# 7.0 Routine Project Activities

Routine project activities were previously described in the Project Description in Section 3.0 and are summarized in terms of frequency and duration in Table 7.1.

**Table 7.1. Project Activity Table to Aid in Developing Frequency and Duration Ratings.**

| Project Phase/Activity | Frequency/Duration Base Case[a] | Maximum Number of Events | Maximum Total Duration[b,c] (months) |
|---|---|---|---|
| **Glory Hole Excavation And TGB Installation** | | | |
| Dredge operation | 60 days | 4 glory holes | 8 |
| Presence of structures | 60 days | 4 glory holes | 8 |
| Safety zone | 60 days | 4 glory holes | 8 |
| Lights | 60 nighttime periods | 4 glory holes | 4 |
| Deck drainage, bilge water, and ballast water | Periodic daily | 4 glory holes | 8 |
| Sanitary or domestic waste water | 60 days | 4 glory holes | 8 |
| Routine air emissions | 60 days - Dredger boats, helicopters | 4 glory holes | 8 |
| Marine vessels | 60 days | 4 glory holes | 8 |
| Helicopter flights | 54 | 4 glory holes | 1-2 |
| | | | |
| **Drilling** | | | |
| Presence of structures | 60 days | 30 wells | 48 |
| Safety zone | 60 days | 30 wells | 48 |
| Lights | 60 nighttime periods | 30 wells | 24 |
| Flaring | Periodic during testing | 30 wells | N/A |
| Mud operations[c] | 40 days | 30 wells | 40 |
| Cement | 1 | 30 wells | N/A |
| BOP discharge[d] | Periodic during drilling by semi-submersible | 30 wells | N/A |
| Cooling water | 60 days | 30 wells | 48 |
| Deck drainage, bilge water, and ballast water | Periodic daily | 30 wells | N/A |
| Sanitary or domestic waste water | 60 days | 30 wells | 48 |
| Produced water | 20 days | 30 wells | 20 |
| Supply boat transits | 18 trips | 30 wells | N/A |
| Supply boat on standby | 1 boat always on standby | 30 wells | 48 |
| Helicopter flights | 54 flights | 30 wells | 11-12 |
| Rig operation | 1 rig | 30 wells | 48 |
| Air emissions (testing) | 20 days testing | 30 wells | 20 |
| Routine air emissions | 60 days - Rig, boats, choppers | 30 wells | 48 |
| VSP | 2 days | 30 wells | 2 |
| | | | |
| **Subsea Production Equipment Installation** | | | |
| Presence of structures | 30 days | 4 glory holes | 4 |
| Safety zone | 30 days | 4 glory holes | 4 |
| Lights | 30 nighttime periods | 4 glory holes | 2 |

**Table 7.1 (continued). Project Activity Table to Aid in Developing Frequency and Duration Ratings.**

| Project Phase/Activity | Frequency/Duration Base Case[a] | Maximum Number of Events | Maximum Total Duration[b,c] (months) |
|---|---|---|---|
| **Glory Hole Excavation And TGB Installation** | | | |
| Deck drainage, bilge water, and ballast water | Periodic daily | 4 glory holes | 4 |
| Sanitary or domestic waste water | 30 days | 4 glory holes | 4 |
| Routine air emissions | 30 days - Boats, choppers | 4 glory holes | 4 |
| Marine vessels | 30 days | 4 glory holes | 4 |
| | | | |
| **Production Operations[e]** | | | |
| Presence of structures | 365 days/year | 12 years | 144 |
| Safety zone | 365 days/year | 12 years | 144 |
| Lights | 365 nighttime periods/year | 12 years | 72 |
| Flaring | 365 days/year | 12 years | 144 |
| Cooling water | 365 days/year | 12 years | 144 |
| Deck drainage, bilge water, and ballast water | Periodic daily | 12 years | N/A |
| Sanitary or domestic waste water | 365 days/year | 12 years | 144 |
| Produced water | 365 days/year | 12 years | 144 |
| Supply boat transits | Nothing additional to existing traffic | | |
| Supply boat on standby | 365 days/year | 12 years | 144 |
| Helicopter flights | 6/week | 12 years | 26 |
| FPSO operation | 365 days/year | 12 years | 144 |
| Routine air emissions | 365 days/year - FPSO, boats, helicopters | 12 years | 144 |
| | | | |
| **Abandonment** | | | |
| Presence of structures | 300 days | 4 glory holes | 40 |
| Safety zone | 300 days | 4 glory holes | 40 |
| Lights | 300 nighttime periods | 4 glory holes | 20 |
| Deck drainage, bilge water, and ballast water | Periodic daily | 4 glory holes | |
| Sanitary or domestic waste water | 300 days | 4 glory holes | 40 |
| Routine air emissions | Boats, choppers | | |
| Marine vessels | 300 days | 4 glory holes | 40 |
| Helicopter flights | Nothing additional to existing traffic | | |

[a] Based on one event (i.e., single glory hole or well)
[b] Maximum duration of Drilling Phase is 48 months (i.e., concurrent drilling of some wells)
[c] Based on Husky estimate of total duration of each Project Phase
[d] As per regulation
[e] Note that most, if not all, production activities fall within the range of the original White Rose EA. They are included here to allow for "within project" cumulative effects assessment.

## 7.1 Potential Zones of Influence

The primary environmental concerns regarding the routine activities associated with the Husky White Rose Development Project: New Drill Centre Construction & Operations Program include the effects of drill mud and cuttings, and the effects of benthic disturbance resulting from glory hole excavation. Other environmental concerns include the effects of noise, light, air emissions and exclusion of fishery activity in the vicinity of the Project activity. These concerns in the context of the proposed Project are discussed in the following sections.

### 7.1.1 Safety Zone

The current safety zone at the White Rose Development Area will have to be altered to accommodate the development of and subsequent production operations at the new drill centres. Consultations with Transport Canada, Marine Safety and the Department of Fisheries and Oceans will be part of the necessary process to increase the area of the existing safety zone. All five Phases of the Project will occur within the modified safety zone.

No one other than operational or C-NLOPB personnel would be allowed within the zone without the express permission of the offshore installation manager. A 'Notice to Mariners regarding the safety zone will be issued. For the White Rose Development Area, Husky is also proposing to the International Maritime Organization (IMO) the establishment of a 'precautionary zone' which would extend five nautical miles (~9 km) beyond the safety zone. This precautionary zone is intended to increase safety by providing earlier notification of approaching vessels.

## 7.2 Sediment Excavation (Removal, Deposition, Suspension)

Approximately 155,540 $m^3$ of seabed sediment will be excavated during the construction of each glory hole (maximum floor dimension of 70 m x 70 m), and subsequently dumped on top of previously dumped spoils. The spoils site is located approximately three km south-southeast of the current Southern Drill Centre. The area of the disturbed spoil site is approximately 240,000 $m^2$, or 0.06% of the Project Area. As a result of sediment removal by a suction hopper dredge, physical, chemical and biological characteristics of the benthic habitat will be altered at each new glory hole site. In addition, some of the sediment will likely be suspended in the lower water column prior to settling on the bottom, thereby affecting the physical, chemical and biological characteristics of the water.

Construction of glory holes will engender a HADD, pursuant to the federal *Fisheries Act*. In order to compensate for the loss of fish habitat and its attendant fish productivity, Husky will be required to design and enact a compensation plan. It is planned that the compensation will involve the construction of marine fish habitat(s) in inshore Newfoundland. Husky will also submit an application for an Ocean Dumping Permit early in 2007.

## 7.3 Lights and Flaring

Lights are used on the dredging vessel, drill rig, FPSO and supply/support vessels for navigation aids and work area illumination. Light and heat could also be emitted for short periods by flaring during well testing (drilling phase) and on an ongoing basis from the FPSO during production operations. Lights under certain conditions have the potential to affect some bird species, particularly storm petrels, by attracting them to the rig. Lights might also attract other biota such as squid, fish and sea turtles. The potential effects of these activities are discussed under the various VEC headings (Section 7.6).

## 7.4 Drill Mud and Cuttings

The assessment of drill cuttings deposition is based on a modeling study of the potential deposition characteristics of cuttings produced by the White Rose Development (Husky 2000; LGL 2002). Results of the White Rose modeling of cuttings deposition indicated that the biological 'zone of influence' (ZOI) is generally confined within approximately 500 m of the drilling area. This has also been concluded by reviews of worldwide information contained in Buchanan et al. (2003), Hurley and Ellis (2004) and Neff (2005).

Drilling muds are needed to convey the drill cuttings out of the hole and keep formation fluids from entering the well. During the drilling of the top hole sections, the riser is not in place and drilling mud and cuttings (or sediments) from the top part of the hole are discharged from the hole to the seabed. Once the riser is in place the mud and cuttings are brought to the surface for cleaning and recycling.

All drilling on the East Coast is conducted using either water-based drilling muds (WBM) or synthetic-based muds (SBM). At present, highly deviated or deepwater wells require mostly SBM during drilling. It is debatable which type of mud is more or less 'environmentally friendly.' It can be argued that WBM is better because it consists of mostly water and cannot form sheens on the surface whereas SBM may form a sheen under certain conditions. On the other hand, SBMs generally do not disperse as widely as WBMs and, therefore, accumulate closer to the wellsite then WBMs.

After installation of the initial casing strings, the riser provides a conduit from the seabed to the rig through which drilling mud and cuttings move back to the surface mud system. Once on board the rig, the drill cuttings are removed from the mud in successive separation stages and discharged. Some mud remains with the discharged cuttings. The treated cuttings are discharged via a chute to just below the water's surface. The mud and cuttings are dispersed in the water column and settle on the sea floor with the heavier particles near the hole and the fines at increasing distances from the rig. At several stages during drilling and at the end of the drilling process, WBM is discharged. In most cases on the Grand Banks, used SBM is brought ashore for recycling or disposal in an approved manner. All drilling fluids will be handled and treated in accordance with C-NLOPB policies and the *OWTG*.

The main component of SBM is a white synthetic based oil called Pure Drill IA-35. This drilling fluid is used by all operators on the East Coast and has been demonstrated to be non acutely or chronically toxic through operator testing or through government testing (Payne et al., 2000). The other additives are primarily the same as WBM, mostly barite (weighting agent with other additives.

The main component of WBM is either fresh water or seawater. The primary WBM additives include bentonite (clay) and/or barite. Other chemicals such as potassium chloride, caustic soda, soda ash, viscosifiers, filtration-control additives and shale inhibitors are added to control mud properties. Low toxicity chemicals are used for the water-based drilling mud to reduce the effect on the environment.

Estimated volumes of water-based mud and cuttings discharges associated with initial casings for a typical Grand Banks (White Rose area) well are shown in Table 7.2. It should be noted that the muds/cuttings from the production casing phase are passed through the solids control system that consists of shale shakers and centrifuges.

Drilling muds and cuttings, and their potential effects were discussed in detail in the White Rose Oilfield Comprehensive Study (Husky 2000) and supplement (Husky 2001a), drilling EA update (Buchanan et al. 2003), and recent drilling EAs and updates for Husky (LGL 2002, 2005a, 2006a). Modeling of the fate of drill mud and cuttings discharges was conducted for the Comprehensive Study. It analyzed the effects of the discharge of drilling wastes from development drilling of 25 wells using SBM at multi-well drilling sites. The White Rose development drilling was deemed to create no significant effect on fish and fish habitat, the fishery, seabirds, marine mammals, or sea turtles. Additional relevant documents not available during the preparation of the White Rose Comprehensive Study include MMS (2000); CAPP (2001a,b), NEB et al. (2002), the White Rose baseline studies (Husky 2001b, 2003), Husky exploratory drilling EAs and updates (LGL 2002, 2003, 2005a, 2006a), the reviews of Buchanan et al. (2003), Hurley and Ellis (2004) and Neff (2005), and the Husky EEM reports (Husky 2005, 2006). All of these documents discuss the discharge of mud and cuttings and associated effects. These recent reports have further confirmed the conclusions of the White Rose work that routine drilling, particularly small scale drilling, has no significant effect on the marine environment of the Grand Banks.

During the 2004 field sampling of the White Rose EEM Program, seafloor sediment samples were collected at 30 locations along transect lines radiating from the centers of development (Husky 2005). The observed elevated concentrations of hydrocarbons and barium were within the range of levels observed at other developments and did not extend beyond the zone of influence predicted by drill cuttings modeling (Hodgins and Hodgins 2000). Elevated hydrocarbon and barium concentrations in the sediment extended to five to eight km and two km from the source, respectively. Elevated levels of fines in the sediment were limited to within one km of the source.

The 2005 White Rose EEM Program involved sediment sampling at 31 locations on the program transects (Husky 2006). Again, the observed elevated concentrations of hydrocarbons and barium near the drill centres were within the range of levels observed at other developments and did not extend beyond the zone of influence predicted by drill cuttings modeling (Hodgins and Hodgins 2000). Weak directional effects for both hydrocarbon and barium contamination were observed primarily to the southeast within one km of the Southern and Central drill centres.

### 7.4.1 Water-Based Muds

Presently, the first two hole sections (surface and conductor)are drilled with WBM Composition of one typical WBM formulation for a Grand Banks drilling program is shown in Table 7.2.

**Table 7.2. M Components and Cuttings Discharge Volume for a Typical Grand Banks Development Well.**

<table>
<tr><th rowspan="2"></th><th rowspan="2">Unit</th><th colspan="3">Casing Strings</th><th rowspan="2"></th></tr>
<tr><th>Conductor</th><th>Surface</th><th>Production</th></tr>
<tr><td>Hole Section</td><td>Inch</td><td>36</td><td>16</td><td>12 1/4</td><td rowspan="21">Notes:<br>1. Three scenarios were taken into account. The 12 ¼" hole section varies in depth with each scenario.<br>2. 36" and 16" hole sections–Near seabed discharge.<br>3. WBM used for complete well.<br>4. All depths are measured below rotary table (brt). The rotary table is 145 m above the seafloor.</td></tr>
<tr><td>DF System</td><td></td><td>Gel/SW</td><td>Gel/SW</td><td>WBM</td></tr>
<tr><td>Depth (See Note 4)</td><td>Meter (brt)</td><td>220</td><td>1200</td><td>3600</td></tr>
<tr><td>Volume Usage</td><td>Bbl</td><td>897</td><td>4199</td><td>5246</td></tr>
<tr><td>Wash Out</td><td>%</td><td>50%</td><td>30%</td><td>10%</td></tr>
<tr><td>Products</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Barite</td><td>MT</td><td></td><td>58</td><td>115</td></tr>
<tr><td>Bentonite</td><td>MT</td><td>16</td><td>65</td><td></td></tr>
<tr><td>Calcium Carbonate</td><td>Kg</td><td></td><td></td><td></td></tr>
<tr><td>Caustic</td><td>Kg</td><td>116</td><td>482</td><td>138</td></tr>
<tr><td>Fluid Loss Agent</td><td>Kg</td><td></td><td></td><td>2385</td></tr>
<tr><td>Inhibitor</td><td>Kg</td><td></td><td></td><td>4769</td></tr>
<tr><td>Fluid Loss Agent</td><td>Kg</td><td></td><td></td><td>9538</td></tr>
<tr><td>Potassium Chloride</td><td>Kg</td><td></td><td></td><td>100153</td></tr>
<tr><td>Lime</td><td>Kg</td><td>116</td><td>482</td><td></td></tr>
<tr><td>Glycol Inhibitor</td><td>L</td><td></td><td></td><td>25024</td></tr>
<tr><td>Soda Ash</td><td>Kg</td><td>116</td><td>482</td><td>238</td></tr>
<tr><td>Viscosifier</td><td>Kg</td><td></td><td></td><td>3577</td></tr>
<tr><td>Biocide</td><td>L</td><td></td><td></td><td>72</td></tr>
<tr><td>Drilled Cuttings</td><td>Kg</td><td>192032</td><td>429562</td><td>521786</td></tr>
<tr><td>Volume of Cuttings</td><td>$m^3$</td><td>74</td><td>165</td><td>201</td></tr>
</table>

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

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

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

- Chemicals such as caustic soda, soda ash, viscosifiers, and shale inhibitors are added to control mud properties. All constituents are normally screened using the *Offshore Chemical Selection Guidelines* (NEB et al. 1999). 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). The discharge of WBM may increase metals in sediments 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, these metals, with a few exceptions, are not bioavailable and few if any biological effects have been associated with these increases in metals due to drill rig discharges (CAPP 2001b).

- The primary effect of WBM appears to be smothering of benthos in a small area proximate to 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. Nonetheless, the White Rose Oilfield Comprehensive Study indicated a worst-case scenario of an area of less than one $km^2$ around each well having a depth of WBM sufficient to result in some smothering (Husky 2000, 2001a). Based upon the published literature (reviewed in Husky 2000, 2001a; LGL 2002, 2005a, 2006a; MMS 2000; CAPP 2001b), the benthos can be expected to recover over a period of several months to several years but most likely within one year after cessation of drilling. Monitoring data from other operators indicate that the actual area of smothering appears to be much less than predicted (Fechhelm et al. 2001; Marathon, unpubl. data in LGL 2003; JWEL 2002). Areas of smothering predicted for the new drill centres are small.

### 7.4.2 Synthetic-based Muds

Synthetic-based muds (SBM) will likely be used for drilling the majority of the wells in the proposed development of new drill centres. Typical constituents of SBM are shown in Table 7.3. In general, SBM is essentially non-toxic, has the potential to biodegrade relatively rapidly (at least under certain conditions of oxygen, depth and temperature), and less mud is required compared to WBM for the same distance drilled. SBM tend to 'clump' cuttings together more than WBM and, therefore, compared to WBM cuttings, SBM associated cuttings tend to disperse less and fall closer to the rig.

**Table 7.3. Typical Constituents of SBM.**

| Component | Quantity (kg/m$^3$) |
|---|---|
| Base chemical (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, Qvert (Husky SBM System) | 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 drilling program on the East Coast.

- When SBM is used, the cuttings are treated to remove oil on cuttings as per the OWTG prior to discharge. Discharges are subject to approval by the C-NLOPB and discharge of whole SBM is not permitted. All synthetic based muds must be tested for toxicity as per the OWTG and the results sent to the C-NLOPB.

- SBM is essentially non-toxic given that the non-toxic white oil with no aromatic component is the base fluid for the SBM

- Biological effects are not normally found beyond 250 to 500 m from the drilling platform (Husky 2000, 2001a; LGL 2002, 2003, 2005a, 2006a; MMS 2000; CAPP 2001b; NEB et al. 2002; Buchanan et al. 2003; Hurley and Ellis 2004). Recent Husky EAs (White Rose, Jeanne d'Arc Basin, and South Whale Basin) have predicted a total area of impact of less than one km$^2$ from multi-well drilling based on modeling and published literature.

- Mitigation measures for drilling include the selection of non-toxic or low toxicity chemicals and muds, and treating any oil-contaminated cuttings to meet the *OWTG and the Offshore chemical Selection Guidelines*.

- The total quantity of mud and cuttings that would be deposited on the seabed would be on the order of 230 m$^3$ per well. Based on a ZOI radius from the well centre of 500 m, a thickness of one centimeter or greater would cover approximately 0.8 km$^2$ of the seabed (based on Figure 4.3-2 in Husky 2000).

- In Nova Scotia, SBMs have been handled in a number of ways including shipping to shore, injection, and discharge. In 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.

## 7.5 Noise

Underwater sound has the potential to affect marine animals in a variety of ways depending on source levels, duration of exposure, proximity of noise source, animal sensitivities, environmental conditions, and 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/support vessels, drill rig machinery and thrusters, dredging vessel, FPSO, echo sounders, VSP seismic array, wellhead removal explosives (if used), and others. DP drill ships are typically noisier than semi-submersibles which, in turn, are nosier than jack-ups (Richardson et al. 1995). Some sound levels reported for routine offshore drilling and VSP activities are provided in Table 7.4.

**Table 7.4. Natural and Development-related Underwater Sound Levels.**

| Source | Broadband Sound Level (dB re 1 µPa[1]) | Sound Levels at Dominant Frequencies | |
|---|---|---|---|
| | | Frequency (Hz) | Level (dB re 1 µPa[1]) |
| **Ambient Noise** | | | |
| Wind < 1.8 km/h | - | 100 | 60 |
| Wind 20.4-29.7 km/h | - | 100 | 97 |
| Wind 40.8-50.0 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 | - |
| **VSP Array** | | | |
| Peak source level | 233 | - | - |
| **Depth Sounder** | 180+ | 12,000+ | - |
| **Semi-submersible Drill Rig** | 154 | 7-14, 29, 70 | - |
| **Drillship** | 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 levels at 3 to 18 m depth | - | - | 65-70 |
| [1] 3rd octave band level | | | |

*Source*: Adapted from Richardson et al. (1995).

VSP uses an airgun array to assist in further defining a petroleum resource or locating well boreholes/tracks. With respect to petroleum bearing formations VSP arrays are similar to those employed during 2-D and 3-D seismic surveys but are typically smaller and have lower source sound pressure levels. VSPs 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. several days).

## 7.6 Potential Effects of Routine Activities

The following sections describe the potential interactions of the proposed Project routine activities with the VECs, identification and evaluation of potential effects of the routine activities on the VECs (including description of mitigation measures and residual effects), and residual effects summary tables, including evaluation of cumulative effects. The effects assessment is based on 'routine activities'. In some cases, a routine activity and its potential effect (s) are associated with only one Phase of the Project. However, in other cases, a routine activity and its potential effect (s) is associated with more than one Phase of the Project. In these instances, the worst-case Routine Activity-Phase scenario is assessed. If this worst-case scenario results in a *not significant* rating, then it follows that the effects of the other Routine Activity-Phase scenario (s) are also *not significant*. This approach aids the reviewer by minimizing the number of tables and amount of repetitive text in this section.

Cumulative effects are considered for both within the new drill centre Project and between the new drill centre Project and other projects/activities occurring on the Grand Banks. These other projects/activities include existing oil development projects such as Hibernia, Terra Nova and White Rose, and other activities such as exploration, marine transportation, fishing, and, in the case of marine birds, hunting.

### 7.6.1 Fish Habitat

Tables 7.5 to 7.7 present the potential interactions of the drill centre Project routine activities and the fish habitat VEC, the assessment of potential residual effects of the routine activities on the fish habitat VEC, and the residual effects summary, respectively. The four components of fish habitat considered in this assessment include water, sediment, plankton and benthos.

#### 7.6.1.1 Presence of Structures

Surface structures will include the dredging vessel, the drill rig (s), the FPSO, and others required during all five Phases of the drill centre Project. Presence of structures results in various effects on fish habitat including those related to the establishment of safety zones and artificial reef effect (Table 7.5).

## Table 7.5. Potential Interactions of Routine Activities and Fish Habitat VEC.

| Valued Environmental Component: Fish Habitat | | | | | |
|---|---|---|---|---|---|
| **Project Activity** | **Project Phase**[a] | **Fish Habitat Components** | | | |
| | | **Water** | **Sediment** | **Plankton** | **Benthos** |
| **Presence of Structures** | | | | | |
| Safety Zone | 1,2,3,4,5 | x | x | x | x |
| Artificial Reef Effect | 1,2,3,4,5 | x | x | x | x |
| **Sediment Excavation** | | | | | |
| Removal | 1 | x | x | x | x |
| Deposition | 1 | x | x | x | x |
| **Lights** | 1,2,3,4,5 | | | x | |
| **Flaring** | 2,4 | | | x | |
| **Drill Mud/Cuttings** | | | | | |
| Water-based Muds | 2 | x | x | x | x |
| Synthetic-based Muds | 2 | x | x | x | x |
| **Other Fluids/Solids**[b] | | | | | |
| Cement | 2 | x | x | | x |
| BOP Fluid | 2 | x | | x | |
| Cooling Water | 2,4 | x | | x | |
| Deck Drainage | 2,4 | x | | x | |
| Bilge Water | 2,4 | x | | x | |
| Ballast Water | Not applicable | | | | |
| Sanitary/Domestic Waste Water | 2,4 | x | | x | |
| Small Transfer Spills | 2,4 | x | | x | |
| Produced Water[c] | 2,4 | x | | x | |
| Garbage[d] | Not applicable | | | | |
| **Atmospheric Emissions** | 1,2,3,4,5 | x | | x | |
| **Ships and Boats** | 1,2,3,4,5 | | | | |
| **Helicopters** | 1,2,3,4,5 | | | | |
| **Noise** | | | | | |
| Dredge | 1 | | | x | x |
| Drilling Rigs | 2 | | | x | x |
| Support Vessels | 1,2,3,4,5 | | | x | x |
| Helicopters | 1,2,3,4,5 | | | | x |
| FPSO | 4 | | | x | x |
| VSP | 2 | | | x | x |
| **Underwater Maintenance** | 1,2,3,4 | x | x | x | x |
| **Shore Facilities**[e] | Not applicable | | | | |
| **Other Projects/Activities** | | | | | |
| Hibernia | | x | x | x | x |
| Terra Nova | | x | x | x | x |
| White Rose | | x | x | x | x |
| Exploration | | x | x | x | x |
| Fisheries | | x | x | x | x |
| Marine Transportation | | x | | x | x |

[a] 1 = Glory Hole Excavation/TGB Installation
2 = Drilling
3 = Subsea Production Equipment Installation
4 = Production Operations
5 = Abandonment
[b] Effects assessment of offshore accidental events (i.e., blowouts, spills) is in Section 8
[c] Produced water associated with well testing may be flared
[d] All garbage will be brought to shore
[e] Existing onshore infrastructure will be used

## Table 7.6. Environmental Effects Assessment of Potential Effects of Routine Activities on Fish Habitat VEC.

| Valued Environmental Component: Fish Habitat | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Evaluation Criteria for Assessing Environmental Effects | | | | | |
| Project Activity | Project Phase[a] | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological/ Socio-Cultural and Economic Context |
| **Presence of Structures** | | | | | | | | | |
| Safety Zone | 1,2,3,4,5 | Safe refuge from fishing (P) | - | 1 | 2 | 6 | 5 | R | 2 |
| Artificial Reef Effect | 1,2,3,4,5 | Increased food and shelter (P) | - | 1 | 2 | 6 | 5 | R | 2 |
| **Sediment Excavation** | | | | | | | | | |
| Removal | 1 | Disruption of substrate (N)<br>Suspension of sediment (N) | | 1 | 1 | 1 | 2 | R | 2 |
| Deposition | 1 | Disruption of substrate (N)<br>Suspension of sediment (N)<br>Smothering (N) | | 1 | 1 | 1 | 2 | R | 2 |
| **Lights** | 1,2,3,4,5 | Attraction (N) | | 0 | 2 | 5 | 5 | R | 2 |
| **Flaring** | 2,4 | Attraction (N) | | 0 | 2 | 1 | 5 | R | 2 |
| **Drill Mud/Cuttings** | | | | | | | | | |
| Water-based Muds | 2 | Contamination (N)<br>Smothering (N) | Recycle mud;<br>and discharge cuttings | 1 | 1 | 6 | 4 | R | 2 |
| Synthetic-based Muds | 2 | Contamination (N)<br>Smothering (N) | Recycle mud;<br>Treat muds and discharge cuttings | 1 | 1 | 6 | 4 | R | 2 |
| **Other Fluids/Solids** | | | | | | | | | |
| Cement | 2 | Disruption of substrate (N)<br>Artificial reef effect (P) | | 0 | 1 | 1 | 5 | R | 2 |
| BOP Fluid | 2 | Contamination (N) | Chemical Selection criteria | 0 | 1 | 6 | 4 | R | 2 |
| Cooling Water | 2,4 | Shock (N)<br>Growth (P) | Minimize concentration and Monitor | 0 | 1 | 6 | 5 | R | 2 |
| Deck Drainage | 2,4 | Contamination (N) | Treatment | 0 | 1 | 5 | 5 | R | 2 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Bilge Water | 2,4 | Contamination (N) | Treatment | 0 | 1 | 5 | 5 | R | 2 |
| Ballast Water | N/A | | | | | | | | |
| Sanitary/Domestic Waste Water | 2,4 | Contamination (N)<br>Nutrient source (P) | Treatment | 0 | 1 | 5 | 5 | R | 2 |
| Small Transfer Spills | 2,4 | Contamination (N) | Safe handling practices; Cleanup protocols | 0 | 1 | 5 | 5 | R | 2 |
| Produced Water[b] | 2,4 | Contamination (N) | Treatment | 0 | 1 | 1 | 5 | R | 2 |
| Garbage[c] | N/A | | | | | | | | |
| **Atmospheric Emissions** | 1,2,3,4,5 | Contamination (N) | Equipment design | 0 | 2 | 6 | 5 | R | 2 |
| **Ships and Boats** | 1,2,3,4,5 | No interaction | - | - | - | - | - | - | - |
| **Helicopters** | 1,2,3,4,5 | No interaction | - | - | - | - | - | - | - |
| **Noise** | | | | | | | | | |
| Dredger | 1 | Disturbance (N) | - | 1 | 2-3 | 6 | 2 | R | 2 |
| Drilling Rigs | 2 | Disturbance (N) | - | 1 | 2-3 | 6 | 4 | R | 2 |
| Support Vessels | 1,2,3,4,5 | Disturbance (N) | - | 1 | 2-3 | 6 | 5 | R | 2 |
| Helicopters | 1,2,3,4,5 | Disturbance (N) | - | 0 | 1 | 4 | 5 | R | 2 |
| FPSO | 4 | Disturbance (N) | - | 1 | 2-3 | 6 | 5 | R | 2 |
| VSP | 2 | Disturbance (N)<br>Physical (N) | Source level selection; Temporal avoidance of sensitive times | 1 | 1-4 | 1 | 1 | R | 2 |
| **Underwater Maintenance** | 1,2,3,4 | Disturbance (N) | Material and method selection | 1 | 1 | 1 | 1 | R | 2 |
| **Shore Facilities[d]** | N/A | | | | | | | | |

**Magnitude**
0 = Negligible
1 = Low
2 = Medium
3 = High

**Geographic Extent**
1 = < 1 $km^2$
2 = 1-10 $km^2$
3 = 11-100 $km^2$
4 = 101-1,000 $km^2$
5 = 1,001-10,000 $km^2$
6 = > 10,000 $km^2$

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

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

**Reversibility (population level)**
R = Reversible
I = Irreversible

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

[a] 1 = Glory Hole Excavation/TGB Installation
2 = Drilling
3 = Subsea Production Equipment Installation
4 = Production Operations
5 = Abandonment

[b] Produced water associated with well testing may be flared

[c] All garbage will be brought to shore

[d] Existing onshore infrastructure will be used

**Table 7.7. Significance of Predicted Residual Environmental Effects of Routine Activities on Fish Habitat VEC.**

| Valued Environmental Component: Fish Habitat | | | | | |
|---|---|---|---|---|---|
| **Project Activity** | **Project Phase[a]** | **Significance of Predicted Residual Environmental Effects** | | **Likelihood[b]** | |
| | | **Significance Rating** | **Level of Confidence** | **Probability of Occurrence** | **Scientific Certainty** |
| **Presence of Structures** | | | | | |
| Safety Zone | 1,2,3,4,5 | P | 3 | - | - |
| Artificial Reef Effect | 1,2,3,4,5 | P | 3 | - | - |
| **Sediment Excavation** | | | | | |
| Removal | 1 | NS | 3 | - | - |
| Deposition | 1 | NS | 3 | - | - |
| **Lights** | 1,2,3,4,5 | NS | 3 | - | - |
| **Flaring** | 2,4 | NS | 3 | - | - |
| **Drill Mud/Cuttings** | | | | | |
| Water-based Muds | 2 | NS | 3 | - | - |
| Synthetic-based Muds | 2 | NS | 3 | - | - |
| **Other Fluids/Solids** | | | | | |
| Cement | 2 | NS | 3 | - | - |
| BOP Fluid | 2 | NS | 3 | - | - |
| Cooling Water | 2,4 | NS | 3 | - | - |
| Deck Drainage | 2,4 | NS | 3 | - | - |
| Bilge Water | 2.4 | NS | 3 | - | - |
| Ballast Water | N/A | | | | |
| Sanitary/Domestic Waste Water | 2,4 | NS | 3 | - | - |
| Small Transfer Spills | 2,4 | NS | 3 | - | - |
| Produced Water[c] | 2,4 | NS | 3 | | |
| Garbage[d] | N/A | | | | |
| **Atmospheric Emissions[e]** | 1,2,3,4,5 | NS | 3 | - | - |
| **Ships and Boats** | 1,2,3,4,5 | NS | 3 | - | - |
| **Helicopters** | 1,2,3,4,5 | NS | 3 | - | - |
| **Noise** | | | | | |
| Dredger | 1 | NS | 3 | - | - |
| Drilling Rigs | 2 | NS | 3 | - | - |
| Support Vessels | 1,2,3,4,5 | NS | 3 | - | - |
| Helicopters | 1,2,3,4,5 | NS | 3 | - | - |
| FPSO | 4 | NS | 3 | - | - |
| VSP | 2 | NS | 3 | - | - |
| **Underwater Maintenance** | 1,2,3,4 | NS | 3 | - | - |
| **Shore Facilities[f]** | N/A | | | | |

**Significance Rating (significance is defined as a medium or high magnitude (2 or 3 rating) and duration > 1 year (≥ 3 rating) and geographic extent > 100 km$^2$ (≥ 4 rating)**

NS = Not significant negative environmental effect
S = Significant negative environmental effect
NS = Not significant negative environmental effect
P = Positive environmental effect

**Level of Confidence (professional judgement)**
1 = Low level of confidence
2 = Medium level of confidence

**Probability of Occurrence (professional judgement)**
1 = Low probability of occurrence
2 = Medium probability of occurrence

| | |
|---|---|
| 3 = High level of confidence | 3 = High probability of occurrence |

**Level of Scientific Certainty (based on scientific information and statistical analysis or professional judgement)**
1 = Low level of scientific certainty
2 = Medium level of scientific certainty
3 = High level of scientific certainty

[a] 1 = Glory Hole Excavation/TGB Installation
2 = Drilling
3 = Subsea Production Equipment Installation
4 = Production Operations
5 = Abandonment

[b] Only considered in the event of significant (S) residual effect
[c] Produced water associated with well testing may be flared
[d] All garbage will be brought to shore
[e] Includes produced water which may be flared
[f] Existing onshore infrastructure will be used

The safety zone would have a potential positive effect on all four fish habitat components (i.e., water, sediment, plankton, benthos) by excluding other users from the area, including commercial fishers (Table 7.6). The safety zone would provide some protection against damage to the seabed by trawlers and shellfish dredges and perhaps lower fish mortality from commercial fisheries. Hibernia, Terra Nova and White Rose have safety zones of 5.2 $km^2$, 13.8 $km^2$, and 49.2 $km^2$, respectively. As previously mentioned, the new drill centre Project will require an increase in the size of the White Rose safety zone.

The artificial reef effect would also have a potential positive effect on all four fish habitat components by increasing habitat complexity and, thereby providing increased food and shelter for a more diverse assemblage of marine organisms (Table 7.6). Structures will create habitat for biofouling organisms (benthic epiflora and fauna). In the North Sea, most of the fouling biomass in the upper 50 m is composed of seaweeds, hydroids, mussels, soft corals and anemones. Below that depth, hydroids, soft corals, anemones and tubeworms are the most common animals (Welaptega 1993). Colonization of subsea structures by fouling epifaunal animals and plants might be considered a nuisance and eventually a hazard (i.e., an effect of the environment on the project). If necessary, fouling organisms may be periodically removed using diver- or ROV-deployed brushes or high-pressure water jets (Welaptega 1993). The accumulation of removed fouling organisms on the bottom may further attract invertebrate and fish predators (Dicks 1982).

Therefore, the overall effect of the presence of structures on fish habitat will be *positive* (Tables 7.6 and 7.7).

#### 7.6.1.2 Sediment Excavation

Sediment excavation will occur only during the Glory Hole Excavation/TGB Installation Phase of the drill centre Project. The potential effects of sediment removal and deposition would interact with all four components of the fish habitat VEC (Table 7.5). Sediment and benthos would be most affected by this activity although water and plankton would also be potentially affected by the suspension of sediment in the water column. Potential negative effects of sediment excavation include disruption of substrate, smothering of benthos and suspension of sediments in the water column (Table 7.5).

Considering the relatively small area of each glory hole (70 m x 70 m floor dimension equivalent to <0.0002 % of Project Area), the reuse of the original spoil area for sediment deposition, and the sandy nature of the sediment minimizing the amount and duration of sediment suspension in the water column, the magnitude, geographic extent and duration of the potential effects of sediment excavation on the fish habitat VEC are *low*, *<1 km*$^2$, and *1-12 months* (2 months per glory hole; 8 months maximum), respectively (Table 7.6). Based on these criteria evaluations, the potential residual effects of sediment excavation on the fish habitat VEC are *not significant* (Table 7.7).

No overlap of glory hole excavations is expected to occur during the new drill centre Project. Cumulative effects of sediment excavation on fish habitat would be considered additive but are judged as being not large enough to change the overall residual effects rating.

#### 7.6.1.3 Lights

The dredging vessel, drill rig, FPSO, and supply and standby ships will all be equipped with navigation and warning lights. Working areas will be illuminated with floodlights. Therefore, potential environmental effects of lights would occur during all five Project Phases. Some plankton may be attracted to illuminated surface waters near the vessels but the potential effects on these biota would be minimal (Table 7.5).

Therefore, using the worst-case Activity-Phase interaction scenario between lights and Production Operations Phase, the magnitude, geographic extent and duration of the potential effects on the fish habitat VEC are *negligible*, *1-10 km*$^2$, and *>72 months* (2009-2020), respectively (Table 7.6). The potential residual effects of lights on the fish habitat VEC are *not significant* (Table 7.7).

Considering that lights will be used during all five Project Phases, there is potential for temporal overlap of this activity in different Phases. However, despite these effects being additive, they are judged to not be large enough to change the overall effects rating. Cumulative effects with respect to other activities on the Grand Banks are considered to be not large enough to change the overall residual effects rating.

#### 7.6.1.4 Flaring

Drill rigs may conduct flaring for short periods during well testing. The FPSO has a continuous flare during production operations. Other than the slight possibility of illumination attracting some zooplankton to surface waters (considered under "lights") (Table 7.5), the effect of flaring on fish habitat will be minimal.

Therefore, using the worst-case Activity-Phase interaction scenario between flaring and Drilling Phase, the magnitude, geographic extent and duration of the potential effects on the fish habitat VEC are *negligible*, *1-10 km$^2$*, and *>72 months* (2009-2020), respectively (Table 7.6). The potential residual effects of flaring on the fish habitat VEC are *not significant* (Table 7.7).

#### 7.6.1.5 Drill Muds and Cuttings

The discharge of drilling muds and cuttings would definitely occur during the Drilling Phase of the Project,. Drill muds and cuttings have the most potential to affect the sediment and benthos components of the fish habitat VEC but could also affect water quality and plankton (Table 7.5).

The total quantity of mud and cuttings that would be deposited on the seabed would be on the order of 230 m$^3$ per well. This will cover an area of the seabed of about 0.8 km$^2$ to a thickness of one cm or greater (based on Figure 4.3-2 in Husky 2000). The Project will use water-based drill muds, comprised primarily of water, bentonite (clay) and barite for the surface and conductor sections. Other typical constituents of WBM's used for drilling are shown in Table 7.2. Typical constituents of SBM's are presented in Table 7.3.

Drilling muds and cuttings, and their potential effects were discussed in detail in the White Rose Oilfield Comprehensive Study (Husky 2000) and supplement (Husky 2001a). The White Rose Oilfield Comprehensive Study analyzed the effects of the discharge of drilling wastes from development drilling of 25 wells using SBM at multi-well drilling sites. The White Rose development drilling was deemed to create *no significant effect* on fish habitat, the fishery, seabirds, marine mammals, or sea turtles.

More specifics on mud formulations per specific hole sections and their respective toxicities will be provided in the applications for approval to drill a well (ADW) that must be approved by C-NLOPB for each well. As well, each generic mud formulation must be toxicity tested and the results presented to the C-NLOPB as per the OWTG, 2002.

##### 7.6.1.5.1 Smothering Effects

Modeling of cuttings was conducted for the White Rose Comprehensive Study (Husky 2000). More recent modeling (Lorax 2002), using the same methods, was conducted for the Lewis Hill EA (LGL 2003). Water depths in the modeled area ranged from about 100 m (excluding a knoll of about 10 m depth) to 150 m, with a depth of approximately 100 m at the proposed drill site in the centre of the area. The oil concentration in the cuttings and muds was assumed to be zero.

Historical ocean data obtained from the Bedford Institute of Oceanography were used to prescribe currents in the area, and particle sizes for cuttings were based on estimates from the Hibernia K-18 well. Four particle size classes ranging from 0.1 mm to 7 mm in diameter were used to specify the cuttings. The bottom section of the well, with diameters of 12¼" (31.1 cm), produces both mud and cuttings that will be discharged from the drilling unit. These solids would be returned to the surface, processed through the mud recovery system and then discharged into the sea at a nominal depth of 5 m. The estimated solids volumes for this section of the well were 834 $m^3$ of mud and 201 $m^3$ of cleaned cuttings. Approximately 634 $m^3$ of mud would be discharged as the 12 ¼" hole is drilled; the balance of 200 $m^3$ would be dumped upon completion of drilling to 3,600 m.

The 12¼" section is represented by four activities that are distinguished by their particle size distributions and mud content. Two separate simulations were performed: the first modeled the drilling schedule for a specific period of interest from March 25 through April 5, 2003. The second simulation estimates the statistical properties of the deposition by combining the results from forty separate model runs over the period from March through August, 2003.

The deposition pattern resulting from the March – April simulation is roughly elliptical in shape with the area covered by cuttings of at least 0.001 mm having dimensions of approximately two by four km (Lorax 2002). The coarse material is deposited within a much smaller area approximately 500 m in diameter centred on the well location. The maximum thickness of approximately 10 mm occurs within a 25 m radius of the well (Lorax 2002). It is unlikely that any smothering effect would occur until thickness was about 10 mm (1 cm) or greater (see Bakke et al. 1989), all of which would occur well within a radius of 500 m of the well.

The mean deposition pattern for the March – August period has a similar orientation and elliptical shape to the March – April simulation, but with dimensions of three by four kilometres (Lorax 2002). The distribution of material is also similar with most of the material being deposited within a 250-m radius of the well site. The maximum mean thickness is less than 1 cm within a very small radius of the well.

Benthic community analyses were performed during the Husky EEM Program in 2004 and 2005 (Husky 2005, 2006). In 2004, there were indications of lower abundance of amphipods near the Southern and Northern drill centres. In 2005, total abundance and dominance of polychaetes appeared to be affected by drilling activity at the Southern drill centre. Both parameters increased significantly with increasing distance from the drill centre. Amphipod abundance was reduced near all drill centres in 2005. All of these abundance and dominance differences appear to be associated with hydrocarbon concentrations in the sediment. However, the significance of these benthic community observations does not imply that effects of the White Rose development are greater than at other development sites. In fact, many project effects on benthic communities observed at other development areas have not been observed at White Rose.

#### 7.6.1.5.2 Contamination Effects

Both snow crab and American plaice were sampled as representative invertebrate and fish species during the Husky EEM Program in 2004 and 2005 (Husky 2005, 2006) and analysed for metal and hydrocarbon body burden, taint, morphometrics, and in the case of the plaice, various health indices. Samples were collected as close as the boundary of the Safety Zone (i.e., 1.25 km from an active drill centre). Results of these analyses indicated no significant difference between crabs and plaice collected closest to the drill centres and those collected at reference stations more than 20 km away from the drill centres, indicating no project effects.

#### 7.6.1.5.3 Mitigation

Mitigation measures include choice prudent choices in muds and treatment before discharge. More specifically, choice of non-toxic WBM and choice of a non-aromatic food grade drilling fluid to be the main component in the low toxicity SBM system. Treatment before discharge further removes excess oil to meet the 2002 *OWTG*, subject to C-NLOPB approvals. Operators report these Monthly to the C-NLOPB.

#### 7.6.1.5.4 Assessment

Based on the worst-case interaction scenario between ‘Drill Muds and Cuttings’ and Drilling Project Phase (magnitude *low*, geographic extent *<1 km*$^2$, duration *37-72 months* [fall 2007 – summer 2011]) (Table 7.6), the potential residual effects of water-based and synthetic-based drill muds and cuttings on fish habitat are *not significant* (Table 7.7).

#### 7.6.1.5.5 Cumulative Effects

A potential scenario for cumulative effects from drill mud and cuttings discharge would be if the material settles on the ocean floor, smothers benthic communities partially or completely, and effects are persistent over time. This scenario is subject to numerous variables such as type of mud, weather conditions, water depth and velocity, discharge depth, species involved, biological and biodegradation activity. In order to obtain some order of magnitude of the area of seabed potentially affected by the Husky development drilling during the 2007-2011 period, one can quickly calculate a very rough approximation of the total affected area.

A maximum of 30 wells would be drilled during the Drilling Phase, all within the constructed glory holes. Assuming 500 m as the radius of each well’s biological zone of influence (ZOI) (i.e., potential smothering due to a minimum of 1 cm thickness of deposited cuttings and mud) and given that the floor dimension of each glory hole will be 70 m x 70 m, there would be essentially 100% overlap of the ZOIs of adjacent wells within a single glory hole. Therefore, the ZOI associated with each glory hole would have an area of approximately 0.78 km$^2$. The total area of ZOI for all four proposed glory holes will be approximately 3.12 km$^2$, equivalent to <1%

of the area of the Project Area. Including the ZOIs of the 19 wells in the existing 3 glory holes increases the total ZOI area to 5.46 $km^2$, equivalent to <1.4% of the area of the Project Area. Since the wells will be drilled on the floor portion of each glory hole which is approximately 11 m below the surface of the ocean substrate, it is likely that much of the mud and cuttings deposition will occur within the glory holes (136 m x 136 m including sloped ramps), areas already subjected to HADD. Deposition from adjacent wells in any single glory hole will accumulate vertically (i.e., overlap of individual well biological ZOIs).

Canadian Association of Petroleum Producers (CAPP) has predicted that there would be between one and four drill rigs per year operating on the Grand Banks between 2000 and 2010 (CAPP 1999). Any cumulative effects of drill muds and cuttings on the Grand Banks ecosystem from routine drilling outside the proposed Project Area will probably not overlap in time and space and thus, will be additive but not multiplicative.

Again, given the relatively small area potentially affected by each well relative to the total Grand Banks area, and the apparent short duration of smothering effect and the potential for recovery, the cumulative effects of the new drill centre Project and all other drilling activities on the Grand Banks is deemed to be *not significant*.

#### 7.6.1.6 Other Fluids/Solids

Husky currently utilizes an Offshore Chemical Management System (OCMS), similar to that in use by Terra Nova and Hibernia, whereby all chemicals that have the potential to reach the environment that are used in the drilling or production phase are screened. The screening assesses the potential toxicity. Where chemicals are deemed to have unacceptable toxicity ratings, a substitution for that chemical is sought. This process is based on the Offshore Chemical Selection Guidelines (C-NOPB, 1999). Based on maximum ‘durations’, the assessments of the effects of cement, BOP fluid, and cooling water use the worst-case scenarios in the Drilling Phase while assessments of the effects of deck drainage, bilge water, ballast water, sanitary/domestic waste water, small transfer spills, and produced water use the worst-case scenarios in the Production Operations Phase of the Project.

##### 7.6.1.6.1 Cement

Cement will be released during the Drilling Phase. This release has the potential to affect all fish habitat components except plankton (Table 7.5). Approximately 33 t (26.4 $m^3$) of excess cement may be released to the marine environment per well, and will smother some benthos locally. It also may affect water quality briefly. If the cement remains in a pile, it will act as an artificial reef, be colonized by epifaunal animals and attract fish. The effects of the cement on fish habitat would be *negligible* in magnitude, *<1* $km^2$ in geographic extent and *37-72 months* in duration (Table 7.6), resulting in a rating of the residual effects of cement on fish habitat of *not significant*

(Table 7.7). Effects will be additive with other projects but the cumulative effect will not exceed this rating.

#### 7.6.1.6.2 BOP Fluid

BOP fluid would definitely be released during the Drilling Phase. This release has the potential to affect water and plankton (Table 7.5). Blowout preventer fluid is used in the blowout preventer stacks during drilling. The fluids will be glycol-water mixes; the lowest toxicity mixes will be selected. Periodic testing of the blowout preventer is required by regulation. The approximate one $m^3$ of the fluid released by semi-submersible rigs per test will be quickly dispersed. The effect of periodic releases of this small amount of glycol on fish habitat would be *negligible* in magnitude, *<1 $km^2$* in geographic extent and *>72 months* in duration (Table 7.6), resulting in a rating of the residual effects of BOP fluid on fish habitat of *not significant* (Table 7.7). Effects will be additive with other projects but the cumulative effect will not exceed this rating.

#### 7.6.1.6.3 Cooling Water

Cooling water will be released during the Drilling Phase and during the Production Operations Phase. This release has the potential to affect water and plankton (Table 7.5). For equipment such as mud pump line-cooling systems and main engines, seawater is used for cooling; it is pumped through heat exchangers and discharged overboard without additives or treatment except chlorine for anti-fouling purposes. Fluids used in closed loop cooling systems are tested for compliance prior to discharge. Proposals for the use of biocides other than chlorine will be submitted to the C-NLOPB as per the current *OWTG* (C-NOPB 2002). For most other drilling rig systems, cooling is via a closed loop system. The effects of the discharge of these small amounts of cooling water on fish habitat would be *negligible* in magnitude, *<1 $km^2$* in geographic extent and *>72 months* in duration (Table 7.6), resulting in a rating of the residual effects of cooling water on fish habitat of *not significant* (Table 7.7). Effects will be additive with other projects but the cumulative effect will not exceed this rating.

#### 7.6.1.6.4 Deck Drainage

Deck drainage is released during the Drilling Phase and during the Production Operations Phase, potentially affecting the water and plankton components of fish habitat (Table 7.5). Typically deck drainage would be collected in the hazardous drains system, routed through an oil-water separator treated to 15 mg/L or less and discharged as per *OWTG*. Oil concentrations in the discharge exceeding 15 mg/L are considered to have exceeded normal operating practice and will be reported to the C-NLOPB as per the OWTG and EPCMP.

On typical semi-submersibles, rain water collecting on walkways and pipe storage areas that are open to the weather and not in oily areas and is not treated but is discharged through open marine gutters and scuppers called the open drains system. Any oil that is found in these areas is treated as a spill and immediately cleaned up to minimize the risk of oil loss to the ocean.

The effects of deck drainage on fish habitat would be *negligible* in magnitude, *<1 km$^2$* in geographic extent and *>72 months* in duration (Table 7.6), resulting in a rating of the residual effects of deck drainage on fish habitat of *not significant* (Table 7.7). Effects will be additive with other projects but the cumulative effect will not exceed this rating.

#### 7.6.1.6.5 Bilge Water

Bilge water is released during the Drilling Phase and during the Production Operations Phase, potentially affecting the water and plankton components of fish habitat (Table 7.5). 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 in the discharge exceeding 15 mg/L are considered to have exceeded normal operating practice and will be reported to the C-NLOPB as per the OWTG exceedance criteria and EPCMP.

The effects of bilge water on fish habitat would be *negligible* in magnitude, *<1 km$^2$* in geographic extent and *>72 months* in duration (Table 7.6), resulting in a rating of the residual effects of bilge water on fish habitat of *not significant* (Table 7.7). Effects will be additive with other projects but the cumulative effect will not exceed this rating.

#### 7.6.1.6.6 Ballast Water

Ballast water will be released during the Drilling Phase and during the Production Operations Phase. 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. Therefore, no interaction of ballast water and fish habitat should occur. 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*.

#### 7.6.1.6.7 Sanitary/Domestic Waste Water (Grey/Black Water)

Sanitary and domestic waste water will is released during the Drilling Phase and during the Production Operations Phase, potentially affecting the water and plankton components of fish habitat (Table 7.5). The total number of persons on a drill rig at any one time will be about 85 to 120, and for the FPSO a maximum of 90. 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 19 m$^3$/d. The sanitary waste will be macerated to a particle size of 6 mm or less and discharged as per the *OWTG*. 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 of sanitary and domestic waste water on fish habitat would be *negligible* in magnitude, *<1 km$^2$* in geographic extent and *>72 months* in duration (Table 7.6), resulting in a rating of the residual effects of sanitary and domestic waste water on fish habitat of *not significant* (Table 7.7). Effects will be additive with other projects but the cumulative effect will not exceed this rating.

#### 7.6.1.6.8 Small Transfer Spills

Small transfer spills apply primarily to the Drilling and Production Operations Phases of the Project, potentially affecting the water and plankton components of fish habitat (Table 7.5). Fuel, drilling fluids and muds, lubricants and other chemicals will be transported by supply vessel from the onshore facilities to the drilling rig and FPSO. Small amounts of these materials have the potential to be spilled, during transfer to the drilling rig and FPSO.

All fuel, chemicals and wastes will be handled in a manner that minimizes or eliminates routine spillage and accidents. Standard Operating procedures referenced in the EPCMP will provide details of safe fuel, chemical, waste handling and storage procedures. Workers will be trained in these procedures.

Husky's East Coast Incident Coordination Plan and Oil Spill Response Plan contains detailed measures for preparing for and responding to spills, including the use of cleanup equipment, training of personnel and identification of personnel to direct cleanup efforts, lines of communications and the lead response organization to handle the clean up.

The effects of small transfer spills on fish habitat would be *negligible* in magnitude, *<1 km$^2$* in geographic extent and *>72 months* in duration (Table 7.6), resulting in a rating of the residual effects of small transfer spills on fish habitat of *not significant* (Table 7.7). Effects will be additive with other projects but the cumulative effect will not exceed this rating.

#### 7.6.1.6.9 Produced Water

Produced fluids only occur if petroleum hydrocarbons are found and subsequent testing occurs. Therefore, this activity applies to the Drilling and Production Operations Phases of the Project. Produced fluids could potentially affect the water and plankton components of the fish habitat VEC (Table 7.5). Produced gas and fluids will be separated on the rig. 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.

Produced water defined as formation or injection water will be realised during production operations. As reservoirs mature, production water volumes will increase until they reach a maximum of 30,000 $m^3$/day at the end of the Whiterose field.

The effects of produced water on fish habitat would be *negligible* in magnitude, *<1 $km^2$* in geographic extent and *>72 months* in duration (Table 7.6), resulting in a rating of the residual effects of produced water on fish habitat of *not significant* (Table 7.7). Effects will be additive with other projects but the cumulative effect will not exceed this rating.

#### 7.6.1.6.10 Garbage

All garbage and other types of waste will be transferred ashore for proper disposal or treatment. Combustible materials such as oily rags, paint cans, and so forth will be placed in separate hazardous materials containers and transferred ashore for proper waste disposal. No garbage will be discharged over the side; thus, there will be no interaction with the marine environment. Therefore, no interaction of garbage and fish habitat should occur.

#### 7.6.1.7 Atmospheric Emissions

Air emissions will occur during all Phases of the Project and have the potential to interact with water and plankton (Table 7.5).

There are Several Main Sources of Emissions Associated with Operations Offshore:

- Flaring from Production Operations on the FPSO and very minimal if any flaring from Drilling
- The burning of fuels for power generation; fuel gas mostly on the FPSO and some diesel, diesel on the drill rig and the supply vessels
- Fugitive emissions

Testing of the wells is critical to the determination 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. The emissions from these booms will include particulate matter containing hydrocarbons, unburned hydrocarbons, various oxide gases and water vapour. A visible fire and smoke plume will also be evident. 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 FPSO, drill rigs and the support vessels. Exhaust gases will contain oxides of nitrogen, carbon dioxide, carbon monoxide and sulphur dioxide and unburned hydrocarbons. Fuel (normally diesel) and equipment will be carefully selected and maintained for maximum combustion efficiency. Newer rigs likely have lower combustion emissions and fugitive emissions.

In addition, there will be some small amounts of fugitive emissions such as hydrocarbon losses at valves and seals, open ended piping and particulate matter from cement and chemical powders.

The FPSO was designed to minimize greenhouse gas emissions (GHG) and volatile organic compounds (VOC). These design modifications are addressed in the document referencing Condition 35 of Approval for the White Rose Project. The quantity of air emissions from the White Rose Development Area is calculated and provided to the C-NLOPB annually as per the *OWTG* (2002).

In general, emissions of potentially harmful materials will be small and of short duration and they will rapidly disperse once released to undetectable levels. Based on the worst-case interaction scenario between air emissions' and Production Operations Project Phase (magnitude *low*, geographic extent *1-10* $km^2$, duration *>72 months* [2009-2020]) (Table 7.6), the residual effects of air emissions on fish habitat are *not significant* (Table 7.7). Effects will be additive with other projects but the cumulative effect will not exceed this rating.

#### 7.6.1.8 Ships and Boats

The presence of support ships and boats will occur during all five Phases of the Project. As indicated in Table 7.5, there really is not any notable interaction of the vessel presence with fish habitat.

#### 7.6.1.9 Helicopters

The presence of helicopters will likely occur during all five Phases of the Project to transport personnel and light supplies between shore and the offshore. No interaction occurs between the presence of helicopters and fish habitat (Table 7.5).

#### 7.6.1.10 Noise

The sea is a naturally noisy environment. Natural ambient noise is often related to sea state. Ambient noise tends to increase with increasing wind speed and wave height. In many areas, shipping is a major contributor to ambient sound. Disturbance related to underwater and air-borne noise could be caused by more stationary sources such as the dredging vessel, drilling platforms, and FPSO or by mobile sources such as supply boats and helicopters (Table 7.4). Noise would obviously occur during all five Phases of this Project and it can potentially affect two biological components of fish habitat, plankton (i.e., zooplankton) and benthos (including fish such as flatfish species) (Table 7.5).

The various types of potential effects of exposure to noise 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. They are certainly interrelated in complex ways. For example, it is possible that certain physiological and behavioural changes could potentially lead to the ultimate pathological effect on individual animals (i.e., mortality). More detail on the potential effects of exposure to noise on invertebrates and fish is provided in the section on the effects of routine activities on the Fish VEC (Section 7.6.2.10).

Based on the worst-case interaction scenario between noise and Production Operations Project Phase (magnitude *low*, geographic extent *1-10 to 11-100* $km^2$, duration *>72 months* [2009-2020]) (Table 7.6), the residual effects of noise on fish habitat are *not significant* (Table 7.7).

#### 7.6.1.10.1 Cumulative Effects

Noise is produced by all activities occurring on the Grand Banks. The cumulative effects of all man-made noise sources on the Grand Banks are, at the moment, impossible to measure. From the perspective of fish habitat, it is likely that the cumulative effects of exposure to noise on zooplankton and benthic fish is *negligible*, given the apparent low sensitivities to sound of these biota compared to hearing specialist fish and higher vertebrate animals such as marine mammals.

#### 7.6.1.11 Underwater Maintenance

This activity includes underwater maintenance work by divers and Remotely Operated Vehicles (ROVs). It has the potential to occur in all Phases of the Project and affect all components of the fish habitat VEC (Table 7.5). Disturbance of the sediment could indirectly affect the water by causing the suspension of sediment. Plankton and benthos would thus be affected by disturbance of the sediment and subsequent sediment suspension. Presence of divers and ROVs could also potentially affect the behaviour of biota.

Considering the periodicity of this activity and the l*ow* magnitude, *<1* $km^2$ geographic extent, and *>72 month* duration, the residual effects of underwater maintenance on fish habitat is predicted to be *not significant*.

### 7.6.2 Fish

Tables 7.8 to 7.10 present the potential interactions of the new drill centre Project routine activities and the fish VEC, the assessment of potential effects of the routine activities on the fish VEC, and the residual effects summary, respectively. The four life stages of fish considered in this assessment include eggs and larvae, juveniles, adult pelagics, and adult groundfish.

## Table 7.8. Potential Interactions of Routine Activities and Fish VEC.

| Valued Environmental Component: Fish | | | | | |
|---|---|---|---|---|---|
| Project Activity | Project Phase[a] | Fish Life Stage | | | |
| | | Eggs[b]/Larvae | Juveniles[c] | Adult Pelagic | Adult Groundfish |
| **Presence of Structures** | | | | | |
| Safety Zone | 1,2,3,4,5 | | x | x | x |
| Artificial Reef Effect | 1,2,3,4,5 | | x | x | x |
| **Sediment Excavation** | | | | | |
| Removal | 1 | | x | x | x |
| Deposition | 1 | | x | x | x |
| **Lights** | 1,2,3,4,5 | x | x | x | |
| **Flaring** | 2,4 | x | x | x | |
| **Drill Mud/Cuttings** | | | | | |
| Water-based Muds | 2 | x | x | x | x |
| Synthetic-based Muds | 2 | x | x | x | x |
| **Other Fluids/Solids[d]** | | | | | |
| Cement | 2 | | x | | x |
| BOP Fluid | 2 | x | | x | |
| Cooling Water | 2,4 | x | | x | |
| Deck Drainage | 2,4 | x | | x | |
| Bilge Water | 2,4 | x | | x | |
| Ballast Water | Not applicable | | | | |
| Sanitary/Domestic Waste Water | 2,4 | x | | x | |
| Small Transfer Spills | 2,4 | x | | x | |
| Produced Water[e] | 2,4 | x | | x | |
| Garbage[f] | Not applicable | | | | |
| **Atmospheric Emissions** | 1,2,3,4,5 | x | | x | |
| **Ships and Boats** | 1,2,3,4,5 | | | | |
| **Helicopters** | 1,2,3,4,5 | | | | |
| **Noise** | | | | | |
| Dredge | 1 | | x | x | x |
| Drilling Rigs | 2 | | x | x | x |
| Support Vessels | 1,2,3,4,5 | | x | x | x |
| Helicopters | 1,2,3,4,5 | | | x | |
| FPSO | 4 | | x | x | x |
| VSP | 2 | x | x | x | x |
| **Underwater Maintenance** | 1,2,3,4 | | x | x | x |
| **Shore Facilities[g]** | Not applicable | | | | |
| **Other Projects/Activities** | | | | | |
| Hibernia | | x | x | x | x |
| Terra Nova | | x | x | x | x |
| White Rose | | x | x | x | x |
| Exploration | | x | x | x | x |
| Fisheries | | | x | x | x |
| Marine Transportation | | | x | x | x |

[a] 1 = Glory Hole Excavation/TGB Installation
2 = Drilling
3 = Subsea Production Equipment Installation
4 = Production Operations
5 = Abandonment
[b] Eggs of some species closely associated with substrate
[c] Often closely associated with substrate
[d] Effects assessment of offshore accidental events (i.e., blowouts, spills) is in Section 8
[e] Produced water associated with well testing may be flared
[f] All garbage will be brought to shore
[g] Existing onshore infrastructure will be used

## Table 7.9. Environmental Effects Assessment of Potential Effects of Routine Activities on Fish VEC.

| Valued Environmental Component: Fish | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Evaluation Criteria for Assessing Environmental Effects | | | | | |
| **Project Activity** | **Project Phase[a]** | **Potential Positive (P) or Negative (N) Environmental Effect** | **Mitigation** | **Magnitude** | **Geographic Extent** | **Frequency** | **Duration** | **Reversibility** | **Ecological/ Socio-Cultural and Economic Context** |
| **Presence of Structures** | | | | | | | | | |
| Safety Zone | 1,2,3,4, | Safe Refuge from Fishing (P) | - | 1 | 2 | 6 | 5 | R | 2 |
| Artificial Reef Effect | 1,2,3,4,5 | Increased Food and Shelter (P) | - | 1 | 2 | 6 | 5 | R | 2 |
| **Sediment Excavation** | | | | | | | | | |
| Removal | 1 | Suspension of Sediment (N) | - | 1 | 1 | 1 | 2 | R | 2 |
| Deposition | 1 | Suspension of Sediment (N) | - | 1 | 1 | 1 | 2 | R | 2 |
| **Lights** | 1,2,3,4,5 | Attraction (N) | - | 0 | 2 | 5 | 5 | R | 2 |
| **Flaring** | 2,4 | Attraction (N) | - | 0 | 2 | 5 | 5 | R | 2 |
| **Drill Mud/Cuttings** | | | | | | | | | |
| Water-based Muds | 2 | Contamination (N) | Recycle mud; and discharge cuttings | 1 | 1 | 6 | 4 | R | 2 |
| Synthetic-based Muds | 2 | Contamination (N) | Recycle mud; Treat muds and discharge cuttings | 1 | 1 | 6 | 4 | R | 2 |
| **Other Fluids/Solids** | | | | | | | | | |
| Cement | 2 | Disruption of Substrate (N) Artificial Reef Effect (P) | | 0 | 1 | 1 | 5 | R | 2 |
| BOP Fluid | 2 | Contamination (N) | Selection criteria | 0 | 1 | 6 | 4 | R | 2 |
| Cooling Water | 2,4 | Shock (N) Growth (P) | Monitor | 0 | 1 | 6 | 5 | R | 2 |
| Deck Drainage | 2,4 | Contamination (N) | Treatment | 0 | 1 | 5 | 5 | R | 2 |
| Bilge Water | 2,4 | Contamination (N) | Treatment | 0 | 1 | 5 | 5 | R | 2 |
| Ballast Water | N/A | | | | | | | | |
| Sanitary/Domestic Waste Water | 2,4 | Contamination (N) Nutrient Source (P) | Treatment | 0 | 1 | 5 | 5 | R | 2 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Small Transfer Spills | 2,4 | Contamination (N) | Safe handling practices; Cleanup protocols | 0 | 1 | 5 | 5 | R | 2 |
| Produced Water[b] | 2,4 | Contamination (N) | Treatment | 0 | 1 | 1 | 5 | R | 2 |
| Garbage[c] | N/A | | | | | | | | |
| **Atmospheric Emissions** | 1,2,3,4,5 | Contamination (N) | Equipment design | 0 | 2 | 6 | 5 | R | 2 |
| **Ships and Boats** | 1,2,3,4,5 | No interaction | - | - | - | - | - | - | - |
| **Helicopters** | 1,2,3,4,5 | No interaction | - | - | - | - | - | - | - |
| **Noise** | | | | | | | | | |
| Dredge | 1 | Disturbance (N) | - | 1 | 2-3 | 6 | 2 | R | 2 |
| Drilling Rigs | 2 | Disturbance (N) | - | 1 | 2-3 | 6 | 4 | R | 2 |
| Support Vessels | 1,2,3,4,5 | Disturbance (N) | - | 1 | 2-3 | 6 | 5 | R | 2 |
| Helicopters | 1,2,3,4,5 | Disturbance (N) | - | 0 | 1 | 4 | 5 | R | 2 |
| FPSO | 4 | Disturbance (N) | - | 1 | 2-3 | 6 | 5 | R | 2 |
| VSP | 2 | Disturbance (N) Physical (N) | Source level selection; Temporal avoidance of sensitive times; Ramp up | 1 | 1-4 | 1 | 1 | R | 2 |
| **Underwater Maintenance** | 1,2,3,4 | Disturbance (N) | Material and method selection | 1 | 1 | 1 | 1 | R | 2 |
| **Shore Facilities[d]** | N/A | | - | | | | | | |

**Magnitude**
0 = Negligible
1 = Low
2 = Medium
3 = High

**Geographic Extent**
1 = < 1 $km^2$
2 = 1-10 $km^2$
3 = 11-100 $km^2$
4 = 101-1,000 $km^2$
5 = 1,001-10,000 $km^2$
6 = > 10,000 $km^2$

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

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

**Reversibility (population level)**
R = Reversible
I = Irreversible

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

[a] 1 = Glory Hole Excavation/TGB Installation
2 = Drilling
3 = Subsea Production Equipment Installation
4 = Production Operations
5 = Abandonment

[b] Produced water associated with well testing may be flared

[c] All garbage will be brought to shore

[d] Existing onshore infrastructure will be used

**Table 7.10. Significance of Predicted Residual Environmental Effects of Routine Activities on Fish VEC.**

| Valued Environmental Component: Fish | | | | | |
|---|---|---|---|---|---|
| **Project Activity** | **Project Phase**[a] | **Significance of Predicted Residual Environmental Effects** | | **Likelihood**[b] | |
| | | **Significance Rating** | **Level of Confidence** | **Probability of Occurrence** | **Scientific Certainty** |
| **Presence of Structures** | | | | | |
| Safety Zone | 1,2,3,4,5 | P | 3 | - | - |
| Artificial Reef Effect | 1,2,3,4,5 | P | 3 | - | - |
| **Sediment Excavation** | | | | | |
| Removal | 1 | NS | 3 | - | - |
| Deposition | 1 | NS | 3 | - | - |
| **Lights** | 1,2,3,4,5 | NS | 3 | - | - |
| **Flaring** | 2,4 | NS | 3 | - | - |
| **Drill Mud/Cuttings** | | | | | |
| Water-based Muds | 2 | NS | 3 | - | - |
| Synthetic-based Muds | 2 | NS | 3 | - | - |
| **Other Fluids/Solids** | | | | | |
| Cement | 2 | NS | 3 | - | - |
| BOP Fluid | 2 | NS | 3 | - | - |
| Cooling Water | 2,4 | NS | 3 | - | - |
| Deck Drainage | 2,4 | NS | 3 | - | - |
| Bilge Water | 2,4 | NS | 3 | - | - |
| Ballast Water | N/A | | | | |
| Sanitary/Domestic Waste Water | 2,4 | NS | 3 | - | - |
| Small Transfer Spills | 2,4 | NS | 3 | - | - |
| Produced Water[c] | 2,4 | NS | 3 | - | - |
| Garbage[d] | N/A | | | - | - |
| **Atmospheric Emissions**[e] | 1,2,3,4,5 | NS | 3 | - | - |
| **Ships and Boats** | 1,2,3,4,5 | NS | 3 | - | - |
| **Helicopters** | 1,2,3,4,5 | NS | 3 | - | - |
| **Noise** | | | | | |
| Dredge | 1 | NS | 3 | - | - |
| Drilling Rigs | 2 | NS | 3 | - | - |
| Support Vessels | 1,2,3,4,5 | NS | 3 | - | - |
| Helicopters | 1,2,3,4,5 | NS | 3 | - | - |
| FPSO | 4 | NS | 3 | - | - |
| VSP | 2 | NS | 3 | - | - |
| **Underwater Maintenance** | 1,2,3,4 | NS | 3 | - | - |
| **Shore Facilities**[f] | N/A | | | | |

**Significance Rating (significance is defined as a medium or high magnitude (2 or 3 rating) and duration > 1 year (≥ 3 rating) and geographic extent > 100 km$^2$ (≥ 4 rating)**

NS = Not significant negative environmental effect
S = Significant negative environmental effect
NS = Not significant negative environmental effect
P = Positive environmental effect

**Level of Confidence (professional judgement)**
1 = Low level of confidence
2 = Medium level of confidence
3 = High level of confidence

**Probability of Occurrence (professional judgement)**
1 = Low probability of occurrence
2 = Medium probability of occurrence
3 = High probability of occurrence

**Level of Scientific Certainty (based on scientific information and statistical analysis or professional judgement)**

1 = Low level of scientific certainty
2 = Medium level of scientific certainty
3 = High level of scientific certainty

[a] 1 = Glory Hole Excavation/TGB Installation
2 = Drilling
3 = Subsea Production Equipment Installation
4 = Production Operations
5 = Abandonment
[b] Only considered in the event of significant (S) residual effect
[c] Produced water associated with well testing may be flared
[d] All garbage will be brought to shore
[e] Includes produced water which may be flared
[f] Existing onshore infrastructure will be used

#### 7.6.2.1 Presence of Structures

Surface structures will include the dredging vessel, the drill rig (s), the FPSO, and others required during all five phases of the new drill centre Project. Presence of structures results in various effects on the fish VEC including those related to safety zones and artificial reef effect (Table 7.8).

Safety zones would have a potential positive effect on juvenile and adult fish by excluding other users from the area, including commercial fishers (Table 7.9). Safety zones will provide some protection against damage to the seabed by trawlers and shellfish dredges and perhaps lower fish mortality from commercial fisheries. Hibernia, Terra Nova and White Rose have safety zones of 5.2 $km^2$, 13.8 $km^2$, and 49.2 $km^2$, respectively. As previously mentioned, the new drill centre Project will require an aerial increase of the White Rose safety zone.

The artificial reef effect would also have a potential positive effect on fish by increasing habitat complexity, thereby providing increased food and shelter for a more diverse assemblage of marine organisms (Table 7.9).

The overall effect of the presence of structures on fish would therefore be *positive* (Tables 7.9 and 7.10).

#### 7.6.2.2 Sediment Excavation

Sediment excavation will occur only during the Glory Hole Excavation/TGB Installation Phase of the new drill centre Project. Sediment removal and deposition would interact primarily with eggs of some species, juveniles, adult pelagic fish, and adult groundfish (Table 7.8) due to disruption of substrate and suspension of sediment in the water column.

Considering the relatively small area of each glory hole (70 m x 70 m floor dimension equivalent to < 0.0002 % of Project Area) and the spoils site, as well as the sandy nature of the sediment which minimizes the amount and duration of sediment suspension in the water column, the magnitude, geographic extent and duration of the potential effects of sediment excavation on fish are *low*, *<1 km$^2$*, and *1-12 months* (2 months per glory hole; 8 months maximum), respectively (Table 7.9). Based on these criteria evaluations, the potential residual effects of sediment excavation on the fish VEC is *not significant* (Table 7.10).

No overlap of glory hole excavations is expected to occur during the new drill centre Project. Cumulative effects of sediment excavation on fish would be additive but are judged as being not large enough to change the overall effects rating.

#### 7.6.2.3 Lights

The dredging vessel, drill rig, FPSO, and supply and standby vessels will all be equipped with navigation and warning lights. Working areas will be illuminated with floodlights. Therefore, this activity would occur during all five Project Phases. Some adult pelagic fish may be attracted to illuminated surface waters near the vessels but the potential effects on them would be minimal (Table 7.8).

Therefore, using the worst-case Activity-Project Phase interaction scenario between lights and Production Operations Phase, the magnitude, geographic extent and duration of the potential effects on the fish VEC are *negligible*, *1-10 km$^2$*, and *>72 months* (2009-2020), respectively (Table 7.9). Therefore, the potential residual effects of lights on the fish VEC are predicted to be *not significant* (Table 7.10).

Considering that lights will be used during all five Project Phases, there is potential for temporal overlap of this activity in different Phases. However, despite these effects being additive, they are judged to not be large enough to change the overall effects rating. Cumulative effects with respect to other activities on the Grand Banks are considered to not be large enough to change the overall residual effects rating.

#### 7.6.2.4 Flaring

Drill rigs may conduct flaring for short periods during testing and the FPSO has continuous flaring during production. Therefore, flaring could potentially occur during the Drilling and definitely occurs during Production Operations Phases of the Project. Other than the slight possibility of illumination attracting some pelagic fish to surface waters, the effect of flaring on the fish VEC would be minimal (Table 7.8).

Therefore, using the worst-case Activity-Project Phase interaction scenario between flaring and Production Operations Phase, the magnitude, geographic extent and duration of the potential effects on the fish VEC are *negligible*, *1-10 km$^2$*, and *>72 months* (2009-2020), respectively (Table 7.9). Therefore, the potential residual effects of flaring on the fish VEC are predicted to be *not significant* (Table 7.10).

#### 7.6.2.5 Drill Muds/Cuttings

The discharge of drilling muds and cuttings would occur during the Drilling Phase of the Project. Drill muds and cuttings have the most potential to affect those fish VEC components occurring in the lowest part of the water column (i.e., eggs of some species, juveniles, adult groundfish) but this potential is much lower than for benthos as described in the last section (Table 7.8).

Based on the worst-case interaction scenario between drill muds and cuttings and Drilling Project Phase (magnitude *low*, geographic extent *<1 km²*, duration *37-72 months* [fall 2007 – summer 2011]) (Table 7.9), the potential residual effects of water-based and synthetic-based drill muds and cuttings on the fish VEC are *not significant* (Table 7.10). Cumulative effects with respect to other activities on the Grand Banks are considered to not be large enough to change the overall residual effects rating.

#### 7.6.2.6 Other Fluids/Solids

Husky utilizes an Offshore Chemical Management System (OCMS), similar to that in use by Petro-Canada on Terra Nova and ExxonMobil on Hibernia, whereby all drilling and production chemicals that may impact the marine environment are screened to minimize potential toxicity. Based on maximum 'durations', the assessments of the effects of cement and BOP fluid, are isolated to, and use the worst-case scenarios in the Drilling Phase while assessments of the effects of deck drainage, bilge water, ballast water, cooling water, sanitary/domestic waste water, small transfer spills, and produced water use the worst-case scenarios in the Production Operations Phase of the Project.

##### 7.6.2.6.1 Cement

Cement would be released during the Drilling Phase. This release has the potential to affect all fish life stages except perhaps eggs of some species and larvae (Table 7.8). Approximately 33 t (26.4 $m^3$) of excess cement may be released to the marine environment per well. It could temporarily cause a disturbance to the substrate, indirectly affecting the fish VEC. If the cement remains in a pile, it will act as an artificial reef, be colonized by epifaunal animals and attract fish. The effects of the cement on fish would be *negligible* in magnitude, *<1 km²* in geographic extent and *>72 months* in duration (Table 7.9), resulting in a rating of the residual effects of cement on the fish VEC of *not significant* (Table 7.10). Effects will be additive with other projects but the cumulative effect will not exceed this rating.

##### 7.6.2.6.2 BOP Fluid

BOP fluid would be released during the Drilling Phase. This release has the potential to affect primarily eggs, larvae and adult pelagic fish (Table 7.8). The approximate one $m^3$ of the fluid released per test will be quickly dispersed. Considering the proposed mitigations, the residual effects of periodic releases of this small amount of glycol by semi-submersible rigs on fish would be *negligible* in magnitude, *<1 km*$^2$ in geographic extent and *37- 72 months* in duration (Table 7.9), resulting in a rating of the residual effects of BOP fluid on the fish VEC of *not significant* (Table 7.10). Effects will be additive with other projects but the cumulative effect will not exceed this rating.

#### 7.6.2.6.3 Cooling Water

Cooling water would be released during the Drilling Phase and the Production Operations Phase. This release has the potential to affect primarily eggs, larvae and adult pelagic fish (Table 7.8). For equipment such as mud pump line-cooling systems and main engines, seawater is used for cooling; it is pumped through heat exchangers and discharged overboard without additives or treatment except chlorine for anti-fouling purposes. Fluids used in closed loop cooling systems are tested for compliance prior to discharge. Proposals for the use of biocides other than chlorine will be submitted to the C-NLOPB as per the current *OWTG* (C-NOPB 2002). Considering the proposed mitigations, the residual effects of the discharge of these small amounts of cooling water on fish would be *negligible* in magnitude, *<1 km*$^2$ in geographic extent and *>72 months* in duration (Table 7.9), resulting in a rating of the residual effects of cooling water on the fish VEC of *not significant* (Table 7.10). Effects will be additive with other projects but the cumulative effect will not exceed this rating.

#### 7.6.2.6.4 Deck Drainage

Deck drainage is released during the Drilling Phase and during the Production Operations Phase. This has the potential to affecting eggs, larvae and adult pelagic fish (Table 7.8). Typically deck drainage would be collected and treated to 15 mg/L or less and discharged as per the OWTG.

Water collecting on walkways and pipe storage areas that are open to the weather is not considered to originate in oily areas and thus is not treated but is discharged through open marine gutters and scuppers. Any oil that is found in these areas is treated as a spill and immediately cleaned up to minimize the risk of oil loss to the ocean.

Considering the proposed mitigations, the residual effects of deck drainage on fish would be *negligible* in magnitude, *<1 km*$^2$ in geographic extent and *>72 months* in duration (Table 7.9), resulting in a rating of the residual effects of deck drainage on the fish VEC of *not significant* (Table 7.10). Effects will be additive with other projects but the cumulative effect will not exceed this rating.

#### 7.6.2.6.5 Bilge Water

Bilge water is released during the Drilling Phase and during the Production Operations Phase., 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 in the discharge exceeding 15 mg/L are considered to have exceeded normal operating practice and will be reported to the within 24 h.

Considering the proposed mitigations, the residual effects of bilge water on fish would be *negligible* in magnitude, *<1* $km^2$ in geographic extent and *>72 months* in duration (Table 7.9), resulting in a rating of the residual effects of bilge water on the fish VEC of *not significant* (Table 7.10). Effects will be additive with other projects but the cumulative effect will not exceed this rating.

#### 7.6.2.6.6 Ballast Water

Ballast water will be released during the Drilling Phase and during the Production Operations Phase. 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. Therefore, no interaction of ballast water and the fish VEC should occur. 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*.

#### 7.6.2.6.7 Sanitary/Domestic Waste Water (Grey/Black Water)

Sanitary and domestic waste water is released during the Drilling Phase and during the Production Operations Phase potentially affecting eggs, larvae and adult pelagic fish (Table 7.8). 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.

Considering the proposed mitigations, the residual effects of sanitary and domestic waste water on fish would be *negligible* in magnitude, *<1* $km^2$ in geographic extent and *>72 months* in duration (Table 7.9), resulting in a rating of the residual effects of sanitary and domestic waste on the fish VEC of *not significant* (Table 7.10). Effects will be additive with other projects but the cumulative effect will not exceed this rating.

#### 7.6.2.6.8 Small Transfer Spills

Small transfer spills apply primarily to the Drilling and Production Operations Phases of the Project, potentially affecting eggs, larvae and adult pelagic habitat (Table 7.8). Fuel, drilling muds and other chemicals will be transported by supply vessel from the onshore facilities to the drilling rig and FPSO. Small amounts of these materials have the potential to be spilled, during transfer to the drilling rig and FPSO.

All fuel, chemicals and wastes will be handled in a manner that minimizes or eliminates routine spillage and accidents. The Drilling EPCMP will provide details of safe fuel, chemical, waste handling and storage procedures. Workers will be trained in these procedures.

Husky's East Coast Incident Coordination Plan contains detailed measures for preparing for and responding to spills, including the use of cleanup equipment, training of personnel and a dedicated response contractor, and communications that could assist cleanup operations. All cleanup measures and procedures are specified in the plan.

Considering the proposed mitigations, the residual effects of small transfer spills on fish would be *negligible* in magnitude, *<1 km$^2$* in geographic extent and *>72 months* in duration (Table 7.9), resulting in a rating of the residual effects of small transfer spills on the fish VEC of *not significant* (Table 7.10). Effects will be additive with other projects but the cumulative effect will not exceed this rating.

#### 7.6.2.6.9 Produced Water

Produced water defined as formation or injection water will be realised during production operations. As reservoirs mature, production water volumes will increase until they reach a maximum at the end of the Whiterose field (Husky 2000). All produced water on the Searose FPSO will be treated to less than 30 mg/L and discharged as per the OWTG. The treatment involves a series of hydrocyclones and a degasser prior to discharge.

This activity applies to the Drilling and Production Operations Phases of the Project. Produced fluids could potentially affect eggs, larvae and adult pelagic (Table 7.8). Produced gas and fluids will be separated on the rig. Gas, oil and condensate, if present, will be flared on the drill 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.

Considering the proposed mitigations, the effects of produced water on fish would be *negligible* in magnitude, *<1 km$^2$* in geographic extent and *>72 months* in duration (Table 7.9), resulting in a rating of the residual effects of produced water on the fish VEC of *not significant* (Table 7.10). Effects will be additive with other projects but the cumulative effect will not exceed this rating.

#### 7.6.2.6.10 Garbage

All garbage will be transferred ashore for disposal. Combustible materials such as oily rags, paint cans, and so forth will be placed in separate hazardous materials containers and transferred ashore. No garbage will be discharged over the side; thus, there will be no interaction with the marine environment. Therefore, no interaction of garbage and fish should occur.

#### 7.6.2.7 Atmospheric Emissions

Air emissions will occur during the first four phases of the project and have the potential to interact with near-surface eggs, larvae and adult pelagic fish (Table 7.8).

In general, emissions of potentially harmful materials will be small and of short duration and they will rapidly disperse to undetectable levels. Based on the worst-case interaction scenario between air emissions' and Production Operations Project Phase (magnitude *low*, geographic extent *1-10* $km^2$, duration *>72 months* [2009-2020]) (Table 7.9), the residual effects of air emissions on fish are *not significant* (Table 7.10). Effects will be additive with other projects but the cumulative effect will not exceed this rating.

#### 7.6.2.8 Ships and Boats

Presence of ships and boats does not have any interaction with the fish VEC.

#### 7.6.2.9 Helicopters

Presence of helicopters does not have any interaction with the fish VEC.

#### 7.6.2.10 Noise

The sea is a naturally noisy environment. Natural ambient noise is often related to sea state. Ambient noise tends to increase with increasing wind speed and wave height. In many areas, shipping is a major contributor to ambient sound. Disturbance related to underwater and air-borne noise could be caused by more stationary sources such as the dredging vessel, drilling platforms, and FPSO or by mobile sources such as supply boats and helicopters (Table 7.4). Noise would obviously occur during all five Phases of this Project and it can potentially affect all life stages of the fish VEC (Table 7.8).

The various types of potential effects of exposure to noise 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. They are certainly interrelated in complex ways. For example, it is possible that certain physiological and behavioural changes could potentially lead to the ultimate pathological effect on individual animals (i.e., mortality). However, it appears that fish and invertebrates have to be exposed to large sound pressure levels for extended period 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 detail in the Orphan 3-D Seismic Program, 2004-2006 EA (Buchanan et al. 2004a), the Orphan Basin 3-D Seismic Program EA Update 2005 (Moulton et al. 2005b), and the Northern Jeanne d'Arc Basin 3-D Seismic EA (LGL 2005c).

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 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).

Some of the published studies of the effects of exposure to seismic sound on fishing have indicated temporary decreases in catch rate (Løkkeborg 1991; Skalski 1992; Engås et al. 1993, 1996). Christian et al. (2004) reported that exposure to seismic sound did not appear to decrease the catch rate of snow crab.

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 are able to detect certain vibrations.

Based on the worst-case Activity-Project Phase interaction scenario between noise and Production Operations Project Phase (magnitude *low*, geographic extent *1-10 to 11-100* $km^2$, duration *72 months* [2009-2020]) (Table 7.9), the residual effects of noise on fish are *not significant* (Table 7.10).

#### 7.6.2.10.1 Cumulative Effects

Noise is produced by all activities occurring on the Grand Banks. The cumulative effects of all man-made noise sources on the Grand Banks are, at the moment, impossible to measure. From the perspective of the fish VEC, it is likely that the cumulative effects of exposure to noise is *negligible*, given the fact that most fish are able to move away from any noise source before any chance of physical impact. While eggs and larvae do not have the same capability of avoiding a noise source, it seems that exposure to very high sound energy levels is required before damage is done to these early life stages.

#### 7.6.2.11 Underwater Maintenance

This activity includes underwater maintenance work by divers and Remotely Operated Vehicles (ROVs). It has the potential to occur during all Phases of the Project and affect primarily the behaviours of juvenile and adult biota of the fish VEC (Table 7.8). Disturbance of the sediment could also possibly affect the eggs of certain species.

However, considering the periodicity of this activity and the l*ow* magnitude, *<1 km*$^2$ geographic extent, and *>72 months* duration, the residual effects of underwater maintenance on fish is predicted to be *not significant* (Tables 7.9 and 7.10)

### 7.6.3 Commercial Fisheries

Potential interactions between routine activities related to the new drill centre Project and the commercial fisheries VEC, the assessment of potential residual effects of these activities on the fisheries, and the residual effects summary are presented in Tables 7-11 to 7-13. The three aspects or components of commercial fishing considered in this assessment are: (1) fishing gear and vessels (fouling or losing gear, vessel conflicts), (2) access to fishing grounds ("off limits" or unharvestable areas), and (3) fish "catchability" (issues related to scaring fish from a harvesting area or away from fishing gear).

This section concerns the activity of commercial harvesting (i.e. the process of catching fish for commercial sale), and not effects on fish habitat or on fish (other than catchability issues), since these effects are assessed separately (Tables 7-5 – 7-7 and 7-8 – 7-10) and were found to be *not significant*.

Potential interactions with, and effects on, fisheries science/research surveys (industry-led and DFO) are also included in this section, and under the same headings, because the effects' pathways are the same (i.e. the surveys are conducted essentially by "fishing"), and because these surveys are concerned primarily with commercial stock status.

**Table 7.11. Potential Interactions of Routine Activities and Commercial Fisheries VEC.**

| Valued Environmental Component: Commercial Fisheries[a] | | | | |
|---|---|---|---|---|
| **Project Activity** | **Project Phase[b]** | **Commercial Fisheries Components** | | |
| | | **Fishing Gear/Vessels** | **Access to Grounds** | **Catchability** |
| **Presence of Structures** | | | | |
| Safety Zone | 1,2,3,4,5 | | x | |
| Artificial Reef Effect | 1,2,3,4,5 | | | x |
| **Sediment Excavation** | | | | |
| Removal | 1 | | x | |
| Deposition | 1 | | x | |
| **Lights** | 1,2,3,4,5 | | | |
| **Flaring** | 2,4 | | | |
| **Drill Mud/Cuttings** | | | | |
| Water-based Muds | 2 | | | |
| Synthetic-based Muds | 2 | | | |
| **Other Fluids/Solids[c]** | | | | |
| Cement | 2 | | | |
| BOP Fluid | 2 | | | |
| Cooling Water | 2,4 | | | |
| Deck Drainage | 2,4 | | | |
| Bilge Water | 2,4 | | | |
| Ballast Water | Not applicable | | | |
| Sanitary/Domestic Waste Water | 2,4 | | | |
| Small Transfer Spills | 2,4 | | | |
| Produced Water[d] | 2,4 | | | |
| Garbage[e] | Not applicable | | | |
| **Atmospheric Emissions** | 1,2,3,4,5 | | | |
| **Ships and Boats** | 1,2,3,4,5 | x | | |
| **Helicopters** | 1,2,3,4,5 | | | |
| **Noise** | | | | |
| Dredge | 1 | | | x |
| Drill Rigs | 2 | | | x |
| Support Vessels | 1,2,3,4,5 | | | x |
| Helicopters | 1,2,3,4,5 | | | |
| FPSO | 4 | | | x |
| VSP | 2 | | | x |
| **Underwater Maintenance** | 1,2,3,4 | | | |
| **Shore Facilities[f]** | Not applicable | | | |
| **Other Projects/Activities** | | | | |
| Hibernia | | | x | |
| Terra Nova | | | x | |
| White Rose | | | x | |
| Exploration | | x | | x |
| Fisheries | | - | - | - |
| Marine Transportation | | x | | |

[a] Includes research surveys
[b] 1 = Glory Hole Excavation/TGB Installation
2 = Drilling
3 = Subsea Production Equipment Installation
4 = Production Operations
5 = Abandonment
[c] Effects assessment of offshore accidental events (i.e., blowouts, spills) is in Section 8
[d] Produced water associated with well testing may be flared
[e] All garbage will be brought to shore
[f] Existing onshore infrastructure will be used

**Table 7.12. Environmental Effects Assessment of Potential Effects of Routine Activities on Commercial Fishery VEC.**

| Valued Environmental Component: Commercial Fisheries[a] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Project Activity** | **Project Phase[b]** | **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 | 1,2,3,4,5 | Area off limits to fishing (N) | Communications; information exchange | 1 | 2 | 6 | 5 | R | 2 |
| Artificial Reef Effect | 1,2,3,4,5 | - | - | <0 | - | - | - | - | - |
| **Sediment Excavation** | | | | | | | | | |
| Removal | 1 | Area off limits to fishing (N) | Communications; information exchange | 0 | 1 | 1 | 2 | R | 2 |
| Deposition | 1 | Area off limits to fishing (N) | Communications; information exchange; disposal site planning | 0 | 1 | 1 | 2 | R | 2 |
| **Lights** | 1,2,3,4,5 | - | - | - | - | - | - | - | - |
| **Flaring** | 2,4 | - | - | - | - | - | - | - | - |
| **Drill Mud/Cuttings** | | | | | | | | | |
| Water-based Muds | 2 | - | - | - | - | - | - | - | - |
| Synthetic-based Muds | 2 | - | - | - | - | - | - | - | - |
| **Other Fluids/Solids** | | | | | | | | | |
| Cement | 2 | - | - | - | - | - | - | - | - |
| BOP Fluid | 2 | - | - | - | - | - | - | - | - |
| Cooling Water | 2,4 | - | - | - | - | - | - | - | - |
| Deck Drainage | 2,4 | - | - | - | - | - | - | - | - |
| Bilge Water | 2,4 | - | - | - | - | - | - | - | - |
| Ballast Water | N/A | | | | | | | | |
| Sanitary/Domestic Waste Water | 2,4 | - | - | - | - | - | - | - | - |
| Small transfer spills | 2,4 | - | - | - | - | - | - | - | - |
| Produced Water[c] | 2,4 | - | - | - | - | - | - | - | - |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Garbage[d] | N/A | | | | | | | | |
| **Atmospheric Emissions[e]** | 1,2,3,4,5 | - | - | - | - | - | - | - | - |
| **Ships and Boats** | 1,2,3,4,5 | Conflict with fishing gear (N) | Communications; information exchange; compensation | 1 | 4 | 6 | 5 | R | 2 |
| **Helicopters** | 1,2,3,4,5 | - | - | - | - | - | - | - | - |
| **Noise** | | | | | | | | | |
| Dredge | 1 | Reduced catch (scaring) (N) | Communications | 1 | 2-3 | 6 | 2 | R | 2 |
| Drilling Rigs | 2 | Reduced catch (scaring) (N) | Communications | 1 | 2-3 | 6 | 4 | R | 2 |
| Support Vessels | 1,2,3,4,5 | - | - | - | - | - | - | - | - |
| Helicopters | 1,2,3,4,5 | - | - | - | - | - | - | - | - |
| FPSO | 4 | Reduced catch (scaring) (N) | Communications | 1 | 2-3 | 6 | 5 | R | 2 |
| VSP | 2 | Reduced catch (scaring) (N) | Communications; information exchange; planning | 1 | 1-4 | 1 | 1 | R | 2 |
| **Underwater Maintenance** | 1,2,3,4 | - | - | - | - | - | - | - | - |
| **Shore Facilities[f]** | N/A | | | | | | | | |

**Magnitude**
0 = Negligible
1 = Low
2 = Medium
3 = High

**Geographic Extent**
1 = < 1 $km^2$
2 = 1-10 $km^2$
3 = 11-100 $km^2$
4 = 101-1,000 $km^2$
5 = 1,001-10,000 $km^2$
6 = > 10,000 $km^2$

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

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

**Reversibility (population level)**
R = Reversible
I = Irreversible

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

[a] Includes research surveys
[b] 1 = Glory Hole Excavation/TGB Installation
2 = Drilling
3 = Subsea Production Equipment Installation
4 = Production Operations
5 = Abandonment
[c] Produced water associated with well testing may be flared
[d] All garbage will be brought to shore
[e] Includes produced water which may be flared
[f] Existing onshore infrastructure will be used

## Table 7.13. Significance of Predicted Residual Environmental Effects of Routine Activities on Commercial Fishery VEC.

| Valued Environmental Component: Commercial Fisheries[a] | | | | | |
|---|---|---|---|---|---|
| **Project Activity** | **Project Phase[b]** | **Significance of Predicted Residual Environmental Effects** | | **Likelihood[c]** | |
| | | **Significance Rating** | **Level of Confidence** | **Probability of Occurrence** | **Scientific Certainty** |
| **Presence of Structures** | | | | | |
| Safety Zone | 1,2,3,4,5 | NS | 3 | - | - |
| Artificial Reef Effect | 1,2,3,4,5 | NS | 3 | - | - |
| **Sediment Excavation** | | | | | |
| Removal | 1 | NS | 3 | - | - |
| Deposition | 1 | NS | 3 | - | - |
| **Lights** | 1,2,3,4,5 | - | - | - | - |
| **Flaring** | 2,4 | - | - | - | - |
| **Drill Mud/Cuttings** | | | | | |
| Water-based Muds | 2 | - | - | - | - |
| Synthetic-based Muds | 2 | - | - | - | - |
| **Other Fluids/Solids** | | | | | |
| Cement | 2 | - | - | - | - |
| BOP Fluid | 2 | - | - | - | - |
| Cooling Water | 2,4 | - | - | - | - |
| Deck Drainage | 2,4 | - | - | - | - |
| Bilge Water | 2,4 | - | - | - | - |
| Ballast Water | N/A | | | | |
| Sanitary/Domestic Waste Water | 2,4 | - | - | - | - |
| Produced Water[d] | 2,4 | - | - | - | - |
| Garbage[e] | N/A | | | | |
| **Atmospheric Emissions** | 1,2,3,4,5 | - | - | - | - |
| **Ships and Boats** | 1,2,3,4,5 | NS | 3 | - | - |
| **Helicopters** | 1,2,3,4,5 | - | - | - | - |
| **Noise** | | | | | |
| Dredge | 1 | NS | 3 | - | - |
| Drilling Rigs | 2 | NS | 3 | - | - |
| Support Vessels | 1,2,3,4,5 | - | - | - | - |
| Helicopters | 1,2,3,4,5 | - | - | - | - |
| FPSO | 4 | - | - | - | - |
| VSP | 2 | NS | 3 | - | - |
| **Underwater Maintenance** | 1,2,3,4 | - | - | - | - |
| **Shore Facilities[f]** | N/A | | | | |

**Significance Rating (significance is defined as a medium or high magnitude (2 or 3 rating) and duration > 1 year (≥ 3 rating) and geographic extent > 100 km$^2$ (≥ 4 rating)**
NS = Not significant negative environmental effect
S = Significant negative environmental effect
P = Positive environmental effect

| **Level of Confidence (professional judgement)** | **Probability of Occurrence (professional judgement)** |
|---|---|
| 1 = Low level of confidence | 1 = Low probability of occurrence |
| 2 = Medium level of confidence | 2 = Medium probability of occurrence |
| 3 = High level of confidence | 3 = High probability of occurrence |

**Level of Scientific Certainty (based on scientific information and statistical analysis or professional judgement)**
1 = Low level of scientific certainty
2 = Medium level of scientific certainty
3 = High level of scientific certainty

[a] Includes research surveys
[b] 1 = Glory Hole Excavation/TGB Installation
2 = Drilling
3 = Subsea Production Equipment Installation
4 = Production Operations
5 = Abandonment
[c] Only considered in the event of significant (S) residual effect
[d] Produced water associated with well testing may be flared
[e] All garbage will be brought to shore
[f] Existing onshore infrastructure will be used

Potential interactions between the Project components and the commercial fisheries and research surveys are shown in Table 7-11. The effects assessment is shown in Table 7-12 and the significance of predicted residual environmental effects on commercial fisheries and research surveys are indicated in Table 7-13.

#### 7.6.3.1 Presence of Structures

As noted, the presence of structures during all five Phases of the Project will result in the establishment of no-fishing areas, which will be contained within safety zones. Note that the safety zone during the Abandonment Phase will occur only during the initial structure removal activities. After structure removal, the area should be open to fishing activities. Presence of structures will likely produce an artificial reef effect as well (Table 7-11).

The establishment of safety zones would preclude fishing in these areas. These zones will also contain the areas affected by excavation (discussed below), and any areas within which drill cuttings would be deposited. The artificial reef created by the surface and underwater structures may attract some species and life stages of fish. This artificial reef effect, while it represents an interaction with both fish (potentially positive in some respects such as increased food and protection), was considered negligible at most.

Hibernia and Terra Nova have safety zones of 5.2 $km^2$ and 13.8 $km^2$, respectively. The area of the current safety zone at Whiterose is 49.2 $km^2$ and it will have to be increased to accommodate the new drill centres as they are developed.

Because fishing will not be safe within these zones, the effect of exclusion has the potential to be *negative* (Tables 7-12 and 7-13). However, since the zones will be located in areas where commercial fishing does not typically occur (see Section 5.0), this is not expected to have any operational or economic impact on fish harvesters. Based on past harvesting data, the areas where the new drill centres will be constructed do not appear to be particularly productive for commercial species. In this general area (Unit Area 3Lt), there are also many other alternative locations of equal productivity available to fishers should they wish to harvest them. If sites selected for DFO science surveys happen to be within a safety zone, alternative sites can be used (DFO typically selects equivalent alternative sites, for example, for random stratified surveys).

Section 4.9 of the C-NLOPB's *Guidelines Respecting Drilling Programs in the Newfoundland Offshore Area* (C-NOPB 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."

The locations of the Project safety zones will be well publicized and communicated to fishers and DFO, and the proponents will continue to communicate with fishers and DFO about fishing and survey activities in these areas.

Considering the drill centre locations in relation to harvesting areas, the effects of the presence of the safety zones on fish harvesting would be *low* in magnitude, *<1-10* $km^2$ in geographic extent and *>72 months* in duration (Table 7-12), resulting in a rating of *not significant* (Table 7-13).

Effects will be additive with other projects (e.g. Hibernia and Terra Nova safety zones) and the current White Rose safety zone but the safety zones of the three projects will still not overlap, and their additive cumulative effect will not exceed the *not significant* rating.

The artificial reef effect would not have an effect on fishing activity, per se, as it would likely be confined within the excluded areas. However, if it results in the creation of enhanced habitat for commercial or prey species, the effect could be positive for fishing success on a very small scale in the long term (see Table 7-9).

### 7.6.3.2 Sediment Excavation

Fishing will not be possible within the area of sediment removal and deposition while these activities are occurring. However, as these areas (and associated effects) will be contained within the excluded (safety zone) area, and since the original spoils area will be used for sediment deposition, there will be no further effects on fish harvesting activities beyond those considered for the safety zone (above).

Thus the magnitude of the potential effects of sediment excavation on harvesting is *negligible*. The geographic extent will be *<1* $km^2$; the duration *1-12 months* (2 months per glory hole; 8 months maximum) (Table 7-12). Based on these criteria, the potential effects of sediment excavation on the commercial fisheries VEC are *not significant* (Table 7-13).

No overlap of glory hole excavations is expected to occur during the drill centre Project. Cumulative effects of excavation work on fish harvesting would not be additive beyond the extent of the safety zones, and thus will not change the overall effects rating.

#### 7.6.3.3 Lights

The presence of lights will not have any interaction with the commercial fisheries VEC.

#### 7.6.3.4 Flaring

Flaring will not have any interaction with the commercial fisheries VEC.

#### 7.6.3.5 Drill Muds/Cuttings

Drill muds and cuttings will not have any interaction with the commercial fisheries VEC.

#### 7.6.3.6 Other Fluids/Solids

The emission of other fluids/solids will not have any interaction with the commercial fisheries VEC.

#### 7.6.3.7 Atmospheric Emissions

Atmospheric emissions will not have any interaction with the commercial fisheries VEC.

#### 7.6.3.8 Ships and Boats

Ships and boats associated with the Drilling and Production Operations Phases could interfere with fish harvesting activities if they interfere with the operation of fishing ships, or – more probably – if their operations conflict with fishing gear. Such conflicts are more likely to involve fixed fishing gear (e.g. crab pots), and might result in gear damage, gear loss, loss of catch and increased operational expenses for harvesters.

While supply vessels and support ships pose minimal risk to fishing gear (no more than other ocean-going ships or other fishing vessels in the area), surveys such as VSP and geohazard surveys during the Drilling Phase do pose more of a specific risk if the seismic equipment is towed through the water. Seismic survey/fishing gear conflicts do occur sometimes once or twice a year in Atlantic Canada, though not usually as the result of localized VSP surveys, which are very small scale (i.e., on the order of a few km). Issues related to the potential effects of sound produced by surveys are considered under "Noise", below. Geohazard surveys associated with the drilling program have been assessed in a separate report (LGL and Canning & Pitt 2005).

The C-NLOPB *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NOPB 2004) provide guidance aimed at minimizing any impacts of VSP/well-site surveys on commercial fish harvesting. These *Guidelines* were developed based on best practices during previous years' surveys in Atlantic Canada, and on guidelines from other national jurisdictions. The relevant *Guidelines* state (Appendix 2, Environmental Mitigative Measures):

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 proponent will implement each of these mitigative measures for any such surveys required for the project.

With these mitigations in place (including compensation if a conflict with gear were to occur), and in light of the localized nature of VSP surveys, their small footprint, short duration (12 to 36 hours), and the lack of past harvesting activities in and near the new drill centre locations, the magnitude of the potential effects on commercial fish harvesting are *low*. The geographic extent will be *101-1,000* $km^2$, based on the routing of support vessels from Newfoundland ports to the construction and operations sites (although VSP footprints would be only a few square km); the duration *>72 months* (based on support ship transits during the life of the Project, although VSP surveys would be confined to the Drilling Phase and typically last less than two days) (Table 7-12). Based on these criteria evaluations, the potential effects of ships and boats on the commercial fisheries VEC is *not significant* (Table 7-13).

Project-related ship activity would be additive to other existing shipping, but these effects are not expected to be large enough to change the overall effects rating. During the production

Operations Phase, there will be no additional supply vessels required (i.e., the supply vessels currently servicing White Rose will continue to do so). Cumulative effects with respect to other shipping activities on the Grand Banks are not considered to be large enough to change the overall effects rating.

#### 7.6.3.9 Helicopters

The presence of helicopters will not have any interaction with the commercial fisheries VEC.

#### 7.6.3.10 Noise

As discussed in the preceding assessment of potential effects of routine activities on the fish VEC, noise from shipping (e.g. Project support vessels), dredging, drilling, the FPSO and VSP surveys can affect fish and invertebrates. Project-related noise will occur during all Project Phases (Table 7-1), although the most concern for potential effects on fish harvesting might be during the Drilling Phase (VSP surveys).

The fish VEC assessment considers potential pathological, physiological and behavioural effects of exposure of fish and invertebrates to noise; consequently, this section considers only those aspects of noise-induced responses that might affect harvesting success. Fisheries industry representatives have registered concerns in the past that seismic survey sound sources, in particular, may scare finfish from their fishing locations, or discourage benthic species (such as snow crab) from entering fixed fishing gear. Indeed, the likelihood that finfish will move away as a survey array approaches is considered a factor that helps prevent physical impacts on these species. [Also, note that seismic arrays are typically ramped up as a mitigation to allow animals to move away.] On a much smaller scale (since the source is stationary), similar effects could also result from drilling and FPSO operations.

The discussion of behavioural effects on fish and invertebrates in Section 7.6.2.10 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 finfish catch rates near seismic arrays, there is less agreement on the duration and geographic extent of the effect, ranging from a quick return to several days before normal catch rates are re-established, and from very localized effects to decreased catch rates several km away.

Depending on the location of the sound source relative to fishing gear, the noise might send finfish towards fishing gear and increase catch rates. However, given the lack of recorded finfish harvesting near the new drill centre locations or Project Area, this is not expected to occur.

Snow crab is the species that would be of concern to fishers nearest the Project Area, though harvesting is not recorded close to the new drill centre locations. For this species, recent studies (see discussion in Section 7.6.2.10) do not indicate significant effects on catch rates or behaviour related to seismic surveying.

In any case, compared to a conventional 2-D or 3-D geophysical survey, a very small area would be affected by sound, since the area where the activities would take place will be quite small (i.e. in the immediate area of the drilling location). Also, the sound generated by drilling and the FPSO results in lower received levels than typical seismic arrays, and the VSP sound source is also typically smaller. In addition, VSP surveys would be expected to last for just 12 to 36 hours.

Based on these considerations, the magnitude of effects on fish harvesting will be *low*, the geographic extent *1-10 to 11-100* $km^2$, and the duration *>72 months* (Table 7-12). Thus, the residual effects of noise on fish are *not significant* (Table 7-13)

In terms of cumulative effects, fishing itself is one of the more notable contributors to the total Grand Banks anthropogenic background sound (e.g., from ships' engines, generators, winches and bottom-tending mobile gears such as dredges and trawls). Other existing sources of sound in the general area of the Project are related to petroleum exploration and production, and marine transportation (commercial, military, and recreational).

Naturally-occurring noise (e.g. from wind, waves, ice, marine animals) also exists throughout the Grand Banks, and is quite variable. Given the level of ambient sound, masking of much anthropogenic sound would be expected to occur. Also, sound itself does not "accumulate" in the environment and it ceases when the sound source stops.

Thus, the cumulative effects on fish harvesting activities of the additional localized contribution of sound from Project construction and operations will be *negligible*, especially given the lack of harvesting recorded in areas close to most Project activities.

### 7.6.4 Marine Birds

In this section, the potential effects of the routine activities associated with the proposed drill centre development and production operations on marine birds are evaluated. Cumulative effects are also considered in this section.

Potential interactions of routine activities and marine birds (as well as marine mammals and sea turtles) are indicated in Table 7.14. These interactions, potential effects, mitigation measures, monitoring approaches, and potential cumulative effects are discussed in this section. The environmental effects assessment and the significance of predicted residual effects on marine birds during the proposed new drill centre Project are summarized in Tables 7.15 and 7.16, respectively.

## Table 7.14. Potential Interactions of Routine Activities and Marine Bird, Marine Mammal and Sea Turtle VECs.

| Valued Environmental Components: Marine Birds, Marine Mammals and Sea Turtles | | | | | | |
|---|---|---|---|---|---|---|
| **Project Activity** | **Project Phase**[a] | **VEC Components** | | | | |
| | | **Marine Birds** | **Baleen Whales** | **Toothed Whales** | **Seals** | **Sea Turtles** |
| **Presence of Structures** | | | | | | |
| Safety Zone | 1,2,3,4,5 | | x | x | x | x |
| Artificial Reef Effect | 1,2,3,4,5 | x | x | x | x | x |
| **Sediment Excavation** | | | | | | |
| Removal | 1 | | x | x | x | x |
| Deposition | 1 | | x | x | x | x |
| **Lights** | 1,2,3,4,5 | x | x | x | x | x |
| **Flaring** | 2,4 | x | | | | |
| **Drill Mud/Cuttings** | | | | | | |
| Water-based Muds | 2 | x | x | x | x | x |
| Synthetic-based Muds | 2 | x | x | x | x | x |
| **Other Fluids/Solids**[b] | | | | | | |
| Cement | 2 | | x | x | x | x |
| BOP Fluid | 2 | x | x | x | x | x |
| Cooling Water | 2,4 | x | x | x | x | x |
| Deck Drainage | 2,4 | x | x | x | x | x |
| Bilge Water | 2,4 | x | x | x | x | x |
| Ballast Water | Not applicable | x | x | x | x | x |
| Sanitary/Domestic Waste Water | 2,4 | x | x | x | x | x |
| Small transfer spills | 2,4 | x | x | x | x | x |
| Produced Water[c] | 2,4 | x | | | | |
| Garbage[d] | Not applicable | | | | | |
| **Atmospheric Emissions** | 1,2,3,4,5 | x | x | x | x | x |
| **Ships and Boats** | 1,2,3,4,5 | x | x | x | x | x |
| **Helicopters** | 1,2,3,4,5 | x | x | x | x | x |
| **Noise** | | | | | | |
| Dredge | 1 | x | x | x | x | x |
| Drilling Rigs | 2 | x | x | x | x | x |
| Support Vessels | 1,2,3,4,5 | x | x | x | x | x |
| Helicopters | 1,2,3,4,5 | x | x | x | x | x |
| FPSO | 4 | x | x | x | x | x |
| VSP | 2 | x | x | x | x | x |
| **Underwater Maintenance** | 1,2,3,4 | | | | | |
| **Shore Facilities**[e] | Not applicable | | | | | |
| **Other Projects/Activities** | | | | | | |
| Hibernia | | x | x | x | x | x |
| Terra Nova | | x | x | x | x | x |
| White Rose | | x | x | x | x | x |

| | | | | | | |
|---|---|---|---|---|---|---|
| Exploration | | x | x | x | x | x |
| Fisheries | | x | x | x | x | x |
| Hunting | | x | | | x | |
| Marine Transportation | | x | x | x | x | x |

[a] 1 = Glory Hole Excavation/TGB Installation
2 = Drilling
3 = Subsea Production Equipment Installation
4 = Production Operations
5 = Abandonment
[b] Effects assessment of offshore accidental events (i.e., blowouts, spills) is in Section 8
[c] Produced water associated with well testing may be flared
[d] All garbage will be brought to shore
[e] Existing onshore infrastructure will be used

## Table 7.15. Environmental Effects Assessment of Potential Effects of Routine Activities on Marine Bird VEC.

| Valued Environmental Component: Marine Birds | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Evaluation Criteria for Assessing Environmental Effects | | | | | |
| **Project Activity** | **Project Phase**[a] | **Potential Positive (P) or Negative (N) Environmental Effect** | **Mitigation** | **Magnitude** | **Geographic Extent** | **Frequency** | **Duration** | **Reversibility** | **Ecological/ Socio-Cultural and Economic Context** |
| **Presence of Structures** | | | | | | | | | |
| Safety Zone | 1,2,3,4,5 | No Interaction | - | - | - | - | - | - | - |
| Artificial Reef Effect | 1,2,3,4,5 | Increased Food (P) | - | - | - | - | - | - | - |
| **Sediment Excavation** | | | | | | | | | |
| Removal | 1 | No Interaction | - | - | - | - | - | - | - |
| Deposition | 1 | No Interaction | - | - | - | - | - | - | - |
| **Lights** | 1,2,3,4,5 | Attraction (N) | Release stranded birds | 1 | 2 | 5 | 5 | R | 2 |
| **Flaring** | 2,4 | Attraction (N)<br>Physical Injury/Mortality (N) | Release stranded birds | 1 | 2 | 2 | 5 | R | 2 |
| **Drill Mud/Cuttings** | | | | | | | | | |
| Water-based Muds | 2 | Contamination (N) | Recycle muds; Treat and discharge cuttings | 1 | 1 | 6 | 4 | R | 2 |
| Synthetic-based Muds | 2 | Contamination (N) | Recycle muds; Treat and discharge cuttings | 1 | 1 | 6 | 4 | R | 2 |
| **Other Fluids/Solids** | | | | | | | | | |
| Cement | 2 | No Interaction | - | - | - | - | - | - | - |
| BOP Fluid | 2 | Contamination (N) | Selection criteria | 0 | 1 | 6 | 4 | R | 2 |
| Cooling Water | 2,4 | Contamination (N) | Monitoring | 0 | 1 | 6 | 5 | R | 2 |
| Deck Drainage | 2,4 | Contamination (N) | Treatment | 0 | 1 | 5 | 5 | R | 2 |
| Bilge Water | 2,4 | Contamination (N) | Treatment | 0 | 1 | 5 | 5 | R | 2 |
| Ballast Water | N/A | | | | | | | | |
| Sanitary/Domestic Waste Water | 2,4 | Contamination (N)<br>Increased Nutrients (P) | Treatment | 0 | 1 | 5 | 5 | R | 2 |
| Small Transfer Spills | 2,4 | Contamination (N) | Safe handling practices; Cleanup | 0 | 1 | 5 | 5 | R | 2 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | protocols | | | | | | |
| Produced Water[b] | 2,4 | Contamination (N) | Treatment | 0 | 1 | 1 | 5 | R | 2 |
| Garbage[c] | N/A | | | | | | | | |
| **Atmospheric Emissions** | 1,2,3,4,5 | Contamination (N) | Equipment Design | 0 | 2 | 6 | 5 | R | 2 |
| **Ships and Boats** | 1,2,3,4,5 | Disturbance (N) | Colony avoidance | 0 | 2 | 6 | 5 | R | 2 |
| **Helicopters** | 1,2,3,4 | Physical Injury/Mortality (N) | Avoidance of breeding colonies and repeated overflights of bird concentrations | 1 | 3 | 2 | 5 | R | 2 |
| **Noise** | | | | | | | | | |
| Dredge | 1 | Disturbance (N) | - | 0 | 2-3 | 6 | 2 | R | 2 |
| Drilling Rigs | 2 | Disturbance (N) | - | 0 | 2-3 | 6 | 4 | R | 2 |
| Support Vessels | 1,2,3,4,5 | Disturbance (N) | Colony avoidance | 0 | 2-3 | 6 | 5 | R | 2 |
| Helicopters | 1,2,3,4,5 | Disturbance (N) | Avoidance of breeding colonies and repeated overflights of bird concentrations | 1 | 3 | 4 | 5 | R | 2 |
| FPSO | 4 | Disturbance (N) | - | 0 | 2-3 | 6 | 5 | R | 2 |
| VSP | 2 | Disturbance (N) | Ramp up | 0 | 1-4 | 1 | 1 | R | 2 |
| **Underwater Maintenance** | 1,2,3,4 | No Interaction | - | - | - | - | - | - | - |
| **Shore Facilities**[d] | N/A | | | | | | | | |

**Magnitude**
0 = Negligible
1 = Low
2 = Medium
3 = High

**Geographic Extent**
1 = < 1 $km^2$
2 = 1-10 $km^2$
3 = 11-100 $km^2$
4 = 101-1,000 $km^2$
5 = 1,001-10,000 $km^2$
6 = > 10,000 $km^2$

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

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

**Reversibility (population level)**
R = Reversible
I = Irreversible

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

[a] 1 = Glory Hole Excavation/TGB Installation
2 = Drilling
3 = Subsea Production Equipment Installation
4 = Production Operations
5 = Abandonment
[b] Produced water associated with well testing may be flared
[c] All garbage will be brought to shore
[d] Existing onshore infrastructure will be used

## Table 7.16. Significance of Predicted Residual Environmental Effects of Routine Activities on Marine Bird VEC.

| Valued Environmental Component: Marine Birds | | | | | |
|---|---|---|---|---|---|
| **Project Activity** | **Project Phase[a]** | **Significance of Predicted Residual Environmental Effects** | | **Likelihood[b]** | |
| | | **Significance Rating** | **Level of Confidence** | **Probability of Occurrence** | **Scientific Certainty** |
| **Presence of Structures** | | | | | |
| Safety Zone | 1,2,3,4,5 | - | - | - | - |
| Artificial Reef Effect | 1,2,3,4,5 | NS | 3 | - | - |
| **Sediment Excavation** | | | | | |
| Removal | 1 | - | - | - | - |
| Deposition | 1 | - | - | - | - |
| **Lights** | 1,2,3,4,5 | NS | 3 | - | - |
| **Flaring** | 2,4 | NS | 3 | - | - |
| **Drill Mud/Cuttings** | | | | | |
| Water-based Muds | 2 | NS | 3 | - | - |
| Synthetic-based Muds | 2 | NS | 3 | - | - |
| **Other Fluids/Solids** | | | | | |
| Cement | 2 | - | - | - | - |
| BOP Fluid | 2 | NS | 3 | - | - |
| Cooling Water | 2,4 | NS | 3 | - | - |
| Deck Drainage | 2,4 | NS | 3 | - | - |
| Bilge Water | 2,4 | NS | 3 | - | - |
| Ballast Water | N/A | | | | |
| Sanitary/Domestic Waste Water | 2,4 | NS | 3 | - | - |
| Small Transfer Spills | 2,4 | NS | 3 | - | - |
| Produced Water[c] | 2,4 | NS | 3 | | |
| Garbage[d] | N/A | | | | |
| **Atmospheric Emissions[e]** | 1,2,3,4,5 | NS | 3 | - | - |
| **Ships and Boats** | 1,2,3,4,5 | NS | 3 | - | - |
| **Helicopters** | 1,2,3,4,5 | NS | 3 | - | - |
| **Noise** | | | | | |
| Dredge | 1 | NS | 3 | - | - |
| Drilling Rigs | 2 | NS | 3 | - | - |
| Support Vessels | 1,2,3,4,5 | NS | 3 | - | - |
| Helicopters | 1,2,3,4,5 | NS | 3 | - | - |
| FPSO | 4 | NS | 3 | - | - |
| VSP | 2 | NS | 3 | - | - |
| **Underwater Installation and Maintenance** | 1,2,3,4 | - | - | - | - |
| **Shore Facilities[f]** | N/A | | | | |

**Significance Rating (significance is defined as a medium or high magnitude (2 or 3 rating) and duration > 1 year (≥ 3 rating) and geographic extent > 100 km$^2$ (≥ 4 rating)**

NS = Not significant negative environmental effect
S = Significant negative environmental effect
NS = Not significant negative environmental effect
P = Positive environmental effect

**Level of Confidence (professional judgement)**
1 = Low level of confidence
2 = Medium level of confidence

**Probability of Occurrence (professional judgement)**
1 = Low probability of occurrence
2 = Medium probability of occurrence

| | |
|---|---|
| 3 = High level of confidence | 3 = High probability of occurrence |

**Level of Scientific Certainty (based on scientific information and statistical analysis or professional judgement)**
1 = Low level of scientific certainty
2 = Medium level of scientific certainty
3 = High level of scientific certainty

[a] 1 = Glory Hole Excavation/TGB Installation
2 = Drilling
3 = Subsea Production Equipment Installation
4 = Production Operations
5 = Abandonment
[b] Only considered in the event of significant (S) residual effect
[c] Produced water associated with well testing may be flared
[d] All garbage will be brought to shore
[e] Includes produced water which may be flared
[f] Existing onshore infrastructure will be used

#### 7.6.4.1 Presence of Structures

Presence of structures in any of the five Project Phases could potentially affect marine birds by attracting them. This is discussed further in Section 7.6.4.3 on ‘Lights’. The artificial reef effect could potentially increase food supply for marine birds in the immediate area of a structure during all Phases of the Project.

#### 7.6.4.2 Sediment Excavation

Sediment excavation will not interact with the marine bird VEC.

#### 7.6.4.3 Lights

Concern was expressed during the White Rose Hearings that night-migrating and other night-active birds would be attracted to light sources on offshore facilities. The dredging vessel, drilling rigs, the FPSO, and supply and standby ships will carry navigation and warning lights, and working areas will be illuminated with floodlights.

Storm-petrels have been reported to land on one of the Terra Nova drill rigs during summer (52 birds in three weeks) (U. Williams, Petro-Canada, pers. comm.). An extensive review of the issue is contained in the White Rose Oilfield Comprehensive Study and supplement (Husky 2000, 2001a) which is based on the Terra Nova EIS (Petro-Canada 1996), Montevecchi et al. (1999), Thomson et al. (2000), and others. The reader is referred to these reports for further detail. In addition, recent seismic monitoring studies in Jeanne d’Arc and Orphan Basin have shown that Leach’s Storm-Petrels regularly strand on seismic ships and appear to be attracted to the ship’s lighting (Moulton et al. 2005a; 2006b; Lang et al. 2006). However, with proper mitigation measures in place, most petrels were released in good condition and are assumed to have survived stranding.

Several studies of bird attraction to offshore oil structures have been conducted elsewhere. Published information is available for offshore oil fields in the North Sea and the Gulf of Mexico and for exploration drilling in the Bering Sea (Husky 2000, 2001a). Field studies of seabird attraction to lights that were not related to offshore oil fields also have been conducted in the Hawaiian Islands. Many other studies have related bird mortality to lighted towers and skyscrapers.

Several species of birds have been attracted at night to lights on offshore oil and gas platforms, especially during foggy or overcast conditions. These include seabirds as well as migrating landbirds. Birds can injure themselves by flying into structures on the platform (Avery et al. 1978). Some accounts also describe birds becoming disoriented and flying aimlessly about the lights for hours, consuming energy and being delayed in their foraging or migration.

There is concern with respect to nocturnal seabirds, particularly young Leach’s Storm-Petrels (Sage 1979; Reed et al. 1985; Reed 1987; Telfer et al. 1987). Large colonies of nesting Leach's Storm-Petrels exist in or near the region, and very large numbers of storm-petrels forage offshore. The period of greatest risk of attraction to offshore lights is in September, when birds are dispersing from nesting colonies and moving to offshore wintering grounds. Young-of-the-year birds appear to be more susceptible to light attraction than are adults, but the extent of storm-petrel susceptibility is unclear.

On vessels currently involved in the White Rose project, reasonable efforts are made to allow seabirds found stranded on the FPSO, support vessels and drilling platforms to recover, and be released at night near minimal lighting, following the protocol developed by Williams and Chardine (1999). Birds found near dawn are not released until the following night. Project personnel involved in development of the new drill centres will also be made aware of bird attraction to the lights on offshore structures and the protocols that are currently in place for White Rose.

Lights are expected to interact with marine birds during all five phases of the new drill centre Project (Table 7.14). There would be *continuous* use of lights during darkness but there would be no such effect during daylight. Based on the worst-case scenario of this activity during the Production Operations Phase, the effects of lights on marine birds are expected to be *low* in magnitude, *1-10* $km^2$ in geographic extent and *>72 months* in duration (Table 7.15), resulting in a rating of the residual effects of lights on marine birds of *not significant* (Table 7.16). Cumulative effects are not expected to exceed those expected for individual oil development sites or other activities. Once the new drill centres are developed, there will be no additional lighting over what is currently there at White Rose. The sites of other activities are separated geographically so birds present in one area will not be attracted to the lights at another site. Effects will be additive with other Grand Banks projects/activities but neither overlapping nor synergistic. Therefore, effects will not magnify.

#### 7.6.4.4 Flaring

Concern was also expressed during the White Rose Hearings that night-migrating and other night-active birds might be attracted to and/or incinerated by gas flaring. There may be some short duration flaring by the drill rig during any testing that occurs. However, the heat and noise generated by the flare may deter marine birds from the immediate area.

No study results are available for the Grand Banks concerning the effects of flaring associated with offshore drilling and/or production on marine birds. A review of the issue is contained in the White Rose Oilfield Comprehensive and supplement (Husky 2000, 2001a) which is based on the Terra Nova EIS (Petro-Canada 1996), Montevecchi et al. (1999), Thomson et al. (2000), and others. The reader is referred to these reports for further detail. It also should be noted that the Environmental Studies Research Funds (ESRF) called for bids for a study on available technologies for monitoring bird movements near flares.

Several species of birds have been attracted at night to lights on offshore oil and gas platforms, especially during foggy or overcast conditions. These include seabirds as well as migrating landbirds. Information relevant to the potential of flare illumination to attract birds is provided in the previous section on 'Lights'. Birds can potentially injure themselves by flying into gas flares and dying (Bourne 1979; Sage 1979; Wood 1999).

There is potential for flaring to interact with marine birds during the Drilling and Production Operations Phases of the Project (Table 7.14). While this activity is relatively infrequent and short duration on a per event basis during the Drilling Phase, flaring during the Production Operations Phase is continuous. Based on the worst-case scenario of this activity during the Drilling Phase, the effects of flaring on marine birds are expected to be *low* in magnitude, *1-10* $km^2$ in geographic extent and *>72 months* in duration (Table 7.15), resulting in a rating of the residual effects of flaring on marine birds of *not significant* (Table 7.16). Cumulative effects associated with other projects/activities on the Grand Banks are likely not large enough to cause a change in the significance rating.

#### 7.6.4.5 Drill Muds/Cuttings

There was some concern expressed during the White Rose Hearings that some SBM might leave a sheen on the water surface that could affect seabirds. During SBM use, subject to C-NLOPB conditions and approval, mitigation (discharge below surface) will be employed to minimize the potential for visible sheens on the water. If conditions are flat calm and a sheen appears, prop wash from support vessels will be used to disperse it.

Based on the worst-case scenario of this activity during the Drilling Phase, the effects of drill muds and cuttings on marine birds are expected to be *low* in magnitude, *<1* $km^2$ in geographic extent and *37-72 months* in duration (Table 7.15), resulting in a rating of the residual effects of drill muds and cuttings on marine birds of *not significant* (Table 7.16).

The cumulative effect of seabird exposure to drilling muds and cuttings from current drilling activities at Terra Nova and White Rose, and past drilling at Hibernia, will be *negligible* and *not significant*. There is little chance seabirds will interact with muds and cuttings, no likely pathway for significant exposure, and little chance that heavy metals will bioaccumulate to harmful levels (see Husky 2000, 2001a for review).

#### 7.6.4.6 Other Fluids/Solids

No interaction is anticipated between discharged cement piles and marine birds (Table 7.14).

The discharge of any blowout preventer fluid by a drill rig will have minimal effects on seabirds because low-toxicity glycol-water mixes will be used and the periodic near-bottom releases will be low volume. 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 with a low residual of chlorine in the discharge, in the order of < 0.5 ppm. Effects of cooling water on marine birds will be minimal because the volume of entrainment will be low and the area of thermal effects will be small.

Other fluids containing treated oily water, like machinery deck drainage and bilge water, may have the potential to affect the health of seabirds. However, because these substances are treated (or diluted), recycled, or discharged below the water surface, the magnitude of effect on seabirds will be minimal.

Sanitary waste generated by both the drill rigs and the FPSO will be macerated to six mm or less before subsurface discharge at a depth about 14.5 m at normal operating ballast. While it is possible that seabirds (mostly gulls) may be attracted to the sewage particles, the small amount discharged below surface over a limited period of time will be unlikely to increase the far-offshore gull populations. Thus, any increase in gull predation on Leach's Storm-petrels as suggested by Wiese and Montevecchi (1999) is likely to be minimal. Since it is unlikely that these discharges will lead to an overall increase in gull populations, any increase in gull predation at the site is likely to be accompanied by decreases elsewhere.

Produced water has the potential to affect birds if there is a malfunction in the equipment which that causes an accidental discharge allowing petroleum hydrocarbons to be released to the environment in excess of the regulated 30 mg/L , causing a potential sheen. This effect is captured within the accidental spills section.

Under the worst-case scenario of the activity 'Other Fluids/Solid' during the Production Operations Phase, effects of discharges on marine birds are expected to be *negligible* in magnitude, *<1* $km^2$ in geographic extent, and *>72 months* in duration, resulting in a rating of the residual effects of discharged fluids and solids on marine birds of *not significant* (Tables 7.15 and 7.16). The combined discharge of the fluids and solids from all offshore oil development sites on the Grand Banks will have the same potential effects rankings as those predicted for the Project alone. The treatment of discharges will result in *negligible* cumulative effects. All tankers used by White Rose will have segregated ballast tanks and/or will not discharge ballast in Canadian waters, minimizing any introduction of oil into the water surface.

#### 7.6.4.7 Atmospheric Emissions

Although atmospheric emissions could, in theory, affect the health of some resident marine seabirds (Table 7.14), the effects would likely be minimal because emissions of potentially harmful materials will be small and rapidly disperse to undetectable levels.

Atmospheric emissions would occur during all Phases of the Project. Based on the worst-case scenario of the atmospheric emissions during the Production Operations Phase, effects of these emissions on the marine bird VEC are expected to be *negligible* in magnitude, *1-10* $km^2$ in geographic extent, and *>72 months* in duration, resulting in a rating of the residual effects of emissions on marine birds of *not significant* (Tables 7.15 and 7.16).

Potential cumulative effects of atmospheric emissions released from the three oil development sites and their supply ships, seismic vessels, fishing vessels, and other ships in the study area will be *negligible* for marine birds. Emissions are not expected to be detectable beyond the immediate area of discharge, as they will rapidly disperse due to their volatility, temperature of emission and the exposed and often windy nature of the Grand Banks. Emissions will not accumulate to potential deleterious levels over the duration of the Project.

#### 7.6.4.8 Ships and Boats

The potential effects of fluid and solid discharges, lights and air emissions from ships and boats during the Project have already been discussed. Noise caused by ships and boats as well as chronic releases from all vessel traffic will be discussed in later sections. The physical presence of ships and boats would occur during all Phases of the Project. It might result in some behavioural disturbance of marine birds in the area (Table 7.14). However, through avoidance of critical areas (i.e., breeding colonies), such disturbances should be minimal.

Based on the worst-case scenario of the ship and boat presence during the Production Operations Phase, effects of their presence are expected to be *negligible* in magnitude, *1-10* $km^2$ in geographic extent, and *>72 months* in duration, resulting in a rating of the residual effects of the presence of ships and boats on marine birds of *not significant* (Tables 7.15 and 7.16).

#### 7.6.4.9 Helicopters

Personnel and supplies will be transported to and from offshore structures via helicopters (Super Puma or equivalent class of aircraft) with flights occurring approximately six times per week. The addition of the extra glory holes will not increase helicopter travel during normal production and drilling. Therefore, presence of helicopters would occur in all five Phases of the Project (Table 7.14). Potential effects of helicopters on the marine environment are mainly related to noise which is discussed in the next section. It might result in some behavioural disturbance of marine birds in the area. However, through avoidance of critical areas (i.e., breeding colonies) and repeated overflights of marine bird concentrations, such disturbances should be minimal.

Based on the worst-case scenario of the helicopter presence during the Production Operations Phase, effects are expected to be *low* in magnitude, *11-100* $km^2$ in geographic extent, and *>72 months* in duration, resulting in a rating of the residual effects of helicopter presence on marine birds of *not significant* (Tables 7.15 and 7.16).

#### 7.6.4.10 Noise

Noise will interact with marine birds during all Phases of the Project (Table 7.14). Noise and disturbance from ships are unlikely to affect marine birds in the area. Birds have adapted to ship traffic throughout the world. Some species, such as Northern Fulmar and gulls, are attracted to ships and often follow them for extended periods (Wahl and Heinemann 1979; Brown 1986). Thus, noise and disturbance from normal offshore ship operations will not affect marine birds in offshore waters. Effects would be minimal.

There is a concern that passing ships could disturb seabird colonies. Prudent seamanship and Husky policy dictate that the supply vessels will maintain adequate distances from any seabird colonies. A distance of two km will ensure the safety of nesting seabirds. Therefore, there should be minimal effects on colonial marine birds.

Most marine birds flush or dive in response to low-flying aircraft (e.g., Polar Gas Project 1977; LGL Ltd., unpubl. data; Husky 2000). The significance of these disturbances is probably low, if the flights are infrequent.

Of most concern are large colonies of nesting seabirds. An aircraft flying near a seabird colony is capable of causing a panic response by the birds, which can result in eggs and flightless young being accidentally pushed off cliff ledges when the adults suddenly flush, or being unguarded and thus exposed to harsh weather and predators. As with current White Rose operations, the helicopters (and any fixed-wing aircraft potentially used for ice reconnaissance) used for the Project will be based at St. John's Airport and will generally fly "straight" to the Project Area site. Project aircraft will be directed to avoid the closest seabird colonies (e.g., Witless Bay Islands). Effects on birds at colonies would be minimal.

If for some reason aircraft have to detour from the normal direct route to and from the Project Area, pilots will be instructed to avoid repeated overflights of concentrations of birds and/or important bird habitats (such as, colonies). Each aircraft will carry maps indicating the location of colonies. Guidelines for avoiding major seabird colonies will be based on Nettleship (1980). These Canadian Wildlife Service guidelines recommend that aircraft not approach closer than eight km seaward and three km landward of a major seabird colony from 1 April to 1 November. The locations of seabird colonies and other areas where marine birds congregate are identified in the White Rose Oilfield Comprehensive Study (Section 3.9 in that document). Witless Bay is the closest seabird sanctuary to the Project Area at a distance of about 350 km. During all flights, the helicopters and aircraft will fly at minimum altitudes of 600 m whenever possible. Effects of aircraft flying at 600 m or more over birds in open water would be minimal. However when lower altitudes are necessary, such as during take-off and landing, birds in the area may be temporarily disturbed.

Noise produced by VSP is primarily a concern for biota occurring below the water's surface. While it is true that some marine birds dive, the likelihood of any serious effect on marine birds is low. Ramp up of the VSP array would likely scare some birds from the area.

Based on the worst-case scenario of helicopter noise during the Production Operations Phase, the noise effects on marine birds would be *low* in magnitude, *11-100 km*$^2$ in geographic extent, and *>72 months* in duration. These evaluation criteria result in a rating of the residual effects of noise on marine birds of *not significant* (Tables 7.15 and 7.16).

Cumulative effects from sound produced from these sources on marine birds would also be *not significant*.

#### 7.6.4.11 Underwater Maintenance

Underwater maintenance is not likely to interact with the marine bird VEC during the new drill centre Project (Table 7.14).

#### 7.6.4.12 Chronic Oil Pollution from Ship Discharge

The illegal discharge of oily bilge water off the southeast coast of Newfoundland is a chronic problem. The Canadian Wildlife Service of Environment Canada has been conducting beach surveys of stranded birds for the last 18 years. The CWS estimates that the southeast coast has the highest recorded percentage in the world of oiled birds among strandings (80%). They estimate that 300,000 birds are lost annually consisting of 280,000 individuals of the auk family and 20,000 of other species (W. Turpin, CWS, pers. comm. in Husky 2002).

Beach survey data from 1984 to 1997 indicated an increase of three percent per year in the percentage of oiled birds (Weise and Ryan 1999). The overall oiling rate of stranded birds is 71 percent with diving ducks and alcids (for example, common and thick-billed murres, Atlantic puffin, black guillemot, dovekie and razorbill) being the groups most affected (Weise and Ryan 1999). These species are most affected because they spend much of their time sitting on water or diving.

Waters off the southeast coast of Newfoundland are a major junction for international marine traffic destined for Canadian and US ports. Analyses of the oil involved in bird strandings show that wastes are composed of mixtures of bunker C and marine diesel, indicating origins in the engine room bilges of ocean-going ships (Lock and Deneault 2000). Husky has funded the Newfoundland and Labrador Environmental Association to monitor and report on seabird mortality on beaches in Placentia Bay for the past two years. These data are provided to CWS to form part of their oiled seabirds databases.

As per legal contract and Husky policy, vessels chartered by Husky will not engage in the illegal discharge of oily bilge water.

#### 7.6.4.13 Cumulative Effects Summary – Marine Birds

One of the pressures on the populations of marine birds is legal and illegal hunting activity. Most of the Newfoundland salt water hunt involves murres (called turres locally). They occur both offshore and inshore (see below) but are normally hunted inshore from small boats.

Thick-billed murres (*Uria lomvia*) comprise 95 percent of the murre species hunted by Newfoundlanders in coastal waters of the island (G. Robertson, CWS, pers. comm.). The majority of thick-billed murres breed in Greenland and the eastern Canadian Arctic and migrate south to winter on the Grand Banks. Some of these birds move into nearshore waters of Newfoundland as the winter progresses to probably forage or seek refuge from storms offshore (G. Robertson, pers. comm.). It is at this time that most murres are hunted. Only a portion of the population that is offshore will be subject to inshore hunting pressures.

The cumulative effects of all Grand Banks routine activities on marine birds are expected to be *not significant*. Mitigation measures and standard treatment of fluids and solids produced during all Project Phases will prevent significant effects on seabird populations within the Project Area.

#### 7.6.4.14 Monitoring and Follow up

Husky Oil participated in a vessel of opportunity seabird monitoring program that was funded through ESRF in conjunction with the 1999-2000 White Rose drilling program. Husky also has been funding beached seabird studies in Placentia Bay.

Handling and release of any stranded Leach's Storm-Petrels will be in accordance with Husky protocols that are on file with CWS and are similar to those developed by Petro-Canada. Husky has obtained the appropriate bird handling permits for new vessels associated with the Project.

### 7.6.5 Marine Mammals

Tables 7-14, 7-17 and 7-18 present the potential interactions of the drill centre Project routine activities and the marine mammal VEC, the assessment of potential residual effects of the routine activities on the marine mammal VEC, and the residual effects summary, respectively. 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 and White Rose Oilfield Comprehensive Study 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.

#### 7.6.5.1 Presence of Structures

Structures that will be present at the water surface for some Project Phases will include the dredging vessel, the drill rig (s), the FPSO, and others required during all five Phases of the drill centre Project. Potential impacts of the physical presence of structures on marine mammals and those impacts related to the artificial reef effect and subsea structures are provided in Table 7-9.

Potential effects on marine mammals are mainly related to the effects of sound produced by offshore structures and activities. See Section 7.6.5.8 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. However, the proposed Project will have no permanent subsea structural components where marine mammals could become entangled. Marine mammals would most likely avoid the immediate area around drilling activities due to physical activities and underwater sound generated by equipment like the dredger, drill rig, and FPSO and attendant vessels. It is possible that marine mammals may be attracted to subsea structures if the artificial reef effect occurs and prey increases. Alternatively, it is possible that subsea structures will disrupt benthos but this would only occur in a small area and most marine mammals that occur in the Project Area do not directly feed on benthos. The physical presence of structures would have negligible effects on marine mammals.

Based on the worst-case interaction scenario between ‘Presence of Structures’ and ‘Production Operations’ Project Phase (magnitude *negligible*, geographic extent 1-10 $km^2$, duration *>72 months* [2009-2020]) (Table 7-17), the identified potential effects of presence of structures on fish habitat are *not significant* (Table 7-18).

Considering that the ‘Presence of Structures’ activity occurs in all five Project Phases, there is potential for temporal overlap of this activity in different Phases. However, despite these effects being additive, they are judged to not be large enough to change the overall effects rating. Cumulative effects with respect to other activities on the Grand Banks are considered to be *negligible*.

#### 7.6.5.2 Sediment Excavation

Sediment excavation will occur only during the 'Glory Hole Excavation/TGB Installation' Phase of the drill centre Project. Potential effects on marine mammals are mainly related to the effects of sound produced during excavation and deposition. See Section 7.6.5.8 for a discussion of this issue. Marine mammals would likely avoid the immediate area around excavation sites. It is possible that the prey of some marine mammals may be affected given that plankton may be affected by the suspension of sediment in the water column (see Section 7.6.1.2). However, the sandy nature of the sediment minimizes the amount and duration of sediment suspension in the water column and the area of each glory hole (70 m x 70 m) is relatively small.

The magnitude, geographic extent and duration of the potential effects of sediment excavation on the marine mammal VEC are *negligible* to *low*, *<1 km$^2$*, and *1-12 months* (2 months days per glory hole; 8 months maximum total), respectively (Table 7-17). Based on these criteria evaluations, the potential effects of sediment excavation on the marine mammal VEC is *not significant* (Table 7-18).

No overlap of glory hole excavations is expected to occur during the drill centre Project. Cumulative effects of sediment excavation on marine mammals would be additive but are judged as being not large enough to change the overall effects rating.

#### 7.6.5.3 Lights

The dredging vessel, drill rig, FPSO, and supply and standby ships will all be equipped with navigation and warning lights. Working areas will be illuminated with floodlights. Therefore, this activity occurs in all five Project Phases. It is possible that lights associated with vessels and rigs may attract prey for marine mammals. However, given the small areas where this may happen, any effects (assumed positive) would be *negligible*.

Therefore, using the worst-case interaction scenario between 'Lights and 'Production Operations' Phase, the magnitude, geographic extent and duration of the potential effects on the marine mammal VEC are *negligible*, *<1 km$^2$*, and *>72 months* (2009-2020), respectively (Table 7-17). The potential effects of lights on the marine mammal VEC are not significant (Table 7-18).

Considering that the 'Lights' activity occurs in all five Project Phases, there is potential for temporal overlap of this activity in different Phases. However, despite these effects being additive, they are judged to not be large enough to change the overall effects rating. Cumulative effects with respect to other activities on the Grand Banks are considered to be *negligible*.

**Table 7.17 Environmental Effects Assessment of Potential Effects of Routine Activities on Marine Mammal VEC.**

| Valued Environmental Component: Marine Mammals | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Evaluation Criteria for Assessing Environmental Effects | | | | | |
| **Project Activity** | **Project Phase[a]** | **Potential Positive (P) or Negative (N) Environmental Effect** | **Mitigation** | **Magnitude** | **Geographic Extent** | **Frequency** | **Duration** | **Reversibility** | **Ecological/ Socio-Cultural and Economic Context** |
| **Presence of Structures** | | | | | | | | | |
| Artificial Reef Effect | 1,2,3,4,5 | May attract prey (P?) | - | 1 | 2 | 6 | 5 | R | 2 |
| Subsea Structures | 1,2,3,4,5 | Disruption of benthos (N) | - | 0 | 2 | 6 | 5 | R | 2 |
| **Sediment Excavation** | | | | | | | | | |
| Removal | 1 | Disruption of substrate (N)<br>Resuspension of sediment (N) | - | 0-1 | 1 | 1 | 2 | R | 2 |
| Deposition | 1 | Disruption of substrate (N)<br>Resuspension of sediment (N)<br>Smothering (N) | - | 0-1 | 1 | 1 | 2 | R | 2 |
| **Lights** | 1,2,3,4,5 | May attract prey (P) | | 0 | 1 | 5 | 5 | R | 2 |
| **Flaring** | 2,4 | May attract prey (P) | | 0 | 1 | 5 | 5 | R | 2 |
| **Drill Mud/Cuttings** | | | | | | | | | |
| Water-based Muds | 2 | Effects on health (N) | Recycle mud;<br>Treat muds and discharge cuttings | 0 | 1 | 6 | 4 | R | 2 |
| Synthetic-based Muds | 2 | Effects on health (N) | Recycle mud;<br>Treat muds and discharge cuttings | 0 | 1 | 6 | 4 | R | 2 |
| **Other Fluids/Solids** | | | | | | | | | |
| Cement | 2 | Disruption of substrate (N)<br>May attract prey (P?) | - | 0 | 1 | 1 | 5 | R | 2 |
| BOP Fluid | 2 | Effects on health (N) | Selection criteria | 0 | 1 | ? | 5 | R | 2 |
| Cooling Water | 2,4 | Effects on health (N) | Monitor | 0 | 1 | 6 | 5 | R | 2 |
| Deck Drainage | 2,4 | Effects on health (N) | Treatment | 0 | 1 | 5 | 5 | R | 2 |
| Bilge Water | 2,4 | Effects on health (N) | Treatment | 0 | 1 | 5 | 5 | R | 2 |
| Ballast Water | N/A | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sanitary/Domestic Waste Water | 2,4 | May attract prey (P?) | Treatment | 0 | 1 | 5 | 5 | R | 2 |
| Small Transfer Spills | 2,4 | Effects on health (N) | Safe handling practices; Cleanup protocols | 0 | 1 | 5 | 5 | R | 2 |
| Produced Water | 2,4 | Contamination (N) | Treatment | 0 | 1 | 5 | 5 | R | 2 |
| Garbage | N/A | | | | | | | | |
| **Atmospheric Emissions** | 1,2,3,4,5 | Contamination (N) | Equipment design | 0 | 2 | 6 | 5 | R | 2 |
| **Ships and Boats** | 1,2,3,4,5 | Disturbance (N) | - | - | - | - | - | - | - |
| **Helicopters** | 1,2,3,4,5 | Disturbance (N) | - | - | - | - | - | - | - |
| **Noise** | | | | | | | | | |
| Dredge | 1 | Disturbance (N) | - | 0-1 | 2-3 | 6 | 2 | R | 2 |
| Drilling Rigs | 2 | Disturbance (N) | - | 0-1 | 2-3 | 6 | 4 | R | 2 |
| Support Vessels | 1,2,3,4,5 | Disturbance (N) | Avoid conc. of marine mammals; maintain steady course/speed when possible | 0-1 | 2-3 | 6 | 5 | R | 2 |
| Helicopters | 1,2,3,4,5 | Disturbance (N) | Fly min. altitude 600 m when possible | 0-1 | 1 | 4 | 5 | R | 2 |
| FPSO | 4 | Disturbance (N) | - | 0-1 | 2-3 | 6 | 5 | R | 2 |
| VSP | 2 | Physical (N) Disturbance (N) | Ramp up; Delay start if MM in safety zone; shut down if endangered marine mammal in safety zone | 0-1 | 2-3 | 1 | 2 | R | 2 |
| **Underwater Maintenance** | 1,2,3,4 | Disturbance (N) | Material and method selection | 1 | 1 | 1 | 1 | R | 2 |
| **Shore Facilities**[a] | N/A | | | | | | | | |

**Magnitude**
0 = Negligible
1 = Low
2 = Medium
3 = High

**Geographic Extent**
1 = < 1 $km^2$
2 = 1-10 $km^2$
3 = 11-100 $km^2$
4 = 101-1,000 $km^2$
5 = 1,001-10,000 $km^2$
6 = > 10,000 $km^2$

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

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

**Reversibility (population level)**
R = Reversible
I = Irreversible

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

[a] 1 = Glory Hole Excavation/TGB Installation
2 = Drilling
3 = Subsea Production Equipment Installation
4 = Production Operations
5 = Abandonment
[a] Existing onshore infrastructure will be used

**Table 7.18. Significance of Predicted Residual Environmental Effects of Routine Activities on Marine Mammal VEC.**

| Valued Environmental Component: Marine Mammals | | | | | |
|---|---|---|---|---|---|
| **Project Activity** | **Project Phase[a]** | **Significance of Predicted Residual Environmental Effects** | | **Likelihood[b]** | |
| | | **Significance Rating** | **Level of Confidence** | **Probability of Occurrence** | **Scientific Certainty** |
| **Presence of Structures** | | | | | |
| Artificial Reef Effect | 1,2,3,4,5 | P | 3 | - | - |
| Subsea Structures | 1,2,3,4,5 | NS | 3 | - | - |
| **Sediment Excavation** | | | | | |
| Removal | 1 | NS | 3 | - | - |
| Deposition | 1 | NS | 3 | - | - |
| **Lights** | 1,2,3,4,5 | NS | 3 | - | - |
| **Flaring** | 2,4 | NS | 3 | - | - |
| **Drill Mud/Cuttings** | | | | | |
| Water-based Muds | 2 | NS | 3 | - | - |
| Synthetic-based Muds | 2 | NS | 3 | - | - |
| **Other Fluids/Solids** | | | | | |
| Cement | 2 | NS | 3 | - | - |
| BOP Fluid | 2 | NS | 3 | - | - |
| Cooling Water | 2,4 | NS | 3 | - | - |
| Deck Drainage | 2,4 | NS | 3 | - | - |
| Bilge Water | 2,4 | NS | 3 | - | - |
| Ballast Water | N/A | | | | |
| Sanitary/Domestic Waste Water | 2,4 | NS | 3 | - | - |
| Small Transfer Spills | 2,4 | NS | 3 | - | - |
| Produced Water[c] | 2,4 | NS | 3 | | |
| Garbage[d] | N/A | | | | |
| **Atmospheric Emissions[e]** | 1,2,3,4,5 | NS | 3 | - | - |
| **Ships and Boats** | 1,2,3,4,5 | NS | 3 | - | - |
| **Helicopters** | 1,2,3,4,5 | NS | 3 | - | - |
| **Noise** | | | | | |
| Dredge | 1 | NS | 3 | - | - |
| Drilling Rigs | 2 | NS | 3 | - | - |
| Support Vessels | 1,2,3,4,5 | NS | 3 | - | - |
| Helicopters | 1,2,3,4,5 | NS | 3 | - | - |
| FPSO | 4 | NS | 3 | - | - |
| VSP | 2 | NS | 3 | - | - |
| **Underwater Installation and Maintenance** | 1,2,3,4 | NS | 3 | - | - |
| **Shore Facilities[f]** | N/A | | | | |

**Significance Rating (significance is defined as a medium or high magnitude (2 or 3 rating) and duration > 1 year (≥ 3 rating) and geographic extent > 100 km$^2$ (≥ 4 rating)**
NS = Not significant negative environmental effect
S = Significant negative environmental effect
NS = Not significant negative environmental effect
P = Positive environmental effect

**Level of Confidence (professional judgement)**
1 = Low level of confidence
2 = Medium level of confidence

**Probability of Occurrence (professional judgement)**
1 = Low probability of occurrence
2 = Medium probability of occurrence

| | |
|---|---|
| 3 = High level of confidence | 3 = High probability of occurrence |

**Level of Scientific Certainty (based on scientific information and statistical analysis or professional judgement)**
1 = Low level of scientific certainty
2 = Medium level of scientific certainty
3 = High level of scientific certainty

[a] 1 = Glory Hole Excavation/TGB Installation
2 = Drilling
3 = Subsea Production Equipment Installation
4 = Production Operations
5 = Abandonment
[b] Only considered in the event of significant (S) residual effect
[c] Produced water associated with well testing may be flared
[d] All garbage will be brought to shore
[e] Includes produced water which may be flared
[f] Existing onshore infrastructure will be used

#### 7.6.5.4 Drill Muds and Cuttings

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 on benthos in the area. The bearded seal, which is considered a benthic feeder, may occasionally occur in the Project Area but typically occurs much farther north near ice.

Based on the worst-case interaction scenario between 'Drill Muds and Cuttings' and 'Drilling' Project Phase, the discharge of drilling muds and cuttings from the proposed drilling operation is predicted to have *negligible* physical impacts on marine mammals, over a duration of *37-72 months* [fall 2007 – summer 2011], in an area *<1 km²* (Table 7-18). Therefore, physical impacts of drilling muds and cuttings on marine mammals would be *not significant* (Table 7-18).

Given the relatively small area potentially affected by each drill centre relative to the total Grand Banks area, and the apparent short duration of smothering effect on benthos, and that few, if any marine mammals that regularly feed on the bottom occur in Study Area, the cumulative effects of the drill centre Project and all other drilling activities on the Grand Banks is deemed to be *not significant*.

#### 7.6.5.5 Other Fluids/Solids

Husky utilizes an OCMS, whereby all chemicals in use production or drilling that have the potential to reach the marine environment are screened to assess and minimize potential toxicity. Based on maximum 'durations', the assessments of the effects of cement, BOP fluid, and cooling water use the worst-case scenarios in the Drilling Phase and assessments of the effects of deck drainage, bilge water, ballast water, sanitary/domestic waste water, small transfer spills, and produced water use the worst-case scenarios in the 'Production Operations' Phase of the Project.

#### 7.6.5.5.1 Cement

Cement piles will act as an artificial reef, and be colonized by epifaunal animals and attract fish. The effects of the cement on marine mammals would be *negligible* in magnitude, *< 1 km²* in geographic extent and *>72 months* in duration (Table 7-17), resulting in a rating of *not significant* (Table 7-18). Effects will be additive with other projects but the cumulative effect will not exceed this rating.

#### 7.6.5.5.2 BOP Fluid

The discharge of any blowout preventer fluid from a semi-submersible rig will not affect marine mammals because glycol-water mixes will be used and the BOP fluid will have a low toxicity. Periodic releases of small amounts of glycol will have a *negligible* effect on marine mammals. The effects of periodic releases of small amounts of glycol on marine mammals would be *negligible* in magnitude, *<1 km²* in geographic extent and 37-72 *months* in duration (Table 7-17), resulting in a rating of *not significant* (Table 7-18). Effects will be additive with other projects but the cumulative effect will not exceed this rating.

#### 7.6.5.5.3 Cooling Water

Cooling water would be released during the drilling Phase and potentially during the Production Operations Phase. The effects of the discharge of cooling water on marine mammals would be *negligible* in magnitude, *<1 km²* in geographic extent and *>72 months* in duration (Table 7.17), resulting in a rating of the residual effects of cooling water on marine mammals of *not significant* (Table 7.18). Effects will be additive with other projects but the cumulative effect will not exceed this rating.

#### 7.6.5.5.4 Deck Drainage/Bilge Water

Discharge of deck drainage and bilge will occur during drilling and production operations; however, with the mitigations in place, there is little potential to affect 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. The effects of release of deck drainage and bilge water on marine mammals would be *negligible* in magnitude, *< 1 km²* in geographic extent and *>72 months* in duration (Table 7.17), resulting in a rating of the residual effects on marine mammals of *not significant* (Table 7.18). Effects will be additive with other projects but the cumulative effect will not exceed this rating.

#### 7.6.5.5.5 Ballast Water

Ballast water will be released during the Drilling Phase and during the Production Operations Phase. 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. Therefore, no interaction of ballast water and marine mammals should occur. 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*.

#### 7.6.5.5.6 Sanitary/Domestic Waste Water (Grey/Black Water)

Sanitary and domestic waste water will be discharged during drilling and production operations (Table 7.5). Organic matter from sanitary wastes will be quickly dispersed (after maceration) and degraded by bacteria and food waste will be shipped ashore. The effects on marine mammals swimming in the receiving waters containing small amounts of organic matter and nutrients will be negligible.

The effects of sanitary and domestic waste water on marine mammals would be *negligible* in magnitude, *<1 km*$^2$ in geographic extent and *>72 months* in duration (Table 7.17), resulting in a rating of the residual effects of sanitary and domestic waste water on marine mammals of *not significant* (Table 7.18). Effects will be additive with other projects but the cumulative effect will not exceed this rating.

#### 7.6.5.5.7 Small Transfer Spills

If small transfer spills (potentially of fuel, drilling muds and other chemicals) occur, they are most likely to occur during the Drilling and Production Operations Phases of the Project and there is some potential to affect marine mammals (Table 7.5).

Protocols are in place to minimize the likelihood of a transfer spill and in the event a small transfer spill does occur mitigations are in place for clean up. Marine mammals that occur in the Study Area are relatively tolerant of hydrocarbon based substances and drilling muds (see Husky 2000). Also, as noted above, 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. The effects of small transfer spills on marine mammals would be *negligible* in magnitude, *<1 km*$^2$ in geographic extent and *>72 months* in duration (Table 7.17), resulting in a rating of the residual effects of small transfer spills on marine mammals of *not significant* (Table 7.18). Effects will be additive with other projects but the cumulative effect will not exceed this rating.

#### 7.6.5.6 Ships and Boats

The presence of support ships and boats will occur during all five Phases of the Project. Potential effects of ships and boats on marine mammals are primarily related to sound, which is discussed in the following sections.

#### 7.6.5.7 Helicopters

The presence of helicopters will likely occur during all five Phases of the Project to transport personnel and light supplies between shore and the offshore. Potential effects of helicopters on marine mammals are primarily related to sound, which is discussed in the following sections.

#### 7.6.5.8 Noise

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 respond to many man-made sounds including ships and sounds made during drilling and seismic operations (i.e., airgun pulses). Thus, the potential negative effects caused by human-made sound within the marine environment, including those associated with each Phase this Project are a concern. The Terra Nova EIS (Petro-Canada 1996a), White Rose EA (Husky 2000, 2001a) and update for Jeanne d'Arc Basin (LGL 2002, 2005a, 2006a), Orphan Basin exploration drilling EA and addendum (LGL 2005b, 2006b), and Husky 3D seismic EA and update (LGL 2005c; Moulton et al. 2006a) provide good reviews of the effects of sound associated with offshore oil development on marine mammals and the reader is referred to those documents for details.

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 in previous documents and summarized below, marine mammals likely can hear the sounds 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.

##### 7.6.5.8.1 Marine Mammal Hearing

As reviewed in the documents listed above, marine mammal groups are known or suspected to have differing hearing abilities.

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.

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.

The hearing abilities of baleen whales have not been studied directly. Behavioral 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) and 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).

It is likely that most marine mammals can hear sounds associated with each Phase of the Project. However, some groups and species are likely more sensitive to some activities than others.

#### 7.6.5.8.2 Dredging Activity

Sediment excavation via a suction-hopper dredge will occur only during the Glory Hole Excavation/TGB Installation Phase of the drill centre Project. There have been some studies of the reactions of marine mammals to dredging and construction activities. Pre-1995 studies are reviewed in Richardson et al. (1995, p. 278-280). The following summarizes some of the more recent studies.

Western gray whales along the coast of Sakhalin Island, Russia, were monitored from a shore-based station before, during, and after the installation of an offshore drilling platform (Würsig et al. 1999). The numbers of gray whales observed from shore declined during the period when the platform was installed. This decline in the numbers of gray whales may have been in response to the increased ship traffic and construction activities. However, gray whales in the same area have been known to shift their location during years with no industrial activity (Johnson 2002).

Urbán et al. (2003) provide a review of the status of gray whales on their wintering ground in Mexican waters. Gray whales in Laguna Guerrero Negro provide the best documented case of a long-term change in baleen whale distribution as a result of industrial activities including dredging. It is thought that constant dredging operations needed to keep a channel open for shipping of salt (from 1957-1967) may have been the main source of disturbance to the whales and decline of whale numbers from 1964-1970 (Bryant *et al.* 1984). Gray whales reoccupied the lagoon after shipping of salt subsided. However, recent surveys suggest that the seasonal abundance of gray whales in the lagoon has decreased 90% since the 1980s. Fishermen in the area suggest that this decline of whales may be due to the natural closure of the lagoon entrance as sand accumulates in the absence of dredging (Urbán et al. 2003).

There was little evidence that ringed seals (*Phoca hispida*) were affected by construction and drilling activities at an artificial island (Northstar) in the central Alaskan Beaufort Sea (Moulton *et al.* 2003). Aerial surveys of seals on landfast ice were conducted pre-construction (1997-99) and during construction and drilling (2000-2001). Underwater sounds, in-air sounds, and iceborne vibrations from the artificial island were above background levels to distances of 1-5, 0.5-4, and 1-4 km, respectively. However, seal densities close to Northstar in 2000 and 2001 were not reduced relative to those farther away or during the 1997-99 period.

Based on previous studies (albeit limited in quantity, especially for toothed whales), it is possible that seals, toothed whales, and baleen whales may respond differently to dredging operation sounds. It appears that seals are more tolerant of dredging noises than perhaps baleen and toothed whales. Disturbance effects on seals are predicted to be *negligible* to *low*, over a duration of *1-12 months* (8 months), in an area of *1-10* $km^2$ (Table 7.17). Therefore, impacts related to disturbance, are judged to be *not significant* for seals (Table 7.18). Baleen whales may avoid a localized area around the dredging vessel. Disturbance effects on baleen whales (including endangered species) are predicted to be *low*, over a duration of *1-12 months* (8 months), in an area of *1-10* $km^2$ to *11-100* $km^2$ (Table 7.17). Therefore, impacts related to disturbance, are judged to be *not significant* for baleen whales (Table 7.18). 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 dredging vessels. Disturbance effects on toothed whales are predicted to be *low*, over a duration of *1-12 months* (8 months), in an area of *1-10* $km^2$ (Table 7.17). Therefore, impacts related to disturbance, are judged to be *not significant* for toothed whales (Table 7.18).Effects will be additive with other projects but the cumulative effect will not exceed this rating.

#### 7.6.5.8.3 Drilling Rigs

Drilling noise will be present throughout the Drilling Phase of the Project, for a maximum duration of 48 months (Table 7.1).

Based on source levels of typical semi-submersible rigs (Table 7.4), 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 *37-72 months* (48 months), in an area $<1$ $km^2$ (Table 7.17). Therefore, hearing impairment and physical impacts of drilling operation sound on marine mammals would be *not significant* (Table 7.18).

Based on previous studies (reviewed in LGL 2005a), it is possible that seals, toothed whales, and baleen whales may respond differently to drilling operation sounds. Because the drilling activities will continue for 60 days for well, some habituation may occur. It appears that seals are somewhat tolerant of drilling rig (and drillship) sounds. Disturbance effects on seals are predicted to be *negligible* to *low*, over a duration of *37-72 months* (48 months), in an area of *1-10* $km^2$ (Table 7.17). Therefore, impacts related to disturbance, are judged to be *not significant* for seals (Table 7.18). Baleen whales may avoid a localized area around the drill rig. Disturbance effects on baleen whales (including endangered species) are predicted to be *low*, over a duration of *37-72 months* (48 months), in an area of *1-10 km*$^2$ to *11-100 km*$^2$ (Table 7.17). Therefore, impacts related to disturbance, are judged to be *not significant* for baleen whales (Table 7.18). 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 *37-72 months* (48 months), in an area of *1-10 km*$^2$ (Table 7.17). Therefore, impacts related to disturbance, are judged to be *not significant* for toothed whales (Table 7.18).

#### 7.6.5.8.4 Support Vessels

Support vessels will be present for all phases of the Project. In addition, there will be regular supply boat trips per week (e.g., 18 trips per well during the Drilling Phase) to the Project site.

Baleen whales may show little reaction or slow, inconspicuous avoidance reactions to boats and supply vessels that are moving slowly on a steady course (see Husky 2000 for a review). 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 various Project activities with supply vessels in attendance 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 *>72 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 *72 months*, in an area of *1-10 km*$^2$ to *11-100 km*$^2$ (Table 7.17). Therefore, impacts related to disturbance, are judged to be *not significant* for baleen whales. 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 supply ships. Disturbance effects on toothed whales are predicted to be *negligible* to *low*, over a duration of *72 months*, in an area of *1-10 km²*. Therefore, impacts related to disturbance, are judged to be *not significant* for toothed whales. 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.

### 7.6.5.8.5 Helicopters

Helicopters will be used regularly during all Project Phases except Abandonment but will be used most often during Production Operations (144 months). However, helicopter activity during Production Operations will be at the same level as it is for the currently operating White Rose Project. 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 Project 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; 1985c; 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 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 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 and FPSO 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 helicopter overflights are predicted to be *negligible* to *low,* over a duration of >72 *months,* in an area of *1-10 km²* (Table 7.17). Therefore, impacts related to disturbance from aircraft, are judged to be *not significant* for marine mammals (Table 7.18).

#### 7.6.5.8.6 FPSO

Husky will use the currently operating SeaRose FPSO throughout the Production Operation phase of the new drill centres. Noise from this source would be predominantly low-frequency and is expected to be noisier than a semi-submersible rig (Richardson et al. 1995; Simmonds et al. 2003).

Based on previous studies of other low-frequency noise sources (reviewed in LGL 2005a), it is possible that seals, toothed whales, and baleen whales may respond differently to sounds from a FPSO. Because FPSO operations will be continuous over many years, some habituation may occur. Disturbance effects on seals are predicted to be *negligible* to *low*, over a duration of *>72 months*, in an area of *1-10 km²* (Table 7.17). Therefore, impacts related to disturbance, are judged to be *not significant* for seals (Table 7.18). Baleen whales may avoid a localized area around the FPSO. Disturbance effects on baleen whales (including endangered species) are predicted to be *low*, over a duration of *>72 months*, in an area of *1-10 km²* to *11-100 km²* (Table 7.17). Therefore, impacts related to disturbance, are judged to be *not significant* for baleen whales (Table 7.18). 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 FPSOs. Also, some toothed whales appear tolerant of low-frequency sounds. Disturbance effects on toothed whales are predicted to be *low*, over a duration of *>72 months*, in an area of *1-10 km²* (Table 7.17). Therefore, impacts related to disturbance, are judged to be *not significant* for toothed whales (Table 7.18).

#### 7.6.5.8.7 VSP

VSP (and geohazard) activities were assessed for Jeanne d'Arc Basin in LGL and Canning and Pitt (2005).

Considering that VSP source levels are typically less than those associated with typical, full-scale 2-D or 3-D exploratory seismic surveys (and that the duration of VSP activities will be two days per well), and that the effects of the 3-D seismic surveys in Jeanne d'Arc Basin were assessed as being *not significant* (LGL 2005c), it is predicted that the effects of exposure to the VSP on marine mammals will not exceed 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 airgun(s) and the short duration of the operation (two days per well), 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 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 *1-12 months* (2 months), in an area *<1 km²* (Table 7.17). Therefore, hearing impairment and physical impacts of VSP sound on marine mammals are predicted to be *not significant* (Table 7.18).

Disturbance effects on marine mammals from VSP activities are predicted to be *negligible* to *low*, over a duration of *1-12 months* (2 months), in an area of *1-10 km²* to *11-100 km²* (Table 7.17). Therefore, impacts related to disturbance, are judged to be *not significant* for marine mammals (Table 7.18).

#### 7.6.5.9 Underwater Maintenance

This activity includes underwater maintenance work by divers and ROVs. It has the potential to occur during all Phases of the Project and there is some (albeit) limited potential to disturb marine mammals.

However, considering the periodic and unobtrusive nature of this activity, impacts on marine mammals are predicted to be *negligible*, *<1 km²* geographic extent, and *>72 months* duration, the residual effects of underwater maintenance on marine mammals are predicted to be *not significant* (Tables 7.17 and 7.18)

### 7.6.6 Sea Turtles

Sea turtles, including the endangered leatherback, are likely rare on the Jeanne d'Arc Basin including the Project Area (see Section 5.0). 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. In the Grand Banks area, sea turtles are caught incidental to the pelagic longline fishery directed at tunas, swordfish and sharks (NOAA 2000).

In most situations, effects of drilling activities on sea turtles were assumed to be the same as those predicted for marine mammals (Tables 7-17, 7-18), although there is little information to support this (except for perhaps response of sea turtles to airgun sounds, and even these studies are limited in quantity and scope). 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 Project activities is provided in Table 7-14; these are essentially the same as for marine mammals.

#### 7.6.6.1 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, the drilling rig, dredge, and FPSO. 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.

#### 7.6.6.2 Assessment of Effects

Effects of routine Project activities were predicted to have *no significant* impacts on sea turtles, including the endangered leatherback sea turtle (Tables 7-19 and 7-20); however, the scientific information to support this is lacking. These impact predictions are primarily based on data that suggest sea turtles likely rarely occur in the Jeanne d’Arc Basin.

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 airgun(s) 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, all airgun activity will be stopped if a sea turtle is sighted within 500 m.

### 7.6.7 Species at Risk

The details of potential effects of routine activities associated with the proposed drill centre development and production Project on relevant marine animal species listed as endangered, threatened or of special concern on Schedules 1, 2 or 3 of *SARA* (Table 5.1) have been discussed in previous sections on the effects on various VECs. Summary statements for the relevant *SARA* species are as follow:

**Table 7.19. Environmental Effects Assessment of Potential Effects of Routine Activities on Sea Turtle VEC.**

| Valued Environmental Component: Sea Turtles | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Evaluation Criteria for Assessing Environmental Effects | | | | | |
| Project Activity | Project Phase[a] | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological/ Socio-Cultural and Economic Context |
| **Presence of Structures** | | | | | | | | | |
| Artificial Reef Effect | 1,2,3,4,5 | May attract prey (P?) | - | 1 | 2 | 6 | 5 | R | 2 |
| Subsea Structures | 1,2,3,4,5 | Disruption of benthos (N) | - | 0 | 2 | 6 | 5 | R | 2 |
| **Sediment Excavation** | | | | | | | | | |
| Removal | 1 | Disruption of substrate (N)<br>Resuspension of sediment (N) | - | 0-1 | 1 | 1 | 2 | R | 2 |
| Deposition | 1 | Disruption of substrate (N)<br>Resuspension of sediment (N)<br>Smothering (N) | - | 0-1 | 1 | 1 | 2 | R | 2 |
| **Lights** | 1,2,3,4,5 | May attract prey (P) | | 0 | 1 | 5 | 5 | R | 2 |
| **Flaring** | 2,4 | May attract prey (P) | | 0 | 1 | 5 | 5 | R | 2 |
| **Drill Mud/Cuttings** | | | | | | | | | |
| Water-based Muds | 2 | Effects on health (N) | Recycle mud; Treat muds and discharge cuttings | 0 | 1 | 6 | 4 | R | 2 |
| Synthetic-based Muds | 2 | Effects on health (N) | Recycle mud; Treat muds and discharge cuttings | 0 | 1 | 6 | 4 | R | 2 |
| **Other Fluids/Solids** | | | | | | | | | |
| Cement | 2 | Disruption of substrate (N)<br>May attract prey (P?) | - | 0 | 1 | 1 | 5 | R | 2 |
| BOP Fluid | 2 | Effects on health (N) | Selection criteria | 0 | 1 | ? | 5 | R | 2 |
| Cooling Water | 2,4 | Effects on health (N) | Monitor | 0 | 1 | 6 | 5 | R | 2 |
| Deck Drainage | 2,4 | Effects on health (N) | Treatment | 0 | 1 | 5 | 5 | R | 2 |
| Bilge Water | 2,4 | Effects on health (N) | Treatment | 0 | 1 | 5 | 5 | R | 2 |
| Ballast Water | N/A | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sanitary/Domestic Waste Water | 2,4 | May attract prey (P?) | Treatment | 0 | 1 | 5 | 5 | R | 2 |
| Small Transfer Spills | 2,4 | Effects on health (N) | Safe handling practices; Cleanup protocols | 0 | 1 | 5 | 5 | R | 2 |
| Produced Water | 2,4 | Contamination (N) | Treatment | 0 | 1 | 1 | 5 | R | 2 |
| Garbage | N/A | | | | | | | | |
| **Atmospheric Emissions** | 1,2,3,4,5 | Contamination (N) | Equipment design | 0 | 2 | 6 | 5 | R | 2 |
| **Ships and Boats** | 1,2,3,4,5 | Disturbance (N) | - | - | - | - | - | - | - |
| **Helicopters** | 1,2,3,4,5 | Disturbance (N) | - | - | - | - | - | - | - |
| **Noise** | | | | | | | | | |
| Dredge | 1 | Disturbance (N) | - | 0-1 | 2-3 | 6 | 2 | R | 2 |
| Drilling Rigs | 2 | Disturbance (N) | - | 0-1 | 2-3 | 6 | 4 | R | 2 |
| Support Vessels | 1,2,3,4,5 | Disturbance (N) | Avoid sea turtles; maintain steady course/speed when possible | 0-1 | 2-3 | 6 | 5 | R | 2 |
| Helicopters | 1,2,3,4,5 | Disturbance (N) | Fly min. altitude 600 m when possible | 0-1 | 1 | 4 | 5 | R | 2 |
| FPSO | 4 | Disturbance (N) | - | 0-1 | 2-3 | 6 | 5 | R | 2 |
| VSP | 2 | Physical (N) Disturbance (N) | Ramp up; Delay start if sea turtle in safety zone; shut down if leatherback in safety zone | 0-1 | 2-3 | 1 | 2 | R | 2 |
| **Underwater Maintenance** | 1,2,3,4 | Disturbance (N) | Material and method selection | 1 | 1 | 1 | 1 | R | 2 |
| **Shore Facilities**[a] | N/A | | | | | | | | |

**Magnitude**
0 = Negligible
1 = Low
2 = Medium
3 = High

**Geographic Extent**
1 = < 1 $km^2$
2 = 1-10 $km^2$
3 = 11-100 $km^2$
4 = 101-1,000 $km^2$
5 = 1,001-10,000 $km^2$
6 = > 10,000 $km^2$

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

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

**Reversibility (population level)**
R = Reversible
I = Irreversible

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

[a] 1 = Glory Hole Excavation/TGB Installation
2 = Drilling
3 = Subsea Production Equipment Installation
4 = Production Operations
5 = Abandonment

[a] Existing onshore infrastructure will be used

**Table 7.20. Significance of Predicted Residual Environmental Effects of Routine Activities on Sea Turtle VEC.**

| Valued Environmental Component: Sea Turtles | | | | | |
|---|---|---|---|---|---|
| **Project Activity** | **Project Phase[a]** | **Significance of Predicted Residual Environmental Effects** | | **Likelihood[b]** | |
| | | **Significance Rating** | **Level of Confidence** | **Probability of Occurrence** | **Scientific Certainty** |
| **Presence of Structures** | | | | | |
| Artificial Reef Effect | 1,2,3,4,5 | P | 3 | - | - |
| Subsea Structures | 1,2,3,4,5 | NS | 3 | - | - |
| **Sediment Excavation** | | | | | |
| Removal | 1 | NS | 3 | - | - |
| Deposition | 1 | NS | 3 | - | - |
| **Lights** | 1,2,3,4,5 | NS | 3 | - | - |
| **Flaring** | 2,4 | NS | 3 | - | - |
| **Drill Mud/Cuttings** | | | | | |
| Water-based Muds | 2 | NS | 3 | - | - |
| Synthetic-based Muds | 2 | NS | 3 | - | - |
| **Other Fluids/Solids** | | | | | |
| Cement | 2, | NS | 3 | - | - |
| BOP Fluid | 2 | NS | 3 | - | - |
| Cooling Water | 2,4 | NS | 3 | - | - |
| Deck Drainage | 2,4 | NS | 3 | - | - |
| Bilge Water | 2,4 | NS | 3 | - | - |
| Ballast Water | N/A | | | | |
| Sanitary/Domestic Waste Water | 2,4 | NS | 3 | - | - |
| Small Transfer Spills | 2,4 | NS | 3 | - | - |
| Produced Water[c] | 2,4 | NS | 3 | | |
| Garbage[d] | N/A | | | | |
| **Atmospheric Emissions[e]** | 1,2,3,4,5 | NS | 3 | - | - |
| **Ships and Boats** | 1,2,3,4,5 | NS | 3 | - | - |
| **Helicopters** | 1,2,3,4,5 | NS | 3 | - | - |
| **Noise** | | | | | |
| Dredge | 1 | NS | 3 | - | - |
| Drilling Rigs | 2 | NS | 3 | - | - |
| Support Vessels | 1,2,3,4,5 | NS | 3 | - | - |
| Helicopters | 1,2,3,4,5 | NS | 3 | - | - |
| FPSO | 4 | NS | 3 | - | - |
| VSP | 2 | NS | 3 | - | - |
| **Underwater Installation and Maintenance** | 1,2,3,4 | NS | 3 | - | - |
| **Shore Facilities[f]** | N/A | | | | |

**Significance Rating (significance is defined as a medium or high magnitude (2 or 3 rating) and duration > 1 year (≥ 3 rating) and geographic extent > 100 km$^2$ (≥ 4 rating)**

NS = Not significant negative environmental effect
S = Significant negative environmental effect
NS = Not significant negative environmental effect
P = Positive environmental effect

**Level of Confidence (professional judgement)**
1 = Low level of confidence

**Probability of Occurrence (professional judgement)**
1 = Low probability of occurrence

| | |
|---|---|
| 2 = Medium level of confidence | 2 = Medium probability of occurrence |
| 3 = High level of confidence | 3 = High probability of occurrence |

**Level of Scientific Certainty (based on scientific information and statistical analysis or professional judgement)**
1 = Low level of scientific certainty
2 = Medium level of scientific certainty
3 = High level of scientific certainty

[a] 1 = Glory Hole Excavation/TGB Installation
2 = Drilling
3 = Subsea Production Equipment Installation
4 = Production Operations
5 = Abandonment
[b] Only considered in the event of significant (S) residual effect
[c] Produced water associated with well testing may be flared
[d] All garbage will be brought to shore
[e] Includes produced water which may be flared
[f] Existing onshore infrastructure will be used

The effects of routine activities associated with the proposed drill centre Project on *SARA*-listed wolffishes and Atlantic cod, and their respective habitats, are *not significant* (Tables 7.7 and 7.10).

The effects of routine activities associated with the proposed drill centre Project on the *SARA*-listed Ivory Gull are considered *not significant* (Table 7.16).

The effects of routine activities associated with the proposed drill centre Project on *SARA*-listed marine mammals including blue whales, North Atlantic right whales, harbour porpoises, and Sowerby's beaked whales whales are *not significant* (Table 7.18).

The effects of routine activities associated with the proposed drill centre Project on the *SARA*-listed leatherback sea turtle are *not significant* (Table 7.20).