet the NEB guidelines for disposal (NEB et al. 2002) (Section 11: Chemical Oceanography), there will be little or no risk of oiling or contaminant effects following breakup. In addition, because wastes are predicted to have no significant effects on plankton, benthos or fish (Sections 12, 13 and 14), no measurable effects on feeding habitat for marine birds are expected. Solid waste

management measures (incineration, storage of ash for landfill disposal) will minimize attraction of ravens.

Air emissions are predicted to be small and will rapidly disperse to undetectable levels. Most of the emissions will occur from flaring during ice-cover conditions when few birds are present.

Although ship movements will occur during the open-water season, when the marine bird VECs are present, noise and disturbance associated with routine offshore activities of towing vessels and barges will only affect a localized area for a short period of time (i.e., a transitory effect). Thus, ship movement effects on marine birds are expected to be not significant.

Overflights from smaller fixed wing aircraft and helicopters (e.g., Jet Rangers®) during platform mobilization are expected to have minimal effects on birds. Devon will establish flight paths in discussion with the HTCs and Inuvialuit co-management bodies. Considerations will include avoidance of concentrated bird nesting areas and sanctuaries during sensitive life stages (Table 15-3). To reduce disturbance to birds and other wildlife, all aircraft associated with the Program will maintain an altitude of at least 600 m (2000 ft) above ground level whenever weather permits. Bird responses to aircraft at these altitudes are minimal.

Barge staging for the ice island platform could cause temporary displacement of a very small amount of coastal habitat in the fall and early spring until the barges can be removed to another site. Sensory disturbances of birds should be limited, because barges will be moored at some distance from the shoreline, and once they are anchored and secured, human activities around the barges will be minimal (i.e., security). Site selection for barge staging areas will include discussions with the HTCs, Inuvialuit co-management agencies and Northwest Territories resource management agencies. The selected site will avoid any sensitive shoreline habitat areas.

Table 15-2 Program Effects on Birds

Potential Effect	Interaction with VEC	Level of Effect[1]				Effect Significance[2]	
		Direction	Magnitude	Extent	Duration	Program-related Effect	Cumulative Effect
Pre-operations							
Noise and disturbance from marine vessel movements	Birds can escape by flying or diving; they are adapted to marine vessel noise; there are only a few coastal nesting colonies and ships will remain well away from shore	Negative	Negligible	Local	Immediate	Not significant	Not significant
Presence of SDC and LTD platform structures	Bird habitat would be temporarily removed by platform	Negative	Negligible	Local	Short term	Not significant	Not significant
Disturbance of birds by aircraft overflights	Flight paths and altitudes will be selected to minimize potential effects	Negative	Negligible	Local	Immediate	Not significant	Not significant

Table 15-2 Program Effects on Birds (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 (cont'd)							
Effect of barge staging for ice island platform on coastal bird habitat	• Barges will be away from the shore; sites will be selected with HTCs and wildlife management agencies	Negative	Negligible to low	Local	Short term	Not significant	Not significant
Operations							
Lights and flares	• Only ravens present or early spring migrants (waterbirds) where the risk of interaction is very small	Negative	Negligible	Local	Short term	Not significant	Not significant
Food wastes attracting birds	• Incineration and storage of ash for on-land disposal will minimize effects	Negative	Negligible	Local	Short term	Not significant	Not significant
Under ice waste release	• No significant effects on water or benthic invertebrate food sources (Section 11: Chemical Oceanography/ Section 13; Benthos); therefore, effects on birds are expected to be not significant	Negative	Negligible	Local	Short term	Not significant	Not significant
Air emissions during flaring	• Few birds present during flaring and effects on ambient air quality are localized (Section 6: Air Quality)	Negative	Negligible	Local	Immediate	Not significant	Not significant
Closure							
Effect of platform storage	• Bird habitat would be removed by platform storage (LTD and SDC) • Regulatory approvals will ensure minimal impact	Negative	Negligible	Local	Unknown	N/A	N/A

Notes: 1 Based on criteria in Table 15-1
2 Based on criteria in Section 15.2.
N/A = not applicable

15.3 Mitigation Measures

Mitigation measures for potential effects on birds are summarized in Table 15-3. Devon will develop a wildlife protection plan in conjunction with its spill contingency plan (Section 2.12.3: Safety and Environmental Plans). This will include specific measures to track bird distributions and possible spill areas, deter birds from any spill areas (should a spill occur) and implement recovery plans for oiled birds.

Table 15-3 Mitigation Measures for Effects on Birds

Potential Effect	Mitigation Measures
• Disturbance from vessel movements (supply barges and towing vessels for SDC and LTD during pre-operations)	• Vessels to maintain straight course and constant speed as much as possible
• Disturbance from a small number of helicopter flights to and from platforms (SDC and LTD) during pre-operations	• Identification of flight routes and minimum altitudes (600 m whenever possible) in consultation with HTCs, Inuvialuit co-management bodies and territorial and federal resource managers • Prohibition of low level flights for wildlife viewing
• Disturbance and habitat loss from barge staging area for ice island during pre-operations	• Selection of staging sites in consultation with HTCs, Inuvialuit co-management bodies and territorial resource managers
• Solid and liquid waste disposal during operations • Under-ice drilling waste release to sea	• Incineration of solid wastes and storage for landfill disposal • Compliance with Offshore Waste Treatment Guidelines (NEB et al. 2002) • Refer also to Section 11: Chemical Oceanography
• Habitat loss from SDC or LTD drilling platform storage at closure	• Regulatory approval process, including storage site selection to minimize impacts

If, at closure, it is necessary to store the SDC or LTD platforms in the region, Devon will select a preferred location with consideration for minimizing biophysical effects and consistent with appropriate regulatory requirements (Section 2.8: Program Activities).

15.4 Residual Program Effects and Significance

Most residual effects associated with routine operations during the drilling Program are rated as negligible, with the highest residual effects being rated as low, short term and local (i.e., temporary and localized habitat displacement because of barge staging during the late summer to fall). Thus, residual Program effects on birds are expected to be not significant.

15.5 Cumulative Effects and Significance

The combined effects for routine operations during all four years of drilling are the same as for each year individually because there are essentially no residual effects on birds in each year.

There are no significant residual Program effects and no other known existing or reasonably foreseeable future drilling programs or offshore industrial activities that will overlap with the Devon Program and have the potential to affect marine birds. Cumulative effects of the Program on birds are, therefore, expected to be not significant.

15.6 Monitoring

An Inuvialuit wildlife monitor will be on board during platform mobilization to ensure mitigation measures are implemented and to monitor Program activities. A protocol will be developed for use by the wildlife monitor that will include systematic daily observations of birds near the drill platform and other activity areas, as well as methods to track implementation and effectiveness of the recommended mitigation and protection measures. Devon is also prepared to support additional studies with government and co-management agencies on specific species where data gaps exist (e.g., spring distribution and abundance for sea ducks). Given that the expected Program-specific and cumulative effects of the Program on birds are not significant, no further monitoring programs are recommended.

Table 15-4 Monitoring and Programs for Birds

Potential Effect	Program Objectives	General Methods	Reporting	Implementation
Disturbance of birds and bird habitat due to vessel movements, aircraft and barge staging during pre-operations	Verify impact predictions Confirm the effectiveness of mitigation measures	On-site Inuvialuit wildlife monitor to ensure mitigation measures are implemented and to observe mitigation effectiveness.	• Annual • Distribute report to Inuvialuit co-management agencies	Devon
	Determine spring distribution and abundance for particular species of concern	Support to additional data collection on species where data gaps exist (e.g., sea ducks)	• Annual • Distribute report to Inuvialuit co-management agencies	Joint program – industry/ government/co-management agencies (e.g., Environmental Studies Research Fund)