5.0 Effects Assessment of Routine Activities

This effects assessment is organized in the following manner. First, assessment methodology is described in detail, including the approach that was used to focus the assessment geographically. Then, potential effects of the environment on the Project are assessed, followed by the potential effects of routine activities on the environment. Potential effects from accidental spills are predicted in Section 6.0. The assessment concludes with a summary of mitigations, cumulative effects and residual effects (Section 7.0).

5.1. Assessment Methodology

Two general types of effects are considered in this document:

1. Effects of the environment on the Project; and
2. Effects of the Project on the environment, particularly the biological environment.

Methods of effects assessment (e.g., VEC selection, definitions of effects, etc.) used here are generally comparable to those used in the Hibernia EIS (Mobil 1985), the Terra Nova EIS (Petro-Canada 1996a,b), the White Rose Oilfield Development EA and Comprehensive Study and associated supplement (Husky 2000, 2001), Jeanne d'Arc Basin Drilling EAs (Husky 2002; LGL 2006), the Orphan Basin SEA (LGL 2003), the Orphan Basin Seismic EA (Buchanan et al. 2004), associated update (Moulton et al. 2005a) and Drilling EA (LGL 2005), and the Laurentian Sub-basin seismic EAs (Buchanan et al. 2004; Christian et al. 2005). These documents conform to the *CEAA* and its associated Responsible Authority's Guide and *CEAA* Operational Policy Statement (OPS-EPO/5-2000) (CEA Agency 2000). Guidance was also provided by the C-NLOPB Scoping Document, a draft of which was circulated to relevant government agencies and the public for comment. Cumulative effects are assessed in accordance with *CEAA* (CEA Agency 1994) and as adapted from Barnes and Davey (1999) and the White Rose EA.

5.1.1. Scoping

Under *CEAA*, the C-NLOPB is the Responsible Authority and thus is responsible for the scope of the EA. The Project is assessed under a screening level EA.

Scoping of an environmental assessment mainly includes determining the spatial and temporal boundaries of the assessment, selecting which components (i.e., sensitive and/or representative species or species-groups and associated habitats) of the ecosystem to assess, and which project activities to analyze. Input was sought from relevant government agencies such as the CEA Agency, Fisheries and Oceans (DFO), Environment Canada (EC), other government departments, and the public. Scoping involves:

- Review of all relevant information on project activities and literature on the effects of offshore oil and gas drilling activities (with emphasis on previous EAs for Newfoundland and Labrador waters),
- Stakeholder and regulatory consultations at various stages of the assessment.

5.1.2. Valued Ecosystem Components (VECs)

The Valued Ecosystem Component (VEC) approach was used to focus the assessment on those biological resources of most potential concern and/or value to society. VECs were identified based on previous East Coast offshore EAs, DFO and EC comments, and consultations with stakeholders and regulators. The results of the White Rose issue scoping sessions, public and agency consultations, and Commission hearings were also considered in identifying the VECs for assessment.

The VECs were also selected based upon expressed public comments related to social, cultural, economic, or aesthetic values and scientific community concerns. From a local perspective, most concern for offshore drilling is related to the fishery or seabirds. National and international issues may include such groups as deep sea corals and marine mammals. The VECs and their respective rationales include:

- **Fish and Fish Habitat.** The fish and fish habitat upon which the commercial fishery is based are typical VECs. Fish habitat is very broadly defined here to include such components as water quality, plankton and benthos (including invertebrates such as deep sea corals). Fish VECs are of prime concern from both a public and scientific perspective, locally, nationally and internationally. Individual species were selected to represent the fish VEC, as in most cases, species can be grouped according to lifestyle and sensitivities (see Section 4.6). The commercial and *SARA* species previously profiled in this EA (e.g., snow crab, red fishes, Atlantic cod, wolffishes) (Section 4.6) are all representative species for the effects assessment.

- **Commercial Fishery.** The commercial fishery is a universally acknowledged and important element in the societal, cultural, economic and aesthetic environment of Newfoundland and Labrador. This VEC is of prime concern from both a public and scientific perspective, locally, nationally and internationally.

- **Marine Birds**. Newfoundland supports some of the largest seabird colonies in the world and Newfoundland waters host very large populations during all seasons. They are important socially, culturally, economically, aesthetically, ecologically and scientifically. Seabirds are a key component near the top of the food chain and are an important resource for bird watching (one of the fastest growing outdoor activities in North America), the tourist industry, local hunting, and scientific study. In addition, this VEC is more sensitive to oil on water than other VECs. This VEC is of prime concern from both a public and scientific perspective, locally, nationally and internationally.

- **Marine Mammals**. Whales and seals are key elements in the social and biological environments of Newfoundland and Labrador. The economic and aesthetic importance of whales is demonstrated by the large number of tour boats that feature whale watching as part of a growing tourist industry. Public concern about whales is evident in the media. Historically, seals have played an important economic and cultural role due to the large annual seal hunt. Newfoundland and Labrador is an internationally recognized location for marine mammal scientific research. This VEC is also of prime concern from both a public and scientific perspective, locally, nationally and internationally.

- **Sea Turtles**. While sea turtles are scarce in Newfoundland waters in general, they attain status of a VEC because of their endangered and threatened status in Canada, the United States and elsewhere. Of the three species potentially present in the area, two are considered endangered and one threatened. While they are of little or no economic, social or cultural importance to Newfoundland and Labrador, their status ensures local, national, and international scientific attention beyond their likely ecological importance to the Laurentian sub-basin ecosystem.

- **Species at Risk**. "Species at Risk" are those listed as endangered or threatened on Schedule 1 of the *Species at Risk Act* (*SARA*). All Species at Risk in Newfoundland and Labrador offshore waters are captured in the five VECs listed above. However, they are also discussed separately because of their rarity and the necessary due caution that must be exercised during the exploration drilling program activities.

5.1.3. Boundaries

Boundaries have been defined using CEA Agency (2003) as guidance.

5.1.3.1. Temporal

Effects have been assessed for a multi-year exploration drilling program (2007 to the end of the licenses) including abandonment of wells in the Laurentian Sub-basin. Effects that could continue after abandonment have also been included. In addition, effects of accidental events were considered. Temporal boundaries are 'year-round' because exact timing of drilling is unknown at present.

5.1.3.2. Spatial

This EA refers to four types of areas as defined by the following boundary terminology. From a *CEAA* perspective, the Study Area is the key definition because it is this area that has been assessed for all potential effects of the Project.

Project Area. The Project Area has been defined broadly to encompass the five exploration licenses of interest (see Figure 1.1) because exact locations of future wells are not known. In reality, and excluding potential major accidental events, Project activities will likely only encompass a few square kilometres per year.

Study Area. The Study Area (Figure 1.1) has been defined to encompass the farthest extent of the Project's potential zone of influence. A large accidental spill or blowout represents the "worst case" scenario and its geographic "envelope" was defined by modelling. [Accidental events are covered in detail in Section 6.0.] For the purposes of defining a Study Area, an "envelope" of a potential zone of influence for a major spill that could occur anywhere in the Project Area was based on the Project Area plus "belts" of 10 km to the west, 40 km to the north and east, and 60 km to the south and southwest. The shape and width of the belts is based upon the maximum distance that could receive a petroleum hydrocarbon concentration of 0.1 ppm (the concentration often used to determine a threshold of biological effects—e.g., Husky 2000, 2001; JWEL 2003) based upon spill fate and behaviour modeling (see Section 6.0) and surface water current patterns.

Affected Area (s). The Affected Area (s) is the geographic area of specific effects on a species, species group, or their habitats. It varies according to the timing and type of Project activity in question and the sensitivities of the species/habitat being assessed. Thus, there are many affected areas (also referred to as "geographic extents") defined and used in this EA.

Regional Area (s). The Regional Area (s) is defined very loosely and varies with the physical and environmental components being discussed. This definition is useful in focusing the regional descriptions and discussions of both physical and biological environmental variables that vary on very large scales and are often reported on very large scales (e.g., currents, ice and icebergs, climate, plankton, benthos and fisheries, etc.).

5.1.4. Effects Assessment Procedures

The systematic assessment of the potential effects of the Project involved three major steps:

1. Preparation of interaction matrices (between Project activities and the environment);
2. Identification and evaluation of potential effects including description of mitigation measures and residual effects; and
3. Preparation of residual effects summary tables, including evaluation of cumulative effects.

5.1.5. Identification and Evaluation of Potential Effects

Interaction matrices were prepared that identify all possible Project activities that could interact with any of the VECs. The matrices include times and places where interactions could occur. The interaction matrices are used only to identify potential interactions; they make no assumptions about the potential effects of the interactions. Interactions were then evaluated for their potential to cause effects. In instances where the potential for an effect of an interaction was deemed impossible or extremely remote, these interactions were not considered further. In this way, the assessment could focus on key issues and the more substantive environmental effects.

An interaction was considered to be a potential effect if it could change the abundance or distribution of VECs, or change the prey species or habitats used by VECs. The potential for an effect was assessed by considering:

- The location and timing of the interaction;
- The existence of any pathways between the project activity and the receiving environment;
- Modelling exercises;
- The literature on similar interactions and associated effects (including the previous drilling EAs for Offshore Nova Scotia and Newfoundland and Labrador);
- When necessary, consultation with other experts; and
- Results of similar effects assessments and especially, monitoring studies done in other areas.

When data were insufficient to allow certain or precise effects evaluations, predictions were made based on professional judgement. In such cases, the uncertainty is documented in the EA. For the most part, the potential effects of offshore oil developments are reasonably well known. Effects were evaluated for the proposed exploratory drilling program, which includes many mitigation measures that are mandatory or have become standard operating procedure in the industry.

5.1.6. Classifying Anticipated Environmental Effects

The concept of classifying environmental effects simply means determining whether they are negative or positive. The following includes some of the key factors that are considered for determining adverse environmental effects, as per the CEA Agency guidelines (CEA Agency 1994):

- Negative effects on the health of biota;
- Loss of rare or endangered species;
- Reductions in biological diversity;
- Loss or avoidance of critical/productive habitat;
- Fragmentation of habitat or interruption of movement corridors and migration routes [It can be argued that while this is relevant for some terrestrial EAs, it is not as relevant to open offshore waters where there are no confined corridors or routes.];
- Transformation of natural landscapes;
- Discharge of persistent and/or toxic chemicals;
- Toxicity effects on human health;
- Loss of, or detrimental change in, current use of lands and resources for traditional purposes;
- Foreclosure of future resource use or production; and
- Negative effects on human health or well-being.

5.1.7. Mitigation

Most significant effects can be mitigated by standard operating procedures, regulatory requirements or project-specific changes in equipment, procedures, timing of activities or other measures. Mitigation measures appropriate for each effect predicted in the matrix were identified and the “residual” or remaining potential effects of various Project activities were then evaluated assuming that appropriate mitigation measures are applied.

5.1.8. Application of Evaluation Criteria for Assessing Environmental Effects

Several criteria were taken into account when evaluating the nature and extent of environmental effects. These criteria include (CEA Agency 1994):

- Magnitude;
- Geographic extent;
- Duration and frequency;
- Reversibility; and
- Ecological, socio-cultural and economic context.

Magnitude describes the nature and extent of the environmental effect for each activity. Geographic extent refers to the specific area (km^2) affected by the Project activity, which may vary depending on the activity and the relevant VEC. Duration and frequency describe how long and how often a project activity and/or environmental effect will occur. Reversibility refers to the ability of a VEC to return to an equal, or improved condition, at the end of the project. The ecological, socio-cultural and economic context describes the current status of the area affected by the project in terms of existing environmental effects. A table is provided for each VEC, indicating the results of the effects analysis.

Magnitude was defined as:

Negligible	An interaction that may create a measureable effect on individuals but would never approach the 10% value of the ‘low’ rating. Rating = 0.
Low	Affects >0 to 10 percent of individuals in the affected area (e.g., geographic extent). Effects can be outright mortality, sublethal or exclusion due to disturbance. Rating = 1.
Medium	Affects >10 to 25 percent of individuals in the affected area (see geographic extent). Effects can be outright mortality, sublethal or exclusion due to disturbance. Rating = 2.

High Affects more than 25 percent of individuals in the affected area (e.g., geographic extent). Effects can be outright mortality, sublethal or exclusion due to disturbance. Rating = 3.

Definitions of magnitude used in this EIS have been used previously in numerous offshore oil-related environmental assessments under *CEAA* over the last 10 years. These include assessments of exploratory, delineation and development drilling (Petro-Canada 1996a,b; Husky 2000, 2001, 2002; LGL 2003, 2005).

Durations are defined as:

1 = < 1 month
2 = 1 – 12 month
3 = 13 – 36 month
4 = 37 – 72 month
5 = > 72 month

Short duration can be considered 12 months or less and medium duration can be defined as 13 to 36 months. For the purposes of assessing duration and frequency, two wells per year were used. It is estimated that each well will take about 80 days to drill (including mobilization and de-mobilization on site) plus 20 days to test (if it occurs) although this can be variable. However, again it should be noted that only one initial well is planed. [On the other hand, it is remotely possible that as many as four wells could be drilled in one year.]

Project criteria used to aid in determining frequency and duration are shown in Table 5.2 in Section 5.3.

5.1.9. Cumulative Effects

Projects and activities considered in the cumulative effects assessment included:

- Drilling program within-project cumulative impacts. For the most part, and unless otherwise indicated, within-project cumulative effects are fully integrated within this assessment;
- Hibernia, Terra Nova, White Rose (existing offshore oil developments);
- Other offshore oil exploration activity (seismic surveys and exploratory drilling);
- Commercial fisheries;
- Marine transportation (tankers, cargo ships, supply vessels, naval vessels, fishing vessel transits, etc.); and
- Hunting activities (marine birds and seals).

5.1.10. Integrated Residual Environmental Effects

Upon completion of the evaluation of environmental effects, the residual environmental effects (effects after project-specific mitigation measures are imposed) are assigned a rating of significance for:

- Each project activity or accident scenario;
- Cumulative effects of project activities within the Project; and
- Cumulative effects of combined projects in the Laurentian Sub-basin and the Grand Banks.

These ratings are presented in summary tables of residual environmental effects. The last of these points considers all residual environmental effects, including project and other-project cumulative environmental effects. As such, this represents an integrated residual environmental effects evaluation.

The analysis and prediction of the significance of environmental effects, including cumulative environmental effects, encompasses the following:

- Determination of the significance of residual environmental effects;
- Establishment of the level of confidence for the prediction; and
- Evaluation of the likelihood of a predicted significant effect occurring and the scientific certainty and probability of occurrence of the residual impact prediction.

Ratings for level of confidence, probability of occurrence, and determination of scientific certainty associated with each prediction are presented in the tables of residual environmental effects. The guidelines used to assess these ratings are discussed in detail in the sections below.

5.1.11. Significance Rating

Significant environmental effects are those that are considered to be of sufficient magnitude, duration, frequency, geographic extent, and/or reversibility to cause a change in the VEC that will alter its status or integrity beyond an acceptable level. Establishment of the criteria is based on professional judgment, but is transparent and repeatable. In this EA, a *significant* effect is defined as:

> *Having a high magnitude or medium magnitude for a duration of greater than one year and over a geographic extent greater than 100 km*^{2}

An effect can be considered *significant*, *not significant*, or *positive*.

5.1.12. Level of Confidence

The prediction of the residual environmental effects is based on a review of relevant literature, consultation with experts, and professional judgment. In some instances, making predictions of potential residual environmental effects is difficult due to the limitations of available data. Ratings are therefore provided to indicate, qualitatively, the level of confidence for each prediction.

5.1.13. Likelihood of Occurrence of Significant Effects

As per Husky (2000, 2001, 2002), the following criteria for the evaluation of the likelihood of significant effects are used.

- Probability of occurrence; and
- Scientific certainty.

5.2. Effects of the Environment on the Project

5.2.1. Physical Environment

The physical environment is described in detail in Section 3.0. Effects of the physical environment on the Project include those caused by geohazards, wind, ice, waves, temperatures and currents. These effects may differ somewhat by rig type. For example, bottom-founded rigs (e.g., jack-ups) are stable under all conditions whereas floating systems (e.g., semi-subs, drillships) are subject to heaving due to wave action, although DP rigs probably less so than anchored rigs. All rigs are constrained by ice but most can disconnect and move away albeit using different procedures and different environmental criteria. A floating rig may be more affected by surface currents and not by bottom type whereas a jack-up may be more affected by bottom currents and bottom substrate type. On the other hand, a floating rig would be relatively immune to a major slumping event such as the 1929 event.

Aside from the obvious concerns associated with extreme wind and wave events, ice poses some environmental and safety concerns affecting oil and gas operations in the Laurentian Sub-basin (Section 3.7).

Iceberg densities are considerably lower in the Laurentian Sub-basin compared to the Grand Banks (Section 3.11). Icebergs will be managed by surveillance, an early warning system, and by towing. In addition, the proposed rig type will be able to safely disconnect and move off site relatively quickly, if required.

Freezing precipitation is of concern because it can affect personnel and structural safety. Accumulations of ice may create slippery decks and cause falls and in extreme cases can affect vessel stability. Precise data on expected icing conditions in the Laurentian Sub-basin were not available at time of writing this EA. Freezing precipitation in the Newfoundland and Labrador area is most likely to occur from March to April (Petro-Canada 1996). Accumulations of ice on structures may be due to precipitation, condensation or sea spray and are highly related to air temperature, wind speed, diameter of surfaces, and other factors. Icing conditions in the Laurentian Sub-basin may not be as severe as on the northern

Grand Banks but in any event, the Operators will manage risk through forecasting, close monitoring of conditions, and adherence to documented and proven safety procedures.

5.2.2. Biological Environment

The biological environment can also affect the Project's efficiency, vessel stability, and safety through biofouling of water intakes, and vessel and rig undersides. Mud systems can also become contaminated with bacteria. These effects will be minimized through regular inspections and cleaning.

5.2.3. Anthropogenic Environment

Contaminated environments may also create effects on worker health and safety. The Laurentian Sub-basin, while at the mouth of the St. Lawrence river system that drains through North America's industrial heartland, can be considered to be relatively uncontaminated as evidenced by commercial fisheries that are approved there. However, there is a known munitions dumpsite in EL 1087 (discussed below) that will be evaluated prior to any drilling activities. The effects of other human activities are considered in the cumulative effects.

Information contained in the Strategic Environmental Assessment (SEA) Laurentian Sub-basin Report (November 2003) indicates the presence of a munitions dump site, known as the Laurentian Fan dump site, located on the south eastern edge of EL 1087. The dump site is approximately 10 nautical miles by 10 nautical miles and located at 44° 40' N and 55° 0' W (SEA, JWEL 2003)

Although discussions have taken place with relevant personnel at DND to ascertain what, if any, UXOs may have been dumped at this location, at the present time, there is no documented evidence of whether any munitions or dangerous chemicals have been dumped. DND did confirm that a project was recently completed to survey known munitions dump sites, however the Laurentian Fan site was not surveyed.

Other information obtained from DND, Formation Safety and Environment department, also indicates the presence of a Second World War torpedoed merchant ship, (Empire Sailor) within the EL at a location of 43° 53' N and 55° 12' W (obtained from chart 4047). The ship, when sunk, was known to have been carrying explosives and chemicals, which included 270 tons of phosgene bombs and 26 tons of concentrated mustard gas in 68 drums.

In addition to the information from DND, there is also anecdotal evidence to indicate that UXOs and other materials may have been dumped at the Laurentian Fan site by the US Navy as part of their de-mobiization from the Argentia Naval Base in Newfoundland. CPC is pursuing through it own channels whether there is any documented evidence to support this possibility.

5.2.4. Mitigation of Effects of the Environment on the Project

The offshore industry mitigates the effects of wind, waves, and ice on project operations and safety through the state-of-the-art, site-specific forecasting by dedicated contractors. Consistent with existing practices, the Operators will use a three-fold strategy in avoiding or mitigating the potential effects of ice and icebergs:

1. Project scheduling,
2. Onboard environmental observer (s), and
3. Ice management protocols (ice mitigations will be defined in the Ice Management Plan).

5.2.4.1. Physical Environmental Monitoring and Forecasting Program

Marine Meteorological Observation Program

Marine observations will be conducted as required by the PEG's and the Drilling Regulations. A qualified observer will record and report both aviation and marine weather observations. Using WMO/MSC-approved, standard meteorological sensors, the observers will provide synoptic weather observations every three hours over the synoptic periods 00:00Z through to 21:00Z and either, hourly aviation observations between 10:00Z to 21:00Z or whenever aviation operations are planned.

All meteorological, oceanographic, and vessel response measurements and observations will be recorded on a computer running the appropriate software to facilitate logging, primary level error checking, coding, and data transmittal of meteorological, oceanographic, and rig response data (Table 5.1).

Table 5.1. Environmental Parameters to be Measured or Observed.

Measured Parameters		
Wind Speed and Direction	Station Barometric Pressure	Air Temperature
	Sea Level Barometric Pressure	Wet-bulb Temperature
Ice Accretion	Pressure Trend	Dew Point Temperature
	Altimeter	Sea Surface Temperature
Observed Parameters		
Present Weather	Wind Wave	Sky Condition
Past Weather	Primary Swell	Cloud Type
Visibility	Secondary Swell	Sea Ice/Icebergs
Additional Observations		
Ocean Currents	Heave, Pitch and Roll	Anchor Tensions
Passing Vessel Traffic	Wildlife Numbers and Behaviour (if required)	Well Offset (if required)

Marine weather observations will be taken every three hours (main and intermediate synoptic hours) according to procedures outlined in the MANMAR manual (including amendments) and the guidelines published by C-NLOPB. If necessary, a Special Weather Report (SPREP) and/or a Storm Report (STORM) will be filed whenever the criteria for such reports are met, regardless of whether the conditions were forecast or not.

A Storm Report will be filed whenever the wind speed equals or exceeds 48 knots.
Special Weather Reports will be issued whenever:

- Mean wind speed doubles to 25 kt. or more;
- Mean wind speed increases to 34 kt. or more with no gale warning in effect;
- Visibility decreases to one-half mile or less;
- Wave height increases by 1.5 m from the value reported at the last main synoptic;
- Ice forms on the superstructure.

Aviation Meteorological Program

Aviation weather observations will be taken hourly from 06:30L to 17:30L, and/or whenever helicopter operations are planned. The observations will be as outlined in the MANOBS manual and as prescribed by the C-NLOPB. Special observations will be taken when changing weather conditions meet the criteria for "specials". These specials will be reported immediately to the Company's helicopter contractor and the Oceans Ltd weather forecasting office.

To be consistent with weather reports from shore-based stations, aviation observations from the rig will be coded and transmitted in METAR format.

The onboard observer will take aviation weather observations at the MODU and will record those observations using suitable software that should code the observation into a METAR format and forward it to both the Helicopter contractor and the Weather Forecasting office.

Environmental and Meteorological Instrumentation

Instrumentation for environmental and weather observations that meet the stated requirements of the C-NLOPB and MSC will be available onboard the MODU. The instrumentation will be inspected and calibrated by qualified personnel.

Meteorological Forecast Services

Meteorological forecasts tailored to meet the operational requirements of the program and satisfy all C-NLOPB guidelines will be in place for the duration of the drilling programs. The forecasts will be verified against the synoptic weather observations collected on the MODU.

At a minimum, the forecasts will consist of:

- A 24-hour weather watch with site-specific forecasts prepared and issued on a 12-hour basis and forecast updates on a 6-hour basis.
- Short-term forecasts out to 54 hours followed by a long-range forecast in 12-hour time steps for an additional three days.
- Updated forecasts issued on a three-hour basis or more frequent, if required, during emergency or storm conditions.
- Issuances of weather warnings when appropriate.
- Weather briefings
- Site-specific forecasts, which will include at a minimum the following:
  - Synopsis of present weather patterns;
  - Mean and maximum wind speed and direction;
  - Precipitation;
  - Visibility and sky condition;
  - Air temperature;
  - Mean sea level pressure;
  - Potential for freezing spray/icing conditions;
  - Significant and maximum wave height and direction;
  - Wave period;
  - Significant height and direction of swells; and
  - Combined significant and maximum wave height and direction.
- An overview of weather and sea state forecast procedures and information sources.
- QA/QC processes as well as forecast verification procedures to ensure ongoing accuracy of forecasts.
- Forecasts prepared by qualified personnel who have experience in the geographical region and familiar with MSC and C-NLOPB requirements and guidance material
- An effective data communications system to ensure timely receipt and issuance of environmental data and forecasts.
- Data archiving, processing, and preparation of all the required reports as outlined in the C-NLOPB Guidelines including the preparation of a forecast verification report.
- Quality control of weather observations. The METAR and MANMAR observations MANMAR coded observations will be forwarded to the MSC network
- Sea state will be verified against observations collected on the MODU and any other observations available.

5.2.4.2. Ice Management and Mitigation Program

This section provides an overview of ice management practices that will be employed on this project to provide a safe environment and minimize operational disruptions caused by ice. Currently ice management is comprised of:

- Detection
- Monitoring and Assessment
- Physical Management.

Detection

Detecting small floating targets in open seas is a well-understood and documented process. Technological advances in the preceding two decades have improved ice detection capabilities to a point where both sea ice and icebergs can be detected and positioned over a large area with great accuracy.

Ice detection will use a combination of radar technologies and procedures to quantify and monitor ice distribution. Between government (both Canadian and US) and private industry there are over 5,000 hours of airborne reconnaissance conducted annually over the Canadian East coast. In addition to these radar-equipped aircraft, the areas off Canada's East Coast are swept daily by an assortment of satellite-based sensors and long-range, shore-based radars. Data from all these sources are integrated into a daily summary of ice distribution. The sequential ice distribution data is then used to monitor growth and movement. Using these procedures, the operator will be able to detect and monitor ice conditions, allowing for long-term resource and operational ice management planning.

Monitoring and Assessment

Once detected, ice will be monitored to establish the speed and direction of its movement (drift) and, when enough information has been obtained, assess its potential threat to the project. Typically this is accomplished in stages. The initial detection is usually accompanied by a general classification of the type of ice or iceberg. As successive detections are made over an area, a general drift track is established. At this stage the available data will allow for general assumptions to be made. As ice closes on the Project Area, more detailed information will be acquired.

The components of detailed ice assessment data are:

- Physical dimensions of sea ice and/or icebergs
- Depth measurements of icebergs (draft)
- Accurate drift (direction and speed).

The standard methodology for obtaining physical dimensions comprises a mix of measurement, calculation and in some cases estimation, depending on the operational significance of the ice in question. Smaller icebergs and ice floes are usually estimated, because their masses are well within the capabilities of ice management vessels. These methods will be described in detail in the Operators' ice management plan.

Obtaining accurate drift information is a simple process of measuring distance over time. The widespread use of the Global Positioning Systems (GPS) now provides very accurate positions, permitting accurate tracks, even over short distances and time spans.

Once these baseline data have been collected, a reasonable assessment of the risk posed by the ice will be made. Typical risk assessment considers the following questions:

- Is the drift of the ice likely to pose a collision risk or disrupt operations?
- Is the ice in excess of the design criteria of the facility?
- Is the ice/iceberg within manageable parameters?
- Is the drift acceptable within the time frame required to move the MODU if required?

If the answer to these simple questions is, 'no' then the ice need only be monitored for any drift changes. If however, the answer is 'yes' then either a physical ice management procedure will be initiated or the facility will be secured and prepared for a possible move.

Physical Management

In general terms, most physical iceberg management consists of towing or deflecting the iceberg off its free drifting track or braking ice floes to a size acceptable to design of the facility

Iceberg towing strategies employed over this project will be the same as those used on the Grand Banks and off Labrador for the past 30 years.

Sea ice management procedures are well documented; breaking up sea ice to assist shipping is a commonplace occurrence in Canadian waters. Because of the loose nature of the pack in the area, sea ice management primarily consists of using support vessels to break up any large ice floes that meet or exceed the design limits of the facility.

The exact procedures for detection, monitoring and mitigation will be described in the projects ice management plan, which will be submitted for regulatory approval prior to the commencement of drilling.

Effects of the biological environment will be mitigated through regular inspections and cleaning and the use of C-NLOPB approved anti-fouling coatings, chemicals and techniques.

5.2.4.3. Munitions Dump Site

ConocoPhillips' risk assessment philosophy, as identified in element 2, Risk Assessment, of the CPC HSE management system, is as a first priority to prevent or avoid the presence of a hazard, if at all possible. In the event that this priority cannot be followed, for whatever reason, a formal structured risk assessment process will be followed, such that the risks associated with known hazards are reduced to "as low as reasonably practicable" (ALARP)

At this stage of the east coast drilling program no definite well locations have been identified and therefore, the steps outlined below cover the situation where well locations may be chosen, which lie within or in close proximity to known UXO dump sites.

In order to meet the C-NLOPB's requirement that "no activity that involves direct physical disturbance of the seabed in the dumpsite area will be authorized, until the Board is satisfied that such activities, in the area of the dumpsite, will not pose a threat to human safety or the environment," CPC proposes the following steps, consistent with element 2, Risk Assessment of the CPC HSE management system.

1. Hazard Identification
2. Hazard Assessment
3. Risk Evaluation
4. Implement appropriate actions to reduce risk to ALARP

5.2.4.4. Hazard Identification

The hazard identification process will consist of the following steps:

- Conduct a seabed site survey of the proposed well location in the Laurentian Fan dump site. The extent of the area to be surveyed will be determined later when a confirmed well location is identified. This initial screening survey may include side scan and multi-beam sonar, and a magnetometry.

- From the screening process, identify those objects, which have the potential to be UXOs. The potential UXOs will then be subjected to a more detailed survey using ROV equipment, capable of providing video of the object at the 2,000m water depth.

- If confirmation is received from the detailed survey that a UXO has been identified, its exact location, size and any other distinguishing features will be noted and photographed.

Hazard Assessment

- The hazard assessment process will consist primarily of attempting to identify the types of UXOs present at the location. This will involve the use of personnel who have specific expertise and knowledge in military ordnance. These personnel will also be able to provide information on the likely status and condition of any UXOs, should they be found. Relevant information pertaining to the UXOs will be passed along to DND for its records.

Risk Evaluation

- In the event UXOs are located on the seabed, the risk evaluation process shall consist of assessing the information provided by the ordnance experts. This information may indicate that owing to the types of UXOs identified, the length of time that has elapsed since they were dumped and the extreme water depths involved, that no hazard currently exists from them or would be posed by drilling activities.

- Should it not be possible to conclude that no hazard is present, an "activity exclusion zone" will be designated around the UXO location. The purpose of the zone will be to ensure that no drilling or seabed related activities are conducted in this area.

- The extent of the "activity exclusion zone" will also be determined through the assessment and will take into consideration the potential types and quantities of UXOs.

- Should the proposed well location be within the designated "activity exclusion zone," CPC will consider the feasibility of moving the well location to outside of the zone, or identify other mitigation measures.

5.2.5. Assessment of Effects on the Project

Weather, ice and icing and wave conditions affect every project on the East Coast to some degree. It is anticipated that these effects could be mitigated by using rigs, vessels and equipment that are certified for use in the Lauentian Sub-basin, by detailed project planning and design, by operational scheduling and by state-of-the-art forecasting. The residual effects of wind and weather are predicted to be adverse (i.e., in the form of delays) but *not significant*.

The effects of ice on the Project will be minimal because most of the Project Area is often free of sea ice and subject to relatively few icebergs. Given careful timing selection and good forecasting, there is expected to be *no effect* on the Project from sea ice. Any potential effects on the Project from icebergs can be mitigated by timing selection and by the Ice Management Plan described above such that residual effects will be *not significant*.

Ice accumulations (superstructure icing) may cause delays while operations are slowed or suspended and ice accumulation is avoided or removed. Any delays are *not* anticipated to be *significant*.

There is a higher risk from seismicity in the Project Area than in other areas of the east coast offshore. However, the risk is not abnormally high and is unlikely to significantly affect exploratory drilling activities if a floating drill rig is used and the emergency systems disconnect as designed. Other geohazards, e.g., steep slopes, slumping, shallow gas, etc., will be evaluated prior to drilling either through dedicated geohazard surveys or further analyses of the 3-D seismic data.

An exclusion zone should reduce the risk from submerged munitions to an acceptable level. Provided the mitigations detailed in the previous section are conducted, *no significant effects* of the environment on the Project are predicted.

5.3. Routine Project Activities

Routine project activities were described in detail previously under "Project Description" (Section 2.0) and are summarized in terms of frequency and duration in Table 5.2. Results of drill cuttings modeling are also included in this section. Accidental events are discussed in Section 6.0.

As discussed previously, only one initial well is planned. The frequency and duration ratings in the assessment tables presented in this EA are based upon two wells per year. However, there is some possibility that four appraisal wells could be drilled in one year if the initial well(s) proved highly successful and if the required rig time could be obtained. In any event, the ratings in the tables can be easily scaled up using Table 5.2. [It should be noted that such scaling up would not affect any of the significance predictions in this EA.]

Table 5.2. Project Activity Estimates Used in Developing Frequency and Duration Ratings.

Activity	Base Case (One Well)	Frequency Per Year (Two Wells)	Duration Per Year (Two Wells)	Total Duration (7 Wells)
Supply boats	1 boat always on standby	Continuous	200 days	23 months
Helicopter flights	6 per week	171 flights	30 days	3.5 months
Rig operation (structure, lights, sound, safety zone, sanitary, bilge, deck drainage)	1 rig; 80-100 d per well	Continuous	200 days	23 months
Mud operations[1]	70 days drilling per well	Continuous	140 days	16 months
Produced water[2,3]	20 days testing per well	Continuous	20 days	1 month
Air emissions (testing)[3]	20 days testing per well, if it occurs	Continuous	20 days	1 month
Routine air emissions	Rig, boats, chopper	Continuous	200 days	23 months
BOP discharge[4]	Periodic testing	9	<1 month	<1 month

1 Based on Operators' estimate of number of days of actual drilling.
2 Produced water may only occur if petroleum hydrocarbons are found.
3 Produced water and testing predicted to occur for 2 of 7 wells (i.e., 25% success rate).
4 As per regulation.

Offshore drilling for oil and gas has occurred since the 1940s and many thousands of wells have been drilled worldwide under a wide variety of environmental conditions. Numerous laboratory and field studies have been conducted, particularly for US, Canadian, North Sea, and Russian waters. The issues and effects of exploratory drilling are well known, particularly for shallow and continental shelf waters, less so for very deep waters. At present, the primary environmental concerns usually revolve around the effects of drill mud and cuttings and accidental spills or blowouts. Other environmental concerns include the effects of noise and light. Air emissions may also be a concern in nearshore areas or in a wider discussion of greenhouse gases. These concerns in the context of the proposed Project are discussed below.

5.3.1. Drilling Activities

Drilling activities are described in detail in Section 2.0. Additional details universally applicable to the effects assessment for several VECs are described and discussed below. Other Project details particular to assessing effects on individual VECs are provided in those specific sections.

5.3.1.1. Drilling Fluids

Water-based Fluids

Specific drill fluid formulations may vary by Operator, drilling contractor, and well characteristics. Composition of one example WBM formulation for a typical exploratory drilling program is shown in Table 5.3.

Table 5.3. Typical WBM Components and Cuttings Discharge Volume for an Exploration Well.

		Casing Strings			
	Unit	**Conductor**	**Surface**	**Production**	
Hole Section	inch	36	16	12 1/4	Notes: 1. Three scenarios were taken into account. The 12 ¼" hole section varies in depth with each scenario. 2. 36" and 16" hole sections–Near seabed discharge. 3. WBM used for complete well. 4. All depths are measured below rotary table (brt).
Drilling Fluid System		Gel/Seawater	Gel/Seawater	WBM	
Depth (See Note 4)	Meter (brt)	220	1200	3600	
Volume Usage	bbl	897	4199	5246	
Wash Out	%	50%	30%	10%	
Products					
Barite	MT		58	115	
Bentonite	MT	16	65		
Calcium Carbonate	kg				
Caustic	kg	116	482	138	
Fluid Loss Agent	kg			2385	
Inhibitor	kg			4769	
Fluid Loss Agent	kg			9538	
Potassium Chloride	kg			100153	
Lime	kg	116	482		
Glycol Inhibitor	L			25024	
Soda Ash	kg	116	482	238	
Viscosifier	kg			3577	
Biocide	L			72	
Drilled Cuttings	kg	192032	429562	521786	
Volume of Cuttings	m^3	74	165	201	

Source: Husky (2003) *in* Buchanan et al. (2003).

The following points are relevant to the discharge of WBM and cuttings.

- Present-day WBM is essentially non-toxic. The main component of WBM is seawater and the primary additives are bentonite (clay), barite ($BaSO_4$) and potassium chloride (Neff 2005).

- Discharge of WBM and associated cuttings is regulated by the C-NLOPB. Spent and excess WBM and cuttings can be discharged without treatment (NEB et al. 2002).

- Chemicals such as caustic soda, soda ash, viscosifiers, and shale inhibitors may be added to control mud properties. All chemicals that may discharged offshore are screened using the *Offshore Chemical Selection Guidelines* (NEB et al. 1999). This screening is a rigorous procedure consisting of 13 steps whereby each chemical is evaluated for its performance, cost, efficacy, applicability of other legislation, guidelines, or international agreements, hazards to humans, potential for tainting fish tissue, toxicity, discharge quantity, and hazard to the environment. The purpose of the process is to ensure that chemicals with the least hazard to the environment are selected. The screening must be documented and is subject to audit by the regulators; it determines the amount of each product that may be discharged.

- The discharge of WBM may enrich sediments slightly with metals such as barium, arsenic, cadmium, copper, mercury, lead, and zinc, generally within 250 to 500 m of the drill site but occasionally farther (usually zinc and sometimes chromium) depending upon mud volumes and environmental conditions. However, in general, these metals are not in a bioavailable form and few if any biological effects have been associated with these increases in metals from drill rig discharges (CAPP 2001a; Buchanan et al. 2003; Hurley and Ellis 2004; Neff 2005).

- The primary effect of WBM, in the absence of hydrocarbons, appears to be smothering of benthos in a small area near the hole. The exact area of effect cannot be predicted because animals' reactions will range from simply avoiding the immediate area of deposition to direct mortality of sessile organisms. The benthos can be expected to recover after the drilling ceased, based upon the published literature (reviewed in Husky 2000, 2001; MMS 2000; CAPP 2001b; Buchanan et al. 2003; Hurley and Ellis 2004; Neff 2005). Field monitoring data from other offshore operators indicate that the actual area of smothering appears to be much less than predicted in EA modeling exercises (Fechhelm et al. 2001; Marathon, unpubl. data; JWEL 2002; Hartley Anderson 2005).

Synthetic or Enhanced Mineral Oil-based Muds

This EA uses the broad definition of SBM to include enhanced mineral oil based muds such as the IPAR used by Petro-Canada on the Grand Banks. Synthetic muds will likely be used for drilling some or all sections of the wells in the Laurentian sub-basin exploratory program. Synthetic muds were developed to replace diesel and mineral oil-based muds. Formulations vary widely; some typical constituents of some common SBMs are shown in Table 5.4. In general, SBM itself is essentially non-toxic, and some types may biodegrade relatively rapidly under certain conditions (e.g., aerobic conditions) (MMS 2000; Buchanan et al. 2003; OGP 2003). In addition, less mud and cuttings are discharged with SBM than for WBM for the same distance drilled. Cuttings with adhering SBM tend to disperse less than those associated with WBM and thus SBM cuttings tend to fall closer to the rig.

Table 5.4. Typical Constituents of SBM.

Component	Quantity (kg/m^3)
Base chemical (for deepwater, typically internal olefins or polymerized olefins) under various trade names such as Baker Hughes' ALPHA-TEQ, M-I's NOVAPLUS or Baroid's PETROFREE SF	Major constituent but variable depending on system used, well conditions
Emulsifier	25.7 – 39.9
Rheological Modifier	2.9 – 5.7
Fluid Loss Additive	2.9 – 5.7
Lime	2.9 – 22.8
Organophilic Clay	15.0 – 21.0
Wetting Agent	0 – 2.9

Source: MMS (2000).

The following points concerning SBM are relevant to any exploration drilling program EA.

- Biological effects have been attributed to smothering under patches of mud/cuttings from physical and/or chemical (e.g., anoxia caused by rapid biodegradation) conditions (EPA 2000; MMS 2000).

- A recent major study on SBM (CSA 2004) used a diverse set of approaches to assess the fate and effects of discharged SBM cuttings at continental shelf and continental slope sites in the Gulf of Mexico. Key findings of that study were
  - no large, multi-meter thick cuttings piles, such as those seen in the North Sea, were
  - detected at any of the 15 sites visited in this study;
  - discharges were deposited in a patchy distribution limited to the vicinity of the
  - discharge location (<250 m);
  - in general, sediment quality and biological communities were not severely affected,
  - and impacts were limited to the vicinity of the discharge (<250 m); and
  - where impacts were observed, progress toward physical, chemical, and biological
  - recovery appeared to occur during the 1-year period between the two Sampling Cruises.

- In the deepwater (500+ m), Gulf of Mexico, organic enrichment with attendant increases in biota, including fishes and crabs, has been reported after a two year multi-well drilling program (Fechhelm et al. 2001). No large cuttings piles were observed by ROV during that study.

- Biological effects are not normally found beyond 250-500 m from the drilling platform (Husky 2000, 2001, 2002, 2003; MMS 2000; CAPP 2001a; NEB et al. 2002; Buchanan et al. 2003) although there have been a few reports out to 1,000 m (Hurley and Ellis 2004). The Husky EAs (White Rose, Jeanne d'Arc Basin, and South Whale Basin) concluded a total area of impact of less than 1 km^2 from multi-well drilling based upon a modeling exercise and published literature. It can reasonably be expected that a single exploratory well would affect a much smaller area.

- SBM cuttings are treated through a system of shakers and cuttings dryer prior to discharge. The present allowable limit according to the *OWTG* is 6.9%. All discharges are subject to approval by the Boards and bulk discharge of whole SBM is not permitted.

- Mitigation measures include the selection of non-toxic or low toxicity chemicals and muds and treating any synthetic oil-contaminated cuttings to meet the *OWTG*.

5.3.1.2. Project Discharge of Mud and Cuttings

A numerical model was used to simulate the bottom distribution of well cuttings and muds discharged five metres below the ocean surface at two locations 375 to 460 km southwest of St. John's, near the south end of the Laurentian Channel on the edge of the continental shelf (Lorax 2006).

Historical ocean current measurements and predicted tidal currents obtained from the Bedford Institute of Oceanography were used to prescribe currents at five depths ranging from 50 to 683 m. Cuttings and muds were discharged in the model at a depth of five metres and the finer particles were assumed to form flocs with a diameter of 0.1 mm upon contact with the ocean. The flocs, together with three larger particle size classes up to seven millimetres in diameter, were used to characterize the mass of discharged material.

The proposed drilling program at each well site consists of three activities distinguished by their duration, hole diameter, and particle cuttings and mud content. The calculation used to determine deposit thickness assumes fully consolidated deposits with a volume weighted mean density of 2,359 kg/m^3.

The first theoretical well location (W-1) modeled by Lorax (2006) was at 44°45'45" N, 55°8'20" W. Water depth at this site is 2,300 m and the simulated period was 58 days in length from May 20 through July 16, 2008. A combined total of 754.4 m^3 of cuttings and mud were discharged during 47 drilling days. The final deposition pattern for well W-1 was roughly circular in shape with 95% of the deposit within approximately 2.2 km of the well location, and 50% within 0.9 km of the well. The total area covered by deposits of at least 0.1 mm thickness was 2.5 km^2, while the total area covered by at least 0.01 mm was approximately 10 km^2. Maximum deposit thickness was 0.7 mm.

The second theoretical well location (W-2) modeled by Lorax (2006) was at 44°34’53”N, 56°33’54”W. Water depth at this site is 750 m and the simulated period was 125 days in length from May 23 through September 25, 2008. A combined total of 754.4 m^3 of cuttings and mud were discharged during 95 drilling days. The final deposition pattern for well W-2 was roughly circular in shape with 95% of the deposit within approximately 1.5 km of the well location, and 50% within 0.5 km of the well. The total area covered by deposits of at least 0.1 mm thickness was 1.5 km^2, while the total area covered by at least 0.01 mm was approximately four square kilometres. Maximum deposit thickness was three millimetres.

The greater water depth of the well site within grid W-1 resulted in the solids being deposited over a significantly larger area than occurred for grid W-2.

The modeling does not include the shallow sedimentary mud, sand and clay cuttings that are deposited to the sea floor at the initial stage of the drilling. These are cuttings that pile up adjacent to the hole and only extend for a few metres as observed during ROV surveys of previous deep wells. The area covered by discharged cuttings is small. In summary, the area covered to a depth of 10 mm (or 1 cm; the depth that is commonly referred to as the cut-off point for biological effects such as smothering of non-mobile benthic species) was much less than 1 km^2 which is the lowest geographic extent category used in Newfoundland offshore EAs.

5.3.2. Light

Lights are used on the drill rig and supply vessels for navigation purposes and to illuminate work areas. Light and heat could also be emitted from flaring during testing if hydrocarbons are discovered. Lights under certain conditions have the potential to affect some species by attracting them to the rig (particularly storm petrels, but also some species of squid, fish and perhaps sea turtles). These potential effects are discussed under the various VEC headings.

5.3.3. Air Emissions

Air emission data for offshore drilling activities based on Gulf of Mexico data are available in MMS (2004a) (Table 5.5). The air emissions of offshore drilling activities are within the range of those from fishing vessels, tanker traffic, and military vessels that routinely transit eastern Canadian waters (see MMS 2004a for comparative figures).

Worldwide, offshore drilling probably accounts for a very small portion of photochemical pollutants, reactive hydrocarbons, NO_x emissions, inert pollutants (e.g., CO, NO_2, SO_2, particulates and lead), greenhouse gases (carbon dioxide, methane, nitrous oxide, ozone, water vapour, and chlorofluorocarbons) compared to other industries and particularly personal automobile use (MMS n.d.).

Table 5.5. Drilling Activity Emissions.

Typical Source	Pollutant	Amount (kg/h)
Jack-up drill rig including prime power, pumps and draw works	NO_x	41.75
	SO_2	7.02
Semi-submersible drill rig including prime power, pumps and draw works	NO_x	52.65
	SO_2	8.86
Helicopter single engine	NO_x	0.25
	SO_2	0.19
Helicopter twin engine	NO_x	4.01
	SO_2	0.33
Helicopter heavy twin engine	NO_x	17.40
	SO_2	1.10
Supply boat	NO_x	6.96
	SO_2	1.19
Seismic vessel	NO_x	6.15
	SO_2	1.03

Source: MMS (2004a).

The offshore environment is windy and air emissions disperse quickly. Equipment will be similar in emissions to other industrial equipment in routine use, will be within the range of what is occurring now offshore, and mitigations will be employed. State of the art safety equipment and procedures, including breathing apparatus will be available to offshore workers, as appropriate.

In summary, the proposed drilling project will not unduly add to air emissions or greenhouse gases and will not endanger the health and safety of offshore workers or the marine environment. Given the rapid dispersal offshore there will be no cumulative effects with other projects. The effects of the Project, including cumulative effects on air quality will be *not significant*.

5.3.4. Sound

The sea is a naturally noisy environment. Ambient noise tends to increase with increasing wind speed and wave height (Table 5.6). In many areas, shipping is a major contributor to ambient noise.

Underwater sound has the potential to affect marine animals in a variety of ways depending upon source levels, duration, proximity, sensitivities, environmental conditions, and many other factors. Marine mammals are generally believed to be the group most sensitive to underwater sound. The main sources of sound for the proposed Project include helicopters, supply vessels, drill rig machinery and thrusters, echo sounders, VSP seismic array and well head removal explosives (if used). Dynamically-positioned (DP) drillships and DP semi-submersibles are generally noisier than moored semi-submersibles which in turn are noisier than bottom-founded rigs such as jack-ups, all other factors being equal (Richardson et al. 1995). Some sound levels reported for routine offshore drilling and VSP activities are provided in Tables 5.6 and 5.7. Sound characteristics of a "typical" tunnel thruster are shown in Figure 5.1.

Table 5.6. Natural and Development-Related Underwater Sound Levels.

Source	Broadband Sound Level (dB re 1 μ Pa[1])	Sound Levels at Dominant Frequencies	
		Frequency Hz	Level dB re 1 μ Pa[1]
Ambient Noise			
Wind < 1.8 km/h	-	100	60
Wind 20.4 to 29.7 km/h	-	100	97
Wind 40.8 to 50.0 km/h	-	100	102
Heavy shipping	-	50	105
Light shipping	-	50	86
Remote shipping	-	50	81
TNT explosion			
0.5 kg at 60 m	267	21	-
Seismic airguns	216-259	50-100	-
Depth sounder	180+	12,000+	-
Semi-submersible drilling rig (working)	154	7-14, 29, 70	-
Drillship (working in 20 m water depth)	174-185	to 600	-
Supply boats			
Reduction with propeller nozzles	(-10)	-	-
Increase with bow thrusters operating	(+11)	-	-
Large tanker	186	100+, 125	177
Supertanker	190->205	70	175
Super Puma Helicopter at 300 m above sea level			
Received level at sea surface	-	20, 50	105-110
Received level at 3 to 18 m depth	-	-	65-70

[1] 3rd octave band level

Source: Richardson et al. (1995).

Table 5.7. Sound Levels Reported for Offshore Drilling Activities.

Source	Source Level (dB re 1μPa at 1 m)	Measurement Type	Reference
VSP array	233	Zero to peak	MMS (2004b)
Drillship Kulluk	185	Broadband (45-1,780 Hz)	Lawson et al. (2001)
Drillship Canmar Explorer II	174	Broadband (45-7,070 Hz)	Lawson et al. (2001)
Helicopter Sik-61 fly-over at 305 m	108 (received level)	Broadband (45-7,070 Hz)	Lawson et al. (2001)
Helicopter Bell 212 fly-over	162	Broadband (45-7,070 Hz)	Lawson et al. (2001)
Supply ship Kigoriak	181	Broadband (45-7,070 Hz)	Lawson et al. (2001)
Thruster (900 HP) Supplier III	190	Broadband (45-7,070 Hz)	Lawson et al. (2001)
650 kW tunnel thruster	120-185*	Broadband (20 - >10,000 Hz)	DNV unpubl.
Drillships (general)	154-191	Broadband (10-10,000 Hz)	MMS (2004b)
Bottom-founded drill platforms (general)	119-127 (received levels)	5-1,200 Hz	MMS (2004b)

*at 0.5 m

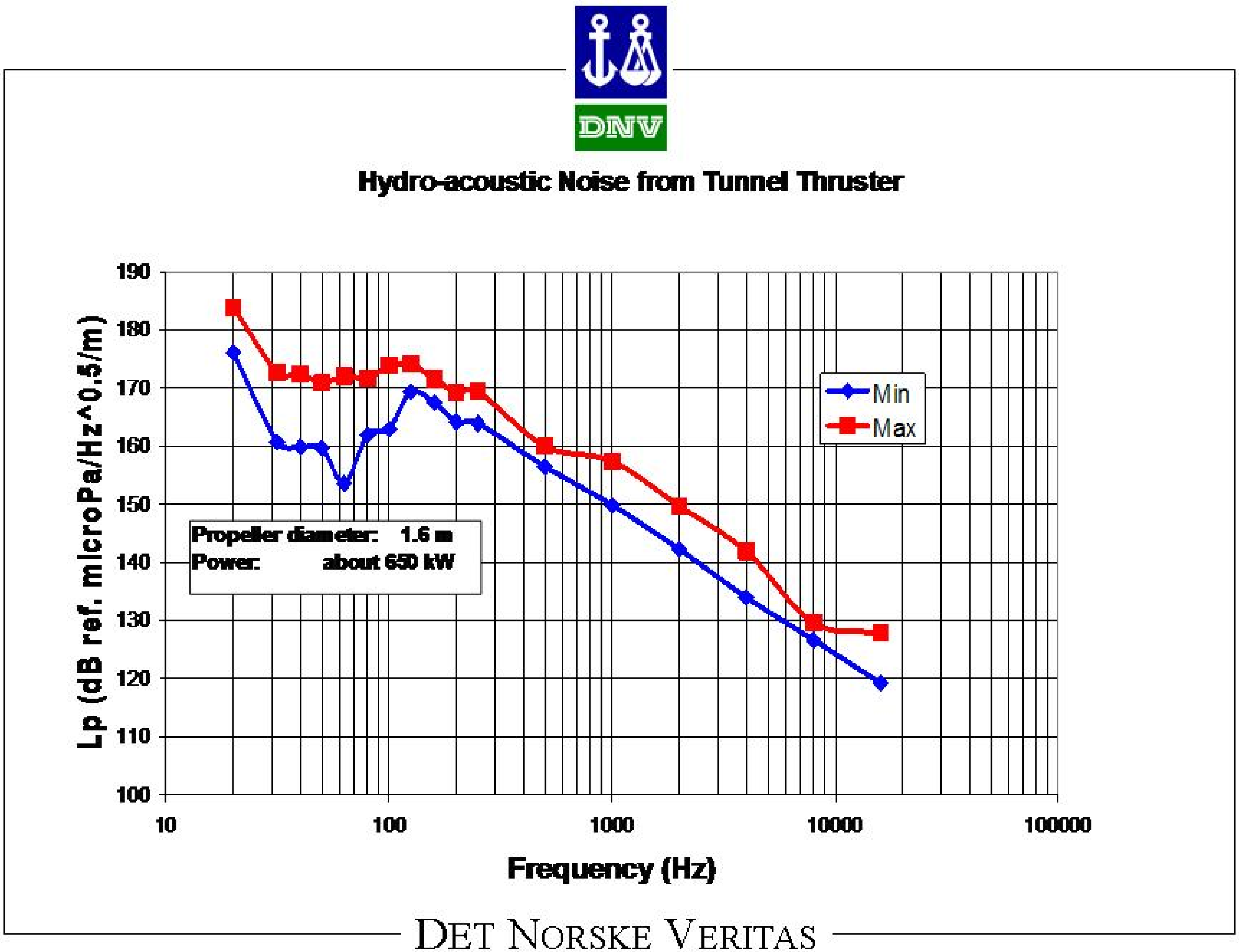

Figure 5.1. Sound Characteristics of a Typical Tunnel Thruster.

Some of the strongest sound levels associated with the Project will be those associated with the vertical seismic profiling or VSP. Typical VSP activities are described in Section 2.0. Effects of sound are assessed under each VEC.

5.3.5. Safety Zone

In deep water, the Project will use a dynamically-positioned drill rig, unless technology advances sufficiently in the future to allow for the use of a suction-anchored rig. The Safety Zone (i.e., vessel exclusion zone) around this type of rig is an area (0.8 km^2) defined by a 500-m radius from the rig (CAPP 2001b). This area is smaller than the exclusion zone around a typical anchored semi-submersible where the exclusion zone is defined by a 50-m radius from each anchor (typically eight positioned some distance from the rig usually resulting in a greater exclusion area). Potential effects are discussed under the following VEC headings, where relevant.

5.4. Potential Effects on Ecosystems, Fish and Fish habitat

This EA does not directly assess effects on the ecosystem (s) but instead focuses on key components (i.e., the "VEC approach"). The reasons for this are two-fold: (1) there are significant scientific and technical constraints, and (2) after 60+ years of worldwide offshore drilling experience there is no reason to suspect ecosystem effects from exploratory drilling, with the possible exception of a major spill or blowout that has the potential to affect seabirds at the population level. Nonetheless, some discussion of potential effects on plankton and benthos are contained in the following two sections because these broad groups may encompass VECs (e.g., eggs of commercial fish) or support VECs (e.g., seabirds). Although plankton and benthos are assessed separately from fish and fish habitat, they are considered to be components of fish habitat.

With the exception of plankton and invertebrate benthos (assessed below), fish and other aspects of fish habitat are considered jointly in this section because the two are so interdependent. Although there will be some references to the fishery in this section, the effects of the Project on the commercial fishery VEC is discussed in a following section. In some cases, it is possible to group species of similar sensitivities together. All effects assessment has been done in a conservative manner by evaluating the most sensitive species or groups and their most sensitive life stages when there is potential for effects.

5.4.1. Plankton

The phytoplankton and zooplankton communities of the Project Area are diverse and constitute a fraction of the huge biomass present throughout the northwest Atlantic. Routine Project activities may affect relatively small numbers of plankton through entrainment into pumps, exposure to near-surface *OWTG*-regulated discharges (e.g., grey/black water, produced water, drill cuttings), or physical damage from prop wash, but these effects will be highly localized and therefore *negligible* relative to the total populations of the Study Area and are not considered further except for VECs such as fish eggs and larvae.

5.4.2. Benthos – Effects of Drill Mud/Cuttings

Reviews of environmental effects of exploratory drilling offshore Canada have concluded that changes in diversity and abundance of benthic organisms have been detected within 1,000 m of drilling sites, but most commonly within 50 to 500 m of the well (Buchanan et al. 2003; Hurley and Ellis 2004). Beyond the bottom area visibly covered by cuttings, benthic communities appear to return to baseline conditions within one year of cessation of drilling discharges. The primary concerns associated with routine drilling activities relate to the discharge of drilling muds and cuttings (Buchanan et al. 2003). The main effects from these discharges are likely smothering and alteration of benthic communities adjacent to the well. The potential for bioaccumulation of chemicals or metals associated with drilling muds and cuttings also requires some consideration.

As previously discussed, most modern WBMs and SBMs, are of very low toxicity or essentially non-toxic. In the field, any observed effects on benthic organisms have been mostly due to anoxia from organic enrichment of the sediments and physical smothering. Scallops may be sensitive to drilling muds and cuttings (Cranford et al. 1999) but scallops, at least in commercial quantities, probably do not occur in the Laurentian Sub-basin Project Area.

Novaplus and IPAR are two common SBM formulations. In a laboratory study, SBM (1.4 mg/L Novaplus and 1.5 mg/L IPAR-3 base fluids) appeared to cause adverse effects on weight of somatic and reproductive tissue of scallops (Armsworthy et al. 2005). No effects were noted at lower concentrations. Based on significant reductions in scallop clearance rate, Armsworthy et al. (2005) suggested that the fine particulate fraction of drilling muds is most likely the primary cause of observed effects on scallop tissue growth. Hamoutene et al. (2004) investigated the acute toxicity of IPAR, currently used offshore Newfoundland, on antioxidant enzymes and peroxisome proliferation in the American lobster (*Homarus americanus*). Lobsters were dosed with 1.0 ml of undiluted IPAR every three days, up to a total of 5.0 mL, which was considered a very high level of exposure. Results of the study indicated that IPAR has little or no potential for adversely affecting the health of lobsters. Payne et al. (1995) reported little effect on a variety of indices in flounder, a benthic fish, chronically exposed for four months to oil well cuttings enriched in relatively high levels of aliphatic hydrocarbons. Toxicity studies carried out on Microtox and amphipods using Hibernia source cuttings containing a synthetic base oil indicated a low potential for acute toxicity.

Zones of effects on benthic organisms likely vary with quantity and type of drilling fluids and cuttings, water depth, physical conditions (e.g., bottom topography, sediments, currents, natural suspended material, etc.), species, life stage, season, and other factors. Reported areas of effects for Hibernia SBM (the aliphatic drilling fluid IPAR) suggest that impact zones less than 500 m in radius (Payne et al. 2001a). According to laboratory studies, IPAR has a very low acute toxicity potential and can degrade in sediments within four months under favourable conditions (Payne et al. 2001a,b) but may last longer in cold deepwater conditions.

In the environmental assessment of a proposed exploratory deep water (up to 2,000 m) drilling program off Nova Scotia, JWEL (2004) predicted that effects on benthos would be limited to an area within 40 m of the well site for mud and cuttings deposited directly to the sea floor and within 800 m from the well site for cuttings discharged near-surface although modeling predicted that some deposition would occur much farther out than 800 m.

Benthic communities of the Project Area are not well-studied but in general are probably similar to other areas of the northwest Atlantic with equivalent oceanographic conditions, substrates and depths. Sensitive coral reefs, if they are concentrated at the depths where drilling will occur, will be identified and avoided through a pre-spud ROV survey. As discussed in a previous section, the only disturbance to the seabed will be from some initial discharge of mud and cuttings, and cement from casings, but discharge modeling and previous post-drilling ROV surveys indicate that this disturbance will cover a relatively small area, particularly given the likely depths of drilling activities. In addition, the regulated limit of synthetic fluid on cuttings is now 6.9% versus the previous 15% which further lessens potential for effects. Thus, in general, effects on benthic communities will be *negligible to low*. Effects on key benthic species (e.g., snow crab) are analysed further in the following fish and fish habitat sections.

According to the C-NLOPB website, thirty-three exploration and delineation wells have been drilled on the Southern Grand Banks between 1966 and 2005, only three during the last twenty years. Cuttings discharge modelling for Husky's Lewis Hill project (SW Grand Banks) predicted deposition of cuttings (10-mm layer or greater) out to about a radius of 200 m from the rig. Modeling conducted by Lorax (2006) for the Laurentian Sub-basin predicted an area covered by a 1-mm layer (the area of the 10-mm layer was too small to be resolved by the model) of <0.002 km^2 for the deep water (2,300 m) well location and <0.1 km^2 for the "shallow" (750 m) location. Based on these model predictions, <0.1 km^2 of seabed could be physically affected (i.e., by a thin cuttings layer) by each Laurentian Sub-basin well. The precise area covered will be mostly a factor of the volume and physical character of cuttings, type of drill fluid, water depth, degree of flocculation, and the local current regime. The area of biological effects will be species/life stage dependent but in total can be expected to be less than the area of physical effects because many benthic species are mobile.

It should be noted that cuttings, especially those associated with SBM, tend to occur in patches as opposed to a continuous layer. Thus, it is clear that even if a 10-mm layer is persistent over time, likely a worst case assumption because it will be broken up and dispersed over time by bottom currents and biological activity, the proposed exploration wells in the Laurentian Sub-basin would add a very small cumulative effect to the total. Environmental effects monitoring data for deep exploratory wells are sparse but reports to date have indicated that the apparent area of physical effect on benthos appears to be quite small (radii of 10's of metres) and overestimated by discharge modelling (Fechhelm et al. 2001; JWEL 2001, 2002; Hartley Anderson Ltd. 2005). Thus, any cumulative effect from exploratory drilling in the Laurentian Sub-basin on benthos is predicted to be additive, low magnitude, small geographic extent (<1 km^2 per well), and thus *not significant*.

It has been shown that both fish and shellfish may accumulate metals or chemicals released during drilling activities but no early warning health effects (e.g., biochemical, histopathological) have been observed (Payne et al. 1995; Payne et al. 2001b; Hurley and Ellis 2004). Payne et al. (1995) reported little effect on a variety of indices in flounder, a benthic fish, chronically exposed for four months to oil well cuttings enriched in relatively high levels of aliphatic hydrocarbons. Microtox and amphipod toxicity tests of Hibernia source cuttings containing synthetic base oil indicated a low potential for acute toxicity. Mathieu (2005) analyzed more than 250 American plaice collected at the Terra Nova Development Site prior to (1997) and after the onset of operations (2000 and 2001). No health effects were found in regard to condition index, visible skin and organ lesions, histopathological alterations in liver and gills, enzyme activation levels (mixed function oxygenase or MFO), and differential blood counts. It should be noted that if no health effects were found on a relatively sedentary benthic fish at Terra Nova, a multi-well development, then no health effect should be expected on fish at a single well site. Furthermore, if there are no effects on individual fish it is reasonable to assume no direct effects on fish populations.

The following sections examine the effects of the proposed drilling program on fish and fish habitat. The interaction matrix (Table 5.8) shows potential interactions between the Project and the fish VEC but makes no judgment about potential effects. Potential effects on the fish VEC are evaluated in Table 5.9 for extent, duration and magnitude, frequency, reversibility, and ecological/socio-cultural and economic context. The significance of those effects on fish is predicted in Table 5.10. Similar tables are also presented for the fish habitat VEC (Tables 5.11 to 5.12).

5.4.3. Presence of Structures

Glory holes will not be excavated and there will be no underwater construction during the exploratory drilling. The installation of seabed or near-seabed components would be restricted to the wellhead, blowout prevention stack and riser. The diameter of the structural hole will be approximately 1,066 mm (42 in). The wellhead would protrude a maximum of five metres above the seabed and be protected by a Coast Guard advisory notice and a minimum 500 m Safety Zone around the rig. Upon abandonment, the wells will be mechanically plugged and cemented over and thus there will be no structures left protruding above the seabed. In rare cases, in may be necessary to use small shaped charges to remove the wellhead. Any use of explosives will be governed by industry “best practice” and the appropriate government permits with corresponding mitigations. As stated previously, wellheads may be left in place if it is determined safe from iceberg incursion and that no fishery would be affected, and if approved by the C-NLOPB, after consultation with fishery interests.

Installation/removal of seabed components could temporarily have a ‘scaring’ effect on mobile fish and invertebrates. In addition, there would be a minimal sediment disruption or alteration. However, effects on fish and fish habitat would be *negligible* given that the numbers and areas affected are very small and the effect will not increase mortality. There would also be a *negligible* effect at the other developments, with an overall *negligible* cumulative effect.

Table 5.8. Potential Interactions between the Project and Fish VEC.

Valued Environmental Component: Fish						
	Feeding		Reproduction		Adult Stage	
	Plankton	Benthos	Eggs/Larvae	Juveniles[d]	Pelagic Fish	Groundfish
Project Activities and Physical Works						
Presence of Structures						
No Fishing Zone	**x**	**x**	**x**	**x**	**x**	**x**
Artificial Reef Effect	**x**	**x**	**x**	**x**	**x**	**x**
Subsea Structures		**x**				
Lights and Flares	**x**		**x**	**x**	**x**	
Drilling Mud/Cuttings						
Water-Based Mud	**x**	**x**	**x**	**x**	**x**	**x**
Synthetic-Based Mud	**x**	**x**	**x**	**x**	**x**	**x**
Produced Water (N/A)*						
Other Fluids and Solids[a]						
Cement		**x**		**x**		**x**
BOP Fluid	**x**	**x**	**x**		**x**	**x**
Cooling Water	**x**		**x**		**x**	
Deck Drainage	**x**	**x**	**x**		**x**	**x**
Bilge Water	**x**		**x**		**x**	
Sanitary/Domestic	**x**					
Garbage (N/A)*						
Atmospheric Emissions[b]						
Ships and Boats						
Helicopters						
Sound						
Drilling Rigs	**x**	**x**		**x**	**x**	**x**
Support Vessels	**x**	**x**		**x**	**x**	**x**
Helicopters					**x**	
VSP	**x**	**x**	**x**	**x**	**x**	**x**
Shore Facilities[c] (N/A)*						
OTHER PROJECTS AND ACTIVITIES						
Hibernia	x	x	x	x	x	x
Terra Nova	x	x	x	x	x	x
White Rose	x	x	x	x	x	x
Hebron	x	x	x	x	x	x
Exploration	x	x	x	x	x	x
Fisheries	x	x		x	x	x
Marine Transportation	x				x	

* Not applicable
[a] Effects assessment of offshore spills is contained in Section 6.0.
[b] Includes produced water that may be flared.
[c] There will not be any new onshore facilities. Existing infrastructure will be used.
[d] Juveniles are young fish that have left the plankton and are often found closely associated with substrates.

Table 5.9. Environmental Effects Assessment on Fish VEC.

Valued Environmental Component: Fish									
Project Activity	**Potential Positive (P) or Negative (N) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**						
			Magnitude	**Geographic Extent**	**Frequency**	**Duration**	**Reversibility**	**Ecological/ Socio-Cultural and Economic Context**
Presence of Structures								
Safety Zone	Safe Refuge From Fishing (P)	-	1	2	6	2	R	1
Artificial Reef Effect	Increased Food and Shelter (P)	-	1	2	6	2	R	1
Subsea Structures	Disruption (N)	-	1	1	6	2[a]	R	1
Lights and Flares	Attraction (N)	-	0	1	2-4	2	R	1
Drilling Mud/Cuttings								
Water-based Mud and Cuttings	Physical Smothering, Contamination (leading to biological effects) (N)	Reuse mud; use of low toxicity additives and mud systems	0-1	1	6	2	R	1
Synthetic-based Mud on Cuttings (whole muds to be skipped to shore for disposal)	Physical Smothering, Contamination (leading to biological effects) (N)	Reuse mud; use of low toxicity additives and base fluid. Maximum fluid on cuttings for discharge of 6.9%	0-1	1	6	2	R	1
Other Fluids and Solids								
Cement	Change in substrate (N or P)		0	1	1	2	R	1
BOP Fluid	Contamination (N)	Selection Criteria	0	1	1	1	R	1
Cooling Water	Growth (P); Shock (N)	Monitor	0	1	6	2	R	1
Deck Drainage	Contamination (N)	Treatment	1	1	2	2	R	1
Bilge Water	Contamination (N)	Treatment	0	1	2	2	R	1
Sanitary/Domestic Waste Water	Contamination (N)	Treatment	0	1	5	2	R	1

Table 5.9. (Cont.)

Valued Environmental Component: Fish									
Project Activity	**Potential Positive (P) or Negative (N) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**						
			Magnitude	**Geographic Extent**	**Frequency**	**Duration**	**Reversibility**	**Ecological/ Socio-Cultural and Economic Context**
Atmospheric Emissions	See Fish Habitat Table	-	-	-	-	-	-	-
Ships and Boats	No interaction	-	-	-	-	-	-	-
Helicopters	No interaction	-	-	-	-	-	-	-
Sound								
Drilling Rigs	Disturbance (N)	-	0	2	6	2	R	1
Support Vessels	Disturbance (N)	-	1	2	6	2	R	1
Helicopters	Disturbance (N)	-	0	1	4	1	R	1
VSP	Physical (N)	-	0-1	1	1	1	R	1
VSP	Disturbance (N)	-	0-1	3	1	1	R	1
Shore Facilities[b]	N/A*	-	-	-	-	-	-	-

Key:

Magnitude:
0 = Negligible, essentially no effect
1 = Low
2 = Medium
3 = High

Frequency:
1 = < 11 events/yr
2 = 11-50 events/yr
3 = 51-100 events/yr
4 = 101-200 events/yr
5 = > 200 events/yr
6 = continuous

Reversibility:
R = Reversible
I = Irreversible
(refers to population)

Duration:
1 = < 1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = > 72 months

Geographic Extent:
1 = < 1 km^2
2 = 1-10 km^2
3 = 11-100 km^2
4 = 101-1,000 km^2
5 = 1001-10,000 km^2
6 = > 10,000 km^2

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not adversely affected by human activity
2 = Evidence of existing adverse effects

*N/A = Not Applicable

[a] Well head could be in place for an indeterminate period.
[b] There will not be any new onshore facilities required. Existing infrastructure will be used.

Table 5.10. Significance of Potential Residual Environmental Effects on Fish VEC.

Valued Environmental Component: Fish				
	Significance Rating	Level of Confidence	Likelihood[c]	
Project Activity	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Presence of Structures				
No Fishing Zone	P	3	-	-
Artificial Reef Effect	P	3	-	-
Subsea Structures	NS	3	-	-
Fishery Exclusion	See Fishery Table			
Lights and Flares	NS	3	-	-
Drilling Mud/Cuttings				
Water-Based Mud	NS	3	-	-
Synthetic-Based Mud	NS	3	-	-
Other Fluids and Solids				
Cement	NS	3	-	-
BOP Fluid	NS	3	-	-
Cooling Water	NS	3	-	-
Deck Drainage	NS	3	-	-
Bilge Water	NS	3	-	-
Sanitary/Domestic Waste Water	NS	3	-	-
Atmospheric Emissions	NS	3	-	-
Ships and Boats	NS	3	-	-
Helicopters	NS	3	-	-
Sound				
Drilling Rigs	NS	3	-	-
Support Vessels	NS	3	-	-
Helicopters	NS	3	-	-
VSP	NS	3	-	-
Shore Facilities[a]				
Accidents[b]			-	-

Key:

Residual environmental Effect Rating:
S = Significant Adverse Environmental Effect
NS = Not-significant Adverse Environmental Effect
P = Positive Environmental Effect

Significance is defined as a medium or high magnitude (2 or 3 rating) and duration greater than 1 year (3 or greater rating) and geographic extent >100 km^2 (4 or greater rating).

Level of Confidence: based on professional judgment:
1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence

Probability of Occurrence: based on professional judgment:
1 = Low Probability of Occurrence
2 = Medium Probability of Occurrence
3 = High Probability of Occurrence

Scientific Certainty: based on scientific information and statistical analysis or professional judgment:
1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence
N/A = Not Applicable

[a] Not Applicable. There will not be any new onshore facilities required. Existing infrastructure will be used.
[b] Effects assessment of offshore spills is contained in Section 6.0
[c] Only applicable to significant effect.

Table 5.11. Potential Interactions between the Project and Fish Habitat VEC.

Valued Environmental Component: Fish Habitat			
	Habitat		
	Water Quality	Sediment	Topography
Project Activities and Physical Works			
Presence of Structures			
No Fishing Zone			
Artificial Reef Effect			
Subsea Structures		**x**	**x**
Lights and Flares			
Drilling Mud/Cuttings			
Water-Based Mud	**x**	**x**	**x**
Synthetic-Based Mud (if used)	**x**	**x**	**x**
Produced Water (N/A)*			
Other Fluids and Solids[a]			
Cement	**x**	**x**	**x**
BOP Fluid	**x**		
Cooling Water	**x**		
Deck Drainage	**x**		
Bilge Water	**x**		
Sanitary/Domestic	**x**		
Garbage (N/A)*			
Atmospheric Emissions[b]	**x**		
Ships and Boats			
Helicopters			
Sound			
Drilling Rigs			
Support Vessels			
Helicopters			
VSP			
Shore Facilities[c] (N/A)*			
OTHER PROJECTS AND ACTIVITIES			
Hibernia	x	x	x
Terra Nova	x	x	x
White Rose	x	x	x
Hebron	x	x	x
Exploration	x	x	x
Fisheries	x	x	x
Marine Transportation	x		

* Not applicable
[a] Effects assessment of offshore spills is contained in Section 6.0.
[b] Includes produced water that may be flared.
[c] There will not be any new onshore facilities. Existing infrastructure will be used.
Note: Plankton and benthos, also considered part of fish habitat, are assessed under "effects on fish."

Table 5.12. Environmental Effects Assessment on Fish Habitat VEC.

Valued Environmental Component: Fish Habitat									
Project Activity	**Potential Positive (P) or Negative (N) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**						
			Magnitude	**Geographic Extent**	**Frequency**	**Duration**	**Reversibility**	**Ecological/ Socio-Cultural and Economic Context**
Presence of Structures								
Artificial Reef Effect	Increased Food and Shelter (P)	-	1	2	6	2	R	1
Subsea Structures	Distruption (N)[a]	-	1	1	6	2	R	1
Safety Zone	See above	-	-	-	-	-	-	-
Lights and Flares	Attraction (N)	-	0	1	2-4	2	R	1
Drilling Mud/Cuttings								
Water-based Mud and Cuttings	Physical Smothering, Contamination (leading to biological effects) (N)	Reuse mud; use of low toxicity additives and mud systems; pre-post ROV survey; place rig away from sensitive corals	0-1	1	6	2	R	1
Synthetic-based Mud on Cuttings (whole muds to be skipped to shore for disposal)	Physical Smothering, Contamination (leading to biological effects) (N)	Reuse mud; use of low toxicity additives and base fluid. Maximum fluid on cuttings for discharge of 6.9%; pre-post ROV survey; place rig away from sensitive corals	0-1	1	6	2	R	1

Table 5.12 (cont'd)

Valued Environmental Component: Fish Habitat									
Project Activity	**Potential Positive (P) or Negative (N) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**						
			Magnitude	**Geographic Extent**	**Frequency**	**Duration**	**Reversibility**	**Ecological/ Socio-Cultural and Economic Context**
Other Fluids and Solids									
Cement	Negligible	-	0	1	1	2	R	1
BOP Fluid	Contamination (N)	Selection Criteria	0	1	1	1	R	1
Cooling Water	Growth (P); Shock (N)	Monitor	0	1	6	2	R	1
Deck Drainage	Contamination (N)	Treatment	1	1	2	2	R	1
Bilge Water	Contamination (N)	Treatment	0	1	2	2	R	1
Sanitary/Domestic Waste Water	Nutrients (P); Contamination (N)	Treatment	0	1	5	2	R	1
Atmospheric Emissions	Water Quality (N)	Equipment Design	0	2	6	2	R	1
Helicopters	No interaction	-	-	-	-	-	-	-
Sound								
Drilling Rigs	See Fish Table	-	-	-	-	-	-	-
Support Vessels	See Fish Table	-	-	-	-	-	-	-
Helicopters	See Fish Table	-	-	-	-	-		
VSP	Physical (N)	-	0-1	1	1	1	R	1
VSP	Disturbance (N)	-	0-1	3	1	1	R	1
Shore Facilities[b]	N/A*	-	-	-	-	-	-	-

Key:

Magnitude:
0 = Negligible, essentially no effect
1 = Low
2 = Medium
3 = High

Frequency:
1 = < 11 events/yr
2 = 11-50 events/yr
3 = 51-100 events/yr
4 = 101-200 events/yr
5 = > 200 events/yr
6 = continuous

Reversibility:
R = Reversible
I = Irreversible
(refers to population)

Duration:
1 = < 1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = > 72 months

Geographic Extent:
1 = < 1 km^2
2 = 1-10 km^2
3 = 11-100 km^2
4 = 101-1,000 km^2
5 = 1001-10,000 km^2
6 = > 10,000 km^2

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not adversely affected by human activity
2 = Evidence of existing adverse effects

*N/A = Not Applicable

[a] Including plankton and benthos as components of habitat.
[b] There will not be any new onshore facilities required. Existing infrastructure will be used.

Surface structures will consist of the drill rig that will be protected by a Safety Zone within which no unauthorized vessels would be allowed to enter. The structures and associated Safety Zone have the potential to alter the local abundance and distribution of fish (and fishing boats) for a short period of time on the order of 80-100 days (i.e., the time for drilling and testing). The Safety Zone is established under regulation (the *Newfoundland Offshore Area Petroleum Production and Conservation Regulations*) and consists of a 500-m safety zone around the rig or 50 m off each of eight or more anchors, if an anchor system is used. The Safety Zone will be on the order of 0.8 km^2 in total area (CAPP 2001b).

The temporarily-closed area could create a small refuge (about 1 km^2), within which fish, including commercially important species, might be attracted to the structures and become somewhat concentrated. Therefore, the reef effect and Safety Zone acting together could have a positive, short term, low magnitude and small geographic extent effect on fish populations (Table 5.9). This small, temporary refuge for local fish populations, which could subsequently move outside the drilling area, could slightly offset any negative effect of the Safety Zone on fisheries conducted in the area and the substrate disturbance caused by the drilling. These negative and/or positive effects on fish and fish habitat are all *not significant* (Tables 5.10 and 5.13).

Other safety zones in the Grand Banks include Hibernia (5.2 km^2), Terra Nova (13.8 km^2), and White Rose (15.4 km^2) all containing subsea structures. These have all been considered to be *not significant* in effect, positive or negative. The Laurentian Sub-basin drilling will add 1 km^2 but only for about 80 days at a time. The cumulative effects on fish and fish habitat will be additive, but are judged to be not large or long enough to change the overall effects rating.

5.4.3.1. Effects on Benthic Animals

The presence of structures can modify the characteristics of the adjacent seabed substrates and associated infaunal communities (Davis et al. 1982). Changes in benthic communities are also related to increased predation by fish (e.g., cod) attracted to the structures, and by invertebrate predators (e.g., starfish) attracted to the area by the presence of epifaunal prey (Davis et al. 1982). Scavengers are attracted to the area by the presence of any dislodged fouling organisms on the bottom (Dicks 1982).

The water depths within the proposed Project Area range from <50 to >2,000 m, with most of the Project Area occurring in >200 m depths. As discussed previously, all coral specimens collected thus far from Newfoundland and Labrador waters have been taken at depths ranging from 164 to 1,400 m. The average depths of collection for the five deep-water coral species/species groups found off Newfoundland and Labrador range between 319 and 622 m. *Lophelia pertusa*, perhaps the most important reef building deepwater coral, appears to require 200 and 1,000-m water depths, four to 12°C temperatures and hard substrates; the hard substrates can be dead coral that has overgrown and broken

Table 5.13. Significance of Predicted Residual Environmental Effects on Fish Habitat VEC.

Valued Environmental Component: Fish Habitat				
	Significance Rating	**Level of Confidence**	**Likelihood[c]**	
Project Activity	**Significance of Predicted Residual Environmental Effects**		**Probability of Occurrence**	**Scientific Certainty**
Presence of Structures				
No Fishing Zone	P	3	-	-
Artificial Reef Effect	P	3	-	-
Subsea Structures	NS	3	-	-
Fishery Exclusion	See Fishery Table			
Lights and Flares	NS	3	-	-
Drilling Mud/Cuttings				
Water-Based Mud	NS	3	-	-
Synthetic-Based Mud	NS	3	-	-
Other Fluids and Solids				
Cement	NS	3	-	-
BOP Fluid	NS	3	-	-
Cooling Water	NS	3	-	-
Deck Drainage	NS	3	-	-
Bilge Water	NS	3	-	-
Sanitary/Domestic Waste Water	NS	3	-	-
Atmospheric Emissions	NS	3	-	-
Ships and Boats	NS	3	-	-
Helicopters	NS	3	-	-
Sound				
Drilling Rigs	NS	3	-	-
Support Vessels	NS	3	-	-
Helicopters	NS	3	-	-
VSP	NS	3	-	-
Shore Facilities[a]				
Accidents[b]			-	-

Key:

Residual environmental Effect Rating:
S = Significant Adverse Environmental Effect
NS = Not-significant Adverse Environmental Effect
P = Positive Environmental Effect

Significance is defined as a medium or high magnitude (2 or 3 rating) and duration greater than 1 year (3 or greater rating) and geographic extent >100 km^2 (4 or greater rating).

Level of Confidence: based on professional judgment:
1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence

Probability of Occurrence: based on professional judgment:
1 = Low Probability of Occurrence
2 = Medium Probability of Occurrence
3 = High Probability of Occurrence

Scientific Certainty: based on scientific information and statistical analysis or professional judgement:
1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence
N/A = Not Applicable

[a] Not Applicable. There will not be any new onshore facilities required. Existing infrastructure will be used.
[b] Effects assessment of offshore spills is contained in Section 6.0
[c] Only applicable to significant effect.

off and fallen down slope to soft sediment areas. Interestingly, this species appears to be moving into shallower water and healthy colonies have been found growing on oil platforms in the NE Atlantic (Roberts et al. 2003). Although deepwater distributional data should be viewed with some caution, the highest likelihood of occurrence of deep-water corals would be in the southern parts of both the western and eastern portion of the Project Area.

Closed areas will provide some protection against damage to the seabed by trawlers and shellfish dredges and perhaps lower fish mortality from commercial fisheries. However, this would be somewhat offset by the loss of fishing ground for the fishery and at least some perception of negative effects on the health of biota in the immediate area.

Hibernia, Terra Nova, and White Rose have a combined safety zone area of about 34.4 km^2. The proposed drilling Project will add another temporary closure of 1 km^2 at each drill site. The cumulative effects on benthos will be additive but they are judged to not be large enough to change the overall effects rating. Thus, the cumulative effect of the small amount of temporary subsea infrastructure and associated Safety Zone on fish habitat can be considered *negligible*.

5.4.3.2. Biofouling

Colonization of offshore structures by fouling epifaunal animals and plants is considered a nuisance and eventually a hazard (i.e., an effect of the environment on the Project). Epifaunal animals make visual inspections more difficult, increase hydrodynamic loading, contribute to fatigue and corrosion, and may interfere with corrosion protection systems (Edyvean et al. 1985). Any accumulated fouling is periodically removed before deployment to the site and thus any potential negative effects will be reduced to *negligible*. This effect of the environment on the Project is *not significant*.

5.4.4. Lights and Flares

Some species of fish and squid may be attracted to illuminated surface waters near the vessels (Hurley 1980) but any effects would be *negligible* because numbers and areas affected are so small. There would also be a *negligible* effect at the other developments, with an overall *negligible* cumulative effect.

5.4.5. Discharge of Other Fluids and Solids

The Operators will utilize an Offshore Chemical Management System (OCMS), similar to that in use by Husky on White Rose, Petro-Canada on Terra Nova and ExxonMobil on Hibernia, whereby all chemicals in use offshore will be screened to minimize potential toxicity.

Based on experience with previous exploratory wells, excess cement will be released to the marine environment and will smother some benthos locally. If the cement remains in a pile, it will act as an artificial reef, be colonized by epifaunal animals and attract fish. The effects (either *negative* or *positive*) of the cement on benthos would be *negligible*.

Blowout preventer (BOP) fluid is used in the blowout preventer stacks during drilling. The fluids will be composed of glycol-water mixes screened in accordance with the *Chemical Selection Guidelines*. Periodic testing of the BOP is required by the C-NLOPB. An approximate 1 m^3 of the fluid released per test (released by semi-submersible rigs but not by jack-ups) will be quickly dispersed. Periodic releases of this small amount of glycol will have a *negligible* effect on water quality or marine biota.

5.4.6. Deck Drainage

Deck drainage from the rotary table area and machinery spaces will be collected and treated in accordance with the *OWTG* prior to discharge. Oil will be recovered and recycled or transferred to shore and disposed in an approved manner. Any loss of oil containment on deck will be immediately cleaned up prior to reaching the ocean. Effects on water quality from treated deck drainage will be low magnitude, very small in geographic extent, and of short duration (Table 5.12). Effects will be additive with other projects but the cumulative effect will not exceed this rating. The effect on water quality will be *not significant*. Deck drainage is unlikely to have any direct effects on fish and will be *not significant*.

5.4.7. Cooling Water

Seawater is used in cooling systems for the main engine and mud pump lines. It is pumped through heat exchangers and discharged overboard without additives or treatment except chlorine in some cases for anti-fouling purposes. Fluids used in closed loop cooling systems are tested for compliance prior to discharge. Proposals for the use of disinfectants will be submitted to the Chief Conservation Officer as per the current *OWTG* (NEB et al. 2002).

Effects of the discharge of these small amounts of cooling water on fish and fish habitat will be *negligible* and *not significant* as will the cumulative effects of cooling waters from other platforms (Hibernia, Terra Nova, and White Rose).

5.4.8. Sanitary and Domestic Waste

The total number of persons on a drill rig at any one time may range from 85 to 120. For a floating drilling platform accommodating about 100 people, Mobil (1985) estimated that grey water discharge would be 40 m^3/d and that black water discharge would be about 19 m^3/d. The sanitary waste will be macerated to a particle size of 6 mm or less and included in the discharge as per *OWTG*. Typically the wastewater is collected via a vacuum/gravity septic system where it is treated and tested for compliance and discharged. Food waste will be compacted and shipped ashore in containers.

Organic matter from ground up sanitary waste will be quickly dispersed and degraded by bacteria. The effects on receiving waters and its inhabitants of this small amount of organic matter and nutrients will be *negligible* and *not significant* as will the cumulative effects with other projects and shipping discharges.

5.4.9. Solid and Hazardous Waste

All solid waste will be transferred ashore for disposal. Combustible materials such as oily rags and paint cans will be placed in separate hazardous materials containers and transferred ashore. The rig will have a routine recycling program that identifies all garbage which can be handled as recyclable materials.

Sludges from oil-water separators, spent lubricants, all plastic material, glass and metal wastes will be transferred to shore for appropriate handling, including reuse and recycling where possible. Excess chemicals or chemicals in damaged containers will not be discharged into the sea. They will be returned to shore by supply boat. Spent or excess acid will be disposed of in accordance with the Waste Management Plan.

No solid waste will be discharged over the side; thus, there will be no interaction with the marine environment. This is similar to the other projects (Hibernia, Terra Nova, and White Rose) and thus the cumulative effects will be non-existent or *negligible*.

No waste material that is hazardous to marine life will be discharged over the side and so, there will be no interaction with the environment and no effects on the marine environment. This is similar to the other projects on the Grand Banks and thus the cumulative effects will be *negligible*.

Any chemical that is used in drilling and has potential to be discharged will be evaluated by the Operators according to the *Offshore Chemical Selection Guidelines* (NEB et al. 1999). An offshore chemical management system will be in place as part of the drilling operational procedures.

Substances not mentioned above or in the current NEB and C-NLOPB guidelines will not be discharged without prior notification and approval of the Chief Conservation Officer in accordance with the *OWTG*.

5.4.10. Ballast Water

On floating drill rigs and supply boats, ballast water is stored in dedicated ballast tanks. No oil is present or stored in ballast tanks and so none will be present in the discharged ballast water. If oil is suspected to be in the water, it will be tested and, if necessary, treated to ensure that oil concentrations in the discharge do not exceed 15 mg/L, as required by the current *OWTG*.

5.4.11. Bilge Water

Bilge water often contains oil and grease that originate in the engine room and machinery spaces. Prior to discharge, bilge water will be treated to meet the current *OWTG*, which specify that the discharge will contain 15 mg/L or less of oil. Oil concentrations exceeding 15 mg/L will be re-treated or skipped to shore for disposal; any inadvertent discharges above 15 mg/L are considered to have exceeded normal operating practice and will be reported to the Chief Conservation Officer within 24 h. Any effects on fish or fish habitat should be *negligible*.

5.4.12. Produced Fluids

Produced gas and fluids will be separated on the rig if testing occurs. Gas, oil and condensate, if present, will be flared on the rig during well testing. The flare boom contains a special burner that atomizes the oil and/or gas and mixes it with air. This allows for relatively complete combustion and minimizes air pollution. The relatively small amounts of produced water, if it occurs, may be burned, discharged under *OWTG* specifications, or transported to shore.

Effects of burning or discharging small amounts of treated produced water from drilling operations on fish or fish habitat would be *negligible*. Cumulative effects will also be *negligible* and *not significant*.

5.4.13. Atmospheric Emissions

During exploratory drilling, there may be four sources of atmospheric emissions:

1. Combustion of well fluids during production tests (only if petroleum hydrocarbons are found in sufficient quantities) and well completions (burner boom emissions);
2. Engine, generator and heating exhausts from the drill rig, helicopters, and supply vessels;
3. Mud, degassing and other mudroom exhausts; and
4. Fugitive emissions.

Testing of the wells helps to determine the extent of the reservoir and fluid conditions. Each test will produce approximately 1,000 m^3 of mixed hydrocarbon liquids. Hydrocarbons produced by the tests and some completion fluid will be burned with burner booms. In addition to the smoke and particulate matter, emissions will also contain unburned hydrocarbons, and oxides of nitrogen (NO_x), carbon monoxide (CO), some sulphur dioxide (SO_2), carbon dioxide (CO_2), and water vapour. Flaring activities will be kept to a minimum reflecting only those tests necessary to determine reservoir parameters.

Exhaust gases will also be emitted from generators, engines and heaters on board the drill rigs and the support vessels. Exhaust gases will contain oxides of nitrogen, carbon dioxide, carbon monoxide and sulphur dioxide and unburned hydrocarbons. It is estimated that engine exhausts from drilling could be approximately 5×10^6 m^3/d per rig (CO, NO_x, CO_2, mixed hydrocarbons and particulates) (Mobil 1985). However, it should be noted that the newer rigs have considerably reduced emissions. For example, the new low NO_x engines achieve up to a 35% reduction in NO_x emissions conventional diesels (LGL 2005).

Small amounts of gas will also be vented through flame arresters on storage tanks on the drill rig. In addition, there will be some small amounts of fugitive emissions such as hydrocarbon losses at valves and seals, and particulate matter from cement and chemical powders.

In general, the effects of atmospheric emissions will be *negligible* because emissions of potentially harmful materials will be small and of short duration and they will rapidly disperse to undetectable levels. In addition, the operators may seek dispensation from the C-NLOPB to exempt them from the requirement of having to test potential discoveries from initial exploratory wells.

5.4.14. Effects of Ships and Boats

The drilling rig will be supported by three vessels of 12-15,000 HP. There will be, on average, two trips per week between the base and the platform. These will be the supply vessels which have commonly been used to support the drilling of an offshore well off Newfoundland. They will transport pipe, liners, casing cement, drilling muds, chemicals, fresh water, food, fuel and all the other material necessary for drilling. One vessel will remain near each rig on standby. This type of vessel also would be used to redirect icebergs that might pose a threat to the drilling rig.

Discharges from vessels are discussed in previous sections. All discharges from vessels, including sanitary and domestic waste and bilge water, will be governed by any current and relevant *OWTG* or MARPOL requirements. Overall, effects of vessel discharges, including cumulative effects on fish and fish habitat, would be *negligible* and *not significant*. Potential effects related to sound are discussed below.

5.4.15. Effects of Helicopters

Personnel and light supplies will be transported to and from the drilling rig via twin-engine, offshore-rated helicopters (e.g., Super Puma) with flights occurring approximately six times per week. Potential effects of helicopters on the marine environment are mainly related to sound, which is discussed in the following section.

5.4.16. Effects of Sound

Fish vary widely in their ability to hear sounds. Some fish have very good auditory capabilities. In many of these species, such as certain herring-like fishes, the swim bladder is connected directly to the inner ear. In contrast, cod do not have a direct connection between swim bladder and inner ear, and are less sensitive to sound than are some other species of fish (Olsen 1969).

The various types of potential effects of exposure to sound on fish and invertebrates can be considered in three categories: (1) pathological, (2) physiological, and (3) behavioural. Pathological effects include lethal and sub-lethal damage to the animals, physiological effects include temporary primary and secondary stress responses, and behavioural effects refer to changes in exhibited behaviours of the fish and invertebrate animals. The three categories should not be considered as independent of each other and are interrelated in complex ways. For example, it is possible that certain physiological and behavioural changes could potentially lead to an ultimate pathological effect on individual animals (i.e., mortality). However, it appears that fish and invertebrates must be exposed to high sound pressure levels for extended periods of time before physical and physiological effects become apparent. Behavioural effects are another issue. There are suggestions that fish horizontal and vertical distributions might be affected by exposure to sound. However, any apparent effect seems to be temporary in nature. Potential effects of exposure to sound on fish and invertebrates are discussed in more detail in the 2004 Laurentian 2-D Seismic Survey Environmental Assessment (Buchanan et al. 2004) and the Laurentian Sub-basin 3-D Seismic Program, Environmental Assessment Update, 2005 (Christian et al. 2005).

The reactions of fish to ship sounds in the field have been measured with a forward-looking sonar and a downward looking echosounder. Sound produced by a ship varies with aspect and is lowest directly ahead of the ship and highest within butterfly-shaped lobes to the side of the ship (Misund et al. 1996). Because of this directivity, fish that react to ship sounds may do so by swimming in the same direction as the ship and will be guided ahead of it (Misund 1997). In other instances, fish will avoid the ship by swimming away from the path and will become relatively concentrated to the side of the ship (Misund 1997). Most schools of fish will not show avoidance if they are not in the path of the vessel. When the vessel passes over fish, some species, in some cases, show sudden escape responses that include lateral avoidance and/or downward compression of the school (Misund 1997). Avoidance reactions are quite variable and depend on species, life history stage, behaviour, time of day, whether the fish have fed, and sound propagation characteristics of the water (Misund 1997).

Little is known about invertebrate reactions to sound. It has been generally believed that seismic exploration has had little effect on important marine invertebrates such as lobster, shrimp and crab because these animals do not have hearing organs. Nonetheless, they may be able to detect certain vibrations (reviewed in Christian et al. 2004).

5.4.17. Effects of Supply Vessels

Effects of sound from passage of a supply vessel will be transitory and no greater than that of passage of a fishing vessel. Effects of supply vessels on fish behaviour will be low magnitude, not extensive geographically, and short to medium duration (Table 5.9). There will be *no significant* effects on fish and fish habitat.

5.4.18. Effects of the Drill Rig

Generally, underwater sound levels produced by drillships are higher than those produced by semi-submersible drill rigs (Richardson et al. 1995). Sound from a semi-submersible drilling rig working in 114 m water depth in the Bering Sea did not exceed ambient sound levels beyond a range of one km (Greene 1986). Support boats were also present at the time these measurements were taken. In contrast, sound produced by working drillships did not decline to ambient levels until distances beyond 10 km from the source (Richardson et al. 1995).

Sounds emitted by a drilling rig are lower in magnitude, but more continuous, than those from supply boats or seismic exploration. The fact that fish are well-known to be attracted to offshore drilling and production platforms (Stanley and Wilson 1990; Black et al. 1994) indicates that fish adapt well to sounds associated with offshore oil exploration. Effects of sound from drill rigs on fish and fish behaviour in the Project Area will be negligible. Similarly, cumulative effects will be negligible and not significant.

5.4.19. Effects of VSP

Vertical seismic profiling (VSP) are usually performed with seismic arrays with lower source levels than 2-D or 3-D seismic exploration surveys, occur over a few hours or days, and any effects on biota are mitigated by safety zones and ramp-ups. Considering that the potential effects of VSP are less than those associated with commercial exploratory seismic surveys, and that the effects of the 2-D and 3-D seismic surveys in the Laurentian Sub-basin were assessed as being *not significant* (Buchanan et al. 2004; Christian et al. 2005), the effects of exposure to the VSP on fish and fish habitat will be *not significant*.

5.4.20. Cumulative Effects of Underwater Sound on Fish and Fish Habitat

Other drilling programs on or near the Grand Banks will not overlap in space with the one proposed here. The amount of future seismic exploration off the Newfoundland east coast will be highly variable and difficult to predict. Four seismic programs (one each in Labrador, Orphan Basin, the Laurentian Sub-basin, and the Grand Banks) were conducted in Newfoundland and Labrador waters in 2005. It is probably reasonable to assume two programs per year over the next few years. Davis et al. (1998) considered the effects of seismic exploration on the Scotian Shelf on adult commercial fish and invertebrates to be *negligible*. However, these authors did conclude that effects on fish eggs and larvae could be minor, sublocal, short term and likely. Similar cumulative effects can be expected for the Grand Banks unless the technology and level of activity changes greatly in the future. Thus, the cumulative effects of the exploratory drilling program and seismic exploration on fish can be expected to be adverse, of low magnitude, limited geographic extent, and short duration. These cumulative effects are considered *not significant*.

5.5. Potential Effects on Commercial Fisheries

The primary sources of potential impacts of the proposed ConocoPhillips exploratory drilling program on commercial fisheries include the following: (1) noise from drilling, vessels, VSP and shallow geohazard surveys, (2) presence of structures in the water and/or on the seabed and any related safety exclusion zones, and (3) presence and activities of ships and seismic streamers. Other sources of potential impacts on commercial fisheries include any physical effects on commercial fish and invertebrates (and prey of commercial species), and routine emissions and discharges (e.g., drilling muds and cuttings, greywater, deck drainage, etc). Physical effects on fish and invertebrates are not discussed in this section as they have already been assessed as *not significant* in Section 5.4 dealing with physical impacts on marine biota. The potential effects on the fisheries due to accidental spills are discussed and assessed separately in Section 6.0

This assessment of drilling activities considers exclusion of fishing from the location of the drill rig, subsea hazards and necessary safety zones, changes in catch rates from noise-induced behavioural changes, and interference from the presence of Project support vessels.

With respect to VSP and geohazard survey activities, this assessment considers changes in catch rates due to noise-induced behavioural effects (scaring of fish) and interference with fishing activities because of possible gear or vessel conflicts, particularly with fixed gear.

Potential effects of routine activities associated with exploratory drilling on stock assessments (DFO and industry research) are also considered in this section. Effects on research surveys could occur either as a result of behavioural responses, fishing interference or displacement (i.e., through the same pathways as impacts on commercial fishing).

The potential effects on fisheries will vary by location within the Project Area, depending on where exploratory drilling occurs. For instance, as the fish harvesting maps in Section 4.7 indicate, there are many areas within the Project Area where there is little recorded fishing activity. Most fishing activity with a good level of consistency from year to year occurs within fairly well-defined zones along the shelf break, in the Laurentian Channel within the southern part of the of the western Project Area, and in the northernmost part of the eastern Area.

Considering that the physical areas occupied by drilling and VSP/shallow geohazard infrastructure is quite limited, the potential "footprint" of Project components with respect to the commercial fisheries would also be small.

For the currently-proposed drilling sites, the eastern area has had no recorded fishing activity during the past three years, while approximately 205 t of landings were reported for the western area in 2005, 80% of which was harvested with mobile gear (stern trawls).

The potential interactions between Project components and the commercial fisheries are shown in Table 5.14. The effects assessment is shown in Table 5.15 and the significance of predicted residual environmental effects on commercial fisheries and research surveys is indicated in Table 5.16.

Section 4.9 of the C-NLOPB's *Guidelines Respecting Drilling Programs in the Newfoundland Offshore Area* (C-NLOPB 2000) state, "the operator should provide for the advance notification of persons engaged in fishing activities in the proposed area of operations and the measures to be put in place to eliminate any potential mutual interference." In addition, the C-NLOPB *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2004) provide guidance aimed at minimizing any impacts of VSP / well-site surveys on commercial fish harvesting. The relevant Guidelines state (Appendix 2, Environmental Mitigative Measures):

Table 5.14. Potential Interactions between the Project and Commercial Fisheries VEC.

Valued Environmental Component: Commercial Fisheries (including Research Surveys)	
	Fishery
Project Activities and Physical Works	
Presence of Structures	
Vessel Exclusion Zones	X
Artificial Reef Effect (Potentially a positive interaction)	x
Subsea Structures (Unlikely to be left abandoned)	X
Lights (Potentially a positive interaction)	x
Flaring (Potentially a positive interaction)	x
Drilling Mud/Cuttings	
Water-Based Mud	x
Synthetic-Based Mud	x
Produced Water (N/A)*	
Other Fluids and Solids[a]	
Cement	
BOP Fluid	x
Cooling Water	x
Deck Drainage	x
Bilge Water	x
Sanitary/Domestic	x
Garbage (N/A)*	
Atmospheric Emissions[b]	x
Ships and Boats (including seismic survey ship and towed streamer)	X
Helicopters	
Noise	
Drilling Rigs	X
Support Vessels	X
Helicopters	
VSP and Geohazard Surveys	X
Shore Facilities[c] **(N/A)***	
OTHER PROJECTS AND ACTIVITIES	
Marine Transportation	x

* Not applicable
[a] Effects assessment of offshore spills is contained in Section 6.
[b] Includes produced water that will be burned.
[c] There will not be any new onshore facilities. Existing infrastructure will be used.

(Note that uppercase X's in table are the only direct interactions between the Project and the fishery. The lower case x's are indirect via fish and/or fish habitat, and are considered in Tables 5.8 -5.11).

Table 5.15. Effects Assessment on Commercial Fisheries.

Valued Environmental Component: Commercial Fisheries (including Research Surveys)									
Project Activity	**Potential Positive (P) or Negative (N) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**						
			Magnitude	**Geographic Extent**	**Frequency**	**Duration**	**Reversibility**	**Ecological/ Socio-Cultural and Economic Context**
Presence of Structures									
Vessel Exclusion Zones	Vessel Exclusion(N)	Fishing in other available areas. For science/ industry surveys, selecting alternative locations, if coincident; communications	1	2	6	2	R	1
Artificial Reef Effect	See Fish and Fish Habitat Tables	-	-	-	-	-	-	-
Subsea Structures[a]	N/A*	-	-	-	-	-	-	-
Lights	Fish Attraction (N) Safety (P)	-	0	1	2-4	2	R	1
Flaring	Fish Attraction (N) Safety (P)	-	0	1	3	2	R	1
Drilling Mud/Cuttings								
Water-Based Mud	Contamination (N)	Recycle; Treat muds and discharge cuttings	0-1	1	6	2	R	1
Synthetic- Based Mud	Contamination (N)	Recycle; Treat muds and discharge cuttings	0-1	1	6	2	R	1
Other Fluids and Solids								
Cement	Negligible		0	1	1	2	R	1
BOP Fluid	Contamination (N)	Selection Criteria	0	1	1	1	R	1
Cooling Water	Growth (P); Shock (N)	Monitor	0	1	6	2	R	1
Deck Drainage	Contamination (N)	Treatment	1	1	2	2	R	1
Bilge Water	Contamination (N)	Treatment	0	1	2	2	R	1
Sanitary/Domestic Waste Water	Contamination (N)	Treatment	0	1	3	2	R	1
Atmospheric Emissions	Water Quality (N)	Equipment Design	0	2	6	2	R	1

Table 5.15 (cont'd)

Valued Environmental Component: Commercial Fisheries (including Research Surveys)									
Project Activity	**Potential Positive (P) or Negative (N) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**						
			Magnitude	**Geographic Extent**	**Frequency**	**Duration**	**Reversibility**	**Ecological/ Socio-Cultural and Economic Context**
Ships and Boats (including seismic survey ship and towed streamer)	Disturbance (N)	Communications, compensation	0	1	2	2	R	1
Helicopters	No Interaction	-	-	-	-	-	-	-
Noise								
Drilling Rigs	Disturbance (N)	-	0	2	6	2	R	1
Support Vessels	Disturbance (N)	-	0	2	6	2	R	1
Helicopters	Disturbance (N)	-	0	1	2	1	R	1
VSP and Geohazard Surveys	Disturbance (N)	Fishing in other available areas; communications, FLO, and SPOC to avoid gear. For science surveys, selecting alternative set locations, if coincident; communications / protocol to avoid overlap;	0	4	1	1	R	1
Shore Facilities[b]	N/A*	-	-	-	-	-	-	-

Key:

Magnitude:
0 = Negligible, essentially no effect
1 = Low
2 = Medium
3 = High

Frequency:
1 = < 11 events/yr
2 = 11-50 events/yr
3 = 51-100 events/yr
4 = 101-200 events/yr
5 = > 200 events/yr
6 = continuous

Reversibility:
R = Reversible
I = Irreversible
(refers to population)

Duration:
1 = < 1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = > 72 months

Geographic Extent:
1 = < 1 km^2
2 = 1-10 km^2
3 = 11-100 km^2
4 = 101-1000 km^2
5 = 1001-10,000 km^2
6 = > 10,000 km^2

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not adversely affected by human activity
2 = Evidence of existing adverse effects

*N/A = Not Applicable

[a] In the unlikely event that a well had to be suspended, a well head could be in place for an indeterminate period.
[b] There will not be any new onshore facilities required. Existing infrastructure will be used.

Table 5.16. Significance of Predicted Residual Environmental Effects on Fishery.

Valued Environmental Component: Commercial Fisheries (including Research Surveys)				
	Significance Rating	**Level of Confidence**	**Likelihood**	
Project Activity	**Significance of Predicted Residual Environmental Effects**		**Probability of Occurrence**	**Scientific Certainty**
Presence of Structures				
Vessel Exclusion Zones	NS	3		
Artificial Reef Effect	See Fish and Fish Habitat Tables			
Subsea Structuresa	See Fish and Fish Habitat Tables			
Lights	NS	3		
Flaring	NS	3		
Drilling Mud/Cuttings				
Water-Based Mud	NS	2		
Synthetic-Based Mud	NS	2		
Other Fluids and Solids				
Cement	NS	3		
BOP Fluid	NS	3		
Cooling Water	NS	3		
Deck Drainage	NS	3		
Bilge Water	NS	3		
Sanitary/Domestic Waste Water	NS	3		
Atmospheric Emissions	NS	3		
Ships and Boats (inc. seismic survey vessels and streamers)	NS	3		
Helicopters	NS	3		
Noise				
Drilling Rigs	NS	3		
Support Vessels	NS	3		
Helicopters	NS	3		
VSP	NS	3		
Shore Facilities[a]				
Accidents[b]	NS	2		

Key:

Residual environmental Effect Rating:
S = Significant Adverse Environmental Effect
NS = Not-significant Adverse Environmental Effect
P = Positive Environmental Effect

Significance is defined as a medium or high magnitude (2 or 3 rating) and duration greater than 1 year (3 or greater rating) and geographic extent >100 km^2 (4 or greater rating).

Level of Confidence: based on professional judgment:

1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence

Probability of Occurrence: based on professional judgment:
1 = Low Probability of Occurrence
2 = Medium Probability of Occurrence
3 = High Probability of Occurrence

Scientific Certainty: based on scientific information and statistical analysis or professional judgement:
1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence
N/A = Not Applicable

[a] Not Applicable. There will not be any new onshore facilities required. Existing infrastructure will be used .
[b] Effects assessment of offshore spills is contained in Section 6.0

1.a) The operator should implement operational arrangements to ensure that the operator and/or its survey contractor and the local fishing interests are informed of each other's planned activities. Communication throughout survey operations with fishing interests in the area should be maintained.

1.b) Where feasible, a soft-start approach – a gradual ramp-up of airguns - should be implemented prior to survey. Ramp up procedures should follow measures outlined below in Section 2(e)

1.c) The operator should publish a Canadian Coast Guard "Notice to Mariners" and a "Notice to Fishers" via the CBC Radio program Fisheries Broadcast.

1.d) Operators should implement a gear and/or vessel damage compensation program, to promptly settle claims for loss and/or damage that may be caused by survey operations. The scope of the compensation program should include replacement costs for lost or damaged gear and any additional financial loss that is demonstrated to be associated with the incident. The operator should report on the details of any compensation awarded under such a program.

1.e) Procedures must be in place on the survey vessel(s) to ensure that any incidents of contact with fishing gear are clearly detected and documented (e.g., time, location of contact, loss of contact, and description of any identifying markings observed on affected gear). As per Section 4.2 of these Guidelines, any incident should be reported immediately to the 24-hour answering service at (709) 778-1400 or to the duty officer at (709) 682-4426.

The following sections describe how the proposed exploratory drilling program and related activities will meet each of the above mitigative guidelines, as well as other measures that will be applied.

5.5.1. Impacts on Harvesting (Exclusion / Disturbance)

5.5.1.1. Rigs Exclusion Areas

The establishment of safety zones around the active drill sites will exclude fishing from those areas while drilling and associated operations are under way. As described, it is expected that each well will take between 80 and 100 days to complete. Assuming a rig at two sites in a given year, this is potentially up to 200 days when fishing might be excluded from some portion of the Project Area. These safety zones are typically defined by a 500 m radius from the rig, so that an area of approximately one square kilometre might be involved. For safety, a hailing zone at a greater distance might also be established to warn approaching ships.

Considering that there is relatively little fishing activity within much of the Project Area throughout the year (as described in Section 4.7), the likelihood that fish harvesting success will be affected by a 1 km^2 exclusion area is low. Even if a rig were positioned in one of the areas where harvesting normally occurs in the zone, the area could be easily avoided by harvesters. Given that most of the harvest in the area is with mobile gear (redfish), avoiding an operating rig would involve no more than a slight course deflection during a trawl. For fixed gear fishers, it might mean shifting their gear set locations by a few hundred metres. Moving the gear such a distance would not be expected to result in lowered overall catch success.

5.5.1.2. Site Survey and Drilling Noise

Noise will be generated by drilling-related activities as well as by vessels conducting VSP/site surveys using seismic sound sources (compressed air arrays). Fisheries industry representatives have registered concerns in the past that seismic survey sound sources may scare finfish from their fishing locations, or discourage benthic species (such as snow crab) from entering fishing gear. Indeed, the likelihood that finfish will move away to a comfortable distance as the array approaches is considered a factor that helps prevent physical impacts on these species. The same issues might be related to the sounds from drilling, though this is expected to be at a lower received level than sound from seismic surveys.

In either case, only a small area will be affected by sound compared to a conventional 2-D or 3-D geophysical survey, since the location where the activities would take place will be quite small, i.e., in the immediate area of the drilling location.

The discussion of the behavioural effects on fish and invertebrates in Buchanan et al. (2004) and Christian et al. (2005) presents the results of studies on the effects of seismic noise on catch rates. While most - though not all - of these studies report some decrease in catch rates near seismic arrays, there is less agreement on the duration and geographical extent of the effect, ranging from a quick return to several days, and from very localized effects to decreased catch rates several kilometres away.

Depending on the juxtaposition of the survey sound source, the fish being harvested, and the fishing gear, the impact on fishing success could be either negative or positive. The effect would be positive if, for instance, the fish (e.g., cod) were driven away from the sound source and towards fishing gear (e.g., fixed gillnets).

5.5.1.3. Assessment

In general, because of the low levels of fish harvesting (especially with fixed gear) in the much of the Project Area, and the ready availability of alternative fishing areas, the short duration and limited extent of exploratory drilling, no mitigations are required to ensure that there are no significant impacts. However, mitigation measures will be employed as described below. Consequently, the proposed Project is predicted to have low disturbance effects on the fishery. Therefore, effects of the Project on this component of the commercial fisheries VEC would be "not significant."

5.5.1.4. Mitigations

Communications / Notification

During the fisheries consultations for this and other offshore oil and gas exploration projects, fisheries representatives have noted that maintaining good communications is one of the best ways to minimize interference with fishing activities. It is also specified in the C-NLOPB *Guidelines*.

Communications will be maintained (directly at sea by the rig and other Project vessels) via marine radio to facilitate information exchange with fisheries participants. Relevant information about the rig locations, the safety zone and other relevant operations will also be publicized using established communications mechanisms, such as the *Notices to Shipping* (Continuous Marine Broadcast and NavTex) and CBC (Newfoundland) Radio's *Fisheries Broadcast*. During any site surveys, a fisheries representative – the Fisheries Liaison Officer (FLO, see below) - will also be on board the survey ship, and assist with fisheries communications, as will the program Single Point of Contact (SPOC, see below).

Avoidance

With the information provided to the fishing industry, potential impacts on fishing (catch success as well as fishing gear interactions, as discussed below) can be mitigated by fishers by avoiding the drilling locations and the designated safety exclusion area. This area will be kept as small as feasible in order to ensure mutual safety.

5.5.2. Fishing - Fishing Gear Interactions

5.5.2.1. Structures

Fishing (and other) vessels will be excluded from a Safety Zone around the drill rig. This information will be publicized and communicated to the fishing industry. This should preclude any opportunity for conflict with fishing gear. Since it is planned that sub-sea structures will be removed upon completion of the drilling program (or left in place if beyond the reach of fishing gear), there should be no continuing risk of a hazard/interference after each drilling program is completed. In the event that this cannot be accomplished for some reason, the hazard would be charted and would have to be avoided by bottom-tending fishing gear.

5.5.2.2. Survey Vessel Streamers

In previous surveys, concerns have been raised about the seismic vessel or streamer becoming entangled with fishing gear, most specifically fixed gear (e.g., crab pots or gillnets) if it is concurrent and co-locational with survey operations. This is unlikely in the present case where the VSP will probably be conducted from the rig or within a kilometre or so of the rig. In general, survey vessels will seek to avoid fishing gear in their path. When conflicts have occasionally occurred during other projects, the claims have been assessed and compensation paid for losses.

5.5.2.3. Other Project Vessels

Other project vessels, as well as the drill ship itself when in transit, will not pose a risk greater than other routine shipping and fishing vessels in the area. This assessment (and the fisheries maps it contains) will help inform vessel operators of the likely locations of fixed fishing gear so that areas can be avoided. If other project vessels do damage fishing gear, compensation will be assessed.

5.5.2.4. Assessment

Given the low levels of fishing likely in many parts of the Project Area, the availability of other fishing locations, communications, and compensation plans in place (described below), the economic impacts on fishers would be negligible, and thus not significant.

5.5.2.5. Mitigations

Avoidance

As discussed above, potential impacts on fishing gear will be mitigated by avoiding drill rigs and safety zones, based on good, at-sea communications and information exchange. Site surveys will avoid any fixed fishing gear.

Fisheries Liaison Officer and Single Point of Contact

As a specific means of facilitating at-sea communications during any site surveying activities and informing the vessel operators about local fisheries, ConocoPhillips will have on-board a fisheries liaison officer. Experienced FLOs are available through the FFAWU. The FLO will remain on the vessel for the survey programs. In particular, the FLO will contact fishing vessels in the vicinity of the work to help identify gear locations, discuss potential interactions and find solutions, and provide essential guidance to the ship's Bridge.

A Single Point of Contact (SPOC) with the fisheries industry, as described in the C-NLOPB Guidelines, will also be used in conjunction with the FLO to assist in communications and to deal with any gear damage compensation claims.

Fishing Gear Compensation

In case of accidental damage to fishing gear, ConocoPhillips will implement gear damage compensation plans to provide appropriate and timely compensation to any affected fisheries participants. The operator will follow the procedures (which have been employed successfully in the past) for documenting any incidents.

ConocoPhillips is familiar with programs developed jointly by the fisheries industry and offshore petroleum operators (e.g., by the Canadian Association of Petroleum Producers and other Operators) as alternatives to claims through the courts or the C-NLOPB, to address all aspects of compensation for attributable gear and vessel damage. These programs include provisions for paying compensation for lost or damaged gear, and any additional financial loss, which is demonstrated to be associated with the incident. The programs include mechanisms for claim payments and dispute resolution. The operator will implement similar procedures to settle claims promptly for any loss or damage that may be caused by survey operations, including the replacement costs for lost or damaged gear, and any additional financial loss that is demonstrated to be associated with the damage, as specified under the 2004 Guidelines, Appendix 2 (1d). ConocoPhillips will provide the C-NLOPB with details of any compensation to be paid.

The Notices to Shipping filed by the vessel will also inform fishers that they may contact the SPOC toll free if they believe that they have sustained Project-related gear damage.

5.5.3. DFO Research Surveys

Since these research surveys are conducted by "fishing" for species, the issues related to potential interference with DFO research surveys are essentially the same as for commercial fish harvesting, i.e., potential effects on catch rates and potential conflicts with the fisheries research operations owing to interference or displacement.

As noted in the commercial fisheries section of this assessment, there is some potential for overlap with DFO and industry research surveys in 4V and /or 3P, depending on timing and actual drilling locations. The DFO surveys are conducted by “fishing” within specific depth zones. With respect to potential interference between the research surveys and exploration activity (for example, the presence of a drilling rig on one of the chosen set locations), DFO has noted that, when selecting a set location, managers typically make provision for several alternative set locations. Thus if a drilling rig happened to be located directly on, or too near, a particular set location, the RV could likely use the alternative location (B. Brodie, pers. comm., April 2005).

Considering the small areas occupied by Project drilling-related activities, displacement of industry surveys would need only implement a diversion of a km or less to avoid drilling activities. For site profiling or geohazard surveys (which would be short in duration and limited in extent), communication and coordination with DFO and the fishing industry would be implemented, as is typically done in this jurisdiction for typical 2-D and 3-D seismic surveys.

Given this, and the mitigations described below, the impact on DFO science surveys will be negligible and not significant

5.5.3.1. Mitigations

Any DFO or industry survey taking place in the Project Area will need to be monitored, information exchanged, and locations selected that avoid Project drilling site locations, if the initial set locations are coincident. The SPOC and project managers will facilitate this process.

5.6. Potential Effects on Seabirds

The potential effects of the proposed exploratory drilling program on seabirds are evaluated in the following section. The potential interactions between drilling activities and seabirds are shown in Table 5.17. The potential effects, mitigation measures, cumulative effects and monitoring practices are discussed. The environmental effects assessment and the significance of predicted residual effects on seabirds are summarized in Tables 5.18 and 5.19.

5.6.1. Presence of Structures

The physical structure, drill rig and supply vessels could affect seabirds by attracting them. Most seabirds would not be attracted to the vessel during daylight but lights on sea-going vessels regularly attract seabirds at night.

5.6.2. Lights and Flaring

In Newfoundland waters Leach's Storm-Petrel is particularly prone to being attracted to lights at night. Leach's Storm-Petrels breed in large numbers in Newfoundland (see Table 4.16). It was the most numerous species of seabird on the Laurentian Sub-basin seabird surveys during the 2005 seismic program (Moulton et al. 2006a). During the 2005 seismic program on the Laurentian Sub-basin a total of 134 Leach's Storm-Petrels were found stranded on 107 nights from 14 June to 29 September (Moulton et al. 2006a).

Checking the drill rig and support vessels early in the morning on a daily bases would locate most Leach's Storm-Petrels that stranded on the decks over night. Birds could be released immediately if dry. Individuals with wet or oiled feathers will be held in a cardboard box lined with absorbent material (i.e., paper towels) and placed in a warm and dry location for several hours or until dry before releasing. Personnel will be assigned to conduct daily checks and be familiar with guidelines for caring and handling instructions in the manual by Williams and Chardine (n.d.). Personnel quickly learn where the birds are most often found stranded. The outdoor deck workers should be made aware of the stranded Leach's Storm-Petrel recovery effort and can contribute by informing the personnel in charge of the handling the stranded birds of any stranded bird found. A permit for handling stranded birds is required from the Canadian Wildlife Service.

Table 5.17. Project-Environment Interaction Matrix for Marine Birds, Marine Mammals, and Sea Turtles.

Valued Environmental Component: Marine Birds, Marine Mammals, and Sea Turtles					
Project Activities and Physical Works	**Marine Birds**	**Baleen Whales**	**Toothed Whales**	**Seals**	**Sea Turtles**
Presence of Structures					
No Fishing Zone					
Subsea structures	x	x	x	x	x
Lights	x	x	x	x	x
Flares	x				
Drilling Mud/Cuttings					
Water-based mud	x	x	x	x	x
Synthetic-based mud	x	x	x	x	x
Produced Water (N/A)*					
Other Fluids and Solids					
Cement					
BOP fluid	x	x	x	x	x
Cooling water	x	x	x	x	x
Deck drainage	x	x	x	x	x
Bilge water	x	x	x	x	x
Sanitary/Domestic Waste Water	x	x	x	x	x
Garbage (N/A)*					
Atmospheric Emissions[a]	x				
Ships and Boats	x	x	x	x	x
Helicopters	x	x	x	x	x
Sound					
Drilling rigs	x	x	x	x	x
Support vessels	x	x	x	x	x
Helicopters	x	x	x	x	x
Shore Facilities[b] (N/A)*					
Accidents (small spills)[c]	x	x	x	x	x
OTHER PROJECTS AND ACTIVITIES					
Hibernia	x	x	x	x	x
Terra Nova	x	x	x	x	x
White Rose	x	x	x	x	x
Hebron	x	x	x	x	x
Oil Exploration					
Seismic surveys	x	x	x	x	x
Exploration drilling	x	x	x	x	x
Commercial Fisheries	x	x	x	x	x
Marine Transportation	x	x	x	x	x
Hunting	x			x	

Notes:
* Not Applicable.
[a] Includes burning of produced water.
[b] There will not be any new onshore facilities required. Existing infrastructure will be used.
[c] Effects assessment of offshore spills is contained in Section 6.0.

Table 5.18. Environmental Effects Assessment for Marine Birds during Drilling.

Valued Environmental Component: Marine Birds									
Project Activity	Potential Positive (P) or Negative (N) Environmental Effect	Regulatory Mitigation	Project Specific Mitigation	Evaluation Criteria for Assessing Environmental Effects					
				Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Presence of Structures									
No Fishing Zone	No Interaction	-	-	-	-	-	-	-	-
Subsea structures	No Interaction	-	-	-	-	6	-	-	-
Lights	Attraction (N)	-	Release stranded birds	1	2	2-4	2	R	1
Flares	Mortality (N)	-	-	1	2	2-4	2	I [a]	1
Drilling Mud/Cuttings									
Water-based mud	Effects on health (N)	Recycle muds Treat and discharge cuttings	-	0	1	6	2	R	1
Synthetic-based mud	Effects on health (N)	Recycle muds Treat and discharge cuttings	-	0	1	6	2	R	1
Other Fluids and Solids									
Cement	No Interaction	-	-	-	-	-	-	-	-
BOP fluid	Effects on health (N)	*Chemical Selection Guidelines*	Selection criteria	0	1	1	1	R	1
Cooling water	Effects on health (N)	Monitoring	-	0	1	6	2	R	1
Deck drainage	Effects on health (N)	Treatment	-	0	1	2	2	R	1
Bilge water	Effects on health (N)	Treatment	-	0	1	2	2	R	1
Sanitary/Domestic waste water	Nutrients (P); Increased predation (N)	Maceration	-	1	2	5	2	R	1
Atmospheric Emissions	Effects on health (N)	Equipment design and maintenance	-	0	1	6	2	R	1
Ships and Boats [b]	Disturbance (N)	-	Avoid colonies	0	2	6	2	R	1
Helicopters [b]	Disturbance (N); Mortality (N)	-	Avoid colonies & repeated overflights of bird concentrations	1	2	4	1	R	1

Table 5.18 (cont'd)

Valued Environmental Component: Marine Birds									
Project Activity	**Potential Positive (P) or Negative (N) Environmental Effect**	**Regulatory Mitigation**	**Project Specific Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**					
				Magnitude	**Geographic Extent**	**Frequency**	**Duration**	**Reversibility**	**Ecological/ Socio-Cultural and Economic Context**
Sound									
Drilling rigs	Disturbance (N)	-	-	0	2	6	2	R	1
Support vessels	Disturbance (N)	-	Avoid colonies	0	2	6	2	R	1
Helicopters	Disturbance (N); Mortality (N)	-	Avoid colonies & repeated overflights of bird concentrations	1	2	2	1	R	1
Shore Facilities[c] (N/A)*	-	-	-	-	-	-	-	-	-
Accidents[d]	-	-	-	-		-	-	-	-

Key:

Magnitude:
0 = negligible
1 = Low
2 = Medium
3 = High

Geographic Extent:
1 = <1 km²
2 = 1-10 km²
3 = 11-100 km²
4 = 101-1,000 km²
5 = 1001-10,000 km²
6 = >10,000 km²

Frequency:
1 = < 11 events/yr
2 = 11-50 events/yr
3 = 51-100 events/yr
4 = 101-200 events/yr
5 = >200 events/yr
6 = continuous

Duration:
1 = < 1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = > 72 months

Reversibility:
R = Reversible
I = Irreversible

[a] Effects on individuals irreversible but any population effects are likely reversible.
[b] Effects of sound considered here.
[c] There will not be any new onshore facilities required. Existing infrastructure will be used.
[d] Effects assessment of offshore spills is contained in Section 6.0.
*N/A = Not Applicable

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not adversely affected by human activity.
2 = Evidence of existing adverse effects.

Table 5.19. Significance of Predicted Residual Environmental Effects on Marine Birds during Drilling.

Valued Environmental Component: Marine Birds				
	Significance Rating	Level of Confidence	Likelihood[c]	
Project Activity	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Presence of Structures				
No Fishing Zone				
Subsea structures				
Lights	NS	3	-	-
Flares	NS	3	-	-
Drilling Mud/Cuttings				
Water-based mud	NS	3	-	-
Synthetic-based mud	NS	3	-	-
Other Fluids and Solids				
Cement				
BOP fluid	NS	3	-	-
Cooling water	NS	3	-	-
Deck drainage	NS	3	-	-
Bilge water	NS	3	-	-
Sanitary/Domestic Water Waste	NS	3	-	-
Atmospheric Emissions	NS	3	-	-
Ships and Boats	NS	3	-	-
Helicopters	NS	3	-	-
Sound				
Drilling rigs	NS	3	-	-
Support vessels	NS	3	-	-
Helicopters	NS	3	-	-
Shore Facilities[a]				
Accidents[b]				

Key:

Residual Environmental Effect Rating:
S = Significant Adverse Environmental Effect
NS = Not-significant Adverse Environmental Effect
P = Positive Environmental Effect

Significance is defined as a medium or high magnitude (2 or 3 rating) and duration greater than 1 year (3 or greater rating) and geographic extend >100 km^2 (4 or greater rating).

Level of Confidence in Impact Prediction:
1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence

Probability of Predicted Effect Occurring: based on professional judgment:
1 = Low Probability of Occurrence
2 = Medium Probability of Occurrence
3 = High Probability of Occurrence

Scientific Certainty: based on scientific information and statistical analysis or professional judgment:
1 = Low Level of Certainty
2 = Medium Level of Certainty
3 = High Level of Certainty

[a] Not applicable. There will not be any new onshore facilities required. Existing infrastructure will be used.
[b] Effects assessment of offshore spill is contained in Section 6.0.
[c] Only applicable to significant effect.

The presence of lights on the drill vessel and support vessels would have a *low* effect within a 1-10 km² area during the drilling period. Lights would have a continuous effect during nighttime hours but no effect in daylight.

Flaring may occur if petroleum hydrocarbons are encountered. There are reports of migrating land birds and Leach's Storm-Petrels flying into gas flares in the North Sea, especially on foggy nights (Sage 1979; Bourne 1979). The bright light of the flare reflects off the water droplets in the fog creating a bright reflective light which is thought to attract a greater number of Leach's Storm-Petrels. The noise and heat should steer birds away from the flare under most night-time conditions. The added light of a flare may draw more Leach's Storm-Petrels to the drill rig causing stranding on the deck. There have been no studies on the possible interactions of birds with gas flares on the Grand Banks. To date, there is no potential mitigation for this effect, if, in fact, it is an effect.

The concern that birds will fly into a potential flare is presently considered low based on current knowledge. The geographic extent affected would be 1-10 km².   The frequency of occurrence is unknown but could be as high as 11-50 events for the drilling season.

5.6.3. Drill Muds and Cuttings

The exploration wells covered under this assessment will likely be drilled using a combination of water based muds and synthetic-based muds depending on the hole section. The discharge of mud will be in compliance with *OWTG*. When synthetic-based muds are used, when possible cuttings will be discharged below the surface to minimize any potential sheen. There is some concern that synthetic-based muds could produce a sheen on the surface of the water under flat calm conditions. Leach's Storm-Petrel are known to feed on naturally produced oily slicks on the water of biological origin and could possibly be attracted to a synthetic-based slick. However, Leach's Storm-Petrel do not spend much time on the water and would probably remain on the wing during an investigation of a slick. Chances of the feathers coming in contact with the synthetic-based mud are minimal. Shearwaters, Northern Fulmars and gulls may be attracted to the drill vessel and may rest on the water and possibly come in contact with a sheen.

The drill muds and cuttings should have *negligible* effects on seabirds because there is little chance of interaction with birds on the surface.

5.6.4. Other Fluids and Solids

The discharge of any blowout preventer fluid by semi-submersibles will have *negligible* effect on seabirds because the glycol-water mixes used will have a low toxicity. The periodic releases of glycol-water mixes will occur near the ocean floor will have *negligible* effects on seabirds.

Cooling water may contain chlorine and will be tested prior to discharge to ensure it complies with the *OWTG*. Any contaminants released in the ocean will be in a concentration very low and quickly diluted. The effects of cooling water on seabirds will be *negligible*.

Deck drainage such as the rotary table floor and machinery spaces will undergo treatment as per *OWTG*. The concentration of oil in drainage water will be so low the effect on seabirds will be *negligible*.

Bilge water will be treated to 15 mg/L of oil or less as per *OWTG*. The concentration of oil in discharged bilge water will be too low to effect seabirds. Effects on seabirds will be *negligible*.

Sanitary and domestic waste water will be produced by a rig accommodating up 150 personnel. Sanitary water discharge could be up to 50 m^3 per day. Domestic water discharge will be macerated to 6-mm particle size or less and discharged as per *OWTG*. The daily discharge of domestic water could be up to 25 m^3 per day. The effects on seabirds will be *negligible*.

5.6.5. Atmospheric Emissions

Atmospheric emissions will originate from engines, generators and machinery on the drill rig supply vessels and helicopters. Diesel will be the primary fuel. Emissions of the potentially harmful materials will be small and rapidly disperse into the atmosphere. The effects of atmospheric emissions on seabirds will be *negligible*.

5.6.6. Ships and Boats

In addition to potential effects of discharges, lights and flares (drill rig) from the drill rig and supply boats already discussed above, there are potential effects from noise and the physical presence on seabirds. The potential effects related to noise and the physical appearance are discussed below. There is concern that supply boats could travel too close to seabird colonies when travelling between shore base and the drill rig. Operators of supply vessel should have a map showing the location of important seabird colonies. There are no officially recommended distances for avoiding colonies but a buffer of at least 2 km should be adequate. The two largest seabird colonies on the southern Avalon Peninsula are designated Provincial Ecological Reserves with boundaries extending approximately 2 km out to sea. Use of motorized vessels within the Provincial Ecological Reserve is prohibited. The physical presence of the drill rig on the drill site and the physical presence of supply vessels at the drill site and in transit from shore base to the drill rig will have a *negligible* effect on seabirds.

5.6.7. Effect of Helicopters

Personnel will be transported to and from the drilling rig via helicopters (Super Puma or equivalent class). The number of flights is unknown at this time but it would probably be no more than six times per week. The physical appearance of a large helicopter combined with the noise could frighten seabirds. This could happen when the helicopter is (1) in route between the shore base and drill rig or

(2) landing and taking off from drill rig. The helicopters will be flying at no less than 600 m above sea level while flying between the shore base and the drill rig. Birds on the water or flying over the open ocean would temporarily be in a zone impacted by noise and the appearance of a helicopter. Birds directly under the path of the helicopter will receive the greatest noise and visual impact. The likely response of a bird frightened by the presence of a low flying aircraft is to dive or fly away (Husky 2000). Birds may not take evasive action in response to a helicopter at 600 m. Helicopters will be near sea level during landing and takeoff from the drill rig. Seabirds within the immediate area of the drill rig will probably move away.

A potential major concern of helicopter disturbance of seabirds is flying over seabird nesting colonies. There are several large and significant seabird colonies in eastern and southern Newfoundland (Table 4.16). These colonies are easily avoided. Each aircraft will carry maps showing the location of significant seabird nesting colonies. Canadian Wildlife Service guidelines for avoiding overflights of seabird colonies are outlined in Nettleship (1980). These guidelines recommend that aircraft not approach closer than eight km seaward and three landward of a major seabird colony from 1 April to 1 November.

The effects of helicopter overflights on seabirds on the open ocean should be temporary and *negligible*. Seabird colonies can be easily avoided if pilots and companies operating the helicopters are aware of the importance of avoiding seabird colonies. The effects of helicopters on seabird colonies should be *negligible*.

5.6.8. Effects of Sound

The normal offshore activities of the drill rig and supply vessels are unlikely to have effects on seabirds. Birds are highly mobile and can easily avoid the sounds created by drill rigs and supply vessels with minimal expenditure of energy. The sound effects from the drill rig, support helicopters and supply vessels are discussed above. The effects of sound from the drill rig, support helicopter and supply vessel on seabirds are *negligible*.

5.6.9. Shore Facilities

The location of shore based facilities is not known at this time. The likely locations are the established ports at St. John’s and/or Marystown. There will be no effects on seabirds at these sites. The port or ports used will determine the seabird colonies en route between shore base and the drill rig.

5.6.10. Cumulative Effects Summary – Marine Birds

The cumulative effects of the routine activities from exploratory drilling are expected to be *not significant* for seabirds. Mitigation measures, including treatment of fluids, muds and cuttings will minimize the potential for significant effects on seabirds within the Study Area. Any other rigs will be beyond the sight capabilities of seabirds and thus there is no potential for overlapping effects from light attraction. There is some potential for cumulative effects from light attraction to fish vessels and other marine vessels.

5.6.11. Monitoring and Follow up

The Operators monitored seabirds and conducted a stranded seabird mitigation program during the 2005 3-D seismic surveys in Laurentian Sub-basin. As part of the proposed exploratory drilling program, environmental observers will be tasked with recording and reporting seabird and marine mammal observations according to established protocols. Handling and release of any stranded storm petrels will be in accordance with CWS protocols.

5.7. Potential Effects on Marine Mammals

The potential effects of ConocoPhillips' proposed exploration drilling program in 2007-2010 on marine mammals are assessed in the following sections. The interaction matrix (see Table 5.17) shows potential interactions between the Project and the marine mammal (sea turtle and seabird) VEC but makes no judgment about potential effects. Potential effects on the marine mammal VEC are assessed in Table 5.20. The significance of those effects on marine mammals are predicted in Table 5.21. The following discussion of the marine mammal VEC is subdivided into baleen whales, toothed whales, and seals when expected effects differ among these groups. The reader is referred to the Terra Nova (Petro-Canada 1996a,b), White Rose EIS (Husky 2000) and Orphan Basin drilling EA (LGL 2005) for a detailed review of the impact literature. Summaries and updates on relevant impact literature that have become available since the submission of the White Rose EIS are provided below.

Effect predictions are based on routine drilling operations that would typically occur in one year. There could be as many as two wells drilled per year with the possibility of four wells per year in the appraisal phase. In total, over the four years of the Project, it is anticipated that five exploration wells and two appraisal wells will be drilled. From the perspective of predicting impacts on marine mammals (birds, and sea turtles as well), it is reasonable to assess impacts on a yearly basis given that marine mammals occur seasonally and are transient in the Project Area.

Cumulative effects are also considered within the Project and in consideration of exploration activities, marine transportation and fisheries.

5.7.1. Presence of Structures

Potential effects on marine mammals are mainly related to the effects of sound produced by offshore structures and activities. See Section 5.5.4 for a discussion of this issue. With offshore projects, there is a slight possibility that marine mammals could interact with subsea pillars, drill strings, mooring cables or other subsea gear and become injured or entangled. Marine mammals would most likely avoid the immediate area around the drilling rig or drillship due to underwater sound generated by the rig or drillship and attendant vessels. It is possible that marine mammals may be attracted to subsea structures

Table 5.20. Environmental Effects Assessment for Marine Mammals during Routine Drilling Operations.

Valued Environmental Component: Marine Mammals									
				Evaluation Criteria for Assessing Environmental Effects					
Project Activity	Potential Positive (P) or Negative (N) Environmental Effect	Regulatory Mitigation	Project Specific Mitigation	Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Presence of Structures									
No Fishing Zone	No Interaction	-	-	-	-	-	-	-	-
Artificial Reef Effect	May attract prey (P?)	-	-	0	1	6	2	R	1
Subsea structures	Disruption of sea floor (N?)	-	-	0	1	6	2	R	1
Lights	May attract prey	-	Minimize lighting	0	1	2-4	2	R	1
Flares	No interaction	-	-	-	-	2-4	-	-	-
Drilling Mud/Cuttings									
Water-based mud	Effects on health (N)	Recycle mud Treat and discharge cuttings	-	0	1	6	2	R	1
Synthetic-based mud	Effects on health (N)	Recycle mud Treat and discharge cuttings	-	0	1	6	2	R	1
Other Fluids and Solids									
Cement	May attract prey (P) if artificial reef effect	-	-	0	1	1	2	R	1
BOP fluid	Effects on health (N)	Recycle	Chemical selection	0	1	1	1	R	1
Cooling water	Effects on health (N)	Treatment	-	0	1	6	2	R	1
Deck drainage	Effects on health (N)	Treatment	-	0	1	2	2	R	1
Bilge water	Effects on health (N)	Treatment	-	0	1	2	2	R	1
Sanitary/Domestic	Effects on health (N)?	Primary Treatment	-	0	1	5	2	R	1
Atmospheric Emissions	No Interaction	-	-	-	-	-	-	-	-
Sound									
Drilling rigs	Disturbance (N)	-		0-1	2-3	6	2	R	1
Drilling rigs	Hearing impairment (N), physical effects (N)			0-1	1	6	2	R	1
Support vessels	Disturbance (N)	-	Avoid conc. of mar. mamm.; maintain steady course & speed when possible	0-1	2-3	6	2	R	1

Table 5.20 (cont'd)

Valued Environmental Component: Marine Mammals									
Project Activity	**Potential Positive (P) or Negative (N) Environmental Effect**	**Regulatory Mitigation**	**Project Specific Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**					
				Magnitude	**Geographic Extent**	**Frequency**	**Duration**	**Reversibility**	**Ecological/ Socio-Cultural and Economic Context**
Helicopters	Disturbance (N)	-	Fly at min. altitude of 600 m whenever possible	0-1	1-2	4	1	R	1
VSP	Disturbance (N)	Ramp up, delay ramp up if MM in safety zone, shutdown if endangered MM in safety zone		0-1	2-3	1	1	R	1
VSP	Hearing impairment (N), physical effects (N)	Ramp up, delay ramp up if MM in safety zone, shutdown if endangered MM in safety zone		0-1	1	1	1	R	1
Shore Facilities[b]	N/A*	-	-	-	-	-	-	-	-
Accidents[c]	See Section 6	-	-	-	-	-	-		-

Key:

Magnitude:	Geographic Extent:	Frequency:	Duration:	Reversibility (population level):
0 = Negligible	1 = <1 km²	1 = < 11 events/yr	1 = < 1 month	R = Reversible
1 = Low	2 = 1-10 km²	2 = 11-50 events/yr	2 = 1-12 months	I = Irreversible
2 = Medium	3 = 11-100 km²	3 = 51-100 events/yr	3 = 13-36 months	
3 = High	4 = 101-1,000 km²	4 = 101-200 events/yr	4 = 37-72 months	
	5 = 1001-10,000 km²	5 = >200 events/yr	5 = > 72 months	
	6 = >10,000 km²	6 = continuous		

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not adversely affected by human activity.
2 = Evidence of existing adverse effects.

[a] Effects of sound considered here.
[b] There will not be any new onshore facilities required. Existing infrastructure will be required
[c] Effects assessment of offshore spills is contained in Section 6.
*N/A = Not Applicable

Table 5.21. Significance of Predicted Residual Environmental Effects on Marine Mammals during Routine Drilling Activities.

Valued Environmental Component: Marine Mammals				
Project Activity	Significance Rating	Level of Confidence	Likelihood[c]	
	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Presence of Structures				
No Fishing Zone				
Subsea structures	NS	3	-	-
Lights	NS	3	-	-
Flares				
Drilling Mud/Cuttings				
Water-based mud	NS	3	-	-
Synthetic-based mud	NS	3	-	-
Other Fluids and Solids				
Cement	NS	3	-	-
BOP fluid	NS	3	-	-
Cooling water	NS	3	-	-
Deck drainage	NS	3	-	-
Bilge water	NS	3	-	-
Sanitary/Domestic Waste Water	NS	3	-	-
Atmospheric Emissions				
Ships and Boats	NS	3	-	-
Helicopters	NS	3	-	-
Sound				
Drilling rigs	NS	3	-	-
Support vessels	NS	3	-	-
Helicopters	NS	3	-	-
VSP	NS	3	-	-
Shore Facilities[a]				
Accidents[b]				

Key:

Residual Environmental Effect Rating:
S = Significant Adverse Environmental Effect
NS = Not-significant Adverse Environmental Effect
P = Positive Environmental Effect

Significance is defined as a medium or high magnitude (2 or 3 rating) and duration greater than 1 year (3 or greater rating) and geographic extend >100 km^2 (4 or greater rating).

Level of Confidence in Effect Prediction:
1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence

Probability of predicted effect occurring, based on professional judgment:
1 = Low Probability of Occurrence
2 = Medium Probability of Occurrence
3 = High Probability of Occurrence

Scientific Certainty: based on scientific information and statistical analysis or professional judgment:
1 = Low Level of Certainty
2 = Medium Level of Certainty
3 = High Level of Certainty

[a] Not Applicable. There will not be any new onshore facilities required. Existing infrastructure will be used.
[b] Effects assessment of offshore spills is contained in Section 6.
[c] Only applicable to significant effect.

if the artificial reef effect occurs and prey increases. Given that there is little chance of negative interactions with the physical presence of structures, any effects, if they occurred, are predicted to be *negligible*. The presence of structures associated with the proposed drilling operation is predicted to have *negligible* impacts on marine mammals, over a duration of *1-12 months* in an area *<1 km^2* (Table 5.20). Therefore, impacts from the presence of structures on marine mammals would be *not significant*. Cumulative effects from the presence of some exploration drilling platforms and other vessels will be additive rather than synergistic, and are *not significant*.

5.7.2. Lights and Flares

It is possible that lights associated with the drilling platform and associated supply vessels may attract prey for marine mammals (see Section 5.4). However, given the small areas where this may happen, any effects (assumed positive) would be *negligible* (Table 5.20). Therefore, impacts from lights from the drilling platform and associated vessels on marine mammals would be *not significant*.

5.7.3. Discharge of Drilling Muds and Cuttings

Modelling conducted for ConocoPhillips' proposed drilling program (Lorax 2006) suggests that smothering of non-mobile benthic species (assumed mud depth of 1 cm) would occur in an area much less than 1 km^2 around the drill location (see Section 5.4).

Drilling activities are unlikely to produce concentrations of heavy metals in muds and cuttings that are harmful to marine mammals (Neff et al. 1980 *in* Hinwood et al. 1994). In addition, none of the marine mammals that regularly occur in the Project Area are known to feed directly on benthos in the area. The discharge of drilling muds and cuttings from the proposed drilling operation is predicted to have *negligible* physical impacts on marine mammals (Table 5.20). Therefore, physical impacts of drilling muds and cuttings on marine mammals would be *not significant*.

The cumulative effects on marine mammals of exposure to drilling muds and cuttings with other Project activities will be *negligible*. As previously stated, heavy metals in muds and cuttings are unlikely to bioaccumulate to harmful levels.

5.7.4. Discharge of Other Fluids and Solids

The discharge of any blowout preventer fluid will have *negligible* effects on marine mammals because the glycol-water mixes used will have a low toxicity and will be rapidly diluted in an open-offshore environment. Periodic releases of small amounts of glycol will have a *negligible* effect on marine mammals. Drilling will require seawater, most of which will be used as cooling water. Cooling water will be chlorinated to a level of one or two mg/L chlorine and discharged at temperatures of approximately 30°C above ambient. Effects on marine mammals will be *negligible* because the volume will be low and the area of thermal effects will be small and dispersion rates are high. Any cement piles, if they occur, will act as an artificial reef, and be colonized by epifaunal animals and may attract fish. The effects (either negative or positive) of the cement on marine mammals would be *negligible*.

The effects rankings for the combined discharge of the fluids and solids from the proposed exploration drilling will be *negligible*. The treatment of discharges and the tolerance of marine mammals to hydrocarbons (see Husky 2000 for review) will result in a *not significant* cumulative effect.

Treatment of oily-water discharge from other drilling fluids and bilge water will reduce any potential effects on marine mammals. Furthermore, the marine mammals of the Project Area rely on blubber rather than fur for insulation and are less likely to be affected by exposure to oily-water than are other species groups such as birds. Releases of treated oily water are likely to have *negligible* effects on marine mammals. Organic matter from sanitary wastes will be quickly dispersed and degraded by bacteria. The effects on marine mammals swimming in the receiving waters containing this small amount of organic matter and nutrients will be *negligible*.

To summarize, discharge of blowout preventer fluid, cooling water, deck drainage, bilge water, sanitary and domestic waste, is predicted to have *negligible* effects on health on marine mammals (Table 5.20). Therefore, effects on mammal health from proposed drilling discharges would be *not significant*.

5.7.5. Effects of Ships and Boats

Discussion of discharges from vessels is included in the previous paragraphs. All discharges from vessels, including sanitary and bilge water will be treated, as described above. Overall, effects of vessel discharges on marine mammals would be *negligible*. Potential effects related to sound are discussed in the following sections.

5.7.6. Effects of Helicopters

Potential effects of helicopters on marine mammals are mainly related to sound, which is discussed in the following section.

5.7.7. Effects of Sound

In spite of the large amount of offshore drilling that has occurred worldwide, there has been little systematic study of the specific effects of drilling activities on marine mammals. As reviewed below, marine mammals likely can hear sounds generated by offshore drilling activities but many data gaps exist in terms of how they respond to drilling activities, and what received sound levels may elicit a response.

Marine mammals depend on the underwater acoustic environment. Thus, the potential negative effects caused by anthropogenic sound within the marine environment are a concern. The Terra Nova EIS, the

White Rose EA, the Scotian Shelf generic EA, the Laurentian Sub-basin 3-D Seismic EA (Buchanan et al. 2004) and Update (Christian et al. 2005) provide good reviews of the effects of sound associated with offshore oil development on marine mammals.

5.7.7.1. Hearing Abilities of Marine Mammals

The hearing abilities of marine mammals are functions of the following (Richardson et al. 1995; Au et al. 2000):

1. Absolute hearing threshold at the frequency in question (the level of sound barely audible in the absence of ambient noise). The "best frequency" is the frequency with the lowest absolute threshold.
2. Critical ratio (the signal-to-noise ratio required to detect a sound at a specific frequency in the presence of background noise around that frequency).
3. The ability to localize sound direction at the frequencies under consideration.
4. The ability to discriminate among sounds of different frequencies and intensities.

Marine mammals rely heavily on the use of underwater sounds to communicate and to gain information about their surroundings. Experiments also show that they hear and may react to many man-made sounds including sounds made during drilling and airgun operations (used during VSP operations).

***Toothed Whales*.—** Hearing abilities of some toothed whales (odontocetes) have been studied in detail (reviewed in Chapter 8 of Richardson et al. [1995] and in Au et al. [2000]). Hearing sensitivity of several species has been determined as a function of frequency. The small to moderate-sized toothed whales whose hearing has been studied have relatively poor hearing sensitivity at frequencies below 1 kHz, but extremely good sensitivity at, and above, several kHz. There are very few data on the absolute hearing thresholds of most of the larger, deep-diving toothed whales, such as the sperm and beaked whales. However, Mann et al. (2005) report that a Gervais' beaked whale showed evoked potentials from 5 to 80 kHz, with the best sensitivity at 80 kHz.

Despite the relatively poor sensitivity of small odontocetes at the low frequencies that contribute most of the energy during drilling and airgun operations, the sounds are sufficiently strong that their received levels sometimes remain above the hearing thresholds of odontocetes at distances out to several tens of kilometres (Richardson and Würsig 1997). However, there is little evidence that small odontocetes react to airgun pulses at such long distances and no evidence that they react to drilling operations at such long distances, or even at intermediate distances where sound levels are well above the ambient noise level (see below).

***Baleen Whales*.—** The hearing abilities of baleen whales have not been studied directly. Behavioural and anatomical evidence indicates that they hear well at frequencies below 1 kHz (Richardson et al. 1995; Ketten 2000). Baleen whales also reacted to sonar sounds at 3.1 kHz and other sources centered at 4 kHz (see Richardson et al. 1995 for a review). Some baleen whales react to pinger sounds up to 28 kHz, but not to pingers or sonars emitting sounds at 36 kHz or above (Watkins 1986). In addition, baleen whales produce sounds at frequencies up to 8 kHz and, for humpbacks, to >15 kHz (Au et al. 2001). The anatomy of the baleen whale inner ear seems to be well adapted for detection of low-frequency sounds (Ketten 1991, 1992, 1994, 2000). The absolute sound levels that they can detect below 1 kHz are probably limited by increasing levels of natural ambient noise at decreasing frequencies. Ambient noise energy is higher at low frequencies than at mid frequencies. At frequencies below 1 kHz, natural ambient levels tend to increase with decreasing frequency.

The hearing systems of baleen whales are undoubtedly more sensitive to low-frequency sounds than are the ears of the small toothed whales that have been studied directly. Thus, baleen whales are likely to hear sounds from routine drilling operations and airgun pulses farther away than can small toothed whales and, at closer distances, low-frequency sounds may seem more prominent to baleen than to toothed whales.

***Pinnipeds*.—** Underwater audiograms have been obtained using behavioural methods for three species of phocinid seals, two species of monachid seals, two species of otariids, and the walrus (reviewed in Richardson et al. 1995: 211*ff*; Kastak and Schusterman 1998, 1999; Kastelein et al. 2002b). In comparison with odontocetes, pinnipeds tend to have lower best frequencies, lower high-frequency cutoffs, better auditory sensitivity at low frequencies, and poorer sensitivity at the best frequency.

At least some of the phocid (hair) seals have better sensitivity at low frequencies (≤1 kHz) than do odontocetes. Below 30–50 kHz, the hearing thresholds of most species tested are essentially flat down to about 1 kHz, and range between 60 and 85 dB re 1 µPa. Measurements for a harbor seal indicate that, below 1 kHz, its thresholds deteriorate gradually to ~97 dB re 1 µPa at 100 Hz (Kastak and Schusterman 1998). The northern elephant seal appears to have better underwater sensitivity than the harbor seal, at least at low frequencies (Kastak and Schusterman 1998, 1999).

5.7.7.2. Drill Rigs

The drill rig(s) employed during the proposed project could be a semi-submersible drill rig (either dynamically positioned (DP) or anchored), jack-up rig, or drillship (DP). In general, drillships are noisier than jack-up rigs and semi-submersibles as noise from the ship's equipment is coupled very well to the water owing to the vessel's large surface area (Richardson et al. 1995). It is anticipated that thrusters will be operating continuously during drilling activities from the drillship, or DP semi-submersible rig as there are no anchors to keep the rigs on station. Sound from the drill rigs will be particularly high when all thrusters are used at high settings, which might be the case during station-keeping in rough seas and high winds (Lawson et al. 2001).

Ringed seals were often seen near drillships drilling in the Arctic in summer and fall (several reports summarized by Richardson et al. 1995). Ringed seals and bearded seals approached and dove within 50 m of a projecter transmitting drilling sound into the water (received sound levels were 130 dB re

1 μPa). More recent studies of seals near active seismic vessels (Harris et al. 2001; Moulton and Lawson 2002; Miller and Davis 2002) confirm that seals are tolerant of offshore industrial activities.

Beluga whales were exposed to playback sounds from a semi-submersible rig in an Alaskan river (Stewart et al. 1982). During the two tests, belugas swimming toward the sound source did not react overtly until they were within 50-75 m and 300-500 m; some belugas altered course to swim around the source, some increased swimming speed, and one reversed direction of travel. Reactions to semi-submersible sound were less severe than were reactions to motorboats with outboards (Stewart et al. 1982). Dolphins and other toothed whales show considerable tolerance of drill rigs and their support vessels, particularly when there are not negative consequences from close approach to the activities (Richardson et al. 1995).

Kapel (1979) reported numerous baleen whales – mainly fin, minke, and humpback whales – within visual range of active drillships off West Greenland. In more formal studies, bowhead whales reacted to drillship sounds within 4 to 8 km of a drillship when received levels were 20 dB above ambient or about 118 dB re 1 μPa (Greene 1985, 1987; Richardson et al. 1985b, 1990). Reaction was greater at the onset of the sound (Richardson et al. 1995). Thus, bowhead whales migrating in the Beaufort Sea avoided an area with radius 10 km around a drillship, which corresponded to received sound levels of 115 dB re 1 μPa (Richardson et al. 1990). Some whales were less responsive and habituation may occur, so that in time, bowheads may be seen within 4 to 8 km of a drillship (Richardson et al. 1985a, 1990). Sound attenuates less rapidly in the shallow Beaufort Sea where these experiments were conducted than in temperate waters of greater depth. Off California, the reaction zone (120 dB re 1 μPa) around a semi-submersible drill rig was much less than 1 km for grey whales (Malme et al. 1983, 1984). Humpback whales showed no clear avoidance response to received drillship broadband sounds of 116 dB re 1 μPa (Malme et al. 1985). Baleen whales may show behavioural changes to received broadband drillship sounds of 120 dB re 1 μPa or greater. Recently, the proximal part of the migration corridor of bowhead whales in the Alaskan Beaufort Sea has been monitored during construction, drilling, and production activities at an artificial island (Northstar) just inshore of the migration corridor (Richardson and Williams [eds.] 2004). The primary objective of the monitoring program was to determine if, at high-noise times, underwater sound propagating from Northstar and its support vessels deflected the southern part of the bowhead migration corridor. An acoustical localization method was used to determine the locations of calling bowhead whales (Greene et al. 2004). Overall, the results showed evidence consistent with slight offshore displacement of the proximal edge of the bowhead migration corridor at some times when levels of underwater sound were unusually high. These high-noise occasions were attributable to support vessels operating near the production facility rather than to the island-based operation itself.

Behavioural reactions to the sound from drilling rigs begin at broadband levels of 115 to 120 dB. Broadband source levels produced by a working semi-submersible drilling rig may be about 154 dB re 1 μPa at 1 m (Greene 1986). Assuming spherical spreading, received levels at 100 m distance would be about 114 dB re 1 μPa. Thus, behavioural reactions would be limited to a very small area around a semi-submersible rig. Drillships are the noisiest of the offshore drilling platforms—with source levels estimated as high as 191 dB re 1 μPa at 1 m. Richardson et al. (1995) summarized the data for drillships and found that received broadband sound levels would decline to 115-120 dB at distances of 1 to 10 km from the ship. Thus, baleen whales could be potentially disturbed at greater distances from a drillship than from a semisubmersible rig. Measured data on sound produced by drillships and thrusters are few; source levels for a 650 kW tunnel thruster have been calculated as 120 to 185 dB re 1 uPa at 0.5 m with frequencies ranging from 20 to >10,000 Hz with highest levels at low frequencies (DNV, unpubl. data).

Based on source levels of typical semi-submersibles and drillships, it is unlikely that marine mammals would incur temporary or permanent changes in their hearing sensitivities. Also, given the low probability that a marine mammal would remain very close to drilling activity for any length of time, it is highly unlikely that any marine mammal would suffer temporary, much less permanent, hearing injuries. The proposed drilling operation is predicted to have *negligible to low* physical impacts on marine mammals, over a duration of *1-12 months*, in an area *<1 km^2* (Table 5.20). Therefore, hearing impairment and physical impacts of drilling operation sound on marine mammals would be *not significant*.

Based on previous studies, it is possible that seals, toothed whales, and baleen whales may respond differently to drilling operation sounds. Because the drilling activities will continue for 2-5 months in a given year, some habituation may occur. It appears that seals (at least ringed and bearded seals) are somewhat tolerant of drillship sounds. Disturbance effects on seals are predicted to be *negligible* to *low*, over a duration of *1-12 months*, in an area of *1-10 km^2*. Therefore, impacts related to disturbance, are judged to be *not significant* for seals. The scientific certainty associated with this prediction is *high*. Baleen whales may avoid a localized area around the drill rig or ship, especially if DP thrusters are in use. Disturbance effects on baleen whales (including endangered species) are predicted to be *low*, over a duration of *1-12 months*, in an area of *1-10 km^2* to *11-100 km^2*.

Therefore, impacts related to disturbance, are judged to be *not significant* for baleen whales. The scientific certainty associated with this prediction is *high*. Toothed whales (perhaps with the exception of sperm whales) are not as sensitive to the lower frequency sounds (relative to seals and especially baleen whales) typically produced by drill rigs. Also, some toothed whales appear tolerant of drilling activity. Disturbance effects on toothed whales are predicted to be *low*, over a duration of *1-12 months*, in an area of *1-10 km^2*. Therefore, impacts related to disturbance, are judged to be *not significant* for toothed whales.

5.7.7.3. Supply Vessels

The drilling rig will be supported by three vessels of 12-15,000 HP. There will be, on average, two trips per week between the base and the platform. These will be the supply vessels which have commonly been used to support the drilling of an offshore well off Newfoundland. A supply boat will be on standby near the rig for the full duration of the mobilization, demobilization and drilling.

Baleen whales may show little reaction or slow, inconspicuous avoidance reactions to boats and supply vessels that are moving slowly on a steady course. If the vessel changes course and/or speed, whales likely will swim rapidly away. Avoidance is strongest when the vessel travels directly toward the whale.

Dolphins may tolerate and often approach vessels of all sizes and ride the bow and stern waves (Shane et al. 1986). At other times, the dolphin species known to be attracted to boats will avoid them. This avoidance is often linked to previous boat-based harassment of the animals (Richardson et al. 1995). Other toothed whale species avoid boats. Generally, small cetaceans avoid vessels when they are approached within 0.5 to 1.5 km, with some species showing avoidance at distances of up to 12 km (Richardson et al. 1995).

The available evidence on the reactions of seals to boats indicates that seals in the water are quite tolerant of infrequent passage by boats; however, effects on the seals are generally unknown (Richardson et al. 1995).

Based on previous studies, it is possible that seals, toothed whales, and baleen whales may respond differently to sound from supply vessels. Because the drilling activities will continue for many days at a time, some habituation may occur. It appears that seals are somewhat tolerant of ship sounds. Disturbance effects on seals are predicted to be *negligible* to *low*, over a duration of *1-12 months*, in an area of *1-10* km^2. Therefore, impacts related to disturbance, are judged to be *not significant* for seals. Baleen whales may avoid a localized area around supply ships. Disturbance effects on baleen whales (including endangered species) are predicted to be *low*, over a duration of *1-12 months*, in an area of *1-10* km^2 to *11-100* km^2. Therefore, impacts related to disturbance, are judged to be *not significant* for baleen whales. Toothed whales in general are not as sensitive to the lower frequency sounds (relative to seals and especially baleen whales) typically produced by supply ships. Disturbance effects on toothed whales are predicted to be *negligible* to *low*, over a duration of *1-12 months*, in an area of *1-10* km^2. Therefore, impacts related to disturbance, are judged to be *not significant* for toothed whales. The scientific certainty associated with this prediction is *high*. Potential effects on mammals can be reduced if the boats maintain a steady course and speed whenever possible and if areas with large numbers of whales are avoided.

5.7.7.4. Aircraft

Personnel and light supplies will be transported to and from the drilling rig via twin-engine, offshore-rated helicopters (e.g., Super Puma) with flights occurring approximately six times per week. Sound does not transmit well from air to water and so effects of helicopter overflights are mainly related to disturbance of seals that are hauled-out on shore or ice, and marine mammals that are directly under the flight path of the helicopter.

Seals hauled out for pupping or moulting are very sensitive to aircraft disturbance (Richardson et al. 1995; Born et al. 1999). It is highly unlikely that there will be overflights of seals that are pupping or moulting as few, if any, seals will be hauled out (either on ice or land) along the flight route to the drilling area during these critical times or at other times of the year.

Toothed whales show variable reactions to aircraft overflights; some dive or swim away, while others exhibit no reaction (see Petro-Canada 1996a). Some baleen species, like minke, bowhead and right whales react to aircraft overflights at altitudes of 150 to 300 m by diving, changing dive patterns or leaving the area (Leatherwood et al. 1982; Watkins and Moore 1983; Payne et al. 1983; Richardson et al. 1985b; Patenaude et al. 2002). Patenaude et al. (2002) conducted a multi-year study of migrating bowhead whale and beluga whale (a toothed whale) behavioural responses to helicopter activity (Bell 212, one of the noisier offshore aircraft) and overflights by a fixed-wing Twin Otter. The helicopter elicited fewer detectable responses by bowheads (14% of 63 groups) than by belugas (38% of 40). Most reactions by both species occurred when the helicopter was at altitudes ≤150 m and lateral distances ≤250 m. In the case of beluga, at least some of the responses may have been due to visual as opposed to auditory stimuli. Virtually no reactions occurred with either species when lateral distance was ≥ 500 m or when altitude was greater than 610 m (Patenaude et al. 2002).

Helicopters and fixed-winged aircraft at low altitude (i.e., when approaching the landing site) may disturb some marine mammals directly in its flight path or in the case of seals, when they are hauled out. It is unlikely that large numbers of marine mammals will be overflown, especially at low altitude. Helicopters will normally fly at a minimum altitude of 600 m whenever possible and thus, little, if any effects on marine mammal behaviour are likely. Helicopter landings at the rig would probably affect a very small area with a radius less than 500 m. Aircraft will be prohibited from flying low over wildlife in order for passengers to “get a better look” or for photography. Disturbance effects on marine mammals from aircraft overflights are predicted to be *negligible* to *low*, over a duration of *<1-12 months*, in an area of *1-10* km^2. Therefore, impacts related to disturbance from aircraft, are judged to be *not significant* for marine mammals.

5.7.7.5. VSP

VSP arrays are typically smaller and have lower source sound pressure levels than 2-D or 3-D seismic surveys. VSP surveys are typically conducted in a small area relative to a full 2-D or 3-D seismic survey, and are conducted over shorter periods (i.e., 8 to 36 hours).

Considering that VSP source levels are typically less than those associated with standard full-scale 2-D or 3-D exploratory seismic surveys (and that the duration of VSP activities will be short), and that the effects of the 3-D seismic surveys in Laurentian Sub-basin were assessed as being *not significant* (Buchanan et al. 2004; Christian et al. 2005), it is predicted that potential effects from exposure to the VSP on marine mammals will be less than those for 3-D surveys. Mitigation measures will also be employed to minimize the potential for effects on marine mammals. An observer will follow the C-NLOPB guidelines for geophysical activities (C-NOPB 2004) and prevent the start up of airgun(s) if a marine mammal (or sea turtle) is sighted within 500 m of the airgun (s) 30 minutes prior to ramp up. Ramp up involves gradually increasing the volume of the array over a 20-40 min period before VSP work begins. [If VSP surveys involve the use of one airgun, then ramp up is not possible.] Also, ramp up will be stopped if a marine mammal (or sea turtle) is sighted within 500 m. During surveying, the airgun(s) will be shut down if an endangered marine mammal is sighted within 500 m of the airgun (s).

Based on source levels of VSP, the short duration of the operation, and use of mitigation measures, it is unlikely that marine mammals, including endangered species, would incur temporary or permanent changes in their hearing sensitivities. Also, given the low probability that a marine mammal would remain very close to the airgun(s) for any length of time, it is highly unlikely that any marine mammal would suffer temporary, much less permanent, hearing injuries. The proposed VSP operation is predicted to have *negligible to low* physical impacts on marine mammals, over a duration of *<1 month* (~one – two days), in an area *<1* km^2 (Table 5.20). Therefore, hearing impairment and physical impacts of VSP sound on marine mammals would be *not significant*.

Disturbance effects on marine mammals from VSP activities are predicted to be *negligible* to *low*, over a duration of *<1 month* (~one – two days), in an area of *1-10* km^2. Therefore, impacts related to disturbance, are judged to be *not significant* for marine mammals.

5.7.8. Shore-Based Facilities

There will not be any new onshore facilities required. Existing infrastructure will be used in St. John's or elsewhere in Newfoundland. The potential cumulative effects from the St. John's harbour facilities for White Rose, Terra Nova and Hibernia will be *negligible* for the few seals that may occur in the harbour. The combined activities from these facilities will not exceed those commonly associated with normal harbour operations nor will cumulative effect rankings increase those predicted for drilling alone.

5.7.9. Cumulative Effects Summary – Marine Mammals

At present, marine mammals in and adjacent to the Laurentian Sub-basin are potentially affected by the activities of shipping, naval maneuvers, hunting (inshore and shelf), commercial fishing, and oil and gas industry activities.

Most effects on marine mammals, at least in terms of direct mortalities, are due to hunting and fishing, and the occasional ship strike. Seals are subject to a government-regulated hunt, normally well inshore and north of the Project Area. It is predicted the Project will not cause any marine mammal mortalities and thus there will be no cumulative effects on marine mammals in terms of direct mortalities. Effects on their prey (e.g., zooplankton, squid, fish, etc.) have all been predicted to be mostly *negligible* and all *not significant* and thus there will be no indirect effects on mortality due to effects on food sources.

As discussed in previous sections and in previous EAs, as far as can be determined, any effects of the Project on marine mammals would most likely be on their behaviour, such as alterations in their swimming course. Course alterations, if they occur, may affect the energy levels of individual marine mammals. Any effects on individual whales are predicted to be within the range of their present activity levels when avoiding predators or other presently-occurring human activities.

Given the amount of commercial shipping and fishing activity that is present on and near the Laurentian Sub-basin and surrounding areas, it is safe to conclude that the underwater environment is already noisy.

The incremental sound emanating from the exploratory drilling Project may increase overall sound levels—but increases are probably low especially considering the distance between operations on the Laurentian Sub-basin and those at Hibernia, White Rose, and Terra Nova. Given the distances between the Project and other offshore activities any effects will likely be additive and not synergistic.

The cumulative effects of activities within the drilling Project are *not* expected to significantly affect marine mammals. The effects of most specific activities (discussed in each section) are predicted to be *negligible* to *low* and *no* activities are expected to cause a *significant* effect on whales and seals. Mitigation measures from this and other existing projects (at Hibernia, White Rose, and Terra Nova) will greatly minimize the likelihood of *significant* effects from routine drilling operations on marine mammal populations within the Study Area during the entire Project.

5.8. Potential Effects on Sea Turtles

Some sea turtles, including the endangered leatherback sea turtle, may occur in the Project Area (see Section 4.9.3). During ConocoPhillips' 2005 seismic survey in the Project Area a sea turtle of unknown species and a (long-dead) leatherback turtle were sighted.

The major threats to sea turtle survival include disturbance and destruction of sensitive reproductive habitat on subtropical and tropical sandy beaches, ingestion of floating plastic debris, and commercial fisheries. [It should be noted that the Project will not discharge solid waste; it will be skipped to shore for disposal.] In the Grand Banks area, sea turtles are caught incidental to the pelagic longline fishery directed at tunas, swordfish and sharks (NOAA 2000). During the period 1995 to 1998, the US pelagic longline fleet caught at least 201 sea turtles in the Northwest Atlantic in the vicinity of the Grand Banks, the vast majority of which were released alive (Appendix Table A2 *in* NOAA 2000). The at-sea observer data indicate that the sea turtles are highly associated with very warm (>20°C) water (NOAA 2000). There are no estimates available for the density of leatherback turtles in the Project Area; however, they are likely a regular part of the marine fauna in the area.

In most situations, effects of drilling activities on sea turtles (see Tables 5.22, 5.23) were assumed to be the same as those predicted for marine mammals, although there is very little information to support this prediction (except for limited studies on response of sea turtles to airgun sounds). Like marine mammals, sea turtles can hear sound associated with ships and offshore oil structures, since the frequencies of their hearing sensitivity overlap with offshore industry sound (see discussion of sea turtle hearing below). A list of potential interactions of sea turtles with drilling activities is provided in Table 5.17; these are the same as for marine mammals.

Table 5.22. Environmental Effects Assessment for Sea Turtles during Routine Drilling Operations.

Valued Environmental Component: Sea Turtles									
				Evaluation Criteria for Assessing Environmental Effects					
Project Activity	**Potential Positive (P) or Negative (N) Environmental Effect**	**Regulatory Mitigation**	**Project Specific Mitigation**	**Magnitude**	**Geographic Extent**	**Frequency**	**Duration**	**Reversibility**	**Ecological/ Socio-Cultural and Economic Context**
Presence of Structures									
Safety (No Fishing) Zone	No Interaction	-	-	-	-	-	-	-	-
Artificial Reef Effect	May attract prey (P?)	-	-	0	1	6	2	R	1
Subsea structures [a]	Disruption of benthos (N)	-	-	0	1	6	2	R	1
Lights	May attract prey	-	Minimize lighting	0	1	2-4	2	R	1
Flaring	No interaction	-	-	-	-	2-4	-	-	-
Drilling Mud/Cuttings									
Water-based mud	Effects on health (N)	Recycle; Treat muds and discharge cuttings	-	0	1	6	2	R	1
Synthetic-based mud	Effects on health (N)	Recycle; Treat muds and discharge cuttings	-	0	1	6	2	R	1
Other Fluids and Solids[b]									
Cement	Contamination (N)	-	-	0	1	1	1	R	1
BOP fluid	Effects on health (N)	-	Chemical selection	0	1	1	1	R	1
Cooling water	Effects on health (N)	Monitor	-	0	1	6	2	R	1
Deck drainage	Effects on health (N)	Treatment	-	0	1	2	2	R	1
Bilge water	Effects on health (N)	Treatment	-	0	1	2	2	R	1
Ballast water	Effects on health (N)	Treatment		0	1	2	2	R	1
Sanitary/Domestic	Effects on health (N)	Treatment	-	0	1	5	2	R	1
Garbage[c]									
Atmospheric Emissions	No Interaction	-	-	-	-	-	-	-	-
Ships and Boats	Disturbance (N)	-	-	0	1	2	2	R	1
Helicopters	-	-	-	-	-	-	-	-	-
Noise									
Drilling rigs	Disturbance (N)	-	-	0-1	2-3	6	2	R	1

Table 5.22 (cont'd)

Valued Environmental Component: Sea Turtles									
				Evaluation Criteria for Assessing Environmental Effects					
Project Activity	**Potential Positive (P) or Negative (N) Environmental Effect**	**Regulatory Mitigation**	**Project Specific Mitigation**	**Magnitude**	**Geographic Extent**	**Frequency**	**Duration**	**Reversibility**	**Ecological/ Socio-Cultural and Economic Context**
Drilling rigs	Hearing impairment (N), physical effects (N)	-	-	0-1	1	6	2	R	1
Support vessels	Disturbance (N)	-	Avoid sea turtles; maintain steady course & speed when possible	0-1	2-3	6	2	R	1
Helicopters	Disturbance (N)	-	Fly at min. altitude of 600 m whenever possible	0-1	1-2	4	2	R	1
VSP	Disturbance (N)	Ramp up, delay ramp up if ST in safety zone, shutdown if endangered ST in safety zone		0-1	2-3	1	1	R	1
VSP	Hearing impairment (N), physical effects (N)	Ramp up, delay ramp up if ST in safety zone, shutdown if endangered ST in safety zone		0-1	1	1	1	R	1
Shore Facilities[d]	N/A								

Key**:**

Magnitude:	Geographic Extent:	Frequency:	Duration:	Reversibility:
0 = Negligible	1 = <1 km²	1 = < 11 events/yr	1 = < 1 month	R = Reversible
1 = Low	2 = 1-10 km²	2 = 11-50 events/yr	2 = 1-12 months	I = Irreversible
2 = Medium	3 = 11-100 km²	3 = 51-100 events/yr	3 = 13-36 months	
3 = High	4 = 101-1000 km²	4 = 101-200 events/yr	4 = 37-72 months	
	5 = 1001-10,000 km²	5 = >200 events/yr	5 = > 72 months	
	6 = >10,000 km²	6 = continuous		

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not negatively affected by human activity.
2 = Evidence of existing negative effects.

[a] In the unlikely event that a well had to be suspended, a well head could be in place for an indeterminate period.
[b] Effects assessment of offshore spills is contained in Section 6.0.
[c] All garbage will be taken ashore.
[d] There will not be any new onshore facilities required. Existing infrastructure will be required.

Table 5.23. Significance of Predicted Residual Environmental Effects on Sea Turtles during Routine Drilling Activities.

Valued Environmental Component: Sea Turtles				
Project Activity	**Significance of Predicted Residual Environmental Effects**		**Likelihood[b]**	
	Significance Rating	**Level of Confidence**	**Probability of Occurrence**	**Scientific Certainty**
Presence of Structures				
Safety (No Fishing) Zone				
Artificial reef effect	NS	3	-	-
Subsea structures	NS	3	-	-
Lights	NS	3	-	-
Flaring				
Drilling Mud/Cuttings				
Water-based mud	NS	3	-	-
Synthetic-based mud	NS	3	-	-
Other Fluids and Solids			-	-
Cement	NS	3	-	-
BOP fluid	NS	3	-	-
Cooling water	NS	3	-	-
Deck drainage	NS	3	-	-
Bilge water	NS	3	-	-
Ballast water	NS	3	-	-
Sanitary/Domestic Waste Water	NS	3	-	-
Garbage[a]				
Atmospheric Emissions				
Ships and Boats	NS	3	-	-
Helicopters	NS	3	-	-
Noise				
Drilling rigs	NS	3	-	-
Support vessels	NS	3	-	-
Helicopters	NS	3	-	-
VSP	NS	3	-	-
Shore Facilities[a]				

Key:

Residual Environmental Effect Rating:
S = Significant Negative Environmental Effect
NS = Not-significant Negative Environmental Effect
P = Positive Environmental Effect

Significance is defined as a medium or high *magnitude (2 or 3 rating) and duration greater than 1 year (3 or greater rating) and geographic* extent >100 km^2 (4 or greater rating).

Level of Confidence in Effect Prediction:
1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence

Probability of predicted effect occurring, based on professional judgment:
1 = Low Probability of Occurrence
2 = Medium Probability of Occurrence
3 = High Probability of Occurrence

Scientific Certainty: based on scientific information and statistical analysis or professional judgment:
1 = Low Level of Certainty
2 = Medium Level of Certainty
3 = High Level of Certainty

[a] Not Applicable.
[b] Only applicable to significant effect.

5.8.1. Hearing Abilities of Sea Turtles

The limited available data indicate that the frequency range of best hearing sensitivity by sea turtles extends from roughly 250–300 Hz to 500–700 Hz (Ridgway et al. 1969; Bartol et al. 1999), which overlaps with the frequencies of sound pulses emitted from the *VSP* seismic array and the drilling ship or platform. Sensitivity deteriorates as one moves away from this range to either lower or higher frequencies. However, there is some sensitivity to frequencies as low as 60 Hz, and probably as low as 30 Hz. Thus, there is substantial overlap in the frequencies that sea turtles detect vs. the frequencies in airgun pulses and ship sounds. Given that, plus the high levels of airgun pulses, sea turtles undoubtedly hear airgun sounds and likely most ship sounds.

5.8.2. Assessment of Potential Effects

Effects of routine drilling operations were predicted to have *no significant* effects on sea turtles, including the endangered leatherback sea turtle (Tables 5.22 and 5.23); however, the scientific information to support this is lacking. These impact predictions are primarily based on data that suggest sea turtles are likely to occur in low numbers in the Laurentian Sub-basin and that proposed mitigation measures will minimize potential impacts.

During VSP operations, mitigation measures will be in place to minimize the potential for effects of sound on sea turtles. An observer will follow the C-NLOPB guidelines for geophysical activities (C-NOPB 2004) and prevent the start up of the survey if a sea turtle is sighted within 500 m of the airgun (s) 30 minutes prior to ramp up. Ramp up involves gradually increasing the volume of the array over a 20-40 min period before VSP work begins. [If VSP surveys involve the use of one airgun, then ramp up is not possible.] Also, ramp up will be stopped if a sea turtle is sighted within 500 m and at all times when an endangered leatherback sea turtle is sighted within the safety zone.

5.9. Potential Effects on Species-at-Risk

As indicated in Section 4.1, eight marine animal species that potentially occur in the Study Area are listed as either endangered or threatened on Schedule 1 of *SARA* (i.e., officially 'at risk' according to Canadian law). They are as follow:

- Blue whale
- North Atlantic right whale
- Northern bottlenose whale (Scotian Shelf population)
- Beluga whale (St. Lawrence Estuary population)
- Leatherback sea turtle
- Atlantic salmon (Inner Bay of Fundy population)
- Northern wolffish
- Spotted wolffish

5.9.1. Marine Mammals

Section 5.7 discussed the potential interactions between marine mammals and the routine activities associated with the proposed exploration drilling program (Table 5.17), and assessed the effects of these interactions (Table 5.20). Activities for which effects assessment was conducted include the following: (1) presence of structures, (2) lights and flares, (3) discharge of drilling muds and cuttings, (4) discharge of other fluids and solids, (5) presence of ships and boats, (6) presence of helicopters, (7) sound produced by drill rigs, supply vessels, aircraft and seismic arrays, and (8) shore-based facilities. The significance of predicted residual environmental effects of each of these routine drilling activities on marine mammals was predicted to be *not significant* (Table 5.21).

These predictions of non-significance can be applied to the four marine mammal populations that potentially occur in the Study Area and are considered "Species at Risk". Some of the potential effects mitigations indicated in Section 5.7 include the following: (1) minimization of lighting, (2) recycling of drilling mud, (3) treatment and discharge of cuttings, (4) recycling and/or treatment of other waste fluids and solids, (5) avoidance of marine mammals by supply vessels, (6) maintenance of minimum flying altitude by helicopters, and (7) ramp up/delay of ramp up/shutdown of seismic array.

5.9.2. Sea Turtle

Section 5.8 discussed the potential interactions between sea turtles and the routine activities associated with the proposed exploration drilling program (Table 5.17), and assessed the effects of these interactions (Table 5.22). Activities for which effects assessment was conducted include the following: (1) presence of structures, (2) lights and flares, (3) discharge of drilling muds and cuttings, (4) discharge of other fluids and solids, (5) presence of ships and boats, (6) presence of helicopters, (7) sound produced by drill rigs, supply vessels, aircraft and seismic arrays, and (8) shore-based facilities. The significance of predicted residual environmental effects of each of these routine drilling activities on sea turtles was predicted to be *not significant* (Table 5.23).

These predictions of non-significance can be applied to the leatherback sea turtle population that potentially occurs in the Study Area and is considered a "Species at Risk". Some of the potential effects mitigations indicated in Section 5.8 include the following: (1) minimization of lighting, (2) recycling of drilling mud, (3) treatment and discharge of cuttings, (4) recycling and/or treatment of other waste fluids and solids, (5) avoidance of sea turtles by supply vessels, (6) maintenance of minimum flying altitude by helicopters, and (7) ramp up/delay of ramp up/shutdown of seismic array.

5.9.3. Fish/Fish Habitat

Section 5.4 discussed the potential interactions between fish/fish habitat and the routine activities associated with the proposed exploration drilling program (Tables 5.8 and 5.11), and assessed the effects of these interactions (Tables 5.9 and 5.12). Activities for which effects assessment was conducted include the following: (1) presence of structures, (2) lights and flares, (3) discharge of drilling muds and cuttings, (4) discharge of other fluids and solids, (5) presence of ships and boats, (6) presence of helicopters, (7) sound produced by drill rigs, supply vessels, aircraft and seismic arrays, and (8) shore-based facilities. The significance of predicted residual environmental effects of each of these routine drilling activities on fish and fish habitat was predicted to be *not significant* (Tables 5.10 and 5.13).

These predictions of non-significance can be applied to the three fish populations that potentially occur in the Study Area and are considered "Species at Risk". Some of the potential effects mitigations indicated in Section 5.4 include the following: (1) recycling of drilling mud, (2) use of low toxicity additives and mud systems, (3) treatment and discharge of cuttings, (4) recycling and/or treatment of other waste fluids and solids, (5) ramp up/delay of ramp up/shutdown of seismic array, and (6) temporal and spatial avoidance of critical habitats.