8.0 MARINE FISH AND FISH HABITAT: ENVIRONMENTAL EFFECTS ASSESSMENT

Marine fish and their habitats are important considerations in the environmental assessment (EA) of activities that occur within, and that may affect, the marine environment. The Project Area and surrounding marine environments are known to be used by a diversity of marine biota. The presence, abundance and distribution of marine fish species and associated habitat characteristics (both abiotic and biotic) vary considerably across this rather large and diverse marine environment, which transitions from relatively shallow shelf zones, through the continental slope to deep areas. These areas are used by fish and invertebrate species of commercial, cultural, and/or ecological importance and support regionally important areas of biodiversity and marine productivity.

Fish and fish habitat, and the potential effects of the Project on this VC, are subject to the relevant provisions of the federal *Fisheries Act* and its associated Regulations, which provides protection to commercial, recreational, and Aboriginal fisheries by protecting the fish resources and habitats that support these activities. Under the *Fisheries Act*, "fish" include all parts and life stages of fish, shellfish, crustaceans, and marine animals. Fish habitats include areas that fish directly or indirectly use to live, including nursery, rearing, spawning, migration and foraging areas. Certain fish species and their habitats may also be provided with legislative protection within Canadian (SARA) and/or provincial (NL ESA) jurisdictions.

For the purpose of this EIS, this VC includes consideration of relevant fish species (both stable and at risk), as well as plankton, algae, marine plants, benthos, and relevant components of their habitats (such as water and sediment), given the clear interrelationships between these environmental components. The consideration of these components within a single VC is in keeping with current and standard EA practice, and provides for a more comprehensive, holistic approach, while at the same time reducing unnecessary repetition. Although identified fish species at risk are considered integrally within the environmental effects assessment for this VC, these species are given special attention and emphasis in the identification, analysis and evaluation of potential environmental effects and required mitigation measures herein.

8.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

A number of spatial assessment boundaries have been defined for the environmental effects assessment of this VC, which reflect the varying ways and scales in which the Project may influence marine fish and their habitats (Figure 8-1).

Within the Project Area itself, potential effects are expected to be direct in nature and associated with the specific environmental interactions that may be associated with planned Project activities. At the larger local and regional scales around the Project Area; however, the environmental effects assessment also considers the larger potential environmental zones of influence of the Project (including both planned activities and potential accidental events), and the characteristics, distributions and movements of the various fish species and habitats that comprise this VC, as described below.

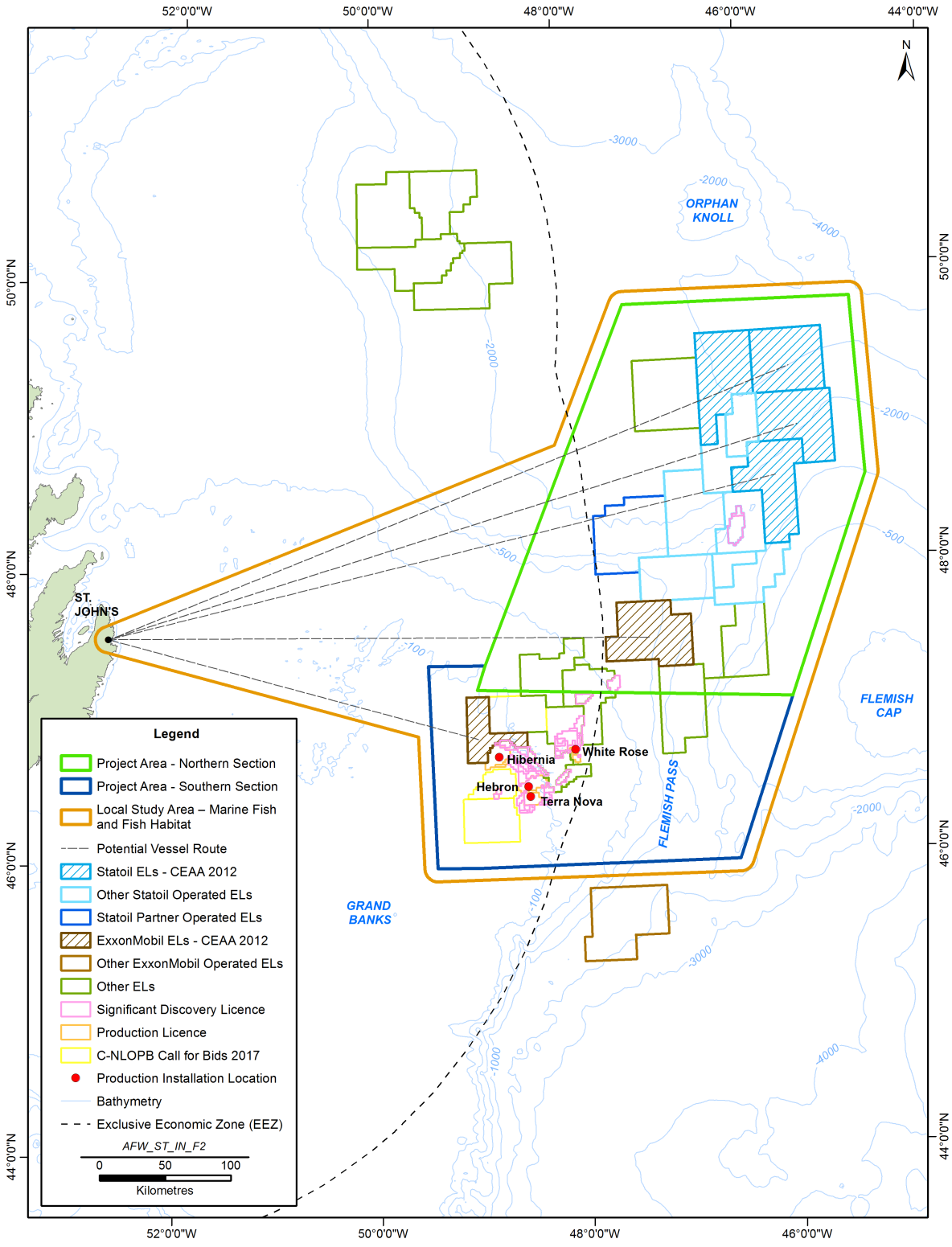


Figure 8-1 Environmental Assessment Study Areas: Marine Fish and Fish Habitat

Project Area: This represents the overall geographic areas offshore Eastern Newfoundland within which planned Project-related exploration activities will take place. While the Project Area is defined as a polygon that encompass such activities over the course of the Project, the various components and activities associated with the drilling of each individual well and other planned components will occupy fairly small areas within this overall area, as described in Chapter 2. The assessment also considers related supply and support vessel and aircraft traffic routes to and from this offshore Project Area.

Local Study Area (LSA): This encompasses the overall geographic area over which planned Project-related environmental interactions (including emissions and other disturbances) will occur. The LSA therefore represents the anticipated environmental zone of influence of the Project's planned components and activities. As described in this chapter, the main Project-related environmental emissions and interactions that may affect Marine Fish and Fish Habitat include the discharge and deposition of drill wastes (cuttings and fluids) and other potential environmental emissions during planned activities, as well as associated underwater noise or other disturbances, which are likely be confined to within the immediate vicinity of (and certainly within several kilometers) of the drilling installation or other survey or supply vessels. The environmental zones of influence for planned Project components and activities are therefore expected to occur primarily within the overall Project Area polygons defined above, with the exception of Project activities that could conceivably occur on the edges of the Project Area boundary. For this VC, the LSA is therefore (conservatively) defined as the offshore Project Area and an appropriately 10 km area around it as well as the associated vessel and aircraft traffic routes to the ELs.

Regional Study Area (RSA): In addition to Project- and disturbance-related factors, from an ecological perspective the environmental effects assessment also recognizes and considers the characteristics, distributions, and movements of the individual VCs under consideration, including the larger Regional Areas within which they occur. Ecological boundaries for Marine Fish and Fish Habitat vary between species, due to difference in their ranges, habitat preferences, movement patterns and key activities. The EA assesses potential effects to fish (individuals and populations) which are known or likely to use the LSA, and considers the overall extent of affected individuals and populations during the time period at which they may be affected by planned Project components and activities. Key aspects of marine biota movements and distributions as they relate to the Project Area / LSA are as presented in Chapter 6 and are generally considered in assessing both potential Project-specific (this Chapter) and cumulative (Chapter 14) effects upon this VC. The overall RSA for the environmental effects assessment is as defined and illustrated earlier in Section 4.3

The temporal boundaries for the effects assessment encompass the frequency and duration of Project-related (in-field) activities in the Project Area (Chapter 2), as well as the likely timing of resulting environmental effects. In conducting the assessment, special consideration is also given to timing of VC presence within the Project and Assessment Areas, including important or sensitive time periods.

It is within the above spatial and temporal boundaries that the potential environmental effects on this VC resulting from planned Project components and activities and their significance are assessed and evaluated.

Significant environmental effects are considered to be those that could cause a change in a VC that would alter its status or integrity beyond an acceptable and sustainable level. For the purposes of this EA, significant environmental effects on Marine Fish and Fish Habitat are defined as those that would cause one or more of the following:

- A detectable decline in overall fish abundance or change in the spatial and temporal distributions of fish populations within the overall RSA over multiple generations
- An alteration or destruction of fish habitat which results in serious harm to fish resources that support a commercial, recreational, or Indigenous fishery in the RSA
- Effects to a designated (protected) species at risk or its critical habitat such that the overall abundance, distribution and health of that species and its eventual recovery within the RSA is adversely affected

The possible environmental effects of accidental events on Marine Fish and Fish Habitat are assessed and evaluated in Chapter 15 (Accidental Events).

8.2 Potential Environmental Changes, Effects, and Associated Parameters

The key potential environmental interactions between planned offshore oil and gas activities and marine fish and their habitats include the following (adapted from Amec 2014):

- The destruction, contamination or alteration of marine habitats and benthic organisms due to the discharge and deposition of drill cuttings and/or fluids, the deployment and use of other Project equipment, and possibly the introduction and spread of aquatic invasive species
- Contamination of fish / invertebrates and their habitats due to other environmental discharges during planned oil and gas exploration drilling and other associated survey and support activities
- The attraction of marine fish to drilling installation and vessels, with increased potential for injury, mortality, contamination, or other interactions
- Temporary avoidance of areas by marine fish due to underwater noise or other disturbances, which may alter their presence and abundance as well as disturbing movements / migration, feeding or other activities
- Changes in the availability, distribution, or quality of feed sources and/or habitats for fish and invertebrates as a result of planned activities and their associated environmental emissions
- Injury, mortality, or other disturbances to marine fish as a result of exposure to noise within the water column during wellsite surveys or vertical seismic profiling (VSP) survey activity

The EIS Guidelines issued by the Agency in December 2016 also identify and specify a number of issues and potential effects on this VC which require consideration in the EIS (Part 2, Sections 6.3.1, 6.3.2 and 6.3.6), including:

- The identification of potential adverse effects to fish and fish habitat as defined in subsection 2(1) of the *Fisheries Act*, including the calculations of potential habitat loss (temporary or permanent) in terms of surface areas (e.g., spawning grounds, juvenile, rearing and feeding areas), and in relation to availability and significance. The assessment will include a consideration of:
  - effects on water quality including changes to chemical composition, temperature, oceanographic conditions
  - the geomorphological changes and their effects on hydrodynamic conditions and fish habitats (e.g., modification of benthic habitat including corals and sensitive habitat, area affected by drilling waste, disturbance to water column)
  - the modifications of hydrological and hydrometric conditions on fish habitat and on the fish species' life cycle activities (e.g., reproduction, juvenile, rearing, and feeding, movements)
  - potential imbalances in the food web in relation to baseline conditions
  - underwater noise and vibration emissions from project activities (i.e., drilling, vertical seismic profiling, offshore supply vessel operation, well abandonment) and how it may affect fish health and behavior
  - effects on the primary and secondary productivity of water bodies and how project-related effects may affect fish food sources

- The effects of changes to the aquatic environment on fish and their habitat, including:
  - the anticipated changes in the composition and characteristics of the populations of various fish species, including shellfish and forage fish including mortality of fish, eggs and larvae, environment, and species (e.g., corals, marine plants)
  - modifications in migration or local movements during and after project activities (e.g., vertical seismic profiling, drilling)
  - modifications and use of habitats by federal or provincial listed fish species

- A discussion of the effects of drilling waste disposal on marine benthos and other components of the aquatic environment, recognizing that the disposal of these wastes is expected to be a primary cause of effect on benthos
- A discussion of the length of time it would take for the benthic environment to return to baseline conditions in water depths within which the Project would occur
- A discussion of how project timing correlates to key fisheries windows and potential effects resulting from overlapping periods
- A discussion of how data examining the deposition of drilling-related wastes (e.g., fluid, mud residues, cuttings) and acoustic monitoring data would be collected during and after drilling operations and how this would be used to verify effects predictions
- Effects on marine plants, including benthic and detached algae, marine flowering plants, brown algae, red algae, green algae, and phytoplankton
- The potential effects of the project on federal listed species at risk and those species listed by the Committee on the Status of Endangered Wildlife in Canada classified as extirpated, endangered, threatened or of special concern (flora and fauna) and their critical habitat, including:

- alteration of habitat (including critical habitat) features
- direct and indirect effects from noise, vibrations, and increased exposure to contaminants of concern
- a discussion of migration patterns of federal species at risk and related effects (e.g., displacement, increased risk of collision)
- direct and indirect effects on the survival or recovery of federally listed species (list species)

A number of questions and comments related to this VC were also noted during the Operators' Project-related consultations with government departments and agencies, stakeholder organizations and Indigenous groups. These include questions and concerns regarding: the potential effects of planned Project activities on key species that are harvested for commercial and/or traditional use purposes, including Atlantic salmon, swordfish, cod, turbot, snow crab, and American eel which may occur in or migrate through the Project Area; the implications of climate change and other natural and human factors for the nature and distribution of fish species in the area; and the possible effects of drilling wastes and underwater noise on key fish species, including possible displacement of their prey (see Chapter 3 for further details).

The environmental effects assessment for this VC considers and focuses upon the various issues and questions identified through these issues scoping exercises, including an initial identification of the key potential environmental changes and possible environmental effects on the VC that may result from these. These are summarized in Table 8.1, along with the identification of key parameters through which these Project-related changes and effects may be reflected.

Table 8.1 Potential Project-Related Environmental Changes and Potential Effects: Marine Fish and Fish Habitat

Potential Environmental Effects	Contributing Potential Environmental Changes Resulting from the Project	Associated Parameter(s)
Change in Habitat Availability and Quality	Project-related components, activities and associated emissions or disturbances (drill cuttings, others) may change the physical and/or chemical characteristics of habitats used by marine fish. Resulting environmental changes in the availability, extent and quality of habitats have the potential to affect the presence, abundance and health of fish that use the affected areas.	Amount of key habitat types present in the LSA and RSA. Amount of altered habitats relative to their availability within the LSA and RSA.
Change in Fish Mortality, Injury, Health	Various sources of fish mortality, injury or health effects may occur as a result of offshore oil and gas-related activities. These could include those resulting from direct environmental changes from the Project (e.g., discharges of drill cuttings smothering benthic invertebrates, or fish injury through contact with Project-related noise). Other possible direct and indirect	Individuals and species present and overall species diversity in the LSA and RSA. Occurrence and success of key life history stages (e.g., feeding, reproduction) by fish affected by the Project.

Table 8.1 Potential Project-Related Environmental Changes and Potential Effects: Marine Fish and Fish Habitat

Potential Environmental Effects	Contributing Potential Environmental Changes Resulting from the Project	Associated Parameter(s)
	effects on fish (e.g., emissions resulting in reduced availability or quality of fish habitats or food sources). These environmental changes may have resulting effects on the presence, density, diversity, and health of marine fish within the affected area.	Habitat availability and quality within the LSA and RSA. Food distribution, availability, and quality within the LSA and RSA.
Change in Fish Presence and Abundance (Behavioral Effects)	In addition to implications for fish mortality / injury or health, some individuals may be attracted to offshore facilities by associated environmental changes (such as food or habitat availability), or, conversely, others may avoid the area because of the associated noise or other disturbances in the marine environment as a result of the Project. Spatial distribution of species may be affected by aquatic invasive species that compete for habitat and food resources. These behavioral effects can influence the spatial and temporal presence and abundance of fish in the area, as well as possibly having ecological implications if this results in increases in the risk of injury / mortality, excludes individuals or populations from key habitats for extended periods, and/or affects key and sensitive life history stages.	Individuals and species present and overall species diversity in the LSA and RSA. Overall spatial and temporal distribution patterns in the LSA and RSA. Occurrence and success of key life history stages (e.g., feeding, reproduction) by fish affected by the Project. Food distribution, availability, and quality within the LSA and RSA.

An overview of the potential for interactions between each of the Project's planned components and activities and Marine Fish and Fish Habitat, and specifically, the potential for these to result in environmental changes and eventual, detectable effects to the various aspects of this VC, is presented in Table 8.2.

Table 8.2 Potential Project-VC Interactions: Marine Fish and Fish Habitat

Project Component / Activity	Potential Environmental Effects		
	Change in Habitat Availability and Quality	Change in Fish Mortality / Injury Risk and Fish Health	Change in Fish Presence and Abundance (Behavioral Effects)
Presence and Operation of Drilling Installation (Including	•	•	•

Table 8.2 Potential Project-VC Interactions: Marine Fish and Fish Habitat

Project Component / Activity	Potential Environmental Effects		
	Change in Habitat Availability and Quality	Change in Fish Mortality / Injury Risk and Fish Health	Change in Fish Presence and Abundance (Behavioral Effects)
lights, noise, air emissions, anchoring)			
Drilling and Associated Marine Discharges (including fluids and cuttings)	•	•	•
Formation Testing with Flaring		•	•
Wellhead Decommissioning	•		•
Geophysical / Geohazard / Wellsite Seabed Surveys and VSP		•	•
Geological, Geotechnical and Environmental Surveys	•	•	•
Supply and Servicing		•	•

8.3 Environmental Effects Assessment and Mitigation

The following sections provide an assessment and evaluation of the potential effects of the Project (planned components and activities) on Marine Fish and Fish Habitat. Mitigation measures to prevent or reduce adverse effects upon this VC are identified and considered integrally within and throughout the environmental effects analysis that follows, as applicable. The environmental effects assessment for accidental events for VCs, including this one, is presented separately in Chapter 15.

8.3.1 Approach and Methods

The analysis and description of the potential environmental effects of the Project on this VC are based on consideration of the nature, scale and timing of the Project's planned components and activities (Chapter 2), and the existing environment for this VC (Section 6.1). This analysis has focused first on identifying key potential Project-VC interactions and, in particular, anticipated changes to the existing biophysical environment resulting from planned Project activities and emissions that may, through one or more associated pathways, lead either directly or indirectly to overall effects on the presence, abundance, diversity, health or other aspects of fish and fish habitat at the individual and/or population levels.

In doing so, the assessment for this VC considers what is known and can reasonably be deduced about the presence, abundance and distribution of fish species and habitats with and around the LSA and broader RSA, with a focus on important or sensitive species and components, and those with the potential to be affected by the Project. The assessment and description of environmental

effects and the identification of mitigation has also been informed by a review of the existing and available literature, including past scientific studies and monitoring initiatives that have investigated and documented the actual effects of such activities on marine fish and their habitats. Each planned component of the Project is considered in terms of its potential for interactions with, and effects on, the VC, with a focus on the various potential environmental changes identified in the previous section.

In some cases, the assessment is based on specific information on planned Project activities and their environmental interactions. For example, to provide additional Project-specific information and analysis related to the nature and extent of drill cuttings disposition resulting from the Project, drill cuttings dispersion modelling was undertaken at representative well sites within the Project Area to evaluate the potential dispersion and eventual seabed "footprint" of these cuttings over summer and winter seasons (Appendix G). The results of this modelling are summarized and used in this VC Chapter to assess the potential effects on benthic habitats and biota associated with the cuttings footprint (including its location, extent, and thickness) and the possible ecological implications of these seabed interactions (see Section 8.3.4).

In other cases, the environmental effects assessment reflects a more regional, issues-based and "mitigation-centric" approach. This is the case given both the current stage of Project planning and design (i.e., specific wellsite locations are not yet determined and defined) and the existence of effective mitigation measures to avoid or reduce potential adverse environmental effects. In terms of the latter, many of these mitigation measures are standard in the offshore oil and gas sector off Newfoundland and Labrador and elsewhere (due to regulatory requirements or otherwise) and are proven to help avoid or reduce such effects. In such cases, the effects assessment identifies the potential environment issues or interactions, applies, and determines the relevance and outcomes of the use of such mitigation measures, and considers the potential for residual effects to occur. A key focus of the analysis in such cases is evaluating the potential (ecological) consequences of these environmental changes, based on their likely nature, scale, and duration, and especially their potential to adversely affect important and sensitive aspects of this VC in a way that may result in significant adverse environmental effects.

In order to assess the potential effects of anthropogenic sources of underwater noise on fish, threshold criteria are commonly used. To date, the Canadian government has not developed or formally adopted guidelines or regulatory thresholds for levels of underwater sound believed to be capable of causing auditory injury (in the form of permanent threshold shifts (PTS)) or behavioural disturbances to fish. In the absence of formal Canadian thresholds, thresholds published in scientific literature, and recent working group technical reports (Popper et al 2014) been used to inform this assessment of potential injury or behavioural disturbance on fish. Under the American National Standards Institute-Accredited Committee S3, Subcommittee 1, an Animal Bioacoustics Working Group has established sound exposure guidelines for marine fish that provides the most current guidance on threshold levels of underwater sound for the onset of temporary threshold shift (TTS) and permanent threshold shift (PTS) in fish (Popper et al. 2014). Dual metrics for threshold values include peak sound pressure levels (SPLpeak) and cumulative (over 24 hours) sound exposure levels (SELcum), and indicate that conclusions should be based on whichever metric is first exceeded. In other words, onset of PTS (i.e., injury) is assumed to occur if a received sound exposure exceeds the peak SPL criterion, or the SEL criterion, or both criteria.

As described in Section 2.10 of this EIS, given the current stage of planning and design for the various aspects of these multi-year exploration programs, the EIS includes and assesses various options and approaches (e.g., types of drilling installation). It also includes and considers potential variation in the possibility, nature and degree of environmental interactions and resulting effects between species and species groups and/or in different parts of the LSA or at different times of the year, as applicable. Fish species at risk are considered integrally within the environmental effects assessment for this VC, although these species are given attention and emphasis in the identification, analysis and evaluation of potential environmental effects and required mitigation measures herein.

8.3.2 Summary of Key Mitigation

Key mitigation measures that will be implemented to help avoid or reduce potential environmental effects on Marine Fish and fish Habitat include:

- Use of existing and common vessel and aircraft travel routes for vessels and helicopters will be used where possible and practicable
- Low-level aircraft operations will be avoided where it is not required per Transport Canada protocols
- Operational discharges will be treated prior to release in accordance with the OWTG and other applicable regulations and standards
- The selection and screening of chemicals to be discharged, including drilling fluids, will be in accordance with the Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands
- During formation flow testing with flaring, produced hydrocarbons and produced water will be flared. If there is a large amount of produced water encountered, it will be treated in accordance with the relevant regulatory requirements prior to ocean discharge, or shipped to shore for appropriate disposal
- Appropriate handling, storage, transportation, and on-shore disposal of solid and hazardous waste
- Prior to the start of a drilling campaign, a pre-drill coral survey will be undertaken. A report summarising the coral mapping, risk assessment and planned mitigation measures (if corals are identified) will be prepared and submitted to the C-NLOPB / DFO for review and acceptance. Potential mitigation include relocation of the well and/or relocation of cuttings discharge through a subsea cuttings transport system
- Relocation of well and/or redirection of WBM cuttings discharge in the event that the pre-drill coral survey and risk assessment identifies mitigation required to protect sensitive benthic habitat (i.e., corals and sponges)
- SBM-related drill cuttings will be returned to the drilling installation and treated in accordance with the OWTG before being discharged to the marine environment. WBM-related drill cuttings will be discharged without treatment
- Use of explosives will not be employed for removal of wellheads
- At the time of decommissioning a well, the well will be inspected in accordance with applicable regulatory requirements

8.3.3 Presence and Operation of Drilling Installations

As described in Chapter 2, the Project will include the drilling of exploration wells on licences within the Project area using one or more drilling installations over the defined temporal scope.

The initiation and conduct of the Project will involve the positioning and operation of the drilling installation which may include the use of semi-submersibles and/or drill ships, and at times have multiple drilling installations operating simultaneously. As discussed in Section 2.10, the type of drilling installation chosen for a drilling campaign is dependent on a number of factors including water depth and ability to operate within the environmental conditions prevalent offshore Newfoundland. The presence and operation of the drilling installation and supporting vessels may result in associated environmental interactions and emissions typically associated with offshore drilling programs. The potential interactions between the presence and operation of the drilling installation and Marine Fish and Fish Habitat related to the associated underwater noise and vibrations, lighting and other environmental discharges that will or may be associated with these activities, as well as associated interaction with the seabed itself and present benthic species. Each of these is assessed in the subsections that follow, which are subdivided in this section by environmental disturbance and interaction in order to enhance readability.

8.3.3.1 Underwater Noise and Vibrations

The positioning, presence and operation of the drilling installation may produce underwater noise and vibrations from equipment operations, dynamic positioning systems (as required) and drilling operations. Section 2.5.1 provides an overview of the typical drilling installations and other types of equipment that may be used for the Project, including the anticipated noise levels that are associated with them, and Section 2.9.5 and Appendix C provide additional information on anticipated underwater noise emissions from the Project.

Anthropogenic noise in the marine environment such as that which may be associated with drilling activities and vessel traffic and other equipment used during offshore oil and gas exploration activities can be transmitted through water and may result in disturbances to marine biota. There is, however, no direct evidence of mortality to fish as a result of continuous underwater noise (Popper and Hastings 2009; Popper et al. 2014) such as is generated from this Project. Typical sound levels from drilling activities are below estimated exposure guidelines for injury to fish, including recoverable injuries (170 dB re 1µPa for 48 hr SEL) and temporary hearing threshold shift (158 dB re 1µPa for 12 hr SEL) (Popper et al. 2014). In addition, given the known behavioural (avoidance) responses of some fish species to underwater noise (as described below), mobile species that may be present within the Project's zone of influence are likely to move out of the area if they are disturbed by the Project. The presence and progression of mobilization and set-up activities at a planned wellsite location prior to the start of drilling activities may be associated with potential for higher levels of sustained noise. This likely means that individuals in the area will have been exposed to the lower levels of sound and have likely moved away from the area.

A variety of responses by marine fish to underwater sound have been reported in literature and anecdotal reports. These responses vary by species, life stage, intensity of sound, distance from source and other factors. These behavioral effects include possible avoidance or attraction of

individual fish, as well as possible physiological effects when fish are continually exposed to noise (Clark et al. 2016). Noise from marine vessels and other sources has, for example, been shown to mask the acoustic sensory environment of fish and invertebrates and affect behavior (Slabbekoorn et al. 2010, Wale et al. 2013a, 2013b; Morley et al.2014), causing avoidance by some species and possible associated effects on fish and their activities (including feeding, reproduction, communication). Overall, however, short-term and low-frequency noises, as produced by travelling vessels, appear to elicit temporary avoidance due to startling effects (Misund et al.1996; Wilson and Dill 2002).

The effects of anthropogenic noise in the marine environment can be short-term in nature, and reversible once the noise source has been removed or reduced, decreasing the potential for detrimental effects (Williams et al. 2015). The operation of these drilling installations and the associated noise emissions may result in some degree of avoidance by individual fish (depending upon the species involved). For example, herring species have a higher hearing sensitivity than salmonids (trout, salmon) and gadids (cods) (Popper and Hastings 2009). Marine fish populations will likely not be disturbed by Project-related activity due to the drilling installations relatively localized and short-term (approximately 35-65 days per well) presence at any one location. For these reasons, it is unlikely that fish will be displaced from habitats or disrupted during key activities over extended areas or periods, or be otherwise affected in a manner that causes negative and detectable effects to fish populations in the region.

8.3.3.2 Light Emissions and Other Environmental Discharges

The presence of the drilling installation and its associated lighting and other discharges (including organic waste material) may also result in the attraction of some individual fish. This may include migrating individuals and pelagic species that are attracted to the lights of the drilling installation shining on the water, or invertebrates that become attached to the subsea structure or plankton concentrated around the platform. The combination of drilling installation colonization opportunities and artificial light emissions from the operating decks and navigation may create a “reef effect” in which fish aggregate underneath in response to increased foraging and shelter opportunities (Picken and McIntyre 1989; Røstad et al. 2006; Slabbekoorn et al. 2010), even in areas of underwater noise around anthropogenic activities in the marine environment. Lighting around the drilling installation may attract phototaxic plankton, and may provide increased opportunities for prey capture by fish and other species (Keenan et al. 2007; Cordes et al. 2016). For example, yellowfin tuna are known to aggregate around production platforms because they are sight feeders that have more foraging opportunities in the associated well-lit surrounding waters (Hoolihan et al. 2014). Furthermore, the drilling installation may provide new habitats for various organisms that increase overall food production in the area, leading to increased abundance (Bomkamp et al. 2004; Sammarco et al. 2004; Punzo et al. 2015).

When combined with the safety zone established around the drilling installation (approximately 3 – 12 km^2, see Section 2.5.2) the area may act as temporary refuge for fish (Cordes et al. 2016), where some fish species may benefit through increased availability of shelter and food for juveniles, and by the decreased fishing pressure on adults. Positive effects will be temporary, however, because removal of the offshore structure from the wellsite will likely result in local fish and invertebrate

abundance and diversity returning to levels prior to enhancement (Bomkamp et al. 2004). Conversely, the attraction of marine biota to Project-related drilling installations or vessels and their lighting or other environmental discharges also increases their potential for interaction with Project-related emissions and disturbances, especially possible contamination through interaction with liquid discharges as described further in the next section.

Other potential emissions and discharges associated with the Project will include drilling wastes (fluids and cuttings, see next section) and cement, other liquid wastes (small amounts of produced water, bilge and deck drainage, ballast water, sewage, cooling water, and fire control water), atmospheric emissions (exhausts from equipment), and solid wastes including food and other non-hazardous waste. These emissions are described in some detail in the Project Description (Section 2.9).

Potential liquid discharges from the drilling installations include deck drainage water, sewage, and cooling water. Waste liquids will be treated as required and discharged in accordance with the OWTG and MARPOL, thereby reducing any potential effects on the marine environment. Bilge and deck drainage water that comes into contact with drilling installation equipment may become contaminated with oil. The bilge and drainage water will be treated prior to discharge. Grey wastewater from the galley, washing and laundry facilities and black wastewater from accommodations will be macerated prior to discharge. Although discharges of organic wastes may lead to localized organic enrichment (Peterson et al. 1996), no adverse effects are anticipated as volumes would be quite small at each drill site.

8.3.3.3 Interaction with Benthic Environment

As described in Section 2.5.1, the installation and positioning of the drilling installation in shallow water depths may involve use of anchoring/mooring systems. The placement of the anchors may disturb bottom habitats and cause injury or mortality to benthic invertebrates, including corals and sponges. However, the seabed footprint associated with setting the anchors and the anchors themselves may add habitat complexity and provide habitat for species that will further support higher trophic levels, although the effect is typically localized and is only for the duration during which the infrastructure is in place (Bomkamp et al. 2004). For this Project, these potential interactions will be restricted to shallow waters (less than 500 m) as in areas of EL1135 and EL1137, when the drilling installation will be anchored to maintain position, rather than using a DP system. The slopes of the Newfoundland Shelf, Flemish Pass and Flemish Cap including ELs 1135, 1137, 1141 and 1142, are more likely to have higher densities of coral and sponge species as compared to other parts of the Eastern Newfoundland Offshore Area. Higher densities of soft corals are present on the shallow areas of the Newfoundland shelf (less than 250 m) as in EL 1135 and EL 1137.

Although affected benthic invertebrates may provide temporary increases in food for predatory and scavenging species (Clark et al. 2016), the ecological function and environmental importance of these species necessitates an approach to avoiding or reducing the potential for adverse effects. In addition, while such effects, if do they occur, would be relatively small and localized given the small footprints involved, the recovery of species is often slow in cold water environments (Clark et al. 2016). In areas where coral and sponge densities are low, the disturbance to bottom habitats by anchor placement may be limited because habitat complexity and subsequent recolonization of the

area is not as dependant on recovery of slow growing habitat forming corals and sponges. In areas where coral colonies are likely to be present, prior to the start of a drilling campaign, a pre-drill coral survey will be undertaken. For the protection of corals from drill cuttings, the setback distance includes a consideration of cuttings dispersion modelling and presence and condition of corals in the area. The threshold for biological effects is 6.5 mm deposition. Therefore, where there is a predicted deposition greater than/equal to 6.5 mm, and healthy coral colonies are present, a setback of the predicted distance to this threshold value will be maintained, as described in greater detail in Section 8.3.4. In cases where dynamic positioning is used, the interaction would be limited to the location of the wellsite as moorings are not required, thereby the potential interaction with Marine Fish and Fish Habitat is limited to the area of the well site.

8.3.3.4 Aquatic Invasive Species

Invasive species can threaten aquatic ecosystems, occupy habitats or out-compete native species, introduce new diseases, and alter ecosystem processes (Bax et al. 2001). These species may show rapid population growth in the absence of natural predators, and may become established to the point where eradication is difficult or impossible. Local and international marine transport may be the cause in many of the accidental introductions of marine invasive species, because ship hulls and bilge water serve as vectors for the range expansion of such species (Bax et al. 2001; McKenzie et al. 2011; Benoit et al. 2012). Several invasive species have been identified off the coast of Newfoundland and Labrador (Templeman 2010), all of which have been shown to have effects on the native species and ecosystems, although these effects are generally thought to be more important to the coastal benthic communities than in the open ocean (Templeman 2010).

As with any ocean-going vessel and associated marine traffic, the presence and operation of Project-related drilling installations and vessels could result in the accidental introduction and spread of invasive species. Species may be transmitted to the drilling installation through ballast water or on the hull of vessels servicing the offshore area (Sammarco et al. 2004) or through local recruitment. Increased habitat due to the presence of the drilling installation may also provide “stepping stone” habitats to increase ranges of colonizing native and invasive invertebrates that are not normally able to traverse large expanses of open water (Sammarco et al. 2004; Cordes et al. 2016). The likelihood of introduction of invasive species will depend on the recent sailing history of the drilling installation or vessel and its operational practices (e.g., cleaning schedule, ballast water management). Vessels from foreign waters that are biofouled have greater potential to serve as vectors for such species (Benoit et al. 2012). For this Project, the required supply and services vessels will likely be sourced from the existing pool of locally-based ships that service the oil and gas industry off Eastern Newfoundland. These vessels are Canadian flagged and operate in Canadian waters, mostly offshore Newfoundland. It is therefore expected that only the drilling installations and speciality vessels used for survey work as part of this Project might be internationally sourced and therefore from other marine areas.

Prevention is considered to be key in controlling the introduction and spread of such species, because control of established populations is often costly and ecologically risky (Bax et al. 2001). Although the likelihood that a Project vessel will result in the introduction and spread of an invasive species is relatively low, Project vessels carrying ballast will use and comply with the *Canada*

Shipping Act, 2001, the associated *Ballast Water Control and Management Regulations*, and International Maritime Organization (IMO) anti-fouling guidelines to reduce the potential spread of invasive species.

8.3.3.5 Summary

In summary, the predicted environmental effects of presence and operation of the drilling installation are primarily related to underwater noise and vibrations, light emissions and other environmental discharges, interactions with the benthic environment, and aquatic invasive species. These interactions may result in potential changes to habitat availability and quality, fish mortality/injury risk and fish health, and fish presence and abundance. These effects are predicted to be adverse, low in magnitude, localized and certainly within the Project Area, short to medium term duration, occurring regularly and reversible, with these predictions being made with a high level of confidence.

8.3.4 Drilling and Associated Marine Discharges

Specific wellsite locations will be selected as Project planning and design activities move forward, based on existing and new geophysical survey data and information derived from previously drilled wells in the region.

Once the drill site clearance has been completed and the drilling installation has been positioned, the drilling processes commence, with each well being drilled in sections by gradually reducing the size of the well bore. Drilling muds are fluids which lubricate and cool the drill bit and hole, circulate cuttings and carry them back to the surface, and help to maintain appropriate pressure in the well. The initial top hole drilling involves a large diameter hole for the first part of the well and associated installation of the surface casing and conductor. These initial sections of the well are drilled using seawater or a WBM. As the initial (conductor) portion of a well is drilled without a riser in place, the WBM muds and cuttings are discharged directly to the seabed.

When top section drilling has been completed to the depth where the rock formation strength is sufficient, a steel casing is run and cemented in place to prevent the wall of the wellbore from caving in and to prevent the seepage of muds and other fluids. The wellhead is also installed at seabed and the riser and BOP are then installed onto the wellhead. The riser is a large diameter pipe that acts as a conduit connecting the drilling installation to the wellhead through the water column, and the wellhead provides structural integrity to house the BOP and pressure integrity for drilling operations. A BOP is a system of high pressure valves that prevent water or hydrocarbons from escaping into the environment in the event of an emergency or equipment failure. At intervals along the well, casing is cemented in place at set depths to reinforce the wellbore. Once the riser has been installed, the remaining sections of the well will be drilled to predefined depth using SBM. SBM cuttings will be returned to the drilling installation for treatment before being discharged. Once the conductor hole is completed and when the riser and BOP are in place, SBM and cuttings can be returned to the surface and onto the drilling installation for recovery and reuse.

The discharge of drill cuttings represents one of the primary potential interactions with Marine Fish and Fish Habitat during offshore drilling programs. The primary interactions from the discharge of drill cuttings including: cuttings deposition and potential seabed disturbance (smothering habitat);

chemical toxicity; and bioaccumulation (uptake of contaminants by fish and the presence or perception of taint). The treatment and discharge of drill cuttings will be in accordance with the OWTG.

8.3.4.1 Water-Based Drilling Muds

WBMs are planned for drilling the initial portion of the wells and will be discharged at the seabed. The use and eventual release of seawater and WBMs are not predicted to result in adverse environmental effects related to toxicity or bioaccumulation. The main component of these WBM drilling fluids is seawater, along with other additives, primarily bentonite (clay), barite and potassium chloride (Neff 2010). Other approved chemicals are also added as required to control and achieve the required mud properties (Amec 2014). As described in Section 2.10, chemicals that will be used as part of the Project – including those used in drilling fluids – will be screened and selected in accordance with the OCGS and in accordance with the Operator's chemical screening and management practices.

Overall, WBMs have varied effects on marine organisms, but due to the non-toxic nature of the drilling mud components (Neff 2010), they are not likely to result in toxicity (Holdway 2002; Trannum et al. 2010, 2011; Bakke et al. 2013; Purser 2015). Exposure to WBMs at low concentrations has, for example, not shown toxicity to sea scallops, polychaetes, amphipods, shrimp, and various other fish species (Cranford et al. 1999, Neff 2010). The acute toxicity potential was tested in relatively high concentrations of barite and was found to be non-toxic to capelin, snow crab larvae or planktonic jellyfish after 24 hours of continuous exposure (Payne et al. 2006). Possible sublethal effects, including reduced growth rates and altered foraging behaviours, have been observed in crustaceans, scallops and haddock that were exposed to high continuous concentrations of WBMs or its components for 96 hours to 68 days, but at experimental exposure levels well beyond the episodic nature of what marine organisms would potentially encounter in the environment (Cranford et al. 1999; Neff 2010). Bechmann et al. (2006) also found that suspensions of barite-based WBM caused effects on biomarker responses, growth and survival in filter feeding bivalves and histopathological changes in gills in juvenile cod. Scallops were most sensitive, with significantly reduced filtrating rate exposed for three weeks to 0.5 mg/L used barite-based WBM.

Because of the physical properties of the drill mud components, associated metals are also not readily incorporated into tissues, limiting the availability of metals for bioaccumulation (Neff 2010, Edge et al. 2016). Infaunal species, including polychaetes and bivalves that have limited ability to migrate away from the disturbance, may accumulate metals from WBMs (Neff et al. 1985; Schaanning et al. 2002; Ruus et al. 2005). However, mobile benthic feeders, including snow crab, are not expected to accumulate metals from WBM because of the relative small area affected compared to the wider home range of the species (Ennis et al. 1990; Trannum et al. 2010; Bakke et al. 2013).

Potential effects of suspended particles from discharge of drilling fluids and associated drilling cuttings to suspension feeding benthic invertebrates, sponges and corals have also been documented (e.g. Edge et al. 2016, Larsson et al. 2013). Continuous exposure of the sponge *Geodia barretti* to the barite component of WBMs, for example, resulted in evidence of toxic and stress effects (Edge et al. 2016). These effects were reduced or not observed at lower barite concentrations (less

than 10 mg/L) or if the exposure was intermittent (Edge et al. 2016). Many corals are considered sensitive to suspended sediments, with increased larval mortality and change in feeding behaviour resulting from exposure to WBM (Raimondi et al. 1997, Neff 2010; Buhl-Mortensen et al. 2015; Järnegren et al. 2016), although some corals have higher tolerance to drill mud deposition (Allers et al. 2013). As such, the Flemish Pass and slope areas of the Flemish Cap and Newfoundland Shelf in the Project Area, where corals and sponges are more prevalent, may be considered more sensitive to such effects resulting from drilling activities.

While relatively non-toxic, degradation of organic components in the drill muds can also initiate eutrophication responses that can create localized anoxic environments (Schaanning et al. 2008; Trannum et al. 2010). These biological effects of WBMs are not normally found beyond approximately 250-500 m from a drilling platform in projects where cuttings piles are formed (Hurley and Ellis 2004; Schaanning et al. 2008; Jorissen et al. 2009; Santos et al. 2009; Trannum et al. 2010; Ellis et al. 2012; Bakke et al. 2013; Deblois et al. 2014a). Environmental monitoring data have also indicated that the area of WBM effect where there was an increase in metal levels is generally within 250-500 m of the drill site (LGL Limited 2003). In addition, the likely distance between individual wells that will be drilled as part of this Project means that there is also little or no potential for these environmental releases from individual wells to interact or accumulate in the LSA.

Released WBM and WBM-associated drill cuttings resulting from the Project will therefore not result in adverse effects from contamination of marine biota or habitats, because these materials are non-toxic, and have low bioaccumulation and localized biological effects (Bakke et al. 2013; Deblois et al. 2014a).

8.3.4.2 Synthetic-Based Drilling Muds

SBM use is planned for drilling the lower portions of each well with cuttings and fluids returned to the drilling installation for treatment and/or reuse before discharge below the water surface. This category of drilling fluid was originally developed to replace oil-based muds (OBMs) that were historically used in drilling activities. The toxic components of the OBMs have been essentially removed in the synthetic based fluids, resulting in drill muds that have lower acute toxicity (Tzvetnetko et al. 2000; Hamoutene et al. 2004; Paine et al. 2014; Tait et al. 2016). Although the specific SBMs that will be used for this Project have yet to be determined, potential base fluids may include esters, poly alpha olefins, internal olefins, and linear alpha olefins. As described in Section 2.10, chemicals that will be used as part of the Project – including those used in drilling fluids – will be screened and selected in accordance with the OCSG and in accordance with the Operator's chemical screening and management practices.

Levels of acute toxicity of SBMs are considered relatively low, based on laboratory experiments and field evaluations of SBM associated drill cuttings piles (Still et al. 2000; Tzvetnetko et al. 2000; Hamoutene et al. 2004; Paine et al. 2014; Tait et al. 2016). Lobsters injected with high levels of SBM, for example, did not experience changes in lipid and protein metabolism or have other adverse health effects after approximately 20 days (Hamoutene et al. 2004). Toxicity experiments with fish indicated that acute toxicity of SBMs was generally low and below environmental guidelines; however, there were potential health effects with chronic exposure to SBM associated cuttings (Jagwani et al. 2011; Gagnon and Baktyar 2013; Vincent-Akpu 2013). Potential effects would be temporary in nature as

SBMs biodegrade within a few years (Terrens et al. 1998; Ellis et al. 2012; IOGP 2016). The distance of biological effect varies with drilling programs as demonstrated by the results of a Department and Fisheries and Oceans study (Payne et al. 2006) in the Jeanne d'Arc Basin area on the Grand Banks, which found that high levels of sediment toxicity stemming from the use of synthetic type (e.g., IPAR) drilling fluids in this area should be confined to a range of tens of meters from cuttings pile deposited on the seabed below the drilling installation. Another study by the Society of Petroleum Engineers (SPE) (Nedwed et al. 2006) on cuttings and associated fluid disposal and its environmental effects in deep water (950 m) found that cuttings drilled with SBMs discharged into deep water had a limited environmental effect.

Petro-Canada Puredrill IA-35LV is, for example, the SBM fluid typically used by offshore operators in Atlantic Canada. It is paraffin based and composed of aliphatic hydrocarbons in the fuel range >C10-C21 and contains no aromatic hydrocarbons (Fefer 2001; DeBlois et al. 2014b). Due to the flotation properties of paraffin, it is suggested that Pure Drill IA-35 may be distributed further in ocean currents than other types of SBM (Lee et al. 2011). Puredrill IA-35LV is rated as a Category E product (least hazardous) in the Offshore Chemical Notification Scheme (OCNS) and is readily biodegradable under aerobic conditions in the environment (Li et al. 2009; DeBlois et al. 2014b).

A detailed risk assessment of PureDrill IA 35-LV was conducted using the PetroTox model which was developed to perform aquatic hazard assessments of petroleum substances based on the composition of their constituents. The model identifies ecologically relevant concentrations according to acute and chronic toxicity test data for constituents (Redman et al 2014a; 2014b; 2017; Redman and Parkerton 2015), below which biological effects would not be expected. The no-effects concentration obtained via PetroTox was 150 mg / kg, with a range of 115 to 190 mg / kg (Stantec 2013). Laboratory examination of the toxicity of Puredrill IA-35LV SBM in particular has been assessed for both fresh and recycled drilling muds in sediments before and after biodegradation. The microcosms used for toxicity analysis were assessed after 0, 30 and 90 days incubation using standardized Microtox Solid Phase Test (EPS 1/RM/42 Environment Canada 2002), and amphipod (Eohaustorius estuarius) bioassays (EPS 1/RM/35 Environment Canada 1998) (Cooger and Lee 2009). None of the samples (control or Puredrill IA-35LV SBM on cuttings) were toxic according to the Microtox assay (Cooger and Lee 2009). Although the amphipod assay showed all samples containing Puredrill IA-35LV SBM on cuttings to be toxic, this was suspected to be a consequence of the amphipods being confined in a test container exposed to greater bioavailable intermediate degradation analytes resulting from high rates of rapid biodegradation of the original organic compounds (Cooger and Lee 2009; Gagnon & Bakhtyar 2013).

The biodegradation and mineralization of SBMs with Puredrill IA-35LV as the active ingredient has also been examined using laboratory microcosm studies (miniature-scale ecosystems maintained under controlled conditions) (Cooger and Lee 2009; Li et al 2009). The aerobic biodegradation of fresh (unused) and recycled (used) SBMs provided by a North Atlantic offshore drilling operation was compared under two temperature regimes (5°C and 20°C). The rate of mineralization of Puredrill IA-35LV SBM in sediment was greater in the higher temperature treatment (20°C) compared to the lower one (5°C) as well as for sediment containing fresh (unused) SBM compared to used SBM. However, the rate of mineralization of the used SBMs was consistent between both temperature treatments (Cooger and Lee 2009). From these results, it was inferred that the rate of degradation

under aerobic conditions at seafloor temperatures on the Grand Banks (approximately 0°C) would likely be slower than experimental results. However, bacteria adapted to cold temperatures may still carry out degradation of hydrocarbons (Cooger and Lee 2009).

The potential effects of disposal of SBM-associated drill cuttings are possible alteration of marine habitats and creation of anoxic environments through local eutrophication from degradation of SBM organic components (Schaanning et al. 2008; Ellis et al. 2012). Previous studies and monitoring programs have shown that the nature and magnitude of these effects on benthic invertebrates and their habitats are linked to the thickness and extent of the associated cuttings pile that may accumulate on the seabed (Smit et al. 2006; Schaanning et al. 2008) and that the response of the benthic community to drill cuttings discharges can be dependent on the types of SBM drilling fluid used (Holdway 2002; Netto et al. 2009). Similar to deposition of WBMs, the area of biological effect is generally limited to less than one kilometre of the SBM discharge source (Deblois et al. 2014a; Tait et al. 2016). Deblois et al. (2014a) also did not detect biological effects in Icelandic scallop or American plaice collected one kilometre from the Terra Nova oil development resulting from SBM discharge. Tait et al. (2016) observed SBM concentrations diminished greatly between 600-800 m from the well site, indicating a localized area of effect.

Released SBM and SBM-associated drill cuttings resulting from the Project will therefore not result in adverse effects from contamination of marine biota or habitats, because these materials have low toxicity, and localized biological effects (Deblois et al. 2014a). Synthetic-based mud chemicals that may be discharged to the marine environment will be screened for use in accordance to the OCSG. Under the OTWG, only residual SBM is retained on cuttings (as described below). Once onboard the Drilling Installation, drill cuttings will be removed from the drilling muds in successive separation stages. Some fluids will be reconditioned and reused, while spent SBM will be returned to shore for disposal. SBM-associated drill cuttings will be treated in accordance with the OWTG (6.9 g/100 g or less oil on wet solids) and discharged overboard.

8.3.4.3 Sedimentation and Burial

The potential biological effects of sedimentation and burial from discharge of drilling fluids and associated drilling cuttings are primarily relevant to the benthic environment (IOGP 2016). Immobile or sessile bivalve and infaunal species are sensitive to burial or drilling mud deposition as they have limited capability to move away from the disturbance (Smit et al. 2006). The physical properties of the cuttings and residual fluids on them may also inhibit escape from burial in comparison to natural sedimentation (Gates and Jones 2012). Sessile species are often suspension feeding organisms with feeding structures that may become clogged with suspended and re-suspended sediments from the cuttings deposition (Neff et al. 2000; Smit et al. 2006). Depending on the receiving environment, the addition of drill cuttings may also change the substrate composition of the seabed, altering benthic community composition as it responds to changing fish habitat (Smit et al. 2006, 2008). The degradation of organic components in SBMs by bacteria increases local oxygen demand, resulting in low oxygen or anoxic environments in areas of cuttings piles (Schaanning et al. 2002, 2008; Trannum et al. 2010). WBM sedimentation layer thickness (3-24 mm) has been negatively correlated with species abundance and diversity associated with eutrophication and oxygen depletion from degradation of WBM organic components (Trannum et al. 2010). Macrofauna surveys of a drilling

operation in the Faroe-Shetland Channel, for example, found that smothering and burial of organisms was primarily within 100 m from the drill cuttings source, with maximum cuttings pile heights of 1.5 m, with lesser effects up to 250 m (Gates and Jones 2012). Oxygen penetration of drill cuttings at the well site was measured to be low (less than 0.5 cm) compared to reference sediments (2.5-3.4 cm), indicating bacterial driven anoxic conditions (Tait et al. 2016). This resulted in overall species richness decline within 800 m of SBM drill cuttings deposition, and infaunal communities dominated by hypoxia-tolerant polychaetes. The overall result of these potential effects is a localized decreased species abundance and diversity of benthic organisms within approximately one kilometre of the source (Neff et al. 2000; Holdway 2002; Schaanning et al. 2008; Trannum et al. 2010; Gates and Jones 2012; Larsson et al. 2013; Cordes et al. 2016; Tait et al. 2016).

As noted previously, corals and sponges are sensitive to sedimentation and burial in the marine environment (Larsson and Purser 2011; Allers et al. 2013; Bell et al. 2015; Purser 2015; Liefmann 2016). The deep-sea cold water coral *Lophelia pertusa* has been studied extensively in response to drill cuttings in the North Sea and Gulf of Mexico (Larsson and Purser 2011; Allers et al. 2013; Purser 2015) and provides an indication of potential coral response to cuttings discharge in the Project Area. Laboratory experiments indicate that coral larvae are sensitive to suspended drill cuttings with exposure leading to clogging of *L. pertusa* larvae feeding and swimming structures, eventually leading to larval mortality (Larsson et al. 2013; Järnegren et al. 2016). Adult corals are often able to tolerate short-term exposure to sedimentation and anoxic conditions without visible detrimental short-term effects or mortality due to their efficient sediment clearing mechanisms (Brooke et al. 2009; Allers et al. 2013; Larsson et al. 2013; Purser 2015). Feeding responses to drill cuttings have also been variable depending on sediment load and ocean conditions (Larsson et al. 2013; Buhl-Mortensen et al. 2015; Baussant et al. 2014). Chronic or high level sedimentation exposure may lead to sublethal effects including reduced growth rates and smaller oocyte size (Larsson et al. 2013; Baussant et al. 2014), however field observations have not shown degradation of *L. pertusa* coral reefs exposed to drill cuttings over time (Purser 2015). Studies with suspended mine tailings on the soft coral *Duva florida*, and a gorgonian coral *Primnoa resedaeformis*, species that are present in the Project Area, indicated that small sharp sediment particles were more harmful than smooth edged particles to corals and resulted in changes in feeding behaviour and increased mortality (Liefmann 2016).

Potential effects of suspended sediments on sponges may include clogging of feeding structures, smothering, and abrasion (Bell et al. 2015). Sponge tolerance for suspended and settled sediments vary with habitat, with species adapted to soft bottom habitats having a higher tolerance for resuspended sediments (Bell et al. 2015; Kutti et al. 2015). *Geodia barretti*, a habitat forming sponge distributed on the slopes of the Flemish Cap and in the Flemish Pass (Knudby et al. 2013), is adapted to cope to sedimentation events by reducing filter feeding and thus decreasing their intake of sediment particles (Tjensvoll et al. 2013; Kutti et al. 2015). However, introduction of sediment sizes atypical from natural conditions may reduce organism condition (Kutti et al. 2015). Larval sponges are more sensitive to sedimentation, resulting in higher larval mortality and decreased settlement (Maldonado et al. 2008; Bell et al. 2015). Therefore, corals and sponges are often adapted to tolerate short-term exposure to drill cutting sedimentation with potential effects on adults related to chronic exposure or high sedimentation and burial. Early life stages also show sensitivity to suspended sediments and sedimentation.

Within the Project Area coral and sponges are mainly distributed on the slopes of the Newfoundland Shelf, the Flemish Cap and the Flemish Pass and may be considered particularly sensitive to areas to drill cuttings deposition. Soft corals (Nephtheid corals including *Gersemia* sp. and *Duva florida*) are well distributed in shallower areas (less than 250 m depth) on the Newfoundland Shelf and Flemish Cap (Wareham 2009), though less concentrated than on continental slopes (Figures 6-9 and 6-11). In the Project Area – Southern Section in EL1137 on the Newfoundland Shelf, soft corals and gorgonian corals have been observed based on the Canadian RV data. Distributional studies indicate that Nephtheid corals may be found on a variety of substrates (fine sediments to cobble and larger substrates) and at temperature ranges of -1ºC to above 9ºC (Cimberg et al. 1981; Sun et al. 2011). Distribution modelling from the Gulf of St. Lawrence for *Gersemia rubiformis* indicated depth (<150 m) was a primary predictor of coral presence (Murillo et al. 2016). Juvenile specimens of the large gorgonian coral *Primnoa resedaeformis* have been observed on the Newfoundland Shelf area of the Grand Banks (Wareham 2009). This species has been observed to occur in areas with large boulders and exposed bedrock, low turbidity and water temperatures of 4.7ºC-10.6ºC (Krieger and Wing 2002). While depth is considered a main predictor of presence of large gorgonian corals like *Primnoa resedaeformis*, summer primary productivity levels are considered a main predictor of biomass (Guijarro et al 2016). In the Project Area – Northern Section there are also known areas of high sponge densities in the Sackville Spur along the northern extent of the Flemish Cap. Although corals may colonize depths occurring in the Orphan Basin in the Northern Section, coral distribution and densities may be lower due to distribution of fine muddy substrates.

8.3.4.4 Project-Specific Modelling of Drilling Discharges

To provide additional, Project-specific information and analysis related to the nature and extent of drill fluid and associated cuttings disposition resulting from the Project, detailed drill cuttings dispersion modelling has been carried out for this EIS at various, representative possible well sites within the Project Area. This included modelling at three sites within the Northern section of the Project Area and one site in the Southern section of the Project Area (Figure 8-2) to evaluate the potential dispersion and eventual seabed “footprint” of these cuttings across seasons (Appendix G). Drilling of one well was considered at each location. Cuttings from drilling the upper two well sections with WBM will be released 2-4 m from the seafloor and therefore, there is little time for the cuttings to be transported large distances by the ambient currents. Conversely SBM cuttings, treated and released in accordance with the OWTG, will be released from the drilling installation near the sea surface and increasing potential dispersal distance.

The key results of this modelling are summarized and used here to assess potential effects on benthic habitats and biota, particularly the overall habitat alternations that may be associated with this cuttings footprint (including its location, extent, and thickness) and the possible ecological implications of these.

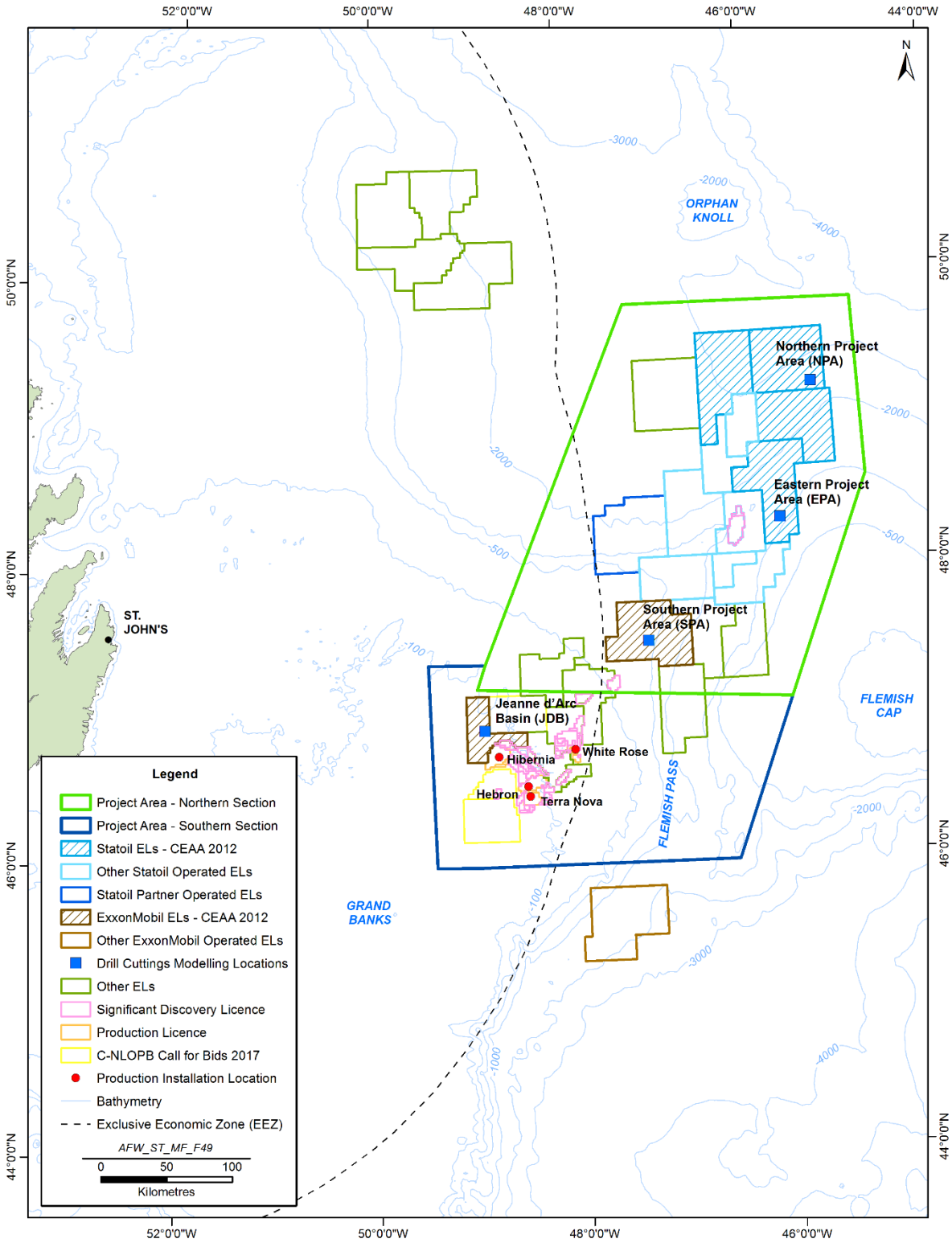


Figure 8-2 Representative Sites Used for Drill Cuttings Modelling

8.3.4.4.1 Project Area – Northern Section

Three sites were modelled for drill cuttings discharges in the Project Area - Northern Section – the Northern Project Area Release Site (NPA) in EL 1140; the Eastern Project Area Release Site (EPA) in EL 1142, and the Southern Project Area Release Site (SPA) in EL 1135. For these deeper water locations in the Project Area – Northern Section, little of the SBM cuttings reach the seabed within the model domain; these cuttings will drift for several days and travel for distances on the order of 20 to 200 km. Information regarding the drill cuttings dispersion model study, including the input data, scenarios and detailed results can be found in Appendix G.

The NPA modelling site is located at 2,700 m water depth on the north slope of the Flemish Cap (Figure 8-2). Across seasons, the WBM and SBM cuttings drift and deposit predominately to the northeast. Modelled WBM cuttings settled within 2 km of the well site (Table 8.3). Average WBM cutting thickness across seasonal scenarios ranged from 4-35 mm within 10 m of the well site and 1-8 mm within 100 m of the well site. Beyond 100 m from the well site, average WBM cuttings thicknesses are up to 4 mm with a maximum range of 1-2 km in the September scenario although with a mean thickness of 0.4 mm. Maximum WBM cuttings thickness was highest (55-78 mm) across season scenarios less than 500 m from the well site.

Table 8.3 WBM Material Settled and Cuttings Thickness by Distance from Well Site at NPA

Month	Parameter	0-10m	10-100m	100-00m	200-500m	500m-1km	1-2km	2-4km	4-5km	5-31km	>31km
Mar	Settled Material (%)	2	46	29	22	-	-	-	-	-	-
	Mean Thickness (mm)	35	8	4	3	-	-	-	-	-	-
	Maximum Thickness (mm)	63	63	50	18	-	-	-	-	-	-
Jun	Settled Material (%)	0.6	11	27	54	4	-	-	-	-	-
	Mean Thickness (mm)	8	3	3	3	1	-	-	-	-	-
	Maximum Thickness (mm)	21	15	50	56	8	-	-	-	-	-
Sep	Settled Material (%)	0.3	0.6	13	18	68	0.4	-	-	-	-
	Mean Thickness (mm)	4	1	2	2	2	0.4	-	-	-	-
	Maximum Thickness (mm)	14	14	48	55	13	1	-	-	-	-
Dec	Settled Material (%)	0.8	20	3	30	46	-	-	-	-	-
	Mean Thickness (mm)	11	5	1	3	3	-	-	-	-	-
	Maximum Thickness (mm)	24	78	8	22	28	-	-	-	-	-

Treated SBM cuttings discharged near the surface at the NPA settle in low quantities within the 32 km model area (Table 8.4). Across seasonal scenarios, 98 percent of SBM cuttings settle outside the 32 km model area. Assuming a mean current speed of 10 cm/s, the material will take on the order of 31 days to settle and likely drift over 200 km. Within the model area, SBM cuttings initially settle

in average thicknesses of less than 0.01 mm with maximum thicknesses of 0.02 mm located between two and four km away.

Table 8.4 SBM Material Settled and Cuttings Thickness by Distance from Well Site at NPA

Month	Parameter	0-10m	10-100m	100-200m	200-500m	500m-1km	1-2km	2-4km	4-5km	5-31km	>31km
Mar	Settled Material (%)*	-	-	-	< 0.1	0.1	0.5	0.8	0.2	0.3	-
	Mean Thickness (mm)	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
	Maximum Thickness (mm)	-	-	-	0.01	0.01	0.02	0.02	<0.01	0.01	-
Jun	Settled Material (%)*	-	-	-	-	< 0.1	< 0.1	0.4	0.4	1.0	-
	Mean Thickness (mm)	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	-
	Maximum Thickness (mm)	-	-	-	-	<0.01	<0.01	0.02	0.01	0.01	-
Sep	Settled Material (%)*	-	-	-	-	-	<0.1	0.4	0.4	1.1	-
	Mean Thickness (mm)	-	-	-	-	-	<0.01	<0.01	<0.01	<0.01	-
	Maximum Thickness (mm)	-	-	-	-	-	0.01	0.01	0.01	0.01	-
Dec	Settled Material (%)*	-	-	-	<0.1	<0.1	0.3	0.8	0.3	0.5	-
	Mean Thickness (mm)	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
	Maximum Thickness (mm)	-	-	-	0.01	0.01	0.02	0.02	<0.01	<0.01	-

* >98% of material remains unsettled and drifts beyond the model area.

The EPA modelling site was located on the north slope of the Flemish Cap at 1,100 m water depth (Figure 8-2). Modelled discharges of WBM and SBM cuttings predominantly drifted to the northeast in the model. Due to relatively lower currents in the region, both SBM and WBM cuttings released from the well site will mainly settle within the 32 km model area with the exception of SBM cuttings in June where 97.5 percent settle beyond the model area (Tables 8.5 and 8.6). Average WBM cuttings thicknesses across seasonal scenarios ranged from 10-41 mm within 10 m of the well site and 6-12 mm within 100 m of the well site. Beyond 100 m from the well site, average WBM cuttings thickness ranges from 1 mm to 6 mm with a maximum range of 200-500 m for all season scenarios. Maximum WBM cuttings thickness was highest (80-116 mm) across season scenarios at less than 100 m from the well site.

Table 8.5 WBM Material Settled and Cuttings Thickness by Distance from Well Site at EPA

Month	Parameter	0-10m	10-100m	100-200m	200-500m	500m-1km	1-2km	2-4km	4-5km	5-31km	>31km
Mar	Settled Material (%)	4	93	3	<0.1	-	-	-	-	-	-
	Mean Thickness (mm)	41	10	1	1	-	-	-	-	-	-
	Maximum Thickness (mm)	58	88	4	1	-	-	-	-	-	-
Jun	Settled Material (%)	2	72	26	0.2	-	-	-	-	-	-
	Mean Thickness (mm)	20	8	3	1	-	-	-	-	-	-
	Maximum Thickness (mm)	35	97	28	1	-	-	-	-	-	-
Sep	Settled Material (%)	1	38	57	4	-	-	-	-	-	-
	Mean Thickness (mm)	10	6	6	1	-	-	-	-	-	-
	Maximum Thickness (mm)	25	80	40	9	-	-	-	-	-	-
Dec	Settled Material (%)	2	87	12	0.1	-	-	-	-	-	-
	Mean Thickness (mm)	17	12	2	1	-	-	-	-	-	-
	Maximum Thickness (mm)	37	116	17	2	-	-	-	-	-	-

Table 8.6 SBM Material Settled and Cuttings Thickness by Distance from Well Site at EPA

Month	Parameter	0-10m	10-100m	100-200m	200-500m	500m-1km	1-2km	2-4km	4-5km	5-31km	>31km
Mar	Settled Material (%)	-	<0.1	<0.1	0.6	1.8	0.1	-	-	7.1	90.4
	Mean Thickness (mm)	-	<0.01	0.01	0.02	0.03	0.02	-	-	0.01	0.03
	Maximum Thickness (mm)	-	<0.01	0.04	0.1	0.1	0.1	-	-	0.05	0.3
Jun	Settled Material (%)*	-	-	-	<0.1	1	1.5	-	-	-	-
	Mean Thickness (mm)	-	-	-	<0.01	0.01	0.02	-	-	-	-
	Maximum Thickness (mm)	-	-	-	0.01	0.1	0.12	-	-	-	-
Sep	Settled Material (%)	<0.1	0.2	0.8	1.3	0.2	<0.1	-	-	97.5	-
	Mean Thickness (mm)	<0.01	0.03	0.05	0.02	<0.01	<0.01	-	-	0.03	-
	Maximum Thickness (mm)	0.01	0.13	0.19	0.15	0.06	0.02	-	-	0.4	-
Dec	Settled Material (%)	<0.1	<0.1	0.1	0.9	1.5	<0.1	-	-	97.5	-
	Mean Thickness (mm)	<0.01	<0.01	<0.01	0.02	0.02	<0.01	-	-	0.06	-
	Maximum Thickness (mm)	<0.01	0.02	0.06	0.1	0.1	0.05	-	-	0.4	-
* >97% of material remains unsettled and drifts beyond the model area.											

Treated SBM cuttings discharged near the surface at the EPA well site have relatively low quantities that settle within the first five km. For three of the four seasonal scenarios, over 97 percent of SBM cuttings settle between 5 and 32 km of the well site. Only the June scenario had over 97 percent of the SBM cuttings that settle outside the 32 km model area. Within the model area, SBM cuttings settle in average quantities of 0.05 mm or less and with maximum thicknesses of up to 0.4 mm between 5 and 32 km.

The SPA modelling site is located in approximately 360 m water depth on the northeast slope of the Grand Bank and adjacent to the Flemish Pass (Figure 8-2). Across seasons the cuttings drift and deposit predominately to the south-southwest. The majority of the discharged WBM cuttings settle within one km of the well site and the majority (over 98 percent) of SBM cuttings drift outside the 32 km model domain. Average WBM cuttings thickness across seasonal scenarios ranged from 2 mm to 4 mm up to one km from the wellsite and 0.6 mm to 2 mm thickness up to two km from the well site (Table 8.7). The maximum thickness of WBM cuttings was mainly between 100 m to 1 km from the well site and ranged from 66-80 mm, with the largest thickness of 80 mm observed in the March scenario 320 m to the south-southwest. SBM cutting thicknesses within the model area were low with average thicknesses of less than 0.01 mm (Table 8.8). Maximum SBM cuttings thickness in the model area reached 0.06 mm.

Table 8.7 WBM Material Settled and Cuttings Thickness by Distance from Well Site at SPA

Month	Parameter	0-10m	10-100m	100-200m	200-500m	500m-1km	1-2km	2-4km	4-5km	5-31km	>31km
Mar	Settled Material (%)	0.4	0.3	<0.1	44	56	-	-	-	-	-
	Mean Thickness (mm)	3	0.4	0.3	2.4	4	-	-	-	-	-
	Maximum Thickness (mm)	12	10	1	80	20	-	-	-	-	-
Jun	Settled Material (%)	0.4	0.3	9	51	39	-	-	-	-	-
	Mean Thickness (mm)	4	0.3	3	3	2	-	-	-	-	-
	Maximum Thickness (mm)	13	8	54	66	15	-	-	-	-	-
Sep	Settled Material (%)	0.3	0.5	21	78	0.1	-	-	-	-	-
	Mean Thickness (mm)	2	0.6	-	2	3	0.6	-	-	-	-
	Maximum Thickness (mm)	9	11	-	57	74	1	-	-	-	-
Dec	Settled Material (%)	0.2	0.5	34	8	58	-	-	-	-	-
	Mean Thickness (mm)	2	0.6	-	3	1	2	-	-	-	-
	Maximum Thickness (mm)	7	7	-	77	10	18	-	-	-	-

Table 8.8 SBM Material Settled and Cuttings Thickness by Distance from Well Site at SPA

Month	Parameter	0-10m	10-100m	100-200m	200-500m	500m-1km	1-2km	2-4km	4-5km	5-31km	>31km
Mar	Settled Material (%)*	-	-	-	0.3	0.8	0.6	-	-	-	-
	Mean Thickness (mm)	-	-	-	<0.01	<0.01	<0.01	-	-	-	-
	Maximum Thickness (mm)	-	-	-	0.05	0.06	0.04	-	-	-	-
Jun	Settled Material (%)*	-	-	-	<0.1	0.7	0.9	-	-	-	-
	Mean Thickness (mm)	-	-	-	<0.01	<0.01	<0.01	-	-	-	-
	Maximum Thickness (mm)	-	-	-	0.03	0.06	0.06	-	-	-	-
Sep	Settled Material (%)*	-	-	-	-	0.1	0.9	0.6	-	-	-
	Mean Thickness (mm)	-	-	-	-	<0.01	<0.01	<0.01	-	-	-
	Maximum Thickness (mm)	-	-	-	-	0.03	0.03	0.03	-	-	-
Dec	Settled Material (%)*	-	-	-	-	0.1	0.9	0.7	-	-	-
	Mean Thickness (mm)	-	-	-	-	<0.01	<0.01	<0.01	-	-	-
	Maximum Thickness (mm)	-	-	-	-	0.04	0.04	0.04	-	-	-

* >98% of material remains unsettled and drifts beyond the model area.

In summary, for the Project Area - Northern Section, the modelling indicates that more than 99 percent of discharged WBM cuttings will initially settle less than 1 km from each of the hypothetical well sites. At the NPA well site, WBM cuttings disperse up to 2 km from the well in the September scenario, however the average (0.4 mm) and maximum (1.0 mm) thicknesses are low. At the EPA location, WBM cuttings thickness was highest within 100 m from the well site, with an average thickness reaching up to 41 mm and a maximum thickness reaching up to 116 mm. Average thicknesses at distances greater than 100 m were up to 6 mm with some areas of accumulation (maximum thickness up to 80 mm). For the NPA and SPA locations, more than 98 percent of discharged SBM cuttings material drifts beyond the model boundary in all season scenarios and becomes highly dispersed and therefore results in low accumulations. For the EPA scenarios, with low currents (generally 5 cm/s or less) initial settling of SBM cuttings takes place from 5-32 km away from the well in all seasons except for June, during which time the current speeds are slightly larger with the result that again approximately 98 percent of the SBM cuttings drift just outside the model domain. Due to the large settling distances away from the well sites, overall average and maximum SBM cuttings thicknesses are relatively low (less than 0.5 mm).

The physical and chemical effects of this volume of WBM drill cuttings over this area are anticipated to have localized habitat disturbances less than two km from the well site and not result in toxic or sublethal effects, as described earlier. The discharge of SBM cuttings in generally deep waters in the Northern Section of the Project Area enhances dispersion and as such accumulation levels are considered low, reducing potential effects on fish and fish habitat.

8.3.4.4.2 Project Area – Southern Section

One site was modelled for drill cuttings discharge in the Project Area – Southern Section. The Jeanne D'Arc Basin (JDB) model location (EL 1137) is located northwest of the Hibernia Platform on the Grand Bank Shelf at approximately 89 m water depth (Figure 8-2). As currents are distributed in most directions in most months, discharged WBM and SBM cuttings drift in all directions at this relatively shallow site. Discharged WBM cuttings settle within 2 km of the wellsite, mainly at distances 100 m to 2 km away (Table 8.9). The average thicknesses of accumulated WBM drill cuttings are 8 mm or less across all seasonal scenarios within 10 m from the well site. Some areas of higher maximum cuttings thickness occur within 500 m of the well site reaching up to 102 mm (December model run, 210 m to the northwest). SBM cuttings initially settle within the 32 km model area with the majority (5-59 percent of SBM material settled) of accumulation from 2-31 km away from the well site (Table 8.10). However, overall average thickness of settled SBM material was 0.4 mm or less across all seasonal scenarios. Areas of accumulation occur 1-4 km from the well site with maximum SBM thicknesses of up to 3 mm.

Table 8.9 WBM Material Settled and Cuttings Thickness by Distance from Well Site at JDB

Month	Parameter	0-10m	10-100m	100-200m	200-500m	500m-1km	1-2km	2-4km	4-5km	5-31km	>31km
Mar	Settled Material (%)	0.4	1	0.1	37	32	29	-	-	-	-
	Mean Thickness (mm)	4	1	0.3	3	2	2	-	-	-	-
	Maximum Thickness (mm)	12	10	1	101	20	16	-	-	-	-
Jun	Settled Material (%)	0.8	14	22	34	29	-	-	-	-	-
	Mean Thickness (mm)	8	4	4	3	3	-	-	-	-	-
	Maximum Thickness (mm)	21	108	25	61	19	-	-	-	-	-
Sep	Settled Material (%)	0.3	0.6	13	18	68	0.4	-	-	-	-
	Mean Thickness (mm)	4	1	2	2	2	0.4	-	-	-	-
	Maximum Thickness (mm)	14	14	48	55	13	1	-	-	-	-
Dec	Settled Material (%)	0.8	15	20	35	0	29	-	-	-	-
	Mean Thickness (mm)	7	4	3	3	1	3	-	-	-	-
	Maximum Thickness (mm)	17	22	23	102	1	22	-	-	-	-

Table 8.10 SBM Material Settled and Cuttings Thickness by Distance from Well Site at JDB

Month	Parameter	0-10m	10-100m	100-200m	200-500m	500m-1km	1-2km	2-4km	4-5km	5-31km	>31km
Mar	Settled Material (%)	-	0.2	1	1	-	15	19	5	59	-
	Mean Thickness (mm)	-	0.1	0.1	0.1	-	0.3	0.4	0.02	0.05	-
	Maximum Thickness (mm)	-	0.3	0.6	0.5	-	3	2	0.2	0.7	-
Jun	Settled Material (%)	<0.1	0.4	1	0.2	<0.1	6	50	15	28	-
	Mean Thickness (mm)	<0.1	0.1	0.1	0.1	<0.1	0.1	0.2	0.04	0.04	-
	Maximum Thickness (mm)	0.1	0.5	0.6	0.3	0.1	0.7	3	0.6	0.5	-
Sep	Settled Material (%)	<0.1	0.4	2	8	0.2	5	28	14	42	-
	Mean Thickness (mm)	<0.01	0.1	0.1	0.3	0.2	0.3	0.2	0.05	0.04	-
	Maximum Thickness (mm)	<0.01	1	2	3	0.4	2	2	0.7	0.6	-
Dec	Settled Material (%)	<0.1	0.4	1	1	6	5	17	26	44	-
	Mean Thickness (mm)	<0.01	0.1	0.1	0.1	0.3	0.1	0.3	0.08	0.04	-
	Maximum Thickness (mm)	0.01	0.3	0.4	0.4	2	2	2	0.6	0.5	-

In summary, any areas of accumulation for WBM cuttings will occur within 2 km of the well site indicating that physical or chemical effects on fish habitat will again be localized. While SBM cuttings are discharged at relatively shallower depths in comparison to other modelled areas, overall average thickness is low (0.4 mm or less). However, there are some areas of accumulation that reach up to 3 mm within the model boundary indicating some potential localized disturbances to fish habitat. Due to the dispersion of SBM cuttings material, any relatively higher accumulations within the model area are spatially small, reducing potential effects on fish and fish habitat.

8.3.4.5 Potential Biological Effects of Drill Cuttings Deposition

Previous studies indicate that sedimentation and burial effects from drill muds and cuttings on benthic invertebrates have mainly been localized to the vicinity of a drill cuttings pile area (Neff et al. 2000; Holdway 2002; Schaanning et al. 2008; Trannum et al. 2010; Gates and Jones 2012; Larsson et al. 2013; Cordes et al. 2016; Tait et al. 2016). Average burial depths of 6.5 mm are considered to be the predicted no effect threshold (PNET) for non-toxic sedimentation based on benthic invertebrate species tolerances to burial (Kjeilen-Eilertsen et al. 2004; Smit et al. 2006; 2008). However, as some species may be more susceptible to shallower burial depths, an average PNET burial depth of 1.5 mm is suggested to be a very conservative approach to assessing drilling discharges (Kjeilen-Eilertsen et al. 2004; Smit et al. 2006, 2008). This level coincides with assessments on more sensitive coral species (*Lophelia pertusa)* where injury from sedimentation was observed with sedimentation of less than 6.3 mm (Larson and Purser 2011; Larsson et al. 2011, 2013).

As described above, modelling conducted for this EIS indicates that drill cuttings will be highly dispersed throughout the area with some areas of accumulation for WBM and SBM materials (Appendix G). The majority of modelled areas within 32 km from the representative modelling sites

will result in average sedimentation levels well below the established 6.5 mm PNET burial depth and below the 1.5 mm conservative PNET burial depth depending on site and seasonal scenario. For the Project Area - Northern Section, WBM cuttings piles are expected to form within 100 m of the wellsite with lesser accumulations up to 1-2 km. Similarly, for the Southern Section at the JDB modelled site, WBM cuttings may reach maximum depths of 102 mm, however, it is localized to within 1-2 km from the well site. Average thicknesses however are generally less than the 6.5 mm PNET, but at times above the conservative 1.5 mm PNET.

While some areas modelled for the Project have predicted cutting thicknesses beyond the PNET burial depths, they would be smaller than cuttings piles produced during other exploration drilling programs that have showed evidence of recovery 3 and 10 years from the initial disturbance (Gates and Jones 2012). Furthermore, cuttings associated with WBM drilling are largely localized reducing potential effects on fish and fish habitat. Modelled SBM cuttings discharges are highly dispersed in the Northern and Southern sections of the Project Area, resulting in low accumulations and thicknesses of settled materials that are below the 6.5 mm PNET burial depth across all seasonal scenarios. In areas with lower currents including the EPA in the Northern Section and the JDB in the Southern Section, there are some areas of accumulations where maximum thickness is above the conservative 1.5 mm PNET, but below the 6.5 mm PNET. The localized nature of these accumulations indicates that the burial effects are relatively limited spatially and the area may be easily recolonized by surrounding undisturbed areas. Beyond the model area discharged SBMs become highly dispersed indicating that potential effects on marine species in the water column or in benthic environments is predicted to be low.

As described in Sections 2.5.2.1 and 8.3.2, prior to the start of a drilling campaign, a pre-drill coral survey will be undertaken at the proposed drilling location to investigate the potential presence and condition of sensitive benthic organisms (corals/sponges). A report summarizing the coral survey results, including abundance and condition of corals observed, the risk assessment, and proposed mitigations specific to the conditions of the well site will be prepared and submitted to C-NLOPB/DFO for review and acceptance prior to drilling. Mitigations may include relocation of the well and/or redirection of the WBM cuttings discharge.

The relatively high dispersion of drill cuttings particles also indicates that there should not likely be substantial interaction with pelagic species. The Project Area depths are also beyond the photic zone and it is therefore also not expected that there will be interaction with marine macroflora species. Discharge of drill cuttings particles may form aggregates with phytoplankton resulting in rapid settling of plankton to the seafloor (Pabortsava et al. 2011). However, due to the high dispersion of particles, it is unlikely that there will be turbidity effects that may adversely affect suspended phytoplankton species.

In summary, discharged volumes of WBM cuttings may result in localized accumulations with potential for smothering effects on benthic species; however, overall low discharge volumes suggest high potential for recovery. SBM drill cuttings will be highly dispersed into the environment due to their planned release at a depth below the sea surface and the bathymetric and oceanographic conditions involved, resulting in low sedimentation and limiting smothering effects on benthic species due to the expected lack of accumulation on the seabed. Released SBM associated drill cuttings will be treated in accordance with the OWTG to reduce toxic effects on biota. This activity is considered

to have low adverse effects within the Project Area all of which will be reversible with eventual recovery and recolonization of the area.

8.3.4.6 Recovery and Recolonization

Recovery of areas of biological effect from drilling waste discharges varies considerably, as it is influenced by disturbance size and frequency, distance to source colonizers and local environmental conditions (Gates and Jones 2012). For example, well sites associated with hydrocarbon drilling activity in the deep-sea Faroe-Shetland Channel produced cuttings depositional areas distributed within 250 m from the source with a maximum thickness of 1.5 m that resulted in smothering and burial of benthic organisms (Jones et al. 2012). The cuttings piles were considerably smaller three years after the disturbance due to high current events, and fauna diversity was found to be similar as at undisturbed sites (Jones et al. 2012). Increased recovery of megafauna diversity and densities were observed after 10 years at the site; however, drill cuttings effects were still apparent indicating the area had not fully recovered (Jones et al. 2012). Also, a drilling site in the Norwegian Sea that produced a cuttings pile distributed over 100 m from the well with cuttings depth of less than 0.5 m had reduced cuttings pile area and similar megafaunal densities to pre-drilling and background surveys three years after the deposition (Gates and Jones 2012). Gates and Jones (2012) also noted that the effects of the exploratory drilling on invertebrate density and diversity were confined to the extent of the cuttings pile itself.

Bottom currents (see Section 5.5) will likely further aid in cuttings dispersion in this area, minimizing potential for long term effects due to burial by sediments. Mobile benthic organisms (such as shrimp) will also quickly recolonize a disturbed area if water quality is not permanently affected (Levin 1982). Opportunistic species that may be tolerant to pollutants like some polychaete and nematodes have also been shown to colonize a cuttings depositional areas within months (Kingston 1992). SBM components in drill cuttings have been observed to degrade quickly, with a greater than 40 percent biodegradation over 7-8 months after the cessation of drilling activity, thereby reducing toxicity over time (Daan et al. 1994; Trannum et al. 2010; Tait et al. 2016). Terrens et al. (1998) indicated that there was an absence of SBM esters in sampling sites 11 months after cessation of drilling, and recovery of crustaceans and nematodes was observed after only four months. The initial decrease in diversity and density of invertebrates was also limited to the drill cuttings pile that was within 100 m from the well site (Terrens et al. 1998). As parts of the Project Area are characterized by a deep-sea cold water area where organisms are generally slow growing and long lived, recovery after disturbance may take a decade or more (Gates and Jones 2012; Jones et al. 2012; Clark et al. 2016). As discussed, drill cuttings sedimentation is estimated to be relatively low for this Project. This, combined with mitigation to reduce potential effects on corals/sponges, indicates limited effects on organisms.

8.3.4.7 Summary

In summary, the predicted environmental effects of drilling and associated marine discharges are primarily related to sedimentation and burial of benthic species and contaminant uptake by fish in the immediate discharge area. These interactions may result in potential changes to habitat availability and quality, fish mortality / injury risk and fish health, and fish presence and abundance.

These effects are predicated to be adverse, low in magnitude, localized and certainly within the Project Area, medium to long term in duration, occurring regularly and reversible, with these predications being made with a high level of confidence.

8.3.5 Formation Flow Testing with Flaring

If there is sufficient indication of hydrocarbon presence during an exploration drilling program, formation flow testing also undertaken to sample and identify formation fluids (which may contain hydrocarbons and/or water) and to measure flow rates. As described in Section 2.5.2, formation flow tests can be undertaken with or without flaring (a FTWT), depending on the type of data required. If a formation flow test with flaring is required, produced hydrocarbons are separated from produced water on the Drilling Installation and are analyzed. The amount of produced water potentially encountered during exploration drilling is typically very small compared to that during production operations. Any such produced water is sent to the drilling installation's flare, treated for disposal in accordance with the OWTG, or shipped to shore. The duration of the formation flow testing is dependent upon the complexity of the subsurface rock formations, and if encountered, the potential for establishing the extent of hydrocarbon reservoir. As part of this Project, flaring activities will only be carried out if a formation flow test is required. The likely duration of flaring during a formation flow test is approximately two to three days, but may last up to five days.

Formation flow test with flaring will be short-term in comparison to the continuous deck and navigation lighting required for maritime and crew safety. Therefore, light emissions associated with formation flow test with flaring are considered low. Atmospheric emissions may be released as a result of formation flow testing with flaring with overall low effects due to the infrequent and short time periods for flaring. Furthermore, emissions levels will adhere to relevant legislation and regulations discussed in Chapter 2. Although it may add to the overall lighting levels and air emissions from the drilling installation during periods of flaring activity, this activity is not expected to interact with Marine Fish and Fish Habitat.

If largers volumes of produced water are encounted that cannot be managed through the flare and must be discharged overboard, it will be treated in accordance with the OWTG prior to discharge. The main contaminants of produced water include aromatic hydrocarbons, polycyclic aromatic hydrocarbons, and related heterocyclic aromatic compounds (Bakke et al. 2013), and thermal emissions as produced water discharges may be higher in temperature than receiving waters (Teixeira et al. 2009). Fish and invertebrates exposed to produced water in laboratories may experience physiological and development effects; however, because the produced water is rapidly dispersed in water column, potential effects are typically limited to within less than one km from the source (Bakke et al. 2013). Although produced water typically accounts for the largest volume of waste from offshore oil and gas producing operations (Neff 2002), this issue is far less of a concern for exploration drilling where produced water volumes, if they do occur, are quite small (Morandin and O'Hara 2016). Furthermore, produced water is treated in accordance to OWTG, removing oils from the water prior to discharge. As the small volume of produced water would rapidly disperse in the water column, it is predicted that effects from this activity will be short term in nature, localized, low magnitude and reversible. Because fish, invertebrate, and plankton communities have a much wider range than the potentially affected area, overall potential effects on fish are considered low.

In summary, the predicted environmental effects of formation flow testing with flaring are primarily related to light and atmospheric emissions and produced water discharge. These interactions may result in potential changes to fish mortality/injury risk and fish health, and fish presence and abundance. These effects are predicted to be adverse, low in magnitude, localized, short term duration, occurring sporadically and reversible, with these predictions being made with a high level of confidence.

8.3.6 Wellhead Decommissioning

Once drilling and associated formation flow testing is completed, the offshore wells drilled as part of this Project will be decommissioned. These activities typically involve the isolation of the well bore by placing cement plugs and/or mechanical devices, at various depths, with the casing then being cut and the wellhead and ony other equipment removed. Wellheads are often removed from the seafloor using a mechanical casing / wellhead cutting device from the drilling installation. A remotely operated vehicle (ROV) or other equipment is then used to inspect the seabed to verify that no equipment or obstructions remain in place. In certain circumstances, the wells may be suspended in accordance with C-NLOPB requirements for future re-entry. This is similar to the abandonment process described above, but the wellhead is not removed and a suspension cap is installed to protect the wellhead connector. Well decommissioning for this Project will be carried out as per the Operators' standard internal procedures for same, as well as applicable industry practice and in accordance with relevant regulatory requirements. These activities will adhere to the requirements set out under the *Newfoundland Offshore Petroleum Drilling and Production Regulations SOR/2009-316.* Wells will be monitored and inspected in accordance with applicable regulatory requirements at the time of their decommissioning.

Throughout its international drilling operations, the Operator has employed various wellhead cutting tools, both internal (below the seafloor) from the drilling installation and external (above the seafloor) from a construction/intervention vessel, to remove wellheads. Mechanical cutting is preferred over the use of explosives to sever wellheads for retrieval as it is a safer and more efficient method. The use of shape charging to remove wellheads increases safety risks to personnel both during handling of the explosives in priming the wellhead and during the removal of the wellhead to the deck. There is also an increased potential for adverse environmental effects on surrounding marine biota. Moreover, experience suggests that the use of explosives on robust casing design used in deep water applications can still result in failure. Mechanical cutting helps to eliminate these potential safety and environmental risks.

For the Project, the well decommissioning approach planned will be based largely upon the water depths at the well site and associated technical considerations. As discussed in Chapter 2, the following wellhead decommissioning strategy is planned:

- In water depths less than 500 m, using the drilling installation, the wellhead will be removed using conventional methods that involve the use of an internal cutting tool placed within the wellhead to cut it below the seafloor and pull it to the drilling installation.
- In water depths between 500 m and 1,500 m, a construction/ intervention vessel using a ROV and an exterior diamond wire cutting saw will be used to cut and remove the

wellheads, leaving a portion of the casing above the sea floor. Cutting of the wellheads above the seafloor will be completed as close to the natural seabed as practicably and technically feasible. A pipe stub with a maximum height of approximately 0.85 m may remain above the seabed. While current technology has a limit of 0.85 m of casing remaining above the seafloor, cutting as close to the seafloor will be attempted.

- In water depths greater than 1,500 m, the wellhead will remain in place and will not be removed.

Wellhead removal at shallower depths (less than 500 m) using conventional wellhead removal methods will result in minimal environmental disturbance, given the localized and short-term (likely 1 to 2 days) nature of these activities, which will use an internal cutting tool and therefore occur within the wellhead itself. Shelf fishes at this depth including redfish, halibut, cod, and capelin, each of which are highly mobile and would likely temporarily avoid areas of noise disturbances (Popper and Hastings 2009). For external cutting of the wellhead occurring at depths between 500-1,500 m, the deployment of an ROV and use of an exterior diamond wire cutting to cut wellheads would likewise have little effects on the environment, as there will be no additional disturbance of the seabed associated with this activity. Deep-sea fishes living in deeper slopes of the Project Area may be photosensitive to artificial lights from the ROV and have been observed to avoid areas of illumination within their light detection range reducing potential effects (Raymond and Widder 2007). Although cutting of the wellhead may produce some noise emissions that result in temporary avoidance of the area by noise-sensitive fish occurring on or close to the seabed (Cordes et al. 2016), such effect may be minimized by previous avoidance of the area by noise-sensitive species during the overall drilling phase (Popper and Hastings 2009; Popper et al. 2014). These disturbances would again be localized and short term in nature, and the type and level of underwater noise or other environmental disturbances will be negligible as compared to the recently completed drilling activity itself.

Remaining wellhead structures left in place after decommissioning (500 to over 1500 m) may provide localized increased habitat structure in a relatively barren and soft bottom habitat (Sink et al. 2010; Gates et al. 2016). Deep-sea habitats are generally limited by available areas for corals and sponges to colonize and wellhead structures may provide a stepping stone for range expansion (Sammacro et al. 2004; Cordes et al. 2016). This process may promote further recovery of the area, although on relatively long time scales due to the long-lived and slow-growing nature of cold-water deep-sea species (Clark et al. 2016; Cordes et al. 2016) and given the small footprint of subsea infrastructure. Within the Project Area. colonization of subsea infrastructure would likely be faster in the Flemish Pass and slopes of the Flemish Cap where there are relatively higher concentrations of source coral and sponge species (Beazley et al. 2013; Murillo et al. 2012), and slower in barren areas.

In summary, the predicted environmental effects of wellhead decommissioning are primarily related to operation of ROVs and may result in changes in habitat availability and quality, and fish presence and abundance. These effects are predicted to be adverse, negligible to low in magnitude, localized, short term duration, occurring sporadically and reversible, with these predictions being made with a high level of confidence.

8.3.7 Project-related Surveys

8.3.7.1 Geophysical, Geohazard, Wellsite, Seabed and VSP Surveys

Prior to drilling at an identified well location, potential drilling hazards such as shallow gas deposits or large debris (e.g., large boulders, ocean debris, shipwrecks) are identified so as to avoid these issues when drilling. These hazards are typically identified through a geohazard/well site survey where the seabed is mapped through MBES, SSS, SBP, 2D seismic, video and other non-invasive equipment. The equipment is deployed either as hull mounted equipment, on a towfish, on ROV / AUVs, or may be towed by the vessel. Wellsite surveys using an acoustic sound source typically involve a specialized vessel, towing a submerged sound source and one to four streamers. Single air source arrays typically produced peak to peak sound levels approximately 222-238 dB re 1 µPa SPLpeak whereas air source arrays may produce levels in the order of 240-265 dB re 1 µPa SPLpeak (Richardson et al. 1995; Parry and Gason 2006). Such surveys will occur as needed within the Project Area at any time of the year. If there is suitable 3D seismic data for the area, it can also be used to identify hazards and geohazard surveys may not be required.

The Project will also include the conduct of VSP surveys as required throughout the Project life. VSP is used in interpreting the results of oil and gas exploration drilling activities through the correlation of time-based depth information from 3D seismic data to the actual drilling depth. VSP enables the acquisition of time, depth, and velocity information for the formations in which drilling has been completed, with a number of techniques being available for acquiring VSP data. In the marine environment, receivers are typically placed in the borehole and a sound source is deployed, usually from the drilling installation crane into the water column at a predetermined depth (approximately 5-20 m) to achieve a near zero offset. Walk-away VSP surveys may also be undertaken, which involve placing a sound source on a vessel which then moves away while firing the sound source at pre-determined distances from the borehole receiver.

The possible effects from the use of sound energy in the marine environment may be behavioural (avoidance, other changes in distribution or activities) or involve injury to or mortality of individual fish. A considerable amount of research has been conducted on the effects of sound from geophysical surveys (including various sound types and intensities) and other such activities on marine fish (McCauley et al. 2000; Payne 2004; Popper and Hastings 2009; Slabbekoorn et al. 2010; LGL 2014; Cordes et al. 2016; Carroll et al. 2017). This has included scientific research, monitoring studies and anecdotal reports of observed reactions by various fish and invertebrate species. Although overall knowledge and understanding of the effects of geophysical and other noises on marine fish and invertebrates remain inevitably incomplete in some areas (Slabbekoorn et al. 2010; Hawkins et al. 2014), the effects of geophysical activities and other noise sources have been documented in a variety of fish and invertebrate species in numerous studies, the key findings of which are briefly summarized below:

- Studies indicate that potential for plankton, eggs or larval injury or mortality would be limited to within a few metres of a sound source array (Pearson et al. 1994; Payne 2004; Payne et al. 2009; Cox et al. 2011; Popper et al. 2014). Localized effects on early life history stages are negligible within the wider distribution of pelagic eggs and larvae (Popper and Hastings 2009). There is little indication or evidence that direct physical

damage to fish occurs at distances greater than several meters from the source, due to the avoidance behaviour exhibited by mobile marine organisms (Popper and Hastings 2009; Popper et al. 2014)

- A variety of behavioural responses by marine fish to sound source arrays have been reported in the published literature and through anecdotal reports (Popper and Hastings 2009; Carroll et al. 2017). Any responses are typically localized and temporary in nature, except in instances where individuals or sensitive early life history stages are significantly and repeatedly affected
- Geophysical activity has limited effects on pelagic invertebrates, as demonstrated by low avoidance or tissue damage (Carroll et al. 2017), and some species may even become habituated to the noise (Samson et al. 2014; Mooney et al. 2016). Benthic invertebrates with lesser avoidance capabilities may exhibit temporary stress responses to geophysical activities that may weaken individuals with chronic exposure (Solan et al. 2016)
- Recent reviews note that research results and observations are highly dependent on species specific hearing capabilities, and extrapolation of effects to distant taxonomic groups must be done with caution (Popper and Hastings 2009). Inconsistent responses of species to geophysical sources indicates that current knowledge of the effects of anthropogenic noise on fish and invertebrates remains incomplete (Hawkins et al. 2015)
- Geophysical activities have been shown to influence the aggregation and dispersal patterns in fish resulting in atypical catch rates (Skalski et al. 1992). Some fish species have been captured at lower rates nearby source arrays (Løkkeborg 1991; Engås et al. 1996; Vold et al. 2009) whereas catch rates for other species did not change or in some cases even increased during geophysical activities (Parry and Gason 2006; Thomson et al. 2014; Przeslawski et al. 2015)
- Geophysical sound levels and their observed effects vary depending upon levels and the distance away from the source, and the effects of sound exposure also appear to vary by species and life stage. Behavioural responses of fish typically begin to occur at sound levels above 155 dB re 1 µPa SELcum (McCauley et al. 2000), whereas auditory damage starts at 180 dB re 1 µPa SELcum, recoverable injuries at 203 dB re 1 µPa SELcum and mortal injury or mortality may start to occur at 210 dB re 1 µPa SELcum (Popper et al. 2014). Some invertebrate species show injury at levels as low as 217 dB re 1 µPa SELcum while others can experience louder noises with no observable consequence (Matishov 1992; Kosheleva 1992)
- Behavioural effects may occur from less than 1 km to dozens of kilometres from the noise source, depending on the geophysical source levels, sound attenuation in the marine environment, species, and life history stage (McCauley et al. 2000; Popper and Hastings 2009; Popper et al. 2014)

The summary above is intended to provide an overview of the known and likely environmental issues and interactions, as background and context for predicting Project effects and for identifying and proposing mitigation. More detailed reviews of such information are available through other sources, including the Eastern Newfoundland SEA (Amec 2014) as well as other sources (LGL 2014; BP 2016).

Although a variety of physiological and behavioural responses by marine fish to sound from geophysical surveys have been reported, studies indicate that such effects vary by species, life stage, intensity of sound, distance from geophysical source and other factors. Individual species differ in their sensitivity and reactions to underwater noise, with some finfish (i.e., cod and redfish) having elevated vulnerability due to the presence of hearing organs and/or air-filled swim bladders (Popper and Hastings 2009). Finfish lacking swim bladders (sharks, sand lance, wolffish, flatfish), and many invertebrate species are likely more affected by the particle displacement component of airgun activities and thus show a more limited effect of exposure to geophysical survey activity, typically even at close range (Popper and Hastings 2009; Popper et al. 2014).

A range of behavioural responses to air source array noise have been observed and reported, including altered spatial and depth distributions, and changes in activity such as increased refuge seeking or schooling (McCauley et al. 2000; Parry and Gason 2006; Popper and Hastings 2009; Popper et al. 2014). Marine invertebrates exposed to geophysical sounds have been observed to be undergo startle or stress behaviours (Solan et al. 2016), but often do not necessarily undergo avoidance behaviours (Carroll et al. 2017). Avoidance or stress behaviours that occur in some species have also been shown to return to pre-activity levels after cessation of geophysical activities (Hassel et al. 2003; Solan et al. 2016).

Geophysical activities may have localized injury and mortality effects on passive drifting early life stages of species occurring within a few meters to approximately 1 km away from sound source array, although overall population effects are considered negligible to species such as shrimp, fish eggs and fish larvae (Payne 2004; Payne et al. 2009; Popper et al. 2014). However, there may be increased interactions with these early life stages during the spring and fall phytoplankton blooms during which there are associated coinciding spawning events for various invertebrate and fish species (Davis et al. 1998). Mortality of adult and larval zooplankton, and larval krill mortality, has also been shown to increase 1.2 km away from sound source arrays (McCauley et al. 2017). More mobile fish species and life stages are able to avoid possible effects of noise exposure by moving away from the sound source array, whereas some larval stages and immobile species may be unable to avoid such exposure (McCauley et al. 2000; Popper and Hastings 2009; McCauley et al. 2017). Within a few metres sound source arrays, some species have been shown to exhibit only modest levels of mortality and may even become habituated to noise levels (Popper and Hastings 2009, Carroll et al. 2017), whereas mortality of some zooplankton groups have been observed at farther distances (McCauley et al. 2017). There is no indication that mortality to fish occurs at distances greater than several meters from the source (Gausland 1993; Popper and Hastings 2009, Popper et al. 2014); however, some species have exhibited a temporary shift in hearing that may affect interspecies cues and increase predation risk (Popper and Hastings 2009). The avoidance behaviour exhibited by mobile fish species (Skalski et al. 1992, Engås et al. 1996; Engås and Løkkeborg 2002) and capability for avoidance in marine environments further reduces the potential for such effects. Overall, studies and reports indicate that responses to geophysical activities are species-specific, however in general they are expected to be somewhat localized up to several kilometres from the source, and temporary in nature.

In the case of planned wellsite surveys, most of the types of equipment that would be used for these activities (MBES, SSS, SBP, video, and other equipment) will not result in significant environmental

emissions (particularly sound) or other disturbances, and therefore, these activities are not likely to adversely affect fish and fish habitat. In the case of 2D seismic equipment being used, the localized and short-term nature of these underwater disturbances at any one location / time also considerably reduces the potential for adverse effects through either injury or disturbance / avoidance, and thus, for localized and repeated environmental disturbances at a specific location and affecting an environmental receptor.

VSP acquisition surveys are also typically short-term activities, lasting several days duration, with an active sound source array firing often limited to just a few hours, with source array volumes ranging from 450-2,400 in^3 with operating pressures of approximately 2,000 psi, producing approximate peak-to-peak pressures of 100 to 180 bar-m. The VSP array and its sound emissions are more localized than those used in larger offshore geophysical surveys, with the majority of sound directed downwards into the well and a lesser degree directed horizontally. Acoustic modelling from the Scotian Basin Drilling Project, for example, estimated that VSP noise would exceeded sound thresholds for avoiding potential injury and mortality to fish (Popper and Hastings 2009; Popper et al. 2014), but this effect was localized to within 140 m of the wellsite (BP 2016).

Operational procedures, such as the use of a gradual “ramp-up” or soft-start procedure over a minimum period allows mobile marine animals to move away from the area if they are disturbed by the underwater sound levels associated with the geophysical survey, will be implemented for this Project. This will help to further avoid fish injury or morality, as will the planned shut-down of the sound array (reduction to the smallest source element, firing intermittently) during required maintenance activities. This will also reduce startle effects (Popper and Hastings 2009) and resulting stress on fish in the nearby area. These, along with the relatively localized and short-term nature of required use of geophysical sound as part of the Project, will reduce potential for fish injury or mortality. While there may be some short-term behavioural effects to individual fish in the immediate vicinity of the survey activity, it is therefore unlikely that fish will be displaced from key habitats or disrupted during key activities over extended areas or periods, or be otherwise affected in a manner that causes negative and detectable effects to fish populations in the region.

In summary, the predicted environmental effects of the above describes surveys are primarily related to geophysical noise and may result in changes to fish mortality / injury risk and fish health and fish presence and abundance. These effects are predicted to be adverse, low in magnitude, occurring within the Project Area, short-term in duration, occurring sporadically and being reversible, with these predictions being made with a high level of confidence.

8.3.7.2 Geological, Geotechnical and Environmental Surveys

Geological, geotechnical, environmental, and other marine survey activities will also be conducted within the Project Area. The specific nature, location, and timing of these activities in any year will be subject to information requirements and data collection objectives, as well as such factors as weather and ice conditions, and the location of other marine activities in the region. Geological surveys may be undertaken using a towed or ROV-mounted seabed camera / video system, grab samplers, gravity or piston core, box corer, and other sampling gear. Geotechnical surveys may also be undertaken to better understand sea bottom conditions at specific locations within the Project Area. These can range from seabed sampling from a vessel of opportunity using core, grab and seabed

sampling equipment, to in-situ sampling well below the seabed using a dedicated geotechnical drillship. In addition, environmental surveys could include the collection of meteorological and oceanographic information within parts of the Project Area, as well as other environmental data collection activities focused on specific physical or biological components in potential drilling locations.

Most of these planned and potential marine survey activities will not result in physical contact with the seabed, and will therefore not directly interact with or disturb benthic animals or their habitats. Any underwater noise or light emissions associated with this equipment would be negligible, localized and short term, and thus would have little or no attraction or avoidance effects on fish species (Cordes et al. 2016). Although seabed samples may also be acquired using the required equipment, these activities likewise have a short duration, and those which involve contact with the seabed will have a small footprint.

In summary, the predicted environmental effects of these types of activities are primarily related to ROV operation and associated, biological and seabed sampling These interactions may result in potential changes to habitat availability and quality, fish mortality / injury risk and fish health, and fish presence and abundance. These effects are predicted to be adverse, negligible to low in magnitude, localized, short term in duration, occurring sporadically and reversible, with these predictions being made with a high level of confidence.

8.3.8 Supply and Servicing

The Project will involve vessel and aircraft use (presence and movements), including supply and support traffic to, from and within the Project Area at all times of year throughout the Project duration. This supply and servicing activity may affect Marine Fish and Fish Habitat as a result of the lighting, noise and discharges and emissions while in transit at the drill site and/or survey location. At the drilling location, support vessels will maintain their location through dynamic positioning, which will avoid direct interactions with the seabed and fish habitats but which can also be a source of underwater noise at the drilling location. Given the nature and frequency of required aircraft support to the active drilling installations (Section 2.5.2), and the planned avoidance of low level flights wherever possible (Section 8.3.2), no adverse environmental effects on fish and fish habitat are anticipated as a result of these activities.

Noise generated by vessel traffic and use can be transmitted through water, and may cause avoidance or attraction by some species (Røstad et al. 2006; De Robertis and Handegard 2013). Noise from marine activities has been shown to mask the acoustic sensory environment of fish and invertebrates and affect behaviour (Slabbekoorn et al. 2010, Wale et al. 2013a, 2013b; Morley et al. 2014), and may result in fish and invertebrate aggregation or avoidance, communications masking, and other alterations in behaviour (Popper and Hastings 2009; Slabbekoorn et al. 2010; Popper et al. 2014; Carroll et al. 2017), with short-term and low frequency noises appearing to elicit temporary avoidance due to startling effects with longer-term avoidance of the noise is of higher frequency or continuous (Misund et al. 1996; Wilson and Dill 2002). Physiological and reproductive effects have been reported when fish are continually exposed to noise (Clark et al. 2016). The effects of anthropogenic noise in the marine environment can be short-lived, however, and the reduction or removal of noise sources may decrease the potential for direct, detrimental effects (Williams et al.

2015). Indeed, vessel noise effects are temporary and are generally limited to the duration of the noise emissions or within days afterwards (Popper and Hastings 2009).

Vessel traffic for supply and servicing of the drilling installation is estimated at 8 to 10 return transits per month for a single drilling installation, while for two drilling installations an average of up to 16 return transits per month is anticipated (Section 2.5.2). This volume of vessel traffic represents a negligible contribution to the overall vessel traffic off Eastern Newfoundland, and Project-related supply vessel traffic will use existing and established routes wherever possible. Although the presence of these vessels may result in some degree of attraction, avoidance or other behavioural responses by individual fish (depending upon the species involved), marine fish will likely not be disturbed by Project-related vessel activity or associated aircraft use, due to its transitory nature and thus its short-term presence at any one location. Moreover, the Project's vessel movements will create noise types and levels that are similar to daily and frequent marine traffic that occurs throughout the region. Ambient vessel noises are estimated to have frequencies of <200 Hz and levels of 195 dB re $\mu Pa^2/Hz$ @ 1 m and are primarily associated with propulsion (Hildebrand 2009). At the drill sites, the noise associated with stationed supply vessels and their use of dynamic positioning is generally lower than the underwater noise produced by drilling activities (700-1,400 Hz, 184 dB re 1µPa at 1 m, Hildebrand 2009) and therefore will not be in addition to existing noise levels in these areas (see Section 5.6).

Lighting is required for safety of marine personnel during operations and will likely be emitted 24 hours a day. Lighting emissions have the potential to attract phototaxic plankton and foraging fish and may support foraging opportunities and increase predator-prey interactions (Keenan et al. 2007; Cordes et al. 2016). Vessel traffic from coastal to offshore areas (Figure 8-2) overlaps areas of relatively high abundance or biomass of fishes, mainly on the slopes and shelf of the Newfoundland Shelf, and the slopes of the Flemish Pass and Flemish Cap in the Northern section of the Project Area. In the Southern section of the Project Area, vessel routes overlap areas of relatively high abundance or biomass of fishes common on the shelf, but are less likely for interactions with areas of high biomass and abundance on the slopes. Of species observed in the Project Area, pelagic species that migrate between inshore and offshore areas, including American eel, Atlantic salmon, Atlantic cod, and capelin, have a relatively higher potential to interact with vessel traffic, but also have higher capability for avoidance. Furthermore, species like Atlantic salmon do not migrate in large concentrations and preferred sea surface temperatures (SSTs) would likely limit habitat use to temporary movement corridors in the Project Area (see Chapter 12 for further details), limiting potential for interactions with supply vessels. Pelagic early life stages of various fish and invertebrates have limited avoidance capabilities as they generally drift passively on ocean currents; however, overall effects are limited due to the transitory and environmentally non-intrusive nature of the vessel traffic.

Other potential environmental discharges from offshore vessels and equipment relate to the possible release of oily water and other substances through deck drainage, bilge / ballast water, open drains, sanitary waste/grey water, and other hazardous/non-hazardous wastes. Bilge and deck drainage water resulting from vessel operations or seawater interactions with ship equipment may contain hydrocarbons and other contaminants. Discharges from the vessels may have effects on benthic fish and invertebrate species on the shelf and slope areas; however, overall effects are considered

limited. Oiled wastewater will be collected and treated in accordance with MARPOL requirements prior to discharge, reducing potential effects on fish and fish habitat. Segregated oily waste is disposed of onshore at approved waste management facilities, thereby avoiding potential interactions with the marine environment. Grey and black water from vessels will be managed and discharged overboard in accordance with the OWTG and MARPOL requirements. Sewage discharge may lead to organic enrichment of areas that have either positive or negative effects on local fish and invertebrates (Peterson et al. 1996). As the ships are travelling, the overall volumes discharged in a single area and time would be expected to be relatively low and will not result in adverse environmental effects.

Air emissions will occur from the operation of vessels, and levels will be in accordance to in the *Canadian Environmental Protection Act*, the National Ambient Air Quality Objectives and the *Newfoundland and Labrador Air Pollution Control Regulations*, MARPOL, as discussed in Chapter 2. Atmospheric emissions are not expected to directly affect fish, and these will again be managed through strict adherence to applicable environmental regulations and standards. Each of the vessels involved in this Project will also use, store and handle fuels, oils, and other such materials in an environmentally acceptable manner, in accordance with applicable regulations and standards.

As discussed in Section 8.3.3 for the drilling installation, other potential issues include the possible introduction and spread of aquatic invasive species and resulting habitat degradation (Bax et al. 2001; Morris et al. 2010), although these effects are generally thought to be more important to the benthic coastal communities as compared to in the open ocean (Templeman 2010). As described previously, Project vessels will adhere to the requirements of the *Canada Shipping Act, 2001*, including the associated *Ballast Water Control and Management Regulations* and IMO anti-fouling guidelines. Ballast exchange in areas at deeper depths as stipulated by regulations minimizes the potential dispersion of shallow water invasive species.

In summary, the predicted environmental effects of Project-related supply and servicing are primarily related to vessel noise, transit to offshore areas and environmental discharges, and may result in changes to fish mortality / injury risk and fish health, and fish presence and abundance. These effects are predicted to be adverse, low in magnitude, localized, short term in duration, occurring regularly and reversible, with these predictions being made with a high level of confidence.

8.4 Species at Risk: Overview of Potential Effects and Key Mitigation

A total of 19 fish species that are known or likely to occur within the LSA and/or RSA have been designated as species at risk and have associated protections under provincial or national legislation (SARA, NL ESA), or have otherwise been identified as being of special conservation concern by COSEWIC or under other processes. These include several wolffish species, Atlantic cod, cusk, American eel, Atlantic salmon, American plaice, Bluefin tuna, and a number of species of grenadier, redfish, sharks, and skates. As with secure fish species, species at risk may interact with Project activities based on occupation of various habitats at different life history stages (Table 8.11) and the same planned mitigation measures will be used to avoid or reduce such adverse interactions. Additional species-specific information and analysis related to the potential for the Project to interact with and affect each of these Species at Risk is provided in Table 8.12. Species that have been identified as being of special conservation concern by COSEWIC or under other processes that are

not likely to overlap with the Project activities and are primarily concentrated outside the Project Area are not discussed, including winter skate and spiny dogfish.

Table 8.11 Marine Fish Species at Risk: Potential Interactions with Project Components by Life History Stage

Freshwater			
Eggs	Larvae	Juveniles / Adults	Project Component Potential Interaction
Atlantic salmon	Atlantic salmon	American eel	No interaction
Marine - Demersal			
Eggs	Larvae	Juveniles / Adults	Project Component Potential Interaction
Thorny Skate Striped wolffish Northern wolffish Spotted wolffish	Thorny Skate	Atlantic cod Cusk American plaice Roughhead grenadier Roundnose grenadier Thorny Skate Spiny dogfish Acadian redfish Deepwater redfish Striped wolffish Northern wolffish Spotted wolffish	Drilling and Associated Marine Discharges Wellhead Decommissioning Vertical Seismic Profiling Geological, Geotechnical, Wellhead, Seabed and Environmental Surveys
Marine - Pelagic			
Eggs	Larvae	Juveniles / Adults	Project Component Potential Interaction
Atlantic cod Cusk Roughhead grenadier Roundnose grenadier American plaice American eel Atlantic bluefin tuna	Atlantic cod Cusk Roughhead grenadier Roundnose grenadier American plaice American eel Atlantic bluefin tuna Acadian redfish Deepwater redfish Striped wolffish Northern wolffish Spotted wolffish	Atlantic salmon Acadian redfish Deepwater redfish Atlantic bluefin tuna Basking shark Porbeagle Shortfin mako Spiny dogfish White shark	Presence and Operation of Drilling Installation Drilling and Associated Marine Discharges Formation Testing with Flaring Geological, Geotechnical, Wellhead, Seabed and Environmental Surveys Supply and Servicing

Table 8.12 Marine Fish Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	SARA	NL ESA	COSEWIC	Summary of Presence and Potential Interactions
Atlantic wolffish	Special Concern	-	Special Concern	Spawns September and October Pelagic larvae Adults along slopes and rocky habitats Abundant in Flemish Pass and continental slopes Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat).
Northern wolffish	Threatened	-	Threatened	Spawns September through November Pelagic larvae and relatively pelagic adults Aggregated in Flemish Pass and northeast slopes Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat).
Spotted wolffish	Threatened	-	Threatened	Spawn June, July, and August Pelagic larvae Found on soft bottom habitats Common on Flemish Cap, eastern Grand Banks, and Newfoundland Shelf Spawning aggregations on the Northeast Shelf and Slope EBSA in the spring Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat).
American eel	-	Vulnerable	Threatened	Spawn in the Sargasso Sea Pelagic larvae and adults May pass through Project Area or interact with vessels during migrations to or from spawning areas Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat).
Atlantic cod (Newfoundland and Labrador population)	-	-	Endangered	Eggs in the water column from April to October Pelagic larvae Distributed on the northeast and southeast tips of the Grand Bank and on the Flemish Cap

Table 8.12 Marine Fish Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	SARA	NL ESA	COSEWIC	Summary of Presence and Potential Interactions
				May pass through Project Area during seasonal migrations Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat).
Cusk	-	-	Endangered	Spawning on Scotian Shelf from May to August Pelagic eggs and larvae Sporadically observed on the Grand Bank, around Flemish Cap. Mainly distributed in the Gulf of Maine. Limited seasonal movements Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat).
Roughhead grenadier	-	-	Special Concern	Spawning occurs in winter and early spring Spawning grounds suggested to lie on the southern and southeastern slopes of the Grand Bank Pelagic eggs Common on the Flemish Cap Flemish Pass and nose of the Grand Banks Limited potential for interaction (mobile species, Project mitigation measures) Potential for long-term adverse effects with accidental events.
Roundnose grenadier	-	-	Endangered	Spawning occurs throughout the year Mesopelagic eggs and juveniles Common on the Flemish Cap and nose of the Grand Banks Limited potential for interaction (mobile species, Project mitigation measures) Potential for long-term adverse effects with accidental events.
American plaice (Newfoundland and Labrador population)	-	-	Threatened	Common on the north and south areas of the Grand bank and on the Flemish Cap May migrate through Project Area St. Pierre Bank, the “Haddock box” on the Scotian Shelf and the Nose and Tail of the Grand Bank are potential nursery areas Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat).

Table 8.12 Marine Fish Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	SARA	NL ESA	COSEWIC	Summary of Presence and Potential Interactions
Spiny dogfish			Special Concern	Epibenthic shark species Resides in Canadian waters mainly on the southwest Scotian Shelf, Bay of Fundy, and Georges Bank Seasonal inshore-offshore migrations Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat)
Thorny skate			Special Concern	Widespread species on Grand Banks in shelf and slope areas Undergo limited seasonal migrations Limited potential for interaction (project mitigation measures, no critical habitat)
Atlantic salmon (South Newfoundland, Quebec Eastern North Shore, Quebec Western North Shore, Anicosti Island, Inner St. Lawrence, Gaspe-Southern Gulf of St. Lawrence, Eastern Cape Breton, Nova Scotia Southern Upland)	-	-	Threatened (South Newfoundland Population); Special Concern (Quebec Eastern North Shore, Quebec Western North Shore, Inner St. Lawrence, Gaspe-Southern Gulf of St. Lawrence); Endangered (Eastern Cape Breton, Nova Scotia Southern Upland, Outer Bay of Fundy, Anicosti Island)	Spawns in freshwater, growth phase in marine environments. May migrate through the project area or interact with coastal and offshore service vessels. Mainly occupies upper 5-10 m of water column with some deeper feeding migrations. Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat).
Acadian redfish (Atlantic population)	-	-	Threatened	Common on the Northeast Newfoundland Shelf and Flemish Cap Larval release between spring and summer May migrate through Project Area Limited potential for interaction (mobile species, project mitigation measures)

Table 8.12 Marine Fish Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	SARA	NL ESA	COSEWIC	Summary of Presence and Potential Interactions
				Potential for long-term adverse effects with accidental events.
Deepwater redfish (Northern Population)	-	-	Threatened	Common on the Northeast Newfoundland Shelf and Flemish Cap Larval release between spring and summer May migrate through Project Area Limited potential for interaction (mobile species, project mitigation measures) Potential for long-term adverse effects with accidental events.
Atlantic bluefin tuna			Endangered	May migrate through Project Area Limited potential for interaction (mobile species, project mitigation measures) No known spawning or rearing habitats for early life stages in Canadian waters
Basking shark (Atlantic Population)			Special Concern	Seasonal summer migrations into Canadian waters May migrate through Project Area Limited potential for interaction (mobile species, project mitigation measures)
Shortfin mako (Atlantic Population)			Special Concern	Seasonal summer migrations into Canadian waters Associated with warm waters in and around the Gulf Stream May migrate through Project Area Limited potential for interaction (mobile species, project mitigation measures)
White shark (Atlantic Population)	Endangered		Endangered	Seasonal, limited migrations into Canadian waters May migrate through Project Area Limited potential for interaction (mobile species, project mitigation measures)
Porbeagle			Endangered	Abundant on the continental shelf of the Grand Bank Mating grounds off Southern Newfoundland, the entrance to the Gulf of St. Lawrence and the Georges Bank May migrate through Project Area Limited potential for interaction (mobile species, project mitigation measures)

8.4.1 Wolffish Species

Striped (Atlantic) wolffish, northern wolffish and spotted wolffish are long lived and slow growing species that mainly inhabit bottom habitats (Kulka et al. 2004; COSEWIC 2012a, 2012b, 2012c). Atlantic and spotted wolffish lay egg clusters on the bottom that are guarded by adults. Following hatching, the wolffish larvae become pelagic and are commonly found over continental slopes. The life history of Northern wolffish is less known, but it may be similar in nature to the other two related species (Kulka et al. 2004).

These species are found on a variety of bottom types with associations with rocky or stony bottoms during spawning. Northern wolffish are mainly observed at depths >500-1,000 m whereas spotted wolffish are common from 200-750 m depths. While striped wolffish have been observed up to 918 m, they are mainly common at depths 150-350 m depth (Kulka et al. 2007). In the Northern and Southern sections of the Project Area, all three wolffish species are mainly distributed on the Grand Bank slopes and the Flemish Pass. Spotted wolffish are also known to aggregate in the spring in the Northeast Shelf and Slope EBSA within the Northern and Southern Sections of the Project Area (Templeman 2007). There are also areas of high wolffish abundance on continental slopes outside the Project Area (See Chapter 6). Critical habitat is somewhat difficult to establish for these species because there is limited information on life history, influences on population dynamics and information on acceptable targets for population abundance and range (Kulka et al. 2007). Draft recovery strategies for the northern and spotted wolffish have tentatively identified critical habitat areas based on areas of high occurrence for these species. These draft critical habitat areas for both species include similar areas along the continental slopes off Newfoundland and Labrador and smaller areas in the Gulf of St. Lawrence (DFO 2015). A portion of the draft critical habitat for northern and spotted wolffish on the northeast shelf and slope of the Grand Banks overlaps with the Northern Section of the Project Area within the EEZ. The draft critical habitat boundaries do not overlap with the Southern Section of the Project Area. The delineated habitat in the recovery strategy is not considered entirely critical habitat, but it is assumed that within the area, the functions and features necessary for the species' survival or recovery exist. No delineation of critical habitat was required or established for the striped wolffish as it is listed as being of "special concern" (DFO 2015).

Migrations of Northern and Spotted wolffish are limited based on tagging studies, however striped wolffish may undergo longer migrations as they move to inshore waters to spawn (Kulka et al. 2007). Bycatch mortality from commercial fisheries and habitat alterations by trawling gear are suggested to be the main threats to these species.

Wolffish eggs and adults are associated with bottom habitats and the larvae live pelagically, therefore changes to habitat availability and quality, fish mortality / injury risk and fish health may result for these species from planned Project. No critical habitat has been established for these species; however, the Northeast Shelf and Slope EBSA is a known aggregation area for spotted wolffish. While activities associated with this Project could potentially occur within the EBSA, these are localized and short-term activities and environmental disturbances. Furthermore, there are high aggregations of wolffish species outside the Project Area, and use of planned mitigation measures will avoid or reduce such adverse interactions with wolffish.

8.4.2 Grenadiers, Plaice, Spiny Dogfish, and Skates

Roughhead grenadier, roundnose grenadier, skate species and American plaice are typically associated with bottom habitats and are mainly threatened by overfishing or bycatch mortality (COSEWIC 2007, 2008, 2009a).

Roughhead and roundnose grenadiers are long lived and slow growing benthopelagic species and may have lesser potential for recovery in response to adverse effects (COSEWIC 2007; 2008). Roundnose grenadiers spawn throughout the year and produce mesopelagic eggs and juveniles, whereas roughhead grenadiers spawn mainly between the winter to early spring and have pelagic larvae (COSEWIC 2007; 2008). Roughhead grenadiers have been captured at depths between 200 and 2,000 m and roundnose grenadier have been captured at depths between 180 and 2,200 m; however, both species are mainly observed at 400-1,200 m depths (COSEWIC 2007, 2008). These two deep-sea species are mainly distributed on the northeast and eastern slopes of the Grand Banks. The Northern section of the Project Area also overlaps with roughhead grenadier catches on the northeastern side of the Flemish Cap (Alpoim and González Troncoso 2016). Roundnose grenadiers are thought to migrate into relatively deeper waters along the slope in winter and into shallower slope areas in the summer; however, large scale migrations are considered unlikely due to their poor swimming capability (COSEWIC 2008). The population structure of roughhead grenadier populations suggests that these overall dispersal and movements of roughhead grenadier are also low (COSEWIC 2007). Critical habitat has not been established for the roundnose grenadier due to lack of information of habitat associations in relation to life history stages (DFO 2010). No critical habitat been established for roughhead grenadier, however, spawning grounds for this species are suggested to lie on the southern and southeastern slopes of the Grand Bank (Scott and Scott 1988; COSEWIC 2007).

American plaice spawning timing varies geographically, with spawning occurring mainly between April to May on the Grand Banks. This species has pelagic egg and larval stages and benthic juvenile and adult stages. Adult and juvenile stages of American plaice are associated with soft bottom habitats where they may burrow. Juveniles on the Grand Bank are mainly associated with sand and shell hash sediments and are less abundant on mud, muddy sand, and rock substrates whereas adults prefer gravely sand habitats (COSEWIC 2009a). Juveniles are typically found at depths 100-200 m whereas adults prefer 100-300 m depths. Although individuals have been captured at 1,400 m depths, deep water channels are considered unsuitable habitat for American plaice. Distribution of this species is mainly on the shelf of the Grand Bank and Flemish Cap, with relatively high aggregations in the Project Area. Adults do not undertake large spawning migrations, but may move into slightly deeper waters in winter (COSEWIC 2009a). Currently, American plaice species distribution is widespread with no established critical habitat (DFO 2012). However, it is suggested that the St. Pierre Bank, the “Haddock box” on the Scotian Shelf, and the Nose and Tail of the Grand Bank are potential nursery areas (COSEWIC 2009a). Overfishing and bycatch mortality are considered the primary threats to this species.

Thorny skate are one of the most abundant skate species in Canadian RV surveys and are densely concentrated and abundant on the Grand Banks (COSEWIC 2012d). This slow-growing species occupies depths of 18-1,400 m and inhabits a broad range of substrates including sand, shell, gravel

and mud (COSEWIC 2012d). Skates lay egg capsules on the seafloor year-round and all life stages occupy demersal habitats. Skates undergo limited seasonal migrations of approximately 100 km, with some skates migrating up to 440 km (COSEWIC 2012d). Areas of high aggregation include the Newfoundland Shelf and slopes within the Northern and Southern sections of the Project Area. Bycatch mortality in commercial fisheries is the main threat to this species. Critical habitat has not been established.

Winter Skate are assessed as "endangered" by COSEWIC but are not a SARA-listed species. This species is found in three main concentrations at depths less than 110 m, including the Southern Gulf of St. Lawrence, Eastern Scotian Shelf, and the Bay of Fundy-Western Scotian Shelf. In the Newfoundland region, winter skate are mainly observed in southern Newfoundland, with few occurrences on the Grand Bank and within the Project Area (COSEWIC 2015). Due to their low distribution within the Project Area, this species was not further assessed with regards to potential Project interactions.

Spiny dogfish are an epibenthic shark species that uses internal fertilization with females giving birth to approximately 2-15 pups every two years (COSEWIC 2010a). This species is typically found in large schools just above the seabed, but exhibit a wide depth range from surface to depths of 730 m. Generally, this shark species occupies depths of 100-250 m in Newfoundland waters with no substrate preference. Spiny dogfish show some north-south migration patterns, but the main patterns are seasonal inshore (summer-fall) to offshore (winter-spring) migrations (COSEWIC 2010a). In Canadian waters, spiny dogfish reside year-round, but are concentrated on the southwest Scotian Shelf, Bay of Fundy, and Georges Bank located outside the Project Area. While spiny dogfish have been observed on the Grand Bank including the Flemish Pass, their presence is limited (COSEWIC 2010a). Currently there are no protective habitat measures specifically to protect spiny dogfish and critical habitat has not been established. Overfishing and bycatch mortalities remain the greatest threat to this species.

Early life stages of grenadier and plaice species live pelagically, therefore changes to habitat availability and quality, fish mortality / injury risk and fish health may result for these species from planned Project activities. Potential interactions with adults of grenadier, spiny dogfish and plaice species and all life stages of skate species would primarily be benthic in nature. American plaice and thorny skate that are widespread in shallow shelf areas may be disturbed in relation to drilling installation anchoring (COSEWIC 2007, 2008, 2009a). As predicted Project-related disturbances are localized and short-term and mitigation measures are implemented to reduce potential effects, there is limited potential for interaction with these species. Furthermore, areas of high aggregation outside the Project Area limits regional population effects on these species.

8.4.3 Atlantic Cod and Cusk

Atlantic cod and cusk are species that are threatened by over fishing and have pelagic eggs (COSEWIC 2010a; 2012c) that are prevalent in the water column from April to November (Knutsen et al. 2009). Juvenile cod settle to the bottom for the first one to four years of life and prefer areas with habitat complexity that help reduce predation risk. Adult cod occupy a diverse range of habitats and do not have particular depth or bottom substrate preferences, though they are generally observed at less than 500 m depths in offshore waters. While there are areas of high cod aggregation

that span the boundary of the Project Area, Atlantic cod are mainly observed on the Tail of the Grand Banks and shelf and slope areas northwest of the Project Area. Cusk prefer habitats that have rocky substrates and are predominately found between 100-400 m depth, but have been observed at depths over 1,100 m (COSEWIC 2012c). Small quantities of cusk have been caught off the Grand Bank and in the Project Area; however, the main area of distribution for this species occurs in the relatively deep waters of the Gulf of Maine (COSEWIC 2012c). Currently no critical habitat has been established for Atlantic cod or cusk. Adult cod undergo extensive migrations as they travel from offshore to inshore areas in the spring to feed on capelin before returning in the fall (COSEWIC 2010a) and may subsequently travel through the Project Area. Cusk are generally sedentary and likely have limited seasonal movements (COSEWIC 2010a). The main threats to these species are overfishing and bycatch mortality (COSEWIC 2010a; 2012c).

Early life stages of Atlantic cod and cusk and adult cod that live pelagically suggest that changes to habitat availability and quality, fish mortality / injury risk and fish health may result for these species from planned Project activities. Potential interactions with adult cod and cusk associated with bottom habitats indicate that benthic interactions may result in changes to fish habitat availability and quality, fish mortality/injury risk and fish presence and abundance for these species. As predicted Project-related disturbances are localized and short-term and mitigation measures are implemented to reduce potential effects, there is limited potential for interaction with these species. The mobile adult stages would also be able to avoid areas of potential short-term effects. The fact that areas of high aggregation are located outside the Project Area also limits regional population effects on these species.

8.4.4 Atlantic Salmon and American Eel

Atlantic salmon and American eel interact with both freshwater and marine environments. Atlantic salmon migrate to freshwater to spawn and juveniles migrate to marine waters for their growth phase (COSEWIC 2010c).

Atlantic salmon occupy freshwater, estuarine, and marine environments. Eggs are laid and fertilized in riffle areas of streams or gravel shoals in lakes from October to November. Young salmon emerge from the gravel between late May and early June and remain in freshwater for two to eight years before migrating to sea as smolt. Salmon reside and grow in marine waters before returning to their natal rivers to spawn after one or more years. Movement patterns of both post-smolt and adult salmon within the marine environment are complex and much information comes from studies related to commercial fisheries and research trawls (Reddin and Friedland 1993; Reddin 2006). Commercial and research vessel catches indicate that Atlantic salmon of all sea-ages occur seasonally over most of the northwest Atlantic (Reddin and Shearer 1987, Reddin and Friedland 1993, Sheehan et al. 2012). In general, both post-smolt and adult salmon are concentrated in the Labrador Sea gyre, where they feed and overwinter.

Atlantic salmon smolts are generally considered to be “energy-deficient” and have low energy reserves for somatic growth upon leaving their natal river and during the early marine phase (Jonsson and Jonsson 2005). It is suggested that post-smolt are therefore distributed according to prevailing surface currents, either close to shore or in open waters, and that strong currents act as transportation vectors that facilitate migration to marine feeding areas (Jonsson et al. 1993) to reduce

energy needs. Therefore, the migration routes of post-smolt from individual rivers may be determined by general ocean currents near its confluence with the ocean. For example, based on tag recaptures, post-smolt from rivers in Maine, Bay of Fundy, Atlantic coast of Nova Scotia, and some rivers in Newfoundland migrate near the coast of eastern Newfoundland, arriving near the Funk Islands in the southern Labrador Sea in early August (Reddin and Friedland 1993).

Tagging studies show that adult salmon migrating southward from feeding and overwintering areas to the Maritimes and Southern Newfoundland rivers in the spring first move into Newfoundland coastal waters and then coastwise in a southerly and then westerly direction along the Newfoundland coast (Reddin and Friedland 1993). Adult salmon have been found in abundance in two general locations during their spring spawning migration; approximately 480 km east of the Strait of Belle Isle and slightly east of the 200 m isobath (depth contour) along the eastern edge of the Grand Bank. Based on catch data provided in Reddin and Shearer (1987), the area of abundance on the eastern edge of the Grand Bank would be south of the Project Area – Northern Section. Sampling near the Flemish Pass in winter and summer-autumn captured no salmon. Low catches (over 0.0-1.0 fish per mile-hour of drift gillnet) of adult salmon were recorded during the spring. While it appears that adult salmon would be located to the south of the Flemish Pass, based on overall habitat conditions and general location of the Flemish Pass relative to potential migration from the Labrador Sea, the Flemish Pass area would likely be included as a portion of their migration route along the northeastern edge of the Grand Bank.

Main threats and limiting factors to Atlantic salmon include predation, climate change, directed fisheries, bycatch mortality, obstructions to spawning areas, and aquaculture. There have also been large declines in marine survival, but the mechanism for mortality is poorly understood. It is suggested that declines in sea survival are occurring in parallel with wide spread changes in the North Atlantic ecosystem (COSEWIC 2010c). To date, there has not been critical habitat established for this species, however freshwater habitat is considered a limitation to salmon production (COSEWIC 2010c).

American eel life stages occupy freshwater, estuarine, and marine environments. Adults migrate from rivers along the continental shelf to the Sargasso Sea where they spawn. As adult migrations follow the shallow shelf areas before directly to the Sargasso Sea in deeper waters, it is unlikely that the eels pass through the Project Area as it encompasses shelf areas that are distant from coastal regions (Béguer-Pon et al. 2015). The pelagic larvae and juveniles drift northward along the Gulf Stream to coastal estuarine environments and are concentrated in the water column in the upper 140 m at night and the upper 350 m during the day (Kleckner and Mcleave 1982). The young eels migrate up rivers between April and August where they grow to maturity (Wildlife Division 2010; COSEWIC 2016a). No critical habitat has been established for American eel (Wildlife Division 2010; COSEWIC 2016a), however it has been noted that freshwater riparian areas may be important habitat for developing eels (Wildlife Division 2010; COSEWIC 2016a). The Sargasso Sea, that lies approximately 2,000 km south of Canadian waters, is an area of importance for spawning and reproduction, but it is distant from the Project Area. The main threats to survival of American eel are mainly barriers to migration in freshwater habitats, bioaccumulation of contaminants, and shifting oceanographic conditions that may affect ocean migrations.

Early life stages of American eel that live pelagically, and adult stages of American eel and Atlantic salmon that migrate through pelagic waters suggest that changes to habitat availability and quality, fish mortality / injury risk and fish health may result for these species from planned Project activities. However, because migration routes for Atlantic salmon and American eel do not reside wholy within the Project Area and can be variable based on environmental conditions such as sea-surface temperatures, interactions may be limited and overall risk is considered low to these species. Project-related disturbances are also localized and short-term with mitigation measures implemented to reduce potential effects.

8.4.5 Redfish Species

Acadian and deepwater redfish are species with COSEWIC status designations that are well distributed in the Flemish Pass and Flemish Cap. Redfish are long lived, slow-growing species and populations are considered to have low resilience to adverse effects (COSEWIC 2010d). Redfish species use internal fertilization, with breeding occurring between September and December (COSEWIC 2010d). The larvae are released during the spring to early summer and are primarily found in surface waters, though they may be found in the upper 200 m of the water column. Adult Acadian redfish are mainly found between 150-300 m whereas deepwater redfish are primarily found between 350-500 m (COSEWIC 2010d). These species generally prefer the shelf slopes and deep channel areas; however, they are considered semi-pelagic due to their large vertical diurnal migrations (COSEWIC 2010d). Furthermore, smaller redfish tend to occupy shallower waters and may migrate to deeper waters as they grow (COSEWIC 2010d), indicating that individuals may migrate through the Project Area. Canadian RV Species surveys indicate that redfish are well distributed on the slopes of the Newfoundland Shelf in of the Project Area. Areas of high aggregation for these species continue on the shelf slopes north and south of the Project Area. To date, no critical habitats have been established for these species, but it has been suggested that habitats made up of anemones and coral beds may be linked to redfish survival (COSEWIC 2010d). Current threats to this species include bycatch mortality, overfishing, predation by seals and unfavourable environmental conditions for groundfish.

Because the various life stages of Acadian and deepwater redfish occupy both demersal and pelagic environments, Project activities may result in changes to habitat availability and quality, fish mortality / injury risk and fish health and presence and abundance of these species. Previous studies indicate that adult redfish are able to avoid areas of disturbance (Popper and Hastings 2009). As predicted, Project-related disturbances are localized and short-term and mitigation measures are implemented to reduce potential effects, there is limited potential for interaction with these species. The presence of areas of high aggregation on the slopes outside the Project Area also limits regional population effects on these species.

8.4.6 Pelagic Species (Sharks and Tuna)

Shark species (basking, porbeagle, shortfin mako, and white sharks) and bluefin tuna are highly mobile, pelagic seasonal species in Canadian waters.

Atlantic bluefin tuna migrate to Canadian waters in summer in search of food and move southward in the fall. Distribution of bluefin tuna in Canadian waters is based on commercial fisheries that have

captured individuals in continental shelf waters of the Gulf of St. Lawrence, the Scotian Shelf, and the Grand Bank (COSEWIC 2011). While bluefin tuna have been observed to migrate through the northern and southern sections of the Project Area, it is not frequently occupied by this species (Walli et al. 2009). Historical and current commercial fisheries are the main threats to this species (COSEWIC 2011). Critical habitat has not been established for this species and there are no known spawning or rearing habitats for early life stages of bluefin tuna in Canadian waters.

Basking, shortfin mako, and white sharks occur in Canadian waters in summer months, indicating they may be associated with the seasonal shift of warm Gulf Stream toward the coast. Basking sharks occur throughout Atlantic continental shelf including the Bay of Fundy, Scotian Shelf, and Grand Banks. Distribution data from the Newfoundland Observer Program from 1980-2004 indicate that the sharks are found on the Flemish Cap and the Northeast slope of the Newfoundland Shelf (COSEWIC 2009b). Shortfin makos are typically associated with the warm waters in and around the Gulf Stream and have been captured from the continental shelf of Nova Scotia, the Grand Banks, and the Gulf of St. Lawrence (COSEWIC 2006c). Shortfin mako presence is seasonal and are found in Canadian waters from the later summer to fall. It is suggested that individuals observed in Canadian waters represent only a small proportion of the population (COSEWIC 2006c). White shark have been recorded in Newfoundland waters from the Northeast Newfoundland Shelf and the St. Pierre Bank (COSEWIC 2006c). Ocearch (2017) has also tracked female white sharks from the continental shelf and slopes south of Newfoundland to the Flemish Cap, but the majority of white sharks occupy waters off the east coast of the United States. To date, no critical habitat has been established for these species and individuals of these three shark species may potentially migrate through the Project Area (COSEWIC 2006b, 2006c; 2009b).

For porbeagle sharks In Canadian waters, early, juvenile, and adult life stages are abundant on or near the continental shelf (COSEWIC 2014). Their distribution spans the Project Area on the continental shelf. They are rarely captured at the surface or at depths greater than 200 m in Canadian waters. No critical habitat has been established for this species, however there are mating grounds that lie outside the Project Area on the Grand Banks off southern Newfoundland, the entrance to the Gulf of St Lawrence, and the Georges Bank. Porbeagle sharks mate in this area in the summer and early fall and migrate south in the winter to the pupping grounds in the Sargasso Sea (COSEWIC 2014). Historical fisheries that overexploited the species, current bycatch mortality, and slow recovery affect porbeagle populations.

Tuna and shark species are highly mobile pelagic species that may migrate though the Project Area. This suggests that changes to habitat availability and quality, fish mortality / injury risk and fish health may result for these species from planned Project activities. However, these species are highly mobile, and, with the implementation of mitigation measures, are unlikely to be adversely affected by the Project, and will not affect the residences of other key habitats of individuals or populations.

8.5 Significance of Residual Environmental Effects

As described above, the Project is not likely to result in significant adverse environmental effects on Marine Fish and Fish Habitat. The implementation of mitigation measures, combined with the short-term nature of activities, a deep-water dynamic environment that rapidly disperses marine

discharges, and avoidance behaviours of fish species, results in adverse effects that are negligible to low magnitude, short-term, localized and reversible.

8.5.1 Residual Environmental Effects Summary

The presence of the drilling installation in combination with lighting effects will have localized positive effects on fish abundance and diversity by creating a "reef effect" that aggregates plankton and increases invertebrate colonization, resulting in increased local productivity and food sources. Continuous operation noises or dynamic positioning may result in localized area avoidance; however, fish may remain in the area for relatively higher foraging opportunities. Safety zones around drilling operations may also afford protection to species that are threatened by overfishing. Direct contact with the seabed will occur if drilling installation anchoring is used rather than dynamic positioning, however, pre-drill coral surveys will be undertaken and anchor will be set with a set-back distance of 50 m, where applicable. As the Project Area is an area of low seabed complexity, the introduction of subsea infrastructure may provide opportunities for colonization and increased distribution of benthic species that have pelagic eggs or larvae. This effect would be temporary for the length of drill operations, but combination of increased colonization opportunities and local enrichment may support faster recovery in an otherwise slow recovering environment. Operational discharges, including produced water and wastewater discharges from the drilling installation, will be treated to reduce released hydrocarbons or contaminants to levels strictly regulated by OWTG. Sewage will be treated before discharge and may result in low localized organic enrichment supporting local productivity. Wastewater discharges will be low in volume and highly dispersed in the deep-water environment, resulting in overall low potential for interactions or effects.

Drilling operations will result in the release of associated discharges into the environment. Initial drilling will involve discharge of WBM-associated cuttings approximately 2 to 4 m above the seabed surface and eventually discharge of SBM-associated cuttings approximately 14 m below the ocean surface. SBM-associated drill cuttings will be treated prior to discharge in accordance with the OWTG. The high dispersal of the low toxicity and non-bioaccumulating drill cuttings will have relatively low potential for adverse environmental effects.

Discharged WBM cuttings will settle within the 32 km modelled boundary and will primarily be localized within 2 km of the well site. The WBM cuttings average thickness is above 6.5 mm PNET and conservative 1.5 mm PNET (Kjeilen-Eilertsen et al. 2004; Smit et al. 2006, 2008) within 100 m from the well site, but decreases with distance to below the threshold. As estimated sedimentation may be more than PNET thresholds (Kjeilen-Eilertsen et al. 2004; Smit et al. 2006, 2008) there will likely be some burial and smothering effects from WBM cuttings localized to the extent of the accumulations. In the event that the pre-drill coral survey and risk assessment identifies mitigations required to protect sensitive benthic habitat (i.e. corals and sponges), mitigations may include relocation of well and/or redirection of WBM cuttings discharge location. However, the localized nature of accumulations will not have population level effects, indicating high potential for recovery and recolonization.

The majority of SBM-associated cuttings are dispersed beyond the 32 km modelled boundary in areas of higher currents (Northern Section NPA and SPA) with settling of material within the modelled boundary in areas of lower currents (Northern Section EPA and Southern Section JDB). Due to high

dispersion, average SBM cuttings thicknesses are below the 6.5 mm PNET and conservative 1.5 m PNET (Kjeilen-Eilertsen et al. 2004; Smit et al. 2006, 2008). Furthermore, the SBM cuttings dispersed beyond the modelled area will not result in appreciable accumulations. As overall accumulation of SBM cuttings is low, there is low potential for smothering effects or creating of oxygen depletion conditions, reducing potential recovery and recolonization times.

During formation flow testing with flaring, small quantities of produced water may be sporadically flared resulting in short term and reversible air emissions localized to the Project Area. Contaminant levels in air emissions will follow applicable regulations and guidelines. Light from flaring is considered low in comparison to drilling installation operations lighting. Due to the low emission quantities, the temporary and short-term nature of air and light emissions, there will be limited potential interactions with fish or their habitat.

Wellhead decommissioning will be conducted by cutting of the wellhead rather than blasting for environmental and safety reasons. Wellhead cutting will be conducted by an ROV and result in short term, negligible to low-magnitude emissions of noise and light. Fish will likely temporarily avoid the area during activities. The remaining seabed infrastructure may add small quantities of habitat heterogeneity to the existing environment and potentially aid in recolonization of benthic species and overall recovery.

Geophysical survey operations are short term, localized and sporadic in nature and have reversible, low magnitude effects within the LSA. Mobile fish and invertebrate species are predicted to temporarily avoid areas of geophysical operations, minimizing potential interactions. Sound source arrays will be 'ramped up' to increase initial fish avoidance to limit potential effects. Eggs, larvae, and benthic invertebrates adjacent to geophysical air source arrays may result in injury or mortality. However, due to the highly localized effects and short term nature of operations, there will not be population effects.

Over the life of the project there will be a variety of geophysical, geological, geotechnical, and environmental surveys undertaken. These activities are short-term, occasional and localized in nature and are expected to have limited interactions with fish and fish habitat within the LSA. Sediment sampling equipment will be in direct contact with the seabed and potentially injure or cause mortality in fish; however, the small footprint of this temporary activity is not likely to cause effects on population scales. Water sampling activities are not likely to have interactions with the seabed or fish. Underwater video surveys may have lighting and noise emissions, however the temporary nature of the activity limits potential effects on the environment. Fish may also migrate away from the area while the short-term activity is ongoing.

Marine vessels and helicopters servicing the drilling installation will have short-term, reversible, and low magnitude effects on the RSA. Helicopters have no direct interactions with fish and fish habitat. Vessel exhaust emission levels will follow air quality regulations and guidelines. Vessel discharges are treated in accordance with MARPOL and Canadian requirements prior to discharge. Due to the transitory nature of vessels, the low volume of discharges will not accumulate in any area. The continuous noise and lighting from vessels in transit would be low and result in temporary avoidance by fish.

Table 8.13 summarizes the environmental effects assessment for the Project as a whole, including characterization of potential effects from potential Project interactions and applicable mitigation measures relating to Marine Fish and Fish Habitat. Tables 8.14 to 8.19 then provide individual environmental effects assessment summaries for planned Project activities on each of the ELs that comprise the Project being assessed under CEAA 2012.

Table 8.13 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat – Overall Project

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY	
Summary of Existing Conditions and Ecological and Social Context: Project Area / LSA • The Project Area encompasses the northeast region of the Grand Bank and extends over the slope regions between the Grand Bank and Flemish Cap and part of the Orphan Basin. • Within this marine environment, habitats transition from relatively shallow shelf zones, through the continental slope to deep abyssal regions. • These habitats are used by fish and invertebrate species of commercial, cultural, ecological and/or conservation importance, and support regionally important areas of biodiversity and marine productivity. • Marine fish and their habitats in the Project Area, RSA and in the larger Northwest Atlantic have been and are being affected by a variety of natural and anthropogenic factors and processes. • These include past and on-going fishing activity, offshore petroleum exploration and production, general vessel traffic and other human activities (both planned and routine, as well as illegal activities and accidental events), as well as the effects of climate change and other natural and anthropogenic processes. • These have all collectively, and to varying degrees, influenced the presence, distribution and abundance of fish and invertebrate species as well as the overall size and health of fish populations. • While most fish species present in the LSA and RSA are considered stable, there are several with conservation designations that do or may occur in the area.	**Summary of Key Mitigation** • Use of existing and common vessel and aircraft travel routes for vessels and helicopters will be used where possible and practicable • Low-level aircraft operations will be avoided where it is not required per Transport Canada protocols • Operational discharges will be treated prior to release in accordance with the OWTG and other applicable regulations and standards • The selection and screening of chemicals to be discharged, including drilling fluids, will be in accordance with the Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands • During formation flow testing with flaring, produced hydrocarbons and produced water will be flared. If there is a large amount of produced water encountered, it will be treated in accordance with the relevant regulatory requirements prior to ocean discharge, or shipped to shore for appropriate disposal • Appropriate handling, storage, transportation, and on-shore disposal of solid and hazardous waste • Prior to the start of a drilling campaign, a pre-drill coral survey will be undertaken. A report summarising the coral mapping, risk assessment and planned mitigation measures (if corals are identified) will be prepared and submitted to the C-NLOPB / DFO for review and acceptance. Potential mitigation include relocation of the well and/or relocation of cuttings discharge through a subsea cuttings transport system • Relocation of well and/or redirection of WBM cuttings discharge in the event that the pre-drill coral survey and risk assessment identifies mitigation required to protect sensitive benthic habitat (i.e., corals and sponges) • SBM-related drill cuttings will be returned to the drilling installation and treated in accordance with the OWTG before being discharged to the marine environment. WBM-related drill cuttings will be discharged without treatment • Use of explosives will not be employed for removal of wellheads • At the time of decommissioning a well, the well will be inspected in accordance with applicable regulatory requirements

Table 8.13 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat – Overall Project

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of Drilling Installation	• Change in habitat availability and quality • Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	L-PA	S-M	R	R	H
Drilling and Associated Marine Discharges	• Change in habitat availability and quality • Change in fish mortality, injury, health • Change in fish presence and abundance)	A	L	L-PA	M-L	R	R	H
Formation Flow Testing with Flaring	• Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	L	S	S	R	H
Wellhead Decommissioning	• Change in habitat availability and quality • Change in fish presence and abundance	A	N-L	L	S	S	R	H

Table 8.13 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat – Overall Project

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	PA	S	S	R	H
Geological, Geotechnical and Environmental Surveys	• Change in habitat availability and quality • Change in fish mortality, injury, health • Change in fish presence and abundance	A	N-L	L	S	S	R	H
Supply and Servicing	• Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	L	S	R	R	H

Evaluation of Significance

- Based on the nature and characteristics of the Project and the existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Project is not likely to result in significant adverse effects on Marine Fish and Fish Habitat.
- Although Project-related components, activities and emissions may result in some localized, short-term interactions with fish and fish habitat in parts of the LSA, the number of individuals and habitat areas that may be affected, and the temporary and reversible nature of these interactions, means that the Project will not have overall ecological or population-level effects, and particularly, will not result in detectable decline in overall fish abundance or changes in the spatial and temporal distributions of fish populations within this area.
- For fish species at risk, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA or RSA. The Project will therefore not have implications for the overall abundance, distribution, or health of such species nor its eventual recovery. The Project is not predicted to result in significant adverse effects on marine fish species at risk.

NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.

Table 8.13 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat – Overall Project

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY					
KEY					
Nature / Direction:		Frequency:		Certainty in Predictions:	
P	Positive	O	Occurs once	L	Low level of confidence
A	Adverse	S	Occurs sporadically	M	Moderate level of confidence
N	Neutral (or No Effect)	R	Occurs on a regular basis	H	High level of confidence
		C	Occurs continuously		
Magnitude:				N/A	Not Applicable
N	Negligible	Duration:			
L	Low	S	Short term (For duration of the activity)		
M	Medium	M	Medium term (Beyond duration of the activity – weeks or months)		
H	High	L	Long term (Beyond duration of the activity – years)		
Geographic Extent:		P	Permanent (Recovery unlikely)		
L	Localized, In Immediate Vicinity of Activity	Reversibility:			
PA	Within Project Area	R	Reversible (Will recover to baseline)		
LSA	Within LSA	I	Irreversible (Permanent)		
RSA	Within RSA or Beyond				

Table 8.14 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat – EL 1135

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY	
Summary of Existing Conditions and Ecological and Social Context: EL 1135 • See Table 8.13 for an overview of the Project Area / LSA as a whole. • This EL encompasses areas of the Grand Bank Newfoundland Shelf and Slopes and Flemish Pass including habitats from relatively shallow shelf zones to the continental slope (200-1,100 m). The associated vessel traffic route includes areas of the Newfoundland Shelf to the Flemish Pass. • In this EL, sponge species from the group Demospongiae are characteristic species of Newfoundland Shelf slope areas (250-1,400 m). Coral groups distributed in this EL include soft corals and sea pens. • Area of relatively high species richness. Characteristic fish species include Newfoundland shelf species (sand lance and capelin) to continental slope species (redfish, lanternfish, grenadier species, American plaice, thorny skate, white hake, and Greenland halibut). • Includes areas of the Northeast Shelf and Slope EBSA that is an aggregation area for Greenland halibut and SARA listed spotted wolffish. • Ongoing activities in this EL and the surrounding area includes commercial fisheries.	**Summary of Key Mitigation** See Table 8.13

Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors						
		Nature	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty
Presence and Operation of Drilling Installation	• Change in habitat availability and quality • Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	L-PA	S-M	R	R	H
Drilling and Associated Marine Discharges	• Change in habitat availability and quality • Change in fish mortality, injury, health • Change in fish presence and abundance)	A	L	L-PA	M-L	R	R	H

Table 8.14 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat – EL 1135

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Formation Flow Testing with Flaring	• Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	L	S	S	R	H
Wellhead Decommissioning	• Change in habitat availability and quality • Change in fish presence and abundance	A	N-L	L	S	S	R	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	PA	S	S	R	H
Geological, Geotechnical and Environmental Surveys	• Change in habitat availability and quality • Change in fish mortality, injury, health • Change in fish presence and abundance	A	N-L	L	S	S	R	H
Supply and Servicing	• Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	L	S	R	R	H

Table 8.14 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat – EL 1135

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY
Evaluation of Significance • Based on the nature and characteristics of the Project and the existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Project is not likely to result in significant adverse effects on Marine Fish and Fish Habitat. • Although Project-related components, activities and emissions may result in some localized, short-term interactions with fish and fish habitat in parts of the LSA, the number of individuals and habitat areas that may be affected, and the temporary and reversible nature of these interactions, means that the Project will not have overall ecological or population-level effects, and particularly, will not result in detectable decline in overall fish abundance or changes in the spatial and temporal distributions of fish populations within this area. • For fish species at risk, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA or RSA. The Project will therefore not have implications for the overall abundance, distribution, or health of such species nor its eventual recovery. The Project is not predicted to result in significant adverse effects on marine fish species at risk. NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.
KEY: See Table 8-13

Table 8.15 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat – EL 1137

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY	
Summary of Existing Conditions and Ecological and Social Context: EL 1137 • See Table 8.13 for an overview of the Project Area / LSA as a whole. • This EL encompasses areas of the Grand Bank Newfoundland Shelf and includes habitats from the relatively shallow shelf zone (<200 m). The associated vessel traffic route includes areas of the Newfoundland Shelf. • Coral groups found in this EL include soft corals and gorgonian corals. • Characteristic fish species for the Newfoundland Shelf include sand lance and capelin. Ongoing activities in this EL and the surrounding area includes commercial fisheries (fixed and mobile gear). In the surrounding area are the ongoing petroleum production projects (Hibernia, Hebron, Terra Nova and White Rose).	**Summary of Key Mitigation** See Table 8-13

Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors						
		Nature	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty
Presence and Operation of Drilling Installation	• Change in habitat availability and quality • Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	L-PA	S-M	R	R	H
Drilling and Associated Marine Discharges	• Change in habitat availability and quality • Change in fish mortality, injury, health • Change in fish presence and abundance)	A	L	L-PA	M-L	R	R	H
Formation Flow Testing with Flaring	• Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	L	S	S	R	H

Table 8.15 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat – EL 1137

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Wellhead Decommissioning	• Change in habitat availability and quality • Change in fish presence and abundance	A	N-L	L	S	S	R	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	PA	S	S	R	H
Geological, Geotechnical and Environmental Surveys	• Change in habitat availability and quality • Change in fish mortality, injury, health • Change in fish presence and abundance	A	N-L	L	S	S	R	H
Supply and Servicing	• Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	L	S	R	R	H

Table 8.15 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat – EL 1137

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY
Evaluation of Significance • Based on the nature and characteristics of the Project and the existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Project is not likely to result in significant adverse effects on Marine Fish and Fish Habitat. • Although Project-related components, activities and emissions may result in some localized, short-term interactions with fish and fish habitat in parts of the LSA, the number of individuals and habitat areas that may be affected, and the temporary and reversible nature of these interactions, means that the Project will not have overall ecological or population-level effects, and particularly, will not result in detectable decline in overall fish abundance or changes in the spatial and temporal distributions of fish populations within this area. • For fish species at risk, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA or RSA. The Project will therefore not have implications for the overall abundance, distribution, or health of such species nor its eventual recovery. The Project is not predicted to result in significant adverse effects on marine fish species at risk. NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.
KEY: See Table 8-13

Table 8.16 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat – EL 1139

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Summary of Existing Conditions and Ecological and Social Context: EL 1139 • See Table 8.13 for an overview of the Project Area / LSA as a whole. • This EL encompasses areas of the Flemish Cap slope into the Orphan Basin and includes continental slope to abyssal zone habitats (2,700-3,400 m). The associated vessel traffic route includes areas of the Newfoundland Shelf to Orphan Basin. • Available data indicates presence of sponges in the Orphan Basin area. • Characteristic species for deep slope areas include armed grenadier, blue hake, rabbitfish, and skate species.								**Summary of Key Mitigation** See Table 8-13
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of Drilling Installation	• Change in habitat availability and quality • Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	L-PA	S-M	R	R	H
Drilling and Associated Marine Discharges	• Change in habitat availability and quality • Change in fish mortality, injury, health • Change in fish presence and abundance)	A	L	L-PA	M-L	R	R	H
Formation Flow Testing with Flaring	• Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	L	S	S	R	H

Table 8.16 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat – EL 1139

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Wellhead Decommissioning	• Change in habitat availability and quality • Change in fish presence and abundance	A	N-L	L	S	S	R	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	PA	S	S	R	H
Geological, Geotechnical and Environmental Surveys	• Change in habitat availability and quality • Change in fish mortality, injury, health • Change in fish presence and abundance	A	N-L	L	S	S	R	H
Supply and Servicing	• Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	L	S	R	R	H

Table 8.16 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat – EL 1139

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY
Evaluation of Significance • Based on the nature and characteristics of the Project and the existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Project is not likely to result in significant adverse effects on Marine Fish and Fish Habitat. • Although Project-related components, activities and emissions may result in some localized, short-term interactions with fish and fish habitat in parts of the LSA, the number of individuals and habitat areas that may be affected, and the temporary and reversible nature of these interactions, means that the Project will not have overall ecological or population-level effects, and particularly, will not result in detectable decline in overall fish abundance or changes in the spatial and temporal distributions of fish populations within this area. • For fish species at risk, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA or RSA. The Project will therefore not have implications for the overall abundance, distribution, or health of such species nor its eventual recovery. The Project is not predicted to result in significant adverse effects on marine fish species at risk. NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.
KEY: See Table 8-13

Table 8.17 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat – EL 1140

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Summary of Existing Conditions and Ecological and Social Context: EL 1140 • See Table 8.13 for an overview of the Project Area / LSA as a whole. • This EL encompasses areas of the Flemish Cap slope into the Orphan Basin and includes continental slope to abyssal zone habitats (2,500-3,400 m). The associated vessel traffic route includes areas of the Newfoundland Shelf to Orphan Basin. • Available data indicate presence of sponges in the Orphan Basin area. • Characteristic species for deep slope areas include armed grenadier, blue hake, rabbitfish, and skate species.								**Summary of Key Mitigation** See Table 8-13
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of Drilling Installation	• Change in habitat availability and quality • Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	L-PA	S-M	R	R	H
Drilling and Associated Marine Discharges	• Change in habitat availability and quality • Change in fish mortality, injury, health • Change in fish presence and abundance)	A	L	L-PA	M-L	R	R	H
Formation Flow Testing with Flaring	• Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	L	S	S	R	H

Table 8.17 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat – EL 1140

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Wellhead Decommissioning	• Change in habitat availability and quality • Change in fish presence and abundance	A	N-L	L	S	S	R	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	PA	S	S	R	H
Geological, Geotechnical and Environmental Surveys	• Change in habitat availability and quality • Change in fish mortality, injury, health • Change in fish presence and abundance	A	N-L	L	S	S	R	H
Supply and Servicing	• Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	L	S	R	R	H

Table 8.17 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat – EL 1140

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY
Evaluation of Significance • Based on the nature and characteristics of the Project and the existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Project is not likely to result in significant adverse effects on Marine Fish and Fish Habitat. • Although Project-related components, activities and emissions may result in some localized, short-term interactions with fish and fish habitat in parts of the LSA, the number of individuals and habitat areas that may be affected, and the temporary and reversible nature of these interactions, means that the Project will not have overall ecological or population-level effects, and particularly, will not result in detectable decline in overall fish abundance or changes in the spatial and temporal distributions of fish populations within this area. • For fish species at risk, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA or RSA. The Project will therefore not have implications for the overall abundance, distribution, or health of such species nor its eventual recovery. The Project is not predicted to result in significant adverse effects on marine fish species at risk. NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.
KEY: See Table 8-13

Table 8.18 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat – EL 1141

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY	
Summary of Existing Conditions and Ecological and Social Context: EL 1141 • See Table 8.13 for an overview of the Project Area / LSA as a whole. • This EL encompasses areas of the Flemish Cap slope into the Orphan Basin and includes continental slope to abyssal zone habitats (1,100-2,900 m). The associated vessel traffic route includes areas of the Newfoundland Shelf to Orphan Basin. • In this EL, sea pens have been observed on the slopes of the Flemish Cap. • Includes areas of the Sackville Spur VME and NAFO FCA that are closed due to known sponge grounds that occur in the area. • Includes areas of the Northern and Northwest Flemish Cap VME and NAFO FCA that are closed to fishing due to coral (sea pen) concentrations that provide habitat complexity to the area. • Characteristic species for continental slope areas include grenadier species, blue hake, Greenland halibut, Smalleyed rabbitfish, skate species, and black dogfish. • Ongoing activities in this EL and the surrounding area include commercial fisheries.	**Summary of Key Mitigation** See Table 8-13

Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors						
		Nature	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty
Presence and Operation of Drilling Installation	• Change in habitat availability and quality • Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	L-PA	S-M	R	R	H
Drilling and Associated Marine Discharges	• Change in habitat availability and quality • Change in fish mortality, injury, health • Change in fish presence and abundance)	A	L	L-PA	M-L	R	R	H

Table 8.18 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat – EL 1141

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Formation Flow Testing with Flaring	• Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	L	S	S	R	H
Wellhead Decommissioning	• Change in habitat availability and quality • Change in fish presence and abundance	A	N-L	L	S	S	R	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	PA	S	S	R	H
Geological, Geotechnical and Environmental Surveys	• Change in habitat availability and quality • Change in fish mortality, injury, health • Change in fish presence and abundance	A	N-L	L	S	S	R	H
Supply and Servicing	• Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	L	S	R	R	H

Table 8.18 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat – EL 1141

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY
Evaluation of Significance • Based on the nature and characteristics of the Project and the existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Project is not likely to result in significant adverse effects on Marine Fish and Fish Habitat. • Although Project-related components, activities and emissions may result in some localized, short-term interactions with fish and fish habitat in parts of the LSA, the number of individuals and habitat areas that may be affected, and the temporary and reversible nature of these interactions, means that the Project will not have overall ecological or population-level effects, and particularly, will not result in detectable decline in overall fish abundance or changes in the spatial and temporal distributions of fish populations within this area. • For fish species at risk, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA or RSA. The Project will therefore not have implications for the overall abundance, distribution, or health of such species nor its eventual recovery. The Project is not predicted to result in significant adverse effects on marine fish species at risk. NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.
KEY: See Table 8-13

Table 8.19 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat – EL 1142

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY	
Summary of Existing Conditions and Ecological and Social Context: EL 1142 • See Table 8.13 for an overview of the Project Area / LSA as a whole. • This EL encompasses areas of the Flemish Cap slope into the Orphan Basin and includes continental slope to abyssal zone habitats (800-2,600 m). The associated vessel traffic route includes areas of the Newfoundland Shelf to Orphan Basin. • In this EL, coral groups observed on the slopes of the Flemish Cap include soft corals, sea pens, and antipatharian corals. • Includes areas of the Sackville Spur VME and NAFO FCA that are closed due to known sponge grounds that occur in the area. • Includes areas of the Northern and Northwest Flemish Cap VME and NAFO FCA that are closed to fishing due to coral (sea pen) concentrations that provide habitat complexity to the area. • Characteristic species for continental slope areas include grenadier species, blue hake, Greenland halibut, smalleyed rabbitfish, skate species, and black dogfish. • Ongoing activities in this EL and the surrounding area includes commercial fisheries.	**Summary of Key Mitigation** See Table 8-13

Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors						
		Nature	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty
Presence and Operation of Drilling Installation	• Change in habitat availability and quality • Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	L-PA	S-M	R	R	H
Drilling and Associated Marine Discharges	• Change in habitat availability and quality • Change in fish mortality, injury, health • Change in fish presence and abundance)	A	L	L-PA	M-L	R	R	H

Table 8.19 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat – EL 1142

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Formation Flow Testing with Flaring	• Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	L	S	S	R	H
Wellhead Decommissioning	• Change in habitat availability and quality • Change in fish presence and abundance	A	N-L	L	S	S	R	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	PA	S	S	R	H
Geological, Geotechnical and Environmental Surveys	• Change in habitat availability and quality • Change in fish mortality, injury, health • Change in fish presence and abundance	A	N-L	L	S	S	R	H
Supply and Servicing	• Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	L	S	R	R	H

Table 8.19 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat – EL 1142

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY
Evaluation of Significance • Based on the nature and characteristics of the Project and the existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Project is not likely to result in significant adverse effects on Marine Fish and Fish Habitat. • Although Project-related components, activities and emissions may result in some localized, short-term interactions with fish and fish habitat in parts of the LSA, the number of individuals and habitat areas that may be affected, and the temporary and reversible nature of these interactions, means that the Project will not have overall ecological or population-level effects, and particularly, will not result in detectable decline in overall fish abundance or changes in the spatial and temporal distributions of fish populations within this area. • For fish species at risk, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA or RSA. The Project will therefore not have implications for the overall abundance, distribution, or health of such species nor its eventual recovery. The Project is not predicted to result in significant adverse effects on marine fish species at risk. NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.
KEY: See Table 8-13

8.5.2 Determination of Significance

The Project will not result in significant adverse environmental effects on Marine Fish and Fish Habitat. This conclusion has been reached with a high level of certainty based on the nature and scope of the Project, knowledge about the existing environment within the LSA and RSA, and current understanding of the effects of similar projects on the VC and relevant, planned mitigation measures.

The primary mechanisms of interaction that may have negative effects on this VC include the noise, lights and other environmental emissions associated with the Project, including those that may result in direct interaction with and effects on the seabed and sensitive benthic organisms or habitats. The overall nature and characteristics, localized extent and short-term duration of the various planned components and activities associated with this Project, along with the offshore and dynamic marine environment involved and the planned implementation of standard and effective mitigation measures, will mean that interactions with this VC will be negligible to low and spatially and temporally limited, and thus number of individuals and habitat areas that may be affected by the Project is not anticipated to have overall ecological or population-level effects. Planned Project components and activities will not result in detectable decline in overall fish abundance or changes in the spatial and temporal distributions of fish populations within this area.

For fish species at risk, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA or RSA. The Project will therefore not have implications for the overall abundance, distribution, or health of these species nor its eventual recovery.

8.6 Environmental Monitoring and Follow-up

The Operator will obtain the required authorizations for the Project, and comply with applicable regulations, guidelines, and mitigation measures as identified and committed to in the preceding sections, the implementation of which will be planned, managed, and monitored in accordance with existing operational procedures and policies.

Based on the information presented in the EIS, and the conclusion of the effects assessment, a follow-up program will be undertaken in consideration of sensitive benthic habitat. Follow-up monitoring will occur if drilling is undertaken in the following circumstances:

1) Within an identified VME or FCA
2) Adjacent / near to an identified VME or FCA, such that drill cuttings dispersion model predicts that drill cuttings deposition may occur within the VME or FCA at levels above the biological effects threshold, or
3) In an area where the results of the pre-drill coral survey and risk assessment (DFO/C-NLOPB reviewed and accepted) indicate that monitoring is required

The purpose of the follow-up program would be to determine the effectiveness of mitigation measures in protecting the sensitive benthic habitat. It may include parameters such as:

- Sediment traps and/or seabed core samples to measure drill cuttings deposition
- Current and turbidity measurements
- Visual assessments using high-definition images / video

Detailed design of a follow-up monitoring program would be based on the pre-drill coral survey, potential zone of influence as estimated in the drill cuttings dispersions modelling, location of the well in proximity to the sensitive benthic habitat, other site-specific information collected during planning, and industry experience in conducting similar monitoring programs (e.g. Norwegian Continental Shelf experience). If exploration wells are planned to be drilled under the circumstances identified above, a follow-up monitoring plan will be developed and submitted for C-NLOPB/DFO for review and acceptance at least 60 days prior to drilling.

Please refer to Section 17.4 for more information on the proposed follow-up and monitoring program.

8.7 References

Allers, E., Abed, R.M.M., Wehrmann, L.M., Wang, T., Larsson, A.I., Purser, A. and D. de Beer. 2013. Resistance of *Lophelia pertusa* to coverage by sediment and petroleum drill cuttings. Marine Pollution Bulletin, 74(2013): 132-140.

Alpoim, R., and D. González Troncoso. 2016. Results from Bottom Trawl Survey on Flemish Cap of June-July 2015. NAFO Scientific Council Research Document, 16/24.

Amec Environment and Infrastructure. 2014. Eastern Newfoundland and Labrador Offshore Area Strategic Environmental Assessment Update. Report prepared for the Canada-Newfoundland and Labrador Offshore Petroleum Board, St. John's, NL.

Bakke, T., Klungsøyr, J. and S. Sanni. 2013. Environmental impacts of produced water and drilling waste discharges from the Norwegian offshore petroleum industry. Marine Environmental Research, 92(2013): 154-169.

Baussant, T., Nilsen, M., Westerlund, S., Ramanand, S., Ravagnan, E., Zetsche, E.-M., Gerla, D. and D. van Oevelen. 2014. Study of *Lophelia pertusa* coral under different food conditions and varying drill cutting exposure concentrations. International Research Institute of Stavanger. Project No. 7911886. 2014/075: 21 p.

Bax, N., Carlton, J.T., Matthews-Amos, A., Haedrich, R.L., Howarth, F.G., Purcell, J.E., Reiser, A. and A. Gray .2001. The control of biological invasions in the world's oceans. Conservation Biology, 15: 1234-1246.

Beazley, L.L., Kenchington, E.L., Murillo, F.J. and M. del Mar Sacau. 2013. Deep-sea sponge grounds enhance diversity and abundance of epibenthic megafauna in the northwest Atlantic. ICES Journal of Marine Sciences, doi:10.1093/icesjms/fst124.

Bechmann, R. K., S. Westerlund, T. Baussant, I. C. Taban, D. M. Pampanin, M. Smith, and D. Lowe. 2006. Impacts of drilling mud discharges on water column organism and filter feeding bivalves. IRIS report: 2006/038.

Béguer-Pon, M., Castonguay, M., Shan, S., Benchetrit, J., and J.J. Dodson. 2015. Direct observations of American eels migrating across the continental shelf to the Sargasso Sea. Nature Communications, 6, 8705.

Bell, J.J., McGrath, E., Biggerstaff, A., Bates, T., Bennett, H., Marlow, J. and M. Shaffer. 2015. Sediment impacts on marine sponges. Marine Pollution Bulletin, 94(2015): 5-13.

Benoît, H.P., Savenkoff, C., Ouellet, P., Galbraith, P.S., Chassé, J., and A. Fréchet. 2012. Impacts of fishing and climate-driven changes in exploited marine populations and communities, with implications for management. In Benoît, H.P., Gagné, J.A., Savenkoff, C., Ouellet, P., and M.-N. Bourassa (Eds.), State-of-the-Ocean Report for the Gulf of St. Lawrence Integrated Management (GOSLIM) Area. Canadian Manuscript Report of Fisheries and Aquatic Sciences, 2986: 36-50.

Bomkamp, R.E., Page, H.M., and J.E. Dugan. 2004. Role of food subsidies and habitat structure in influencing benthic communities of shell mounds at sites of existing and former offshore oil platforms. Marine Biology, 146(1): 201-211.

BP Canada Energy Group ULC. 2016. Scotian Basin Exploration Drilling Project Environmental Impact Statement. Prepared by Stantec Consulting Ltd. for BP Canada Energy Group ULC.

Brooke, S.D., Holmes, M.W. and C.M. Young. 2009. Sediment tolerance of two different morphotyopes of the deep-sea coral *Lophelia pertusa* from the Gulf of Mexico. Mar. Ecol. Prog. Ser., 390, 137–144.

Bulh-Mortensen, P., Tenningen, E. and A.B.S. Tysseland. 2015. Effects of water flow and drilling waste exposure on polyp behavior in *Lophelia pertusa*. Marine Biology Research, 11(7): 725-373.

Carroll, A.G., Przeslawski, R., Duncan, A., Gunning, M. and B. Bruce. 2017. A critical review of the potential impacts of marine seismic surveys on fish and invertebrates. Marine Pollution Bulletin, 114(2017): 9-24.

Cimberg, R.L., T. Gerrodette and K. Muzik. 1981. Habitat Requirements and Expected Distribution of Alaska Coral. Final Report, Research Unit 601, VTN Oregon, Inc. Report prepared for the Office of Marine Pollution Assessment, Alaska Office, US Department of Commerce, NOAA, OCSEAP Final Report 54: 207-308.

Clark, M.R., Althaus, F., Schlacher, T.A., Williams, A., Bowden, D.A. and A.R. Rowden. 2016. The impacts of deep-sea fisheries on benthic communities: A review. ICES Journal of Marine Science, 73(Supplement 1): 51-69.

COOGER (Centre for Offshore Oil, Gas and Energy Research) and K. Lee. 2009. Environmental Persistence of Drilling Mud and Fluid Discharges and Potential Impacts. Environmental Studies Research Funds Report, No. 176:1-35.

Cordes, E.E., Jones, D.O.B., Schlacher, T.A., Amon, D.J., Bernardino, A.F., Brooke, S., Carney, R., DeLeo, D.M., Dunlop, K.M., Escobar-Briones, E.G., Gates, A.R., Génio, L., Gobin, J., Henry, L., Herrera, S., Hoyt, S., Joye, M., Kark, S., Mestre, N.C., Metaxas, A., Pfeifer, S., Sink, K., Sweetman, A.K. and U. Witte. 2016. Environmental impacts of the deep-water oil and gas industry: A review to guide management strategies. Frontiers in Environmental Science, 4: 1-26.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2006a. COSEWIC assessment and status report on the American eel *Anguilla rostrata* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. x + 71 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2006b. COSEWIC assessment and status report on the shortfin mako *Isurus oxyrinchus* (Atlantic population) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. vi + 24 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2006c. COSEWIC assessment and status report on the White Shark Carcharodon carcharias (Atlantic and Pacific populations) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, O N. vii + 31 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2007. COSEWIC assessment and status report on the Roughhead Grenadier *Macrourus berglax* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. vii + 40 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2008. COSEWIC assessment and status report on the Roundnose Grenadier *Coryphaenoides rupestris* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. vii + 42 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2009a. COSEWIC assessment and status report on the American Plaice *Hippoglossoides platessoides*, Maritime population, Newfoundland and Labrador population and Arctic population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. x + 74 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2009b. COSEWIC assessment and status report on the Basking Shark *Cetorhinus maximus*, Atlantic population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. viii + 56 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2010a. COSEWIC assessment and status report on the Atlantic Cod *Gadus morhua* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. xiii + 105 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2010b. COSEWIC assessment and status report on the Spiny Dogfish *Squalus acanthias*, Atlantic population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. vii + 50 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2010c. COSEWIC assessment and status report on the Atlantic Salmon *Salmo salar* (Nunavik population, Labrador population, Northeast Newfoundland population, South Newfoundland population, Southwest Newfoundland population, Northwest Newfoundland population, Quebec Eastern North Shore population, Quebec Western North Shore population, Anticosti Island population, Inner St. Lawrence population, Lake Ontario population, Gaspé-Southern Gulf of St. Lawrence population, Eastern Cape Breton population, Nova Scotia Southern Upland population, Inner Bay of Fundy population, Outer Bay of Fundy population) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. xlvii + 136 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2010d. COSEWIC assessment and status report on the Deepwater Redfish/Acadian Redfish complex *Sebastes mentella* and *Sebastes fasciatus*, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. X + 80 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2011. COSEWIC assessment and status report on the Atlantic Bluefin Tuna *Thunnus thynnus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. ix + 30 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2012a. COSEWIC assessment and status report on the Atlantic Wolffish *Anarhichas lupus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. ix + 56 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2012b. COSEWIC assessment and status report on the Spotted Wolffish *Anarhichas minor* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. x + 44 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2012c. COSEWIC assessment and status report on the Northern Wolffish *Anarhichas denticulatus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. x + 41 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2012d. COSEWIC assessment and status report on the Thorny Skate *Amblyraja radiata* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. ix + 75 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2012e. COSEWIC assessment and status report on the Cusk *Brosme brosme* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. x + 85 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2014. COSEWIC assessment and status report on the Porbeagle *Lamna nasus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. xi + 40 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2015. COSEWIC assessment and status report on the Winter Skate *Leucoraja ocellata*, Gulf of St. Lawrence population, Eastern Scotian Shelf - Newfoundland population and Western Scotian Shelf - Georges Bank population in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. xviii + 46 pp.

Cox, B.S., Dux, A.M. and C.S. Guy. 2011. Use of seismic air guns to reduce survival of salmonid eggs and embyros: A pilot study.

Cranford, P.J., Gordon Jr, D.C., Lee, K., Armsworthy, S.L., and G.H. Tremblay. 1999. Chronic toxicity and physical disturbance effects of water-and oil-based drilling fluids and some major constituents on adult sea scallops (*Placopecten magellanicus*). Marine Environmental Research, 48(3), 225-256.

Daan, R., Mulder, M. and A.V. Leeuwen. 1994. Differential sensitivity of macrozoobenthic species to discharges of oil-contaminated drill cuttings in the North Sea. Netherlands Journal of Sea Research, 33(1): 113-127.

Davis, R.A., Thomson, D. H., and C.I. Malme. 1998. Environmental Assessment of Seismic Exploration on the Scotian Shelf. Prepared for Mobil Oil Canada Properties Ltd., Shell Canada Ltd. and Imperial Oil Ltd. Submitted to the Canada - Nova Scotia Offshore Petroleum Board, Halifax, NS.

DeBlois, E.M., Paine, M.D., Kilgour, B.W., Tracy, E., Crowley, R.D., Williams, U.P., and G.G. Janes. 2014a. Alterations in bottom sediment physical and chemical characteristics at the Terra Nova offshore oil development over ten years of drilling on the Grand Banks of Newfoundland, Canada. Deep Sea Research Part II: Topical Studies in Oceanography, 110: 13-25.

DeBlois, E.M., Tracy, E., Janes, G.G., Crowley, R.D., Wells, T.A., Williams, U.P., Paine, M.D., Mathieu, A., and B.W. Kilgour. 2014b. Environmental effects monitoring at the Terra Nova offshore oil development (Newfoundland, Canada): Program design and overview. Deep Sea Research Part II: Topical Studies in Oceanography, 110, 4-12.

De Robertis, A. abd N.O. Handegard. 2013. Fish avoidance of research vessels and the efficacy of noise-reduced vessels: A review. ICES Journal of Marine Sciences, 70(1): 34-45.

Det Norske Veritas. 2013. Monitoring of drilling activities in areas with presence of cold water corals. Prepared for Norsk Olje og Gass. Project No. EP021626.

DFO (Fisheries and Oceans Canada). 2010. Recovery Potential Assessment for Roundnose Grenadier, *Coryphaenoides rupestris*. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep., 2010/021.

DFO (Fisheries and Oceans Canada). 2012. Proceedings of the Newfoundland and Labrador Regional Advisory Process for the Recovery Potential Assessment of American Plaice (*Hippoglossoides platessoides*), Newfoundland and Labrador Designatable Unit; January 24-26, 2011. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2011/042.

DFO (Fisheries and Oceans Canada). 2015. Recovery Strategy for Northern Wolffish (*Anarhichas denticulatus*) and Spotted Wolffish (*Anarhichas m*inor), and Management Plan for Atlantic Wolffish (*Anarhichas lupus*) in Canada [Draft]. Fisheries and Oceans Canada: Newfoundland and Labrador Region. St. John's, NL. viii + 81 p.

Edge, K.J., Johnston, E.L., Dafforn, K.A., Simpson, S.L., Kutti, T., and R.J. Bannister. 2016. Sublethal effects of water-based drilling muds on the deep-water sponge *Geodia barretti*. Environmental Pollution, 212: 525-534.

Ellis, J.I., Fraser, G., and Russell. 2012. Discharged drilling waste from oil and gas platforms and its effects on benthic communities. Marine Ecology Progress Series, 456, 285-302.

Engås, A, S. Løkkeborg, E. O., and A.V. Soldal. 1996. Effects of seismic shooting on local abundance and catch rates of cod (*G. morhua*) and haddock (*M. aeglefinus*). Canadian Journal of Fisheries and Aquatic Sciences, 53(10): 2238-2249.

Engås, A. and S. Løkkeborg. 2002. Effects of seismic shooting and vessel-generated noise on fish behaviour and catch rates. Bioacoustics, 12(2-3), 313-316.

Environment Canada. 1998. Reference methods for determining acute lethality of sediment to marine or estuarine amphipods. Report EPS 1/RM/35. Environment Canada, Ottawa, Ontario.

Environment Canada. 2002. Biological test Method: Reference Method for Determining the Toxicity of Sediment Using Luminescent Bacteria in a Solid-Phase Test. Report EPS 1/RM/42. Environment Canada, Ottawa, Ontario.

Ennis, G.P., Hooper, R.G. and D.M. Taylor. 1990. Changes in the composition of snow crab (*Chionoecetes opilio*) participating in the annual breeding migration in Bonne Bay, Newfoundland. Can. J. Fish. Aquat. Sci., 47: 2242-2249

Fefer, M. 2001. January. Environmentally Friendlier Drilling Mud Base Fluids. In Canadian International Petroleum Conference. Petroleum Society of Canada.

Gagnon, M.M., and S. Bakhtyar. 2013. Induction of fish biomarkers by synthetic-based drilling muds. PloS one, 8(7): e69489.

Gates, A.R. and D.O.B. Jones. 2012. Recovery of benthic megafauna from anthropogenic disturbance at a hydrocarbon drilling well (380m depth in the Norwegian Sea). PLOS One, 7(10).

Gates, A.R., Benfiled, M.C., Booth, D.J., Fowler, A.M., Skropeta, D. and D.O.B. Jones. 2016. Deep-sea observations at hydrocarbon drilling locations: Contributions from the SERPENT Project after 120 field visits. Deep-Sea Research II (in press).

Gausland, L. 1993. Impact of offshore seismic on marine life. 55th Meeting of the European Association of Exploration Geophysicists, Stavanger.

Hamoutene, D., Payne, J. F., Andrews, C., Wells, J., and J. Guiney. 2004. Effect of a Synthetic Drilling Fluid (IPAR) on Antioxidant Enzymes and Peroxisome Proliferation in the American Lobster, Homarus americanus. Can. Tech. Rep. Fish. Aquat. Sci./Rapp. Tech. Can. Sci. Halieut. Aquat., (2554), 15.

Hassel, A., Knutsen, T., Dalen, J., Løkkeborg, S., Skaar, K., Østensen, Ø. Haugland, E.K., Fonn, M., Høines, Å., and M.A. Misund. 2003. Reaction of sandeel to seismic shooting: A field experiment and fishery statistics study. Institute of Marine Research, Bergen, Norway.

Hawkins, A.D., Pembroke, A.E. and A.N. Popper. 2015. Information gaps in understanding the effects of noise on fishes and invertebrates. Reviews in Fish Biology and Fisheries, 25: 39-64.

Hildebrand, J. 2004. Impacts of anthropogenic sound on cetaceans. Unpublished paper submitted to the International Whaling Commission Scientific Committee SC/56 E, 13.

Holdway, D.A. 2002. The acute and chronic effects of wastes associated with offshore oil and gas production on temperate and tropical marine ecological processes. Marine Pollution Bulletin, 44(2002): 185-203.

Hoolihan, J.P., Wells, R.J.D., Luo, J., Falterman, B., Prince, E.D., and J.R. Rooker. 2014. Vertical and horizontal movements of yellowfin tuna in the Gulf of Mexico. Marine and Coastal Fisheries, 6(1), 211-222.

Hurley, G., and J. Ellis. 2004. Environmental Effects of Exploratory Drilling Offshore Canada: Environmental Eeffects Monitoring Data and Literature Review: Final Report.

IOGP (International Association of Oil and Gas Producers). 2016. Environmental Fate and Effects of Ocean Discharge of Drill Cuttings and Associated Drilling Fluids from Offshore Oil and Gas Operations. IOGP Report 543.

Jagwani, D., Shukla, P., Kulkarni, A., Ramteke, D.S., and H.D. Juneja. 2011. Organ Specific Distribution of PAHs in a Carnivorous Fish Species Following Chronic Exposure to Used Synthetic-Based Drilling Mud. Polycyclic Aromatic Compounds, 31(4), 227-242.

Järnegren, J., Brooke, S. and H. Jensen. 2016. Effects of drill cuttings on larvae of the cold-water coral *Lophelia pertusa*. Deep-Sea Research II (in press).

Jones, D.O.B., Gates, A.R. and B. Lausen. 2012. Recovery of deep-water megafaunal assemblages from hydrocarbon drilling disturbance in the Faroe-Shetland Channel. Marine Ecology Progress Series, 461:71-82.

Jonsson, N., L.P. Hansen, and B. Jonsson. 1993. Migratory behaviour and growth of hatchery-reared post-smolt Atlantic salmon *Salmo salar*. Journal of Fish Biology, 42: 435-443.

Jonsson, B. and N. Jonsson. 2005. Factors affecting marine production of Atlantic salmon (*Salmo salar*). Can. J. Fish. Aquat. Sci., 61: 2369-2383.

Jorissen, F. J., Bicchi, E., Duchemin, G., Durrieu, J., Galgani, F., Cazes, L., Gaultier, M. and R. Camps. 2009. Impact of oil-based drill mud disposal on benthic foraminiferal assemblages on the continental margin off Angola. Deep Sea Research Part II: Topical Studies in Oceanography, 56(23): 2270-2291.

Keenan, S.F., Benfield, M.C., and J.K. Blackburn. 2007. Importance of the artificial light field around offshore petroleum platforms for the associated fish community. Marine Ecology Progress Series, 331: 219-231.

Kingston, P.F. 1992. Impact of offshore oil production installations on the benthos of the North Sea. ICES Journal of Marine Science, 49: 45-53.

Kjeilen-Eilertsen, G., Trannum, H., Jak, R., Smit, M., Neff, J., and G. Durell. 2004. Literature report on burial: Derivation of PNEC as component in the MEMW model tool. Report AM 2004, 24.

Kleckner, R.C., and J.D. McCleave. 1982. Entry of migrating American eel leptocephali into the Gulf Stream system. Helgoländer Meeresuntersuchungen, 35(3), 329.

Knudby, A., Kenchington, E., and F.J. Murillo. 2013. Modeling the distribution of Geodia sponges and sponge grounds in the Northwest Atlantic. PLOS One, 8(12).

Knutsen, H., Jorde, P. E., Sannaes, H., Rus Hoelzel, A., Bergstad, O. A., Stefanni, S., Johansen, T. and N.C. Stenseth. 2009. Bathymetric barriers promoting genetic structure in the deepwater demersal fish cusk (*Brosme brosme*). Molecular Ecology, 18(15): 3151-3162.

Kosheleva, V. 1992. The impact of air guns used in marine seismic explorations on organisms living in the Barents Sea. In Fisheries and Offshore Petroleum Exploitation 2nd International Conference, Bergen, Norway (Vol. 6, No. 8).

Krieger, K.J. and Wing, B.L. 2002. Megafauna associations with deepwater corals (*Primnoa* spp.) in the Gulf of Alaska. Hydrobiologia, 471(1-3), 83-90.

Kulka D., Hood C., Huntington J. 2007. Recovery strategy for Northern wolffish (*Anarhichas denticulatus*) and spotted wolffish *(Anarhichas minor*), and management plan for Atlantic wolffish (*Anarhichas lupus*) in Canada. Fisheries and Oceans Canada: Newfoundland and Labrador region. St-John's, NL.

Kulka, D.W., Simpson, M.R., and R.G. Hooper. 2004. Changes in distribution and habitat associations of Wolffish (Anarhichadidae) in the Grand Banks and Labrador Shelf. DFO. Can. Sci. Advis. Sec. Res. Doc., 04/113. 48 pp.

Kutti, T., Bannister, R.J., Fosså, J.H. Krogness, C.M., Tjensvoll, I. and G. Søvik. 2015. Metabolic responses of the deep-water sponge *Geodia barretti* to suspended bottom sediment, simulated mine tailings and drill cuttings. Journal of Experimental Marine Biology and Ecology, 473(2015): 64-72.

Larsson, A.I. and A. Purser. 2011. Sedimentation of the cold-water coral *Lophelia pertusa*: Cleaning effiency from natural sediments and drill cuttings. Marine Pollution Bulletin, 62(2011): 1159-1168.

Larsson, A.I., van Oevelen, D., Purser, A. and L. Thomsen. 2013. Tolerance to long-term exposure of suspended benthic sediments and drill cuttings in the cold-water coral *Lophelia pertusa*. Marine Pollution Bulletin, 70(2013): 176-188.

Lee, K., Armsworthy, S.L., Cobanli, S.E., Cochrane, N.A., Cranford, P.J., Drozdowski, A., Hamoutene, D., Hannah, C.G., Kennedy, E., King, T., Niu, H., Law, B.A., Li, Z., Milligan, T.G., Neff, J., Payne, J.F., Robinson, B.J., Romero, M. and T. Worcester. 2011. Consideration of the potential impacts on the marine environment associated with offshore petroleum exploration and development activities. DFO. Can. Sci. Advis. Sec. Res. Doc., 2011/060: xii + 134 pp.

Levin, L.A. 1982. The Roles of Life History, Dispersal and Interference Competition in the Population and Community Structure of a Dense Infaunal Polychaete Assemblage (Doctoral Dissertation). University of California, San Diego, CA.

LGL Limited. 2003. Orphan Basin Strategic Environmental Assessment. Report Prepared for Canada-Newfoundland Offshore Petroleum Board, St. John's, NL. Project No. SA767.

LGL Limited. 2014. Environmental assessment of BP Exploration (Canada) Limited's Tangier 3-D Seismic Survey. BP Document NS-HS-REP-BP-01-000 and LGL Rep. SA1222. Rep. by LGL Limited, Mahone Bay, NS and St. John's, NL for BP Exploration Canada Limited, Calgary, AB. 177 pp. + appendices.

Li, Z., Ribinson, B., Ma, E., Cobanli, S., and K. Lee. 2009. Biodegradation of Synthetic Drilling Mud in Marine Sediments. in: G.B. Wickramanayake and H.V. Rectanus (Chairs), In Situ and On-Site Bioremediation-2009. Tenth International In Situ and On-Site Bioremediation Symposium (Baltimore, MD; May 5-8, 2009).

Liefmann, S. 2016. Eco-physiological responses of cold-water corals to anthropogenic sedimentation and particle shapes. MSc Thesis; Norwegian University of Science and Technology, Trondheim, Norway.

Løkkeborg, S. 1991. Effects of geophysical survey on catching success in longline fishing. Paper presented at the International Council for the Exploration of the Sea (ICES) Annual Science Conference. ICES. 40: 1-9.

Maldonado, M., Giraud, K., and C. Carmona. 2008. Effects of sediment on the survival of asexually produced sponge recruits. Marine Biology, 154(4): 631-641.

Martin, B., J. Quijano, J., and M.-N. Matthews. 2017. Eastern Newfoundland Drilling Noise Assessment: Qualitative Assessment of Radiated Sound Levels and Acoustic Propagation Conditions. Document 01366, Version 2.0. Technical report by JASCO Applied Sciences for Stantec Consulting Ltd.

Matishov, G. G. 1992. The reaction of bottom-fish larvae to airgun pulses in the context of the vulnerable Barents Sea ecosystem. In Fisheries and Offshore Petroleum Exploitation 2nd International Conference, Bergen, Norway (pp. 6-8).

McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, M.-N., Jenner, C., Prince, R.I.T. and J. Murdoch. 2000. Marine seismic surveys - A study of environmental implications. APPEA (Australian Petroleum Production and Exploration Association) Journal, 40, 692-708.

McCauley, R., Day, R. D., Swadling, K. M., Fitzgibbon, Q. P., Watson, R. A., and J.M. Semmens. 2017. Widely used marine seismic survey air gun operations negatively impact zooplankton. Nature Ecology and Evolution, 1, 1-8.

McKenzie, L.A., Brooks, R., and E.L. Johnston. 2011. Heritable pollution tolerance in a marine invader. Environmental Research, 111(7), 926-932.

Misund, O. A., Øvredal, J. T. and M.T. Hafsteinsson. 1996. Reactions of herring schools to the sound field of a survey vessel. Aquatic Living Resources, 9(1), 5-11.

Mooney, T. A., Samson, J. E., Schlunk, A. D. and S. Zacarias. 2016. Loudness-dependent behavioral responses and habituation to sound by the longfin squid (*Doryteuthis pealeii*). Journal of Comparative Physiology, 202(7), 489-501.

Morandin, L.A. and P.D. O'Hara. 2016. Offshore oil and gas, and operational sheen occurrence: is there potential harm to marine birds? Environmental Reviews, 24(3), 285-318.

Morley, E.L., Jones, G., and A.N. Radford. 2014. The importance of invertebrates when considering the impacts of anthropogenic noise. Proc. R. Soc. B, 281(1776): 2013-2683.

Morris, C.J., Gregory, R. S., Laurel, B.J., Methven, D.A. and M.A. Warren. 2010. Potential effect of eelgrass (*Zostera marina*) loss on nearshore Newfoundland fish communities, due to invasive green crab (*Carcinus maenas*). DFO Can. Sci. Advis. Sec. Res. Doc., 2010/140: iv + 17 pp.

Murillo, F.J., Kenchington, E., Beazley, L., Lirette, C., Knudby, A., Guijarro, J., Benoît, H., Bourdages, H., Sainte-Marie, B. 2016. Distribution modelling of sea pens, sponges, stalked tunicates and soft corals from Research Vessel survey data in the Gulf of St. Lawrence for use in the identification of significant benthic areas. Can. Tech. Rep. Fish. Aquat. Sci., 3170: vi + 132 pp.

Murillo, F.J., Muñoz, P.D., Cristobo, J., Rios, P., Gonzalez, C., Kenchington, E. and A. Serrano. 2012. Deep-sea sponge grounds of the Flemish Cap, Flemish Pass and the Grand Banks of Newfoundland (Northwest Atlantic Ocean): Distribution and species composition. Marine Biology Research, 8:842-854.

Nedwed, T., Smith, J. P., and R. Melton. 2006. Fate of Nonaqueous Drilling Fluid Cuttings Discharged from a Deepwater Exploration Well. In: SPE International Health, Safety & Environment Conference. Society of Petroleum Engineers.

Neff, J.M. 2002. Bioaccumulation in Marine Organisms: Effects of Contaminants from Oil Well Produced Water. Elsevier, Amsterdam, 452 pp.

Neff, J.M. 2010. Fate and Effects of Water-based Drilling Muds and Cuttings in Cold Water Environments. Houston (TX): Report to Shell Exploration and Production Company.

Neff, J.M., Breteler, R.J., Saksa, F.I., and R.S. Carr. 1985. Chronic Effects of Drilling Fluids Discharged to the Marine Environment, with Emphasis on Bioaccumulation/Biomagnification Potential of Drilling Fluid Metals. American Petroleum Institute, Washington, DC.

Neff, J.M., S. McKelvie and R.C. Ayers Jr. 2000. Environmental Impacts of Synthetic-based Drilling Fluids. Report prepared for MMS by Robert Ayers & Associates, Inc. August 2000. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2000-064.

Netto, S. A., Gallucci, F., and G. Fonseca. 2009. Deep-sea meiofauna response to synthetic-based drilling mud discharge off SE Brazil. Deep Sea Research Part II: Topical Studies in Oceanography, 56(1), 41-49.

Pabortsava, K., Purser, A., Wagner, H. and L Thomsen. 2011. The influence of drill cuttings on physical characteristics of phytodetritus. Marine Pollution Bulletin, 62(2011): 2170-2180.

Paine, M. D., DeBlois, E. M., Kilgour, B. W., Tracy, E., Pocklington, P., Crowley, R. D., Williams, U.P., and G.G. Janes. 2014. Effects of the Terra Nova offshore oil development on benthic macro-invertebrates over 10 years of development drilling on the Grand Banks of Newfoundland, Canada. Deep Sea Research Part II: Topical Studies in Oceanography, 110: 38-64.

Parry, G.D., and A. Gason. 2006. The effect of seismic surveys on catch rates of rock lobsters in western Victoria, Australia. Fisheries Research, 79: 272-284.

Payne, J.F. 2004. Potential effect of seismic surveys on fish eggs, larvae and zooplankton. DFO Canadian Science Advisory Secretariat Research Document, 2004/125.

Payne, J.F., Andrews, C., Guiney, J. and S. Whiteway. 2006. Risks associated with drilling fluids at petroleum development sites in the offshore: Evaluation of the potential for an aliphatic hydrocarbon based drilling fluid to produce sedimentary toxicity and for barite to be acutely toxic to plankton. Canadian Technical Report in Fisheries and Aquatic Sciences, 2679: 28 pp.

Payne, J.F., Coady, J. and D. White. 2009. Potential effects of seismic airgun discharges on monkfish eggs (Lophius americanus) and larvae. Environmental Studies Research Funds Report No. 170, St. John's, NL. 32 pp.

Pearson, W. H., Skalski, J.R., Sulkin, S.D. and C. I. Malme. 1994. Effects of seismic energy releases on the survival and development of zoeal larvae of Dungeness crab (*Cancer magister*). Marine Environmental Research 38:93-113.

Peterson, C.H., Kennicutt II, M.C., Green, R.H., Montagna, P., Harper, Jr, D.E., Powell, E.N., and P.F. Roscigno. 1996. Ecological consequences of environmental perturbations associated with offshore hydrocarbon production: A perspective on long-term exposures in the Gulf of Mexico. Canadian Journal of Fisheries and Aquatic Sciences, 53(11): 2637-2654.

Picken, G. B. and A.D. McIntyre. 1989. Rigs to reefs in the North Sea. Bulletin of Marine Science, 44(2), 782-788.

Popper, A. N., and M. C. Hastings. 2009. The effects of human-generated sound on fish. Integrative Zoology, 4: 43-52.

Popper, A. N., Hawkins, A. D., Fay, R. R., Mann, D., Bartol, S., Carlson, T., Coombs, S., Ellison, W. T., Gentry, R., Halvorsen, M. B., Løkkeberg, S., Rogers, P., Southall, B. L., Zeddies, D. and W.N. Tavolga. 2014. Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI," ASA S3/SC1.4 TR-2014. Springer and ASA Press, Cham, Switzerland (2014).

Przeslawski, R., Byrne, M. and C. Mellin. 2015. A review and meta-analysis of the effects of multiple abiotic stressors on marine embryos and larvae. Global Change Biology, 21(6), 2122-2140.

Punzo, E., Strafella, P., Scarcella, G., Spagnolo, A., De Biasi, A.M., and G. Fabi. 2015. Trophic structure of polychaetes around an offshore gas platform. Marine Pollution Bulletin, 99(1): 119-125.

Purser, A. 2015. A time series study of Lophelia pertusa and reef megafauna response to drill cuttings exposure on the Norwegian margin. PLOS One, 10(7).

Raimondi, P. T., Barnett, A. M., and P.R. Krause. 1997. The effects of drilling muds on marine invertebrate larvae and adults. Environmental Toxicology and Chemistry, 16(6), 1218-1228.

Raymond, E.H. and E.A. Widder. 2007. Behaviuoral responses of two deep-sea fish species to red, far-red and white light. Marine Ecology Progress Series, 350: 291-298.

Reddin, D.G., and W.M. Shearer. 1987. Sea-Surface Temperature and Distribution of Atlantic salmon in the Northwest Atlantic Ocean. American Fisheries Society Symposium, I: 262-275.

Reddin, D.G. and K.D. Friedland. 1993. Marine environmental factors influencing the movement and survival of Atlantic salmon. Pages 79-103 In: D. Mills (ed.). Salmon in the Sea and New Enhancement Strategies. Atlantic Salmon Federation, Fishing New Books/Blackwell Publishing, ON.

Reddin, D.G. 2006. Perspectives on the marine ecology of Atlantic salmon (*Salmo salar*) in the Northwest Atlantic. Canadian Science Advisory Secretariat Research Document 2006/018.

Redman, A. D., Parkerton, T. F., Letinski, D. J., Manning, R. G., Adams, J. E. and P.V. Hodson. 2014a. Evaluating toxicity of heavy fuel oil fractions using complementary modeling and biomimetic extraction methods. Environmental Toxicology and Chemistry, 33(9), 2094–2104. https://doi.org/10.1002/etc.2659

Redman, A. D., Parkerton, T. F., Comber, M. H., Paumen, M. L., Eadsforth, C. V., Dmytrasz, B., King D, Warren CS, den Haan K, and N. Djemel. 2014b. PETRORISK: A risk assessment framework for petroleum substances. Integrated Environmental Assessment and Management, 10(3), 437–448. https://doi.org/10.1002/ieam.1536

Redman, A. D. and T.F. Parkerton. 2015. Guidance for improving comparability and relevance of oil toxicity tests. Marine Pollution Bulletin, 98(1–2), 156-170. https://doi.org/10.1016/j.marpolbul.2015.06.053

Redman, A. D., Parkerton, T. F., Leon Paumen, M., Butler, J. D., Letinski, D. J. and K den Haan. 2017. A re-evaluation of PETROTOX for predicting acute and chronic toxicity of petroleum substances. Environmental Toxicology and Chemistry, 9999(9999), 1-8. https://doi.org/10.1002/etc.3744

Richardson, W.J., Greene, C.R. Jr., Malme, C.I., and Thomson, D.H. 1995. Marine Mammals and Noise. Academic Press, San Diego, CA.

Røstad, A., Kaartvedt, S., Klejvar, T.A. and W. Melle. 2006. Fish are attracted to vessels. ICES Journal of Marine Science, 63: 1431-1437.

Ruus, A., Schaanning, M., Øxnevad, S., and K. Hylland. 2005. Experimental results on bioaccumulation of metals and organic contaminants from marine sediments. Aquatic Toxicology, 72(3), 273-292.

Sammarco, P.W., Atchison, A.D. and G.S. Boland. 2004. Expansion of coral communities within the Northern Gulf of Mexico via offshore oil and gas platforms. Marine Ecology Progress Series, 280: 129-143.

Samson, J.E., Mooney, T.A., Gussekloo, S.W.S. and R.T. Hanlon. 2014. Graded behavioral responses and habituation to sound in the common cuttlefish *Sepia officinalis*. Journal of Experimental Biology, 217: 4347-4355.

Santos, M.F.L., Lana, P.C., Silva, J., Fachel, J.G., and F.H. Pulgati. 2009. Effects of non-aqueous fluids cuttings discharge from exploratory drilling activities on the deep-sea macrobenthic communities. Deep Sea Research Part II: Topical Studies in Oceanography, 56(1), 32-40.

Schaanning, M., Russ, A., Bakke, T., Hylland, K. and F. Olsgard. 2002. Bioavailability of heavy metals in drilling muds. Norwegian institute for Water Research report SNO 4571-2002.

Schaanning, M.T., Trannum, H.C., Øxnevad, S., Carroll, J. and R. Bakke. 2008. Effects of drill cuttings on biogeochemical fluxes and macrobenthos of marine sediments. Journals of Experimental Marine Biology and Ecology, 361 (2008): 49-57.

Scott, W.B., and M.G. Scott. 1988. Atlantic fishes of Canada. Canadian Bulletin of Fisheries and Aquatic Sciences, 219: 731 p.

Sheehan, T.F., D.G. Reddin, G. Chaput, and M.D. Renkawitz. 2012. SALSEA North America: a pelagic exosystem survey targeting Atlantic salmon in the Northwest Atlantic. ICES Journal of Marine Science, 69(9): 1580-1588. Doi:10.1093/icesjms/fss052.

Sink, K., Atkinson, L., Kerwarth, S. and T. Samaai. 2010. Assessment of offshore benthic biodiversity on the Agulhas Bank and the potential role of petroleum infrastructure in offshore spatial management. Report prepared for WWF South Afrive and PetroSA.

Skalski, J.R., Pearson, W.H. and C.I. Malme. 1992. Effects of sounds from a geophysical survey device on catch-per-unit-effort in a hook-and-line fishery for rockfish (*Sebastes* spp). Canadian Journal of Fisheries and Aquatic Sciences, 49: 1357-1365

Slabbekoorn, H., Bouton, N., van Opzeeland, I., Coers, A., Cate, C., and A.N. Popper. 2010. A noisy spring: the impact of globally rising underwater sound levels on fish. Trends Ecol. Evol. 25, 419 –427. (doi:10. 1016/j.tree.2010.04.005.

Smit, M.G.D., Tamis, J.E., Jak, R.G, Karman, C.C., Kjeilen-Eilertsen, H., Trannum, H. and J. Neff. 2006. Threshold levels and risk functions for non-toxic sediment stressors: burial, grain size changes and hypoxia. Summary. ERMS Report no. 9.

Smit, M.G.D., Holthaus, K.I.E., Trannum, H.C., Neff, J.M., Kjeilen-Eilertsen, G., Jak, R.G., Singsaas, I., Huiihbregts, M.A.J. and A.J. Hendriks. 2008. Species sensitivity distributions for suspended clays, sediment burial and grain size change in the marine environment. Environmental Toxicology and Chemistry, 27(4): 1006-1012.

Solan, M., Hauton, C., Godbold, J.A., Wood, C.L., Leighton, T.G. and P. White. 2016. Anthropogenic sources of underwater sound can modify how sediment-dwelling invertebrates mediate ecosystem properties. Science Reports, 6: 20540.

Stantec Consulting Ltd. 2013. Development of a Marine Sediment Quality Guideline for Puredrill IA-35. Prepared for Hibernia Management and Development Company Limited, St. John's, NL. ii + 15 pp.

Stantec Consulting Ltd. 2016. Scotian Basin Exploration Drilling Project – Environmental Impact Statement. Prepared for BP Canada Energy Group ULC.

Still, I., Rabke, S., and J. Candler. 2000. Development of a standardized reference sediment to improve the usefulness of marine benthic toxicity testing as a regulatory tool. Environmental Toxicology, 15(5), 406-416.

Sun, Z., Hamel, J.F. and Mercier, A. 2011. Planulation, larval biology, and early growth of the deep-sea soft corals *Gersemia fruticosa* and *Duva florida* (Octocorallia: Alcyonacea). Invertebrate Biology, 130(2), 91-99.

Tait, R.D., Maxon, C.L., Parr, T.D. and F.C. Newton III. 2016. Benthos Response following petroleum exploration in the southern Caspian Sea: Relating effects of nonaqueous drilling fluid, water depth and dissolved oxygen. Marine Pollution Bulletin, 110(2016): 520-527.

Teixeira, T.P., Neves, L.M. and F.G. Araújo. 2009. Effects of nuclear power plant thermal discharge on habitat complexity and fish community structure in Ilha Grande Bay, Brazil. Marine Environmental Research, 68 (2009): 188-195.

Templeman, N.D. 2010. Ecosystem status and trends report for the Newfoundland and Labrador Shelf. Canadian Science Advisory Secretariat Research Document 2010/026.

Terrens, G.W., Gwyther, D., Keough, M.J. and R.D. Tait. 1998. Environmental assessment of synthetic based drilling mud discharge to Bass Strait, Australia. SPE 46622.

Thomson, R. B., Sporcic, M., Foster, S. D., Haddon, M., Potter, A., Carroll, A., Przeslawski, R., Knuckey, I., Koopman, M. and J. Hartog. 2014. Examining Fisheries Catches and Catch Rates for Potential Effects of Bass Strait Seismic Surveys. CSIRO and Geoscience Australia. Hobart and Canberra.

Tjensvoll, I., Kutti, T., Fosså, J.H. and R.J. Bannister. 2013. Rapid respiratory responses of the deep-water sponge *Geodia barretti* exposed to suspended solids. Aquatic Biology, 19: 65-73.

Trannum, H.C., Nilsson, H.C., Schaanning, M.T. and S. Øxnevad. 2010. Effects of sedimentation from water based drill cuttings and natural sediment on benthic macrofaunal community structure and ecosystem processes. Journal of Experimental Biology and Ecology, 383: 111-121.

Trannum, H.C., Nilsson, H.C., Schaanning, M.T., and K. Norling. 2011. Biological and biogeochemical effects of organic matter and drilling discharges in two sediment communities. Marine Ecology Progress Series, 442: 23-36.

Tsvetnenko, Y.B., Black, A.J., and L.H. Evans. 2000. Development of marine sediment reworker tests with Western Australian species for toxicity assessment of drilling mud. Environmental Toxicology, 15(5), 540-548.

Vincent-Akpu, I. F. 2013. Chronic Toxicity of Synthetic Based Fluid (Parateq©) on growth of three life stages of *T. guineensis*. Scientific Research Journal, 1(3), 36-40.

Vold, A., Lokkeborg, S., Tenningen. M. and J. Saltskar. 2009. Analysis of commercial catch data to study the effects of seismic surveys on the fisheries of Lofoten and Vesteralen summer of 2008. Fisken og Havet 5/2009, Havforskningsinstituttet, Bergen. (summary in English).

Wale, M.A., Simpson, S.D., and A.N. Radford. 2013a. Noise negatively affects foraging and antipredator behaviour in shore crabs. Animal Behaviour, 86(1), 111-118.

Wale, M.A., Simpson, S.D., and A.N. Radford. 2013b. Size-dependent physiological responses of shore crabs to single and repeated playback of ship noise. Biology letters, 9(2), 20121194.

Walli, A., Teo, S. L., Boustany, A., Farwell, C. J., Williams, T., Dewar, H., Prince, E., and B.A. Block. 2009. Seasonal movements, aggregations and diving behavior of Atlantic bluefin tuna (*Thunnus thynnus*) revealed with archival tags. PLoS One, 4(7), e6151.

Wareham, V.E. 2009. Updates on deep-sea coral distributions in the Newfoundland and Labrador and Arctic Regions, Northwest Atlantic. The ecology of deep-sea corals of Newfoundland and Labrador waters: biogeography, life history, biogeochemistry, and relation to fishes. Canadian Technical Report on Fisheries and Aquatic Sciences, 2830: 4-22.

Wildlife Division 2010. Management Plan American Eel (*Anguilla rostrata*). Department of Environment and Conservation, Government of Newfoundland and Labrador, Corner Brook, NL. v + 29 pp.

Williams, R., Wright, A.J., Ashe, E., Blight, L.K., Bruintjes, R., Canessa, R., Clark, C.W., Cullis-Suzuki, S., Dakin, D.T., Erbe, C., Hammond, P.S., Merchant, N.D., O'Hara, P.D., and J. Purser. 2015. Impacts of anthropogenic noise on marine life: Publication patterns, new discoveries, and future directions in research and management. Ocean & Coastal Management, 115, 17-24.

Wilson, B., and L.M. Dill. 2002. Pacific herring respond to simulated odontocete echolocation sounds. Canadian Journal of Fisheries and Aquatic Sciences, 59(3), 542-553.

Zykov, M.M. 2016. Modelling Underwater Sound Associated with Scotian Basin Exploration Drilling Project: Acoustic Modelling Report. JASCO Document 01112, Version 2.0. Technical report by JASCO Applied Sciences for Stantec Consulting Ltd.

9.0 MARINE AND MIGRATORY BIRDS: ENVIRONMENTAL EFFECTS ASSESSMENT

A variety of avifauna species occur within the marine and coastal environments off Eastern Newfoundland at various times of the year, including seabirds and other avifauna that inhabit the region for breeding, feeding, migration and other activities according to their individual life histories and habitat requirements. A number of important habitats for birds have also been identified at locations along the coastline of Newfoundland and Labrador.

Birds are important from an ecological, social, and economic perspective, because they often function near the top of the food chain, and may be relatively vulnerable to certain types of environmental disturbance. Some species are also an important resource for recreational and tourism-related pursuits. Most migratory birds found in Canada are also protected under the MBCA and its associated Regulations, which implement the terms of the Migratory Birds Convention of 1916 between Canada and the United States. Further, wildlife in Newfoundland and Labrador (including certain species not protected under the MBCA) are managed under the provincial *Wildlife Act* and associated Regulations. Avian species at risk and their habitats, including some species that are known or have potential to occur in the Project Area and surrounding marine environments, are protected by both federal (SARA) and provincial (NL ESA) legislation. This VC integrally considers avian SAR that are listed under SARA and NL ESA and other species that are otherwise considered to be of special conservation concern (SOCC).

9.1 Environmental Assessment Study Areas and Effects Assessment Criteria

Three spatial assessment boundaries have been defined for the environmental effects assessment of this VC. They reflect the varying ways and scales in which the Project may influence marine-associated birds and their habitats. These Study Areas are defined as follows (Figure 9-1):

Project Area: This represents the overall geographic areas offshore Eastern Newfoundland within which planned Project-related activities will take place. While the Project Area is defined as overall polygons that encompass such activities over the course of each Project, the various components and activities associated with the drilling of each individual well and other planned components will occupy fairly small areas within this overall area, as described in Chapter 2. The assessment also considers related supply and support vessel and aircraft traffic to and from this offshore Project Area.

Local Study Area (LSA): This encompasses the overall geographic area over which planned Project-related environmental interactions (including emissions and other disturbances) will occur. The LSA therefore represents the anticipated environmental zone of influence of the Project's planned components and activities. As described in this chapter, the main Project-related environmental emissions and interactions that may affect birds include light emissions and waste materials that may be generated by the active drilling installations and vessels, which will likely be confined to within several kilometers of the source. The environmental zones of influence for planned Project components and activities are therefore expected to occur primarily within the overall Project Area polygons defined above, with the exception of Project activities that could conceivably occur on the edges of the Project Area boundary. For this VC, the LSA is therefore (conservatively) defined as the offshore Project Area and an

appropriately 10 km area around it as well as the associated vessel and aircraft traffic routes to the ELs.

Regional Study Area (RSA): In addition to Project- and disturbance-related factors, from an ecological perspective the environmental effects assessment also recognizes and considers the characteristics, distributions, and movements of the individual VCs under consideration, including the larger Regional Areas within which they occur. Ecological boundaries for Marine and Migratory Birds vary between species, due to difference in their ranges, habitat preferences, movement patterns and key activities. The EA assesses potential effects to birds (individuals and populations) which are known or likely to use the LSA, and considers the overall extent of affected individuals and populations during the time period at which they may be affected by planned Project components and activities. Key aspects of marine biota movements and distributions as they relate to the Project Area / LSA are as presented in Chapter 6 and are generally considered in assessing both potential Project-specific (this Chapter) and cumulative (Chapter 14) effects upon this VC. The overall RSA for the environmental effects assessment is as defined and illustrated earlier in Section 4.3.

The temporal boundaries for the effects assessment encompass the likely timing and duration of Project-related (in-field) activities in the Project Area, as well as the likely duration of resulting environmental effects (Chapter 2). In conducting the assessment, special consideration is also given to timing of VC presence within the Project and Assessment Areas, including important or sensitive periods. Section 6.2 provides details of marine and migratory bird species known to occur, and their timing of presence, within these areas

It is within the above described spatial and temporal boundaries that the Project's potential environmental effects on this VC and their significance are assessed and evaluated.

For the purposes of this EA, significant environmental effects on Marine and Migratory Birds are defined as those that would cause one or more of the following:

- A detectable decline in overall bird abundance or change in the spatial and temporal distributions of bird populations within the overall RSA over multiple generations;
- Effects to a designated (protected) species at risk or its critical habitat such that the overall abundance, distribution and health of that species and its eventual recovery within the RSA is adversely affected

Effects to a designated (protected) species at risk or its critical habitat such that the overall abundance, distribution and health of that species and its eventual recovery within the RSA is adversely affected.

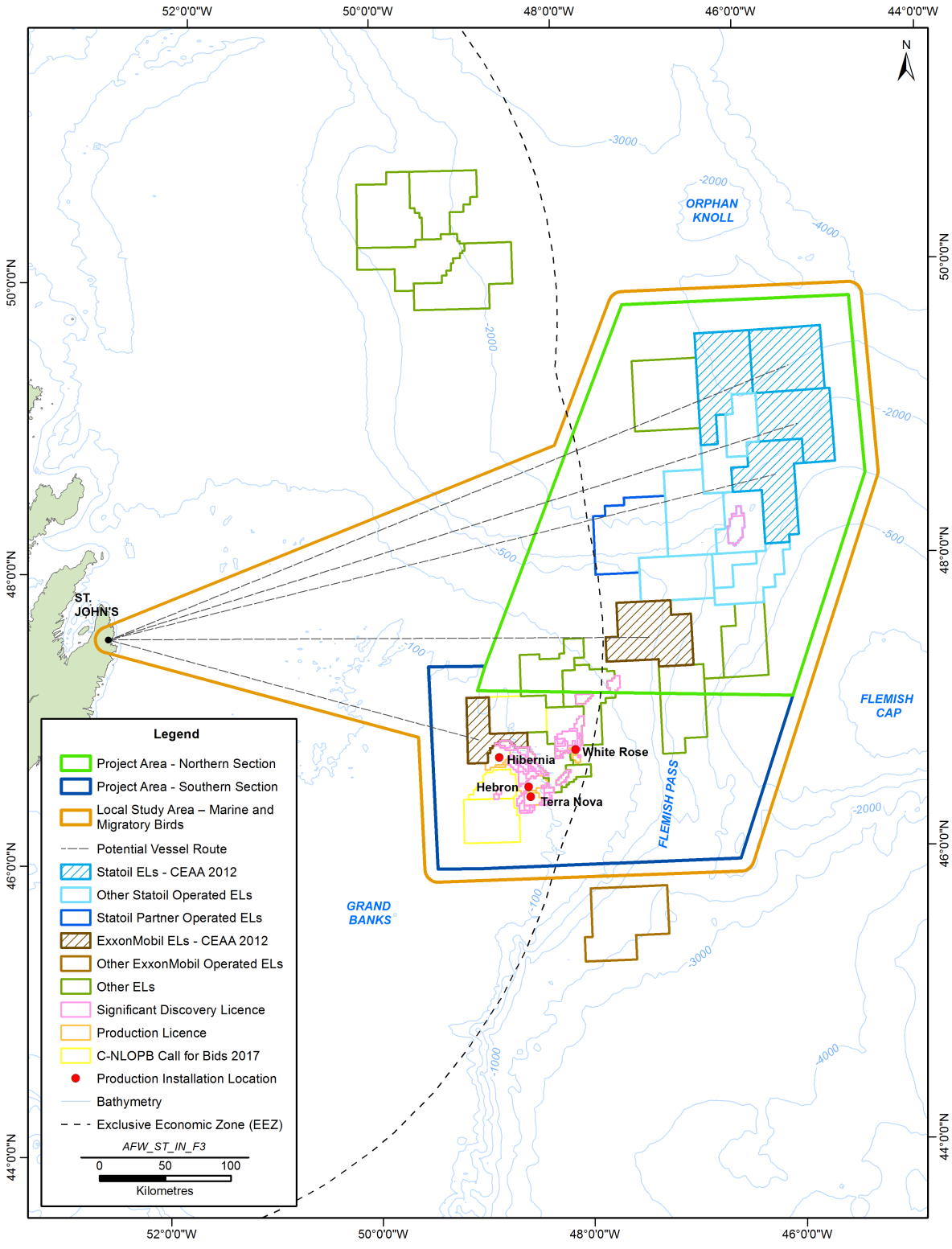


Figure 9-1 Environmental Assessment Study Areas: Marine and Migratory Birds

9.2 Potential Environmental Changes, Effects, and Associated Parameters

The key potential environmental interactions between planned Project activities and Marine and Migratory Birds, including the associated environmental changes and possible resulting environmental effects on this VC, are as follows (adapted from Amec 2014):

- Potential attraction of birds to drilling installations and vessels, including their lights, flares or other light emissions and waste discharges, resulting in possible injury or mortality (strikes, strandings, incineration, disorientation, energy expenditure)
- Possible injury of avifauna (particularly diving birds) due to exposure to noise within the water column during VSP or wellsite surveys using geophysical sound sources or disruptions to and changes in their distributions and behaviours
- Changes in the presence, abundance, distribution and/or health of birds (individuals and populations) resulting from direct exposure to waste discharges from drilling installations or vessels (physical exposure, ingestion)
- Possible indirect effects due to changes in the availability, distribution and/or quality of feed sources or habitats for marine and migratory birds due to disturbances (noise, light) and/or Project-related waste discharges (such as drilling fluids, other liquid, and solid waste materials).

The EIS Guidelines issued by the Canadian Environmental Assessment Agency in December 2016 identify and specify a number of issues and potential effects on this VC that are also considered in the EIS (refer to Section 6.3.5 of the EIS Guidelines).

Direct and indirect adverse effects on migratory birds, including population level effects that could be caused by all project activities, include but are not limited to:

- noise disturbance from geophysical equipment including both direct effects (physiological), or indirect effects (foraging behaviour of prey species)
- physical displacement because of vessel presence (e.g., disruption of foraging activities)
- night-time illumination levels from lights and flares during different weather conditions and seasons and during different project activities (e.g., drilling, formation flow testing with flaring) and associated nocturnal disturbance (e.g., increased opportunities for predators, attraction to the drilling installation and vessels and subsequent collision or exposure to vessel-based threats, incineration in flares, disruption of normal activities)
- exposure to spilled contaminants (e.g., fuel, oils) and operational discharges (e.g., deck drainage, gray water, black water)
- attraction of, and increase in, predator species because of waste disposal practices (i.e., sanitary and food waste) and the presence of incapacitated/dead prey near the drilling installation or support vessels
- physical harm or mortality from flaring on the drilling installation or other vessel based threats
- collision risk with the drilling installation and other project infrastructure
- the effects of oil spills in the nearshore or that reach land on landbird species
- change in marine habitat quality from drill muds and cuttings and sedimentation, and

- indirect effects caused by increased disturbance (e.g., noise, light, presence of workers), relative abundance movements and changes in migratory bird habitat

Questions and comments related to this VC were also noted during Statoil's Project-related consultations with government departments and agencies, stakeholder organizations and Indigenous groups (see Chapter 3 for further details). These include concerns regarding the potential effects of the Project on migratory bird species that are harvested for traditional purposes by Indigenous groups (Section 7.3), particularly in the unlikely event of a large oil spill (see Chapter 15).

The environmental effects assessment for this VC considers and focuses upon the issues and questions identified through these issues scoping exercises, including an initial identification of the key potential environmental changes and possible environmental effects on the VC that may result from them. These are summarized in Table 9.1, along with the identification of key parameters through which these Project-related changes and effects may be reflected.

Table 9.1 Potential Project-Related Environmental Changes and Potential Effects: Marine and Migratory Birds

Potential Environmental Effects	Contributing Potential Environmental Changes Resulting from the Project	Associated Parameter(s)
Change in Mortality / Injury Levels and Bird Health (Individuals or Populations)	• Potential avifauna mortality, injury or health effects may occur because of offshore oil and gas related activities. • These could include potential direct project induced environmental changes on birds (e.g., presence of drilling installations and increased light levels or flaring, leading to bird strandings or incineration) or possible indirect outcomes (e.g., artificial lighting leading to increased rates of predation) with potential resulting implications for the presence, density, diversity, and health of marine-birds • Drilling discharges may also cause changes to the health of birds • The MBCA, SARA and NL ESA prohibit the loss of such birds and avian species at risk	• Identified levels of avian injury or mortality during the Project (as identified through opportunistic seabird observations / deck searches) • Numbers of individuals and species present in the Project Area / LSA • Predator numbers and predation levels • Occurrence and success of key life history stages (e.g., reproduction) by avifauna affected by the Project
Change in Avifauna Presence and Abundance (Behavioral Effects)	• In addition to implications for bird mortality / injury / health, some individuals may be attracted to drilling installations by associated environmental changes (such as food availability) or by disorientation due to increased lighting levels • Conversely, others may avoid the area because of the associated sensory disturbances in the marine environment because of the Project	• Numbers of individuals and species present in the Project Area / LSA • Overall spatial and temporal distribution patterns in the assessment area and beyond • Occurrence and success of key life history stages (e.g., reproduction) by

Table 9.1 Potential Project-Related Environmental Changes and Potential Effects: Marine and Migratory Birds

Potential Environmental Effects	Contributing Potential Environmental Changes Resulting from the Project	Associated Parameter(s)
	• These potential behavioral changes may influence the spatial and temporal presence and abundance or birds in the area, as well as possibly affecting individuals or populations of birds if risk of injury / mortality, loss of access to key habitats for extended periods occurs, and/or affects key and sensitive life history stages	avifauna affected by the Project
Change in Habitat Availability and Quality	• Project-related components, activities and associated emissions or disturbances may change the physical characteristics of habitats used by marine-associated birds • Resulting environmental changes in the availability, extent, and quality of habitats for birds have the potential to affect the presence, abundance, and health of birds in the affected areas.	• Area and relative abundance of key habitat types in the Project Area / LSA • Ratio of altered habitats relative to their availability within the ranges of affected avifauna
Change in Food Availability or Quality	• Changes to the availability, quantity, and quality of food sources (e.g., marine fish and invertebrates. other birds. waste generated from Project site) have the potential to affect the presence, abundance, and health of birds	• Prey availability and quality within the affected areas • Quantity of organic waste released into the waters of the Project Area

An overview of the potential for interactions between each of the Project's planned components and activities and Marine and Migratory Birds, and specifically, the potential for these to result in environmental changes and eventual, detectable effects to the various aspects of this VC, is presented in Table 9.2.

Table 9.2 Potential Project-VC Interactions: Marine and Migratory Birds

Project Component / Activity	Potential Environmental Effects			
	Change in Mortality / Injury Levels and Bird Health (Individuals or Populations)	Change in Avifauna Presence and Abundance (Behavioral Effects)	Change in Habitat Availability and Quality	Change in Food Availability or Quality
Presence and Operation of drilling installation (Including lights, noise, air emissions, anchoring)	•	•	•	•

Table 9.2 Potential Project-VC Interactions: Marine and Migratory Birds

Project Component / Activity	Potential Environmental Effects			
	Change in Mortality / Injury Levels and Bird Health (Individuals or Populations)	Change in Avifauna Presence and Abundance (Behavioral Effects)	Change in Habitat Availability and Quality	Change in Food Availability or Quality
Drilling and Associated Marine Discharges (including fluids and cuttings)	•			•
Formation Testing with Flaring	•			
Wellhead Decommissioning				
Geophysical, Geohazard, Wellsite and Seabed Surveys and VSP	•	•	•	
Geological, Geotechnical and Environmental Surveys				
Supply and Servicing	•	•		

9.3 Environmental Effects Assessment and Mitigation

The following sections provide an assessment and evaluation of the potential effects from planned Project operations and activities on Marine and Migratory Birds. Mitigation measures to prevent or reduce potential adverse effects are identified and considered integrally within and throughout the environmental effects analysis that follows, as applicable. The environmental effects assessment for accidental events for VCs is presented in Chapter 15.

9.3.1 Approach and Methods

The environmental effects assessment for Marine and Migratory Birds requires an analysis of the potential interactions between the Project and the VC. Knowledge of the potential interactions obtained through a literature review is summarized and has been used to inform the effects analysis and the identification of applicable mitigation measures. More detailed reviews of these known and likely environmental issues and interactions are available through other sources, including the Eastern Newfoundland SEA (Amec 2014), Ellis et al. (2013) and Ronconi et al. (2015). Each planned component of the Project is considered in terms of its potential for effects on the VC, with a focus on the various potential environmental interactions and changes identified in the previous section.

9.3.2 Summary of Key Mitigations

Key mitigation measures that will be implemented in relation to the Project to help avoid or reduce potential environmental effects on Marine and Migratory Birds include:

- Low-level aircraft operations will be avoided where it is not required per Transport Canada protocols
- Operational discharges will be treated prior to release in accordance with the OWTG (2016) and other applicable regulations and standards.
- The selection and screening of chemicals to be discharged, including drilling fluids, will be in accordance with the Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands
- During formation flow testing with flaring, produced hydrocarbons and produced water will be flared. If there is a large amount of produced water encountered, it will be treated in accordance with the relevant regulatory requirements prior to ocean discharge, or shipped to shore for appropriate disposal
- The Operator will avoid, where possible, established bird colonies. Helicopters will avoid known coastal seabird colonies per requirements of the *NL Seabird Ecological Reserve Regulations, 2015*
- During drilling operations, routine observations of seabirds, following the CWS protocols will be undertaken from the drilling installation
- Routine searches for stranded birds will be conducted on the platform and supply vessels, and appropriate programs and protocols for the collection and release of marine and migratory birds will be implemented for birds that become stranded (i.e., "ECCC-CWS's Oiled Birds Protocol and Protocol for Collecting Dead Birds from Platforms. Best Practices for Stranded Birds Encountered Offshore Atlantic Canada (Draft 2)" and Williams and Chardine (n.d.): The Leach's storm-petrel: General Information and Handling Instructions)
- The Operator will obtain a Seabird Handling permit from ECCC-CWS
- Maceration of sewage and kitchen waste, in accordance with the OWTG to 6 mm particle size
- Operators are required to notify the C-NLOPB for plans to flare associated with formation flow testing for exploration drilling. The C-NLOPB then consults with ECCC-CWS to determine a safe timeline to proceed to reduce effects on migrating birds

9.3.3 Presence and Operation of Drilling Installation

Potential interactions between the VC and the presence and operation of the drilling installation include the possible attraction of birds due to lighting, avoidance of the drilling installation due to sensory disturbance, and the creation of new foraging opportunities for predator species (e.g., through prey attraction due to organic waste disposal, creation of new "artificial reef" habitat).

Marine-associated birds are known to be attracted to offshore platforms (Montevecchi 2006; Ronconi et al. 2015), which may result in direct mortality or injury through collisions with facility infrastructure, or through disorientation (Baird 1990; Montevecchi et al. 1999; Wiese and Montevecchi 2000). Although Bruinzeel and van Belle (2010) recently reported that most bird mortality on offshore platforms was due to collision, disoriented birds may fly continuously around lights, depleting energy resources, delaying foraging or migration, and potentially increasing their susceptibility to predation (Bourne 1979; Sage 1979; Wiese and Montevecchi 2000; Wiese et al. 2001; Jones and Francis 2003; Schummer and Eddleman 2003; Bruinzeel and van Belle 2010). This attraction has been noted in several studies. For example, Tasker et al. (1986) noted higher densities of birds within 500 m of

a platform when compared to the surrounding waters. Baird (1990) found that bird densities were six to seven times higher than previously observed following construction of a new platform in the Bering Sea, and Wiese and Montevecchi (2000) found that seabird concentrations around offshore oil platforms on the Grand Banks were 19 to 38 times higher than areas further from the platforms. Many birds navigate nocturnally using visual cues, and such lights may be used (perhaps mistakenly) as a visual navigational cue (Wiese et al. 2001; Gauthreaux and Belser 2006; Poot et al. 2008), although coastal lighting can be more of an influence as most migrating landbirds tend to fly closer to land (Weir 1976; Blomqvist and Peterz 1984). Night-feeding seabirds such as shearwaters and storm-petrels may mistake the lighting for bioluminescent prey (Imber 1975; Wiese et al. 2001; Gauthreaux and Belser 2006; Poot et al. 2008).

The attraction of birds to oil and gas installations may be especially pronounced during periods of fog or otherwise reduced visibility (Gauthreaux and Belser 2006; Montevecchi 2006). In fog or drizzle, the moisture droplets in the air refract the light and greatly increase the illuminated area, thus enhancing the attraction (Wiese et al. 2001), and these conditions are not uncommon at installations in the Canada-NL Offshore Area. Conversely, Bruinzeel and van Belle (2010) found that the distance at which birds become disoriented ranges from 200 m in dense fog to 1000 - 1400 m in lighter fog to light rain, to up to 4.5 km in overcast skies with no celestial cues and otherwise good visibility. Poot et al. (2008) found that birds could be attracted to fully lit (30 kW) oil platforms from a distance of up to 5 km. The wavelength and intensity of lighting have been shown to influence the degree of attraction, with white and red-coloured lights associated with the highest levels of mortality, while blue and green lights appear to result in considerably less attraction (Gautreaux and Belser 2006; Poot et al. 2008; Marquenie et al. 2013). Bird attraction has been found to be highly correlated with lighting intensity (Marquenie and van der Laar 2004; Marquenie et al. 2013), and when platform lighting was reduced from full illumination to only beacon and obstruction lights the number of birds observed circling the platform has been greatly reduced. Shielding lights downward has also been shown to reduce attraction (Reed et al. 1985).

Although there is a known association of birds with oil platforms, the degree of associated mortality is not known with a high level of confidence (Montevecchi et al. 1999). It is difficult to quantify the numbers of birds potentially killed because the available estimates rely on recovery of birds on platforms and vessels, and it is not known how many birds are killed but not recovered due to scavenging or landing in the ocean (Bruinzeel et al. 2009; Ellis et al. 2013). Further, these recoveries are often conducted on an incidental basis, which provides limited spatial and temporal coverage compared to a systematic observer-based monitoring system (Ronconi et al. 2015). Nonetheless, even incidental information from industry-based monitoring is helpful to determine seasonal and weather-related patterns in strandings, and to determine which species are likely more susceptible to this phenomenon. A review of systematic daily searches and opportunistic observations conducted on Statoil facilities and vessels between 2012 and 2015 showed that of a total of 135 birds recovered, 126 were released alive. Leach's Storm-petrels comprised 86 percent of these birds and another 10 percent were great shearwaters. Other species found were great black-backed gull, thick-billed murre, northern fulmar, South Polar skua and Lincoln's sparrow. Most of these strandings occurred in the summer months (June to August), although the search effort was not consistent throughout the year as drilling operations may not have been continuous. This is similar to previous observations reported in the region, such as by Husky Energy (2000), where it was reported that 52 Leach's storm-

petrels were recovered and released from aboard a Terra Nova vessel over a three-week period during the summer of 1998 with no mortality observed. Baillie et al. (2005) reported 469 stranded birds (mostly Leach's storm-petrels) at offshore installations and vessels off Newfoundland between 1998 and 2002, of which nine were reported to have died and 213 were released. The fate of the rest of the birds was not reported. Similar results were reported between 2003 and 2006 on the Grand Banks (Ellis et al. 2013). Environment Canada (2015) also reports that Leach's storm-petrels are the most commonly found species stranded on vessels in Atlantic Canada.

In addition to possible attraction, some researchers have documented the displacement of birds due to offshore platforms (Bramford et al. 1990). Alcids, for example, are prone to disturbance from vessel and traffic which may at least partially explain observed avoidance behaviour around platforms (Ronconi and St Clair 2002; Bellefleur et al. 2009). Alcid distributions along survey transects to platforms on the Grand Banks were more strongly related to ocean temperature than with proximity to platforms (Burke et al. 2005), although these attraction effects differed among species and seasons (Burke et al. 2012). Similarly, Baird (1990) found that puffins, unlike most seabird species, occurred at lower densities within 10 km from the platform than further away. Observed densities of dovekie, northern fulmar, shearwaters, and storm-petrels on the Scotian Shelf were lower within 10 km of platforms compared to regions further away, suggesting some avoidance of platforms by certain species, although the effects of habitat preferences were not assessed (Amec 2011).

The presence of offshore platforms can also provide new habitats for marine-associated birds, which are referred to by Russell (2005) as "artificial archipelagos". Structures may be used as roosting and resting sites by gulls (Burke et al. 2012), as stopover locations for migrating landbirds who may forage around the platforms (Russell 2005; Bruinzeel and van Belle 2010), or even potentially as hunting grounds for predatory species such as peregrine falcons which take advantage of concentrations of birds around the structures (Russell 2005). While typically found in coastal areas of the province, a peregrine falcon has been recorded near an offshore production platform in Newfoundland (McTavish and Lang 2015). Foraging opportunities may also be enhanced around platforms because they themselves may become artificial reefs around which new invertebrate and fish assemblages are established (Fabi et al. 2002, 2004).

On-board lighting will be required for Project activities that occur at night and during periods of reduced visibility, and must be in place to meet safety and regulatory requirements. Overall, however, the planned presence and operation of the drilling installation in the Project Area is anticipated to be a negligible addition to the total amount of lighting in the overall offshore area, especially as compared to existing offshore activities such as fishing vessels, other petroleum exploration and production facilities, commercial traffic and other vessel movements that regularly move to and through the Project area throughout the year. Further, the nature of the potential disturbance will be short-term in a location, as it is estimated that the drilling installation will be on location between 35 and 65 days to drill one well at a specific location. The distance at which Project-related lighting in the offshore environment will be visible (and thus, its likely zone of influence) may be up to five kilometers (Poot et al. 2008), but this will be influenced by site and time specific factors, as such disturbances appear to occur most frequently during periods of drizzle and fog and in overcast conditions (Wiese et al. 2001; Bruinzeel and van Belle 2010). The drilling installation will be situated several hundred kilometers offshore, which is far from coastal breeding sites and IBAs, and well

beyond the foraging range of almost all species that nest in Newfoundland other than the Leach's storm-petrel, which is known to make foraging trips of thousands of kilometres during the breeding season (Pollet et al. 2014). Therefore, effects on most breeding birds will be low.

While there is some potential for the attraction of migratory landbirds, particularly during the fall, most migrating landbirds tend to fly closer to land (Weir 1976; Blomqvist and Peterz 1984), and so it is unlikely that large numbers of birds will be affected.

Some species, notably alcids, may be displaced from the area around the active drilling installation during drilling operations through general avoidance responses. The effect of habitat displacement on marine-associated birds is considered likely to be minor, except potentially in areas such as the North Sea where platforms occur in high concentrations, or where they are situated on or in the vicinity of productive sites associated with discrete physiographic features such as continental shelf edges and slopes (Hedd et al. 2011; Ronconi et al. 2015). However, this is not the case in the Canada-NL Offshore Area, where there are just four production platforms (with distances between platforms ranging from 25-75 km), and one to two drilling installations operating at any one time. The distance between these platforms could be between 25 and 50 km. As stated above, the drilling installations will not be situated in one location for extended periods of time, so disturbance will be short-term and transient in nature. As well, because the area of displacement is small relative to the total areas of the highly productive feeding grounds within the LSA and the overall ranges of these species, foraging activities will not be disrupted. The drilling installation will be far from coastal breeding sites and IBAs, so effects on nesting birds and key habitats will be negligible. Implementation of mitigation measures to reduce levels of sound, atmospheric emissions and wastes and adherence to appropriate performance targets (Section 9.3.2) will further reduce the degree to which marine and migratory birds are displaced from key habitats.

The creation of new habitats and increased food availability associated with presence and operation of the drilling installation will be short term at a Project drilling location, and may result in both positive and negative effects on marine and migratory birds, especially during fall migration when landbirds are most likely to occur in the offshore environment. Enhancement of the local food supply and provision of roosting and resting sites may attract birds to platforms, but the benefits in terms of energy gains may be offset by increased exposure to risk of collision with the drilling installation or predation as well as energetic costs due to deviation from normal movement / migration patterns. Proper waste management, particularly with regards to disposal of organic wastes, will reduce the degree to which foraging opportunities are enhanced by the presence and operation of the drilling installation.

Based on the information and analysis summarised here, and with the implementation of appropriate mitigation measures as summarized in Section 9.3.2, the overall magnitude of the effect of the presence and operation of the drilling installation on marine and migratory birds is anticipated to be low. There may be a slight increase in mortality / injury levels due to collisions, disorientation, and potential predation, although, based on previous monitoring, the mortality rate is anticipated to be low as most stranded birds encountered on platforms and vessels are released successfully. Some localized and short-term behavioral effects (change in presence and abundance) are also likely to occur, with some species displaced from the Project Area / LSA and others attracted by lighting and created foraging opportunities. The localized, transient, and short-term nature of these disturbances

at one location and time during the Project considerably reduces the potential for adverse effects upon marine and migratory birds (individuals or populations). It is therefore unlikely that individuals will be attracted or displaced over extended areas or timeframes. Given that the likely zone of influence of the Project at one time or location will represent a small proportion of the feeding, breeding or migration area of species, birds will not be displaced from key habitats or during important activities, or be otherwise affected in a manner that causes negative and detectable effects to overall populations in the region. Changes in habitat and food availability and quantity will also be on a localized scale and for a short-term duration.

In summary, the predicted environmental effects of presence and operation of the drilling installation are primarily related to lighting and emissions. These may result in changes in bird mortality/injury levels and bird health, presence and abundance of avifauna, and habitat and food availability and quality. These changes are predicted to be adverse but low in magnitude, localized and certainly within the Project Area, short- to medium-term in duration, to regular in frequency, and reversible, with these predictions being made with a moderate level of certainty.

9.3.4 Drilling and Associated Marine Discharges

Expected and potential environmental emissions and discharges associated with the Project will include drilling wastes (fluids and cuttings) and cement, other liquid wastes (produced water, bilge and deck drainage, ballast water, sewage, cooling water, and fire control water), atmospheric emissions (exhausts from equipment), and solid wastes including food and other non-hazardous waste. These emissions are described in some detail in the Project Description (Section 2.9).

Wastes generated from drilling include drilling muds and cuttings. WBM mud and cuttings are discharged to the seabed and will accumulate in the vicinity of the wellhead, whereas SBM is recovered, reconditioned, and reused until it is spent and then returned to shore for disposal at an approved facility. Surplus cement associated with riserless drilling (if any) will be discharged at the seabed, while cement returned to the drilling installation is disposed of appropriately and in accordance with regulatory requirements and authorizations. Chemical composition of fluids and allowable discharge limits associated with drilling muds and cuttings are managed in accordance with the OWTG (Morandin and O'Hara 2016). Any such drilling wastes such as cement, WBM and cuttings released at the seafloor will be far below the maximum diving range of any seabird, and therefore will not interact with marine-associated birds and their habitats. Water depths in the Project Area range from approximately 80 m to over 3,000 m. Thick-billed murres, the deepest-diving seabirds found in the Project Area, rarely reach depths of 200 m (Gaston and Hipfner 2000). SBM has a synthetic base fluid as a component, but SBM cuttings are treated prior to discharge, and have only a small (and permitted) fraction of residual SBM when discharged. Discharging the SBM-related drill cuttings below the water's surface further mitigates the potential for marine and migratory birds to come into contact with the chemical components of SBM. With appropriate screening and selection of chemicals (including use of non-toxic drilling fluids), and proper disposal of drill muds and cuttings, effects on birds due to disposal of drill muds and cuttings and associated waste materials are considered unlikely.

Other potential liquid discharges from offshore vessels and equipment relate to the possible release of oily water and other substances through produced water, deck drainage, bilge water, ballast water

and liquid wastes. These discharges will be managed in accordance with the OWTG. that cannot be discharged overboard will be stored and transported to shore for disposal in an approved facility (Section 2.9). Seawater used for cooling purposes aboard the platform will be treated through an oil-water separator before being disposed of at sea.

Produced water typically accounts for the largest volume of waste from offshore oil and gas production operations (Neff 2002), and in calm conditions, discharges within allowable levels can result in formation of hydrocarbon sheens of up to 3 µm thickness (ERIN Consulting Ltd and OCL Services Ltd 2003; Morandin and O'Hara 2016). This issue is, however, far less of a concern for exploration drilling, where produced water may only be found during a formation flow test and volumes are small (Morandin and O'Hara 2016). If hydrocarbons are found during an exploration drilling program and a formation flow test is undertaken, formation fluids (which may contain hydrocarbons and/or water) flow to the drilling installation where produced hydrocarbons are separated from produced water on the drilling installation and analysed. Produced water is sent to the drilling installation's flare or treated for disposal in accordance with the OWTG or shipped to shore for appropriate disposal.

The treated discharge of some operational wastes may cause surface sheening, typically under calm conditions; however, the potential for sheen formation is reduced with proper treatment and management of operational discharges in accordance with the OWTG. Small amounts of oil from sheens has been shown to affect the structure and function of seabird feathers (O'Hara and Morandin 2010), which has the potential to result in water penetrating plumage and displacing the layer of insulating air, resulting in loss of buoyancy and hypothermia. This can in turn cause a heightened metabolic rate (increased energy expenditure), as well as behavioural changes such as increased time spent preening at the expense of foraging and breeding, and potentially death, especially in the winter months when conditions are colder and thermoregulation is most difficult (Morandin and O'Hara 2016). Chicks and eggs are most susceptible to negative effects of exposure to oil (even at low levels) (Morandin and O'Hara 2016). Butler et al. (1986, 1988) and Trivelpiece et al. (1984), for example, have found effects from relatively low levels of oil on Leach's storm-petrel metabolic rate and chick growth, and so this species may be vulnerable to potential effects of hydrocarbon exposure. Observations of sheens in the Newfoundland and Labrador Offshore Area are reported to C-NLOPB. On average, the number of reported sheens off platforms in the Grand Banks between 2003 and 2014 was 24 per year (Morandin and O'Hara 2016). Data from ERIN Consulting Ltd and OCL Services Ltd (2003) showed that sheens of 1 µm persist for up to 24 h, while thinner (0.1 µm) sheens tended to disperse in less than an hour. Based on the perceived colour of sheens observed in the Grand Banks, the thickness was estimated to be in the range of 0.07 - 1 µm for sheens where descriptions were provided. It is thought that thicker sheens, which are more persistent and therefore pose greater potential for interactions with seabirds, are rare in routine offshore operations (Morandin and O'Hara 2016). Discharges from the drilling installation are treated prior to discharge. The potential for sheening to occur is low, and therefore likelihood of exposure to surface sheens by marine and migratory birds are considered to be low.

Atmospheric emissions associated with the Project include exhaust from power and heat generation from the drilling installation(s), and from vessels and aircraft traffic. It is unlikely that such emissions

will have any measurable effect on marine and migratory birds, as the emissions will be within regulatory standards, transient in nature, and short-term at one location.

Solid and domestic waste will be collected on-board drilling installations and vessels, and waste materials will be separated and recycled where possible. Non-hazardous and hazardous waste solids will be shipped to shore for disposal at approved waste management facilities. Non-hazardous industrial waste will be directed to an approved municipal waste disposal site, while hazardous waste will be directed through an approved hazardous waste collection contractor. Waste food and sewage will be macerated to maximum particle size (6 mm), and discharged overboard after treatment in accordance with the OWTG and MARPOL, and is expected to be quickly degraded by bacteria and other biological activity after release (BP 2016). Effects to the fish species upon which avifauna depend may also indirectly affect birds (see Chapter 8). Discharge of organic wastes (sewage and food scraps) may result in enhancement of the local food supply and attraction of birds to vessels and platforms. However, this effect will be short-term in one location and localized in nature. This potentially positive effect may be offset by increased exposure to risk of collision / strandings or predation as well as energetic costs due to deviation from normal movement/migration patterns. Proper waste management will reduce such effects of discharges of organic waste on birds.

With the proper implementation of mitigation measures summarized in Section 9.3.2, the overall magnitude of the effect of drilling and other marine discharges on marine and migratory birds is anticipated to be low. These effects will be prevented or minimized through the waste management and discharge treatment measures outlined herein.

The predicted environmental effects of drilling and associated marine discharges are primarily related to release of organic wastes. These may result in changes in mortality/injury levels and bird health, and food availability and quality. Any such effects are predicted to be low in magnitude, localized, short term in duration, sporadic in frequency, and reversible, with these predictions being made with a moderate level of certainty.

9.3.5 Formation Flow Testing with Flaring

Formation flow testing may occur during drilling of the well, or it may be carried out at a later date upon re-entering a suspended well, and in certain situations, flaring may be required. In Atlantic Canada, nocturnal migrants, and night-flying seabirds such as Leach's storm-petrels are the migratory birds most at risk of attraction to flares, although little is known about the severity of such interactions. Available estimates often rely on recovery of birds on platforms and vessels, and it is not known how many birds are killed but not recovered due to scavenging or landing in the ocean (Bruinzeel et al. 2009; Ellis et al. 2013).

In order to help address an important data gap identified by Burke et al. (2012), Mactavish and Lang (2015) studied attraction of birds to offshore flares through a series of nighttime observations in October to November of 2015 using infrared and regular binoculars. The authors observed that Leach's storm-petrels, as well as small numbers of shorebirds and migrating landbirds, did approach the flares but no associated mortality was observed. Hope Jones (1980) reported on surveys of bird attraction to a flare on an offshore platform in the North Sea. Seabirds (mainly fulmars and gulls) were attracted to the flare, feeding directly below it. However, only one bird was observed flying up

near the flame during the five-week observation period, and no bird mortality was observed because of the flare. It was noted that mortality had been reported from gas flares elsewhere in the North Sea, but typically in low numbers.

As with offshore lighting, a number of factors influence the potential severity of marine bird interactions with flares including the time of year, location (i.e., whether concentrations of birds are present near the flare), height and weather conditions (Weir 1976; Wiese et al. 2001). Mortality can also increase during migration, particularly when poor weather conditions force birds to fly relatively low (Wiese et al. 2001). Risk of mortality due to artificial light sources such as flares may also be higher in the latter part of the night, because most nocturnal migrants climb to their migrating height soon after takeoff and then undertake a gradual descent shortly after midnight (Weir 1976).

Flaring events conducted during the Project will occur several hundred kilometers offshore, far away from coastal breeding sites and IBAs and well beyond the foraging range of almost all species that nest in Newfoundland and Labrador. Therefore, breeding birds are unlikely to be affected by this activity, with the potential exception of the Leach's storm-petrel which may forage thousands of kilometres from the nest site during the breeding season (Pollet et al. 2014). There is again some potential for the attraction of migratory landbirds, especially during the fall months when unfavorable weather conditions are most common and landbirds are most likely to be present offshore. However, migrating landbirds tend to fly closer to land (Weir 1976; Blomqvist and Peterz 1984), and so it is unlikely that large numbers of landbirds will be affected. Required flaring activities will be short in duration (up to five days), and associated bird attraction will be limited to within several kilometers the drilling installation. Mitigation measures regarding flaring will be adhered to throughout the Project, including the use of high efficiency burners. Additionally, operators are required to notify the C-NLOPB of plans to flare associated with well testing for exploration drilling. The C-NLOPB then consults with ECCC-CWS to determine a safe timeline to proceed to minimise effects on migrating birds. The effects of formation flow testing with flaring on marine associated birds are therefore anticipated to be negligible.

The predicted environmental effects of formation flow testing with flaring are primarily related to attraction of birds to flares, which may result in changes in mortality/injury levels. Any such effects are predicted to be low in magnitude, localized and certainly within the Project Area, short term in duration, sporadic in frequency, and reversible, with these predictions being made with a moderate level of certainty.

9.3.6 Wellhead Decommissioning

Wellhead decommissioning is conducted underwater, at depth, and in adherence to the requirements set out under the *Newfoundland Offshore Petroleum Drilling and Production Regulations SOR/2009-316*. At water depths of less than 1,500 m wellheads will be removed by mechanical cutting, while in depths greater than 1,500 m, wellheads will be left in place. Decommissioning activities will be infrequent and of short duration at any one location, and will be conducted well below diving depths for even the deepest-diving seabirds. Thick-billed murres, the deepest-diving seabirds found in the Project Area for example, rarely reach depths of 200 m (Gaston and Hipfner 2000).

Effects on Marine and Migratory Birds because of wellhead decommissioning are therefore not anticipated. The potential effects of any associated onboard lighting during these activities would be as described and assessed in Section 9.3.3.

9.3.7 Project-Related Surveys

Project-related survey activities involving underwater sound may be undertaken to support drilling operations. Geophysical surveys and vessel traffic entail mapping and analysis of seabed / subsea features using a variety of sound-emitting equipment which create underwater noise.

Based on available literature, there are no studies that have tested the levels of sound (and especially, underwater noise) that cause injury to marine birds, although temporary hearing impairment can occur in avifauna that are exposed to sound in air (Saunders and Dooling 1974). Studies have found that avian species vary in their susceptibility to hearing damage due to noise exposure (Ryals et al. 1999), although they are generally more resistant to damage than mammals (Dooling and Popper 2007). In addition, birds (unlike mammals) can regenerate sensory hair cells in the ear (Dooling and Popper 2007). The available evidence suggests that the underwater hearing of birds is poorer than in air, given that the middle ear constricts under the increased pressure associated with diving (Dooling and Therrien 2012). Unlike some other marine animals, seabirds are not known to communicate vocally underwater, and a heightened auditory sensitivity in water is thus unlikely to have developed.

Deep-diving birds such as alcids (including murres, dovekies and puffins), as well as other bird species that forage underwater, may be at somewhat higher risk of injury or disruption due to exposure to underwater noise such as that generated by geophysical sound sources. These species dive from a resting position on the water in search of small fish and invertebrates, and are capable of reaching depths between 20 to 60 m, and spending up to 40 seconds underwater at a time (Gaston and Jones 1998). Unlike fish or marine mammals, diving birds typically place their heads under the water suddenly in pursuit of prey, and could therefore be exposed to higher noise levels without the benefit of a steady gradient or associated ramp up procedures. Consequently, they would find it difficult to predict or avoid excessively high sound levels in the water column. This interaction may be further accentuated by the attraction of many bird species to offshore vessels and drilling installations (as discussed above). Permanent physiological damage, namely hearing loss (acoustic threshold shift), is unlikely to result from geophysical arrays, because although low-frequency sound waves propagate further than higher frequencies, they are less damaging. However, temporary auditory damage from exposure to loud impulse noise may last days (Hashino et al. 1988), which may impede a bird's ability to find their kin at nest sites, for example.

Available information and previous research suggests that there are no substantial behavioural effects of underwater sound on birds (Davis et al. 1998; MMS 2004). For example, a study of moulting long-tailed ducks in the Beaufort Sea found no changes in movements or diving behaviour during geophysical surveys, although the authors noted that smaller-scale behavioural changes could not be ruled out based on the study design (Lacroix et al. 2003; Flint et al. 2003). In the Davis Strait, Stemp (1985) studied three species that are also found in the current Project Area (thick-billed murre, northern fulmar and black-legged kittiwake) and found no evidence of effects of geophysical surveys on marine bird mortality or distributions in the offshore. Stemp (1985) also notes that shearwaters

have been observed close to a geophysical sound array with their heads underwater, with no behavioural response being observed. Research in the Irish Sea also indicated no evidence that seabirds were attracted to or repelled by offshore geophysical survey activity (Evans et al. 1993).

Geophysical surveys will be undertaken, as required, as part of the Project. These surveys will, however, be short-term and localized in nature, and marine and migratory birds are unlikely to be affected by the underwater sound energy that is associated with these activities. As illustrated above, there is little or no evidence that marine birds are adversely affected by marine geophysical surveys, particularly the underwater sound energy that is associated with these exploration activities. This is likely to be the case for birds during times when they are in the air or on the water's surface. Because geophysical pulses are directed downward and highly attenuated at the surface, the potential for birds feeding underwater to be exposed to sound levels that would result in mortality or injury is low. Above the water, the sound is reduced to a muffled shot that should have little or no effect on birds that have their heads above water or are in flight. It is possible that birds on the water at close range would be startled by the sound, although the presence of the drilling installation or vessel may have already warned the bird of unnatural visual and auditory stimuli. The localized and short-term nature of these underwater disturbances at one location and time during the program, however, reduces the potential for individuals and populations to be affected, either through injury or disturbance / avoidance. Also, many of the deep-diving birds that may be somewhat more likely to interact with underwater noise from geophysical sound sources, including murres and dovekies, are most common off Eastern Newfoundland during the winter months (November to February). It is unlikely that non-diving marine species within the Study Area, such as gulls, shearwaters, and storm-petrels, would be affected by these activities and the underwater noise that they generate.

Effects of noise disturbance on the nesting or foraging behaviour of surface-feeding seabirds are also unlikely, given that the above-water noise levels of geophysical sound arrays are minimal. Because the Project activities will be offshore, it is also unlikely that birds at coastal locations (including nesting sites and IBAs) will be subject to disturbance due to noise from these activities, including adult attendance at nests. Although diving species such as alcids and Northern gannets, as well as pursuit plungers such as shearwaters, spend some amount of time below the water surface, sound is not believed to be important for seabirds in securing food, and available evidence suggests that avian hearing is relatively poor underwater. Underwater noise from such surveys could also adversely affect surface-feeding and diving seabirds indirectly, through potential changes in the presence, abundance or concentration of prey and potential displacement from key foraging areas. As described in Chapter 8, however, significant effects to fish resources are not expected to occur because of the Project, and so changes in the availability, location, or quality of food sources for marine birds are not likely.

Other planned activities include geotechnical, geological, environmental, and ROV / AUV / video surveys. They may occur throughout the life of the Project, at any time of the year.

These activities will have a short duration (a few days to weeks), and those which involve contact with the seabed will have a small footprint, well below the maximum diving depths of any bird found in the Project Area. These surveys will typically be conducted opportunistically from support / supply vessels or in some cases may require the use of dedicated vessels and equipment. In either case, the associated potential for negative interactions (as discussed in Section 9.3.8) from these activities

will be negligible. No change in mortality or injury levels, or to avifauna presence and abundance, in the Project Area / LSA is therefore anticipated. Changes in habitat and food availability and quantity from these surveys are likewise not anticipated because the activity will be extremely localized and short-term, with negligible environmental interactions.

The predicted environmental effects of survey activities are primarily related to noise exposure from survey activities; these may result in changes in presence and abundance of avifauna, and potentially short-term injury. These changes are predicted to be negligible in magnitude, localized and certainly within the Project Area, short-term, sporadic in frequency, and reversible, with a high level of certainty.

9.3.8 Supply and Servicing

The Project will involve vessel and aircraft use (presence and movements), including supply and support traffic to, from and within the Project Area at all times of year during the Project life. This traffic may affect seabirds through lighting, noise and other associated environmental emissions and discharges. The various bird species that occupy the Project Area will not likely be disturbed by Project-related vessel activity or associated aircraft use, due to its transitory nature and thus, its short-term presence at any one location, and because it is generally in keeping with the overall marine traffic that has occurred throughout the region for years.

The potential effects of bird attraction to nocturnal artificial lighting sources in the offshore environment were discussed in in Section 9.3.3. and potential effects due to lighting on the drilling installation are anticipated to be similar to those resulting from lighting on supply vessels. For the most part, project vessels are not stationary, except for occurrences when vessels must maintain station (stand-by vessel and some survey activities), meaning that any disturbances will be highly transient in nature but will extend across a wider area along the identified vessel traffic routes. Mitigation measures outlined in Section 9.3.2 will be in place during Project operations to reduce the effects of bird attraction due to offshore lighting from Project vessels. Overall, however, the presence of these vessels in the Canada-NL Offshore Area as part of this Project would be a negligible addition of night lighting in this region.

The potential effects of Project-related discharges from Project-related drilling installations and vessels are described in Section 9.3.4. Supply vessel traffic to and from the drilling installation(s) will again not be stationary, therefore, environmental disturbances and effects will be highly mobile and thus transient in nature. The release of organic wastes by offshore vessels and activities can attract birds, which may increase the potential for interactions including risk of predation, collision, and exposure to contaminants. However, this will be minimized with proper waste management practices and adherence to associated MARPOL requirements. The potential effects of waste discharges on marine-associated birds are detailed in Section 9.3.4. and as stated in the Project Description (Section 2.9), will be managed in keeping with regulatory requirements. Solid waste management practices, as outlined in Section 2.9 will be followed.

In addition to vessel traffic, the Project will require helicopter use (presence and movements) within the Project Area at various times of year throughout its duration. The primary interaction associated with helicopter use is the possible disturbance effects of aircraft overflights on birds. These include

a possible temporary loss of useable habitat and increased energy expenditure of birds due to escape reactions, increased heart rate, and lower food intake due to interruptions (Ellis et al. 1991; Trimper et al. 2003; Komenda-Zehnder et al. 2003). Helicopter noise can disturb nesting seabirds at colonies, although seabird reactions to helicopters and other aircraft depend on a number of factors including species, previous exposure levels, and the location, altitude, and number of flights (Hoang 2013). In terms of behavioural effects of helicopter noise on birds, flushing of breeding birds from the nest in response to loud noises is perhaps the most obvious and can have immediate negative consequences including predation of eggs and chicks and decreased incubation and brooding (Burger 1981; Brown 1990; Bolduc and Guillemette 2003; Beale 2007; Burger et al. 2010). Nestlings may also be vulnerable to exposure, and adults may inadvertently knock eggs and flightless young from the nest, which is of concern for cliff- nesting species (Burger 1981; Carney and Sydeman 1999). Other behavioural effects may include reduced foraging and provisioning rates (Davis and Wiseley 1974; Lynch and Speake 1978; Belanger and Bedard 1990; Delaney et al. 2002; Goudie 2006). Noise may also deter birds from favourable habitats and may alter migration paths, resulting in greater energy expenditure (Larkin 1996; Beale 2007). Research has shown that overt behavioural responses in response to aircraft traffic, such as flushing, may occur at a distance of 366 m for Common Murres (Rojek et al. 2007), although there is inherent variability in behavioural responses between and even within species (Blumstein et al. 2005; Hoang 2013).

Overall, however, interactions between Project-related supply and servicing activities and bird species are anticipated to be minor due to the localized, short-term, and mobile (transitory) nature of these activities, and because it is generally in keeping with the overall marine traffic that has occurred throughout the region for years. Vessel traffic for supply and servicing of the drilling installation represents a negligible contribution to the overall vessel traffic off Eastern Newfoundland, and Project-related supply vessel traffic will use existing and established routes wherever possible. Helicopters will be used for crew transfers and other purposes as required, but these are anticipated to be infrequent. Helicopters will avoid coastal seabird colonies during the nesting season as per the *Seabird Ecological Reserve Regulations, 2015*.

Negative interactions with and effects on coastal breeding colonies and IBAs are also unlikely. In accordance with standard practices, vessels will transit in a straight line approach from port, unless the presence of pack ice or other environmental phenomena requires routes to be altered, and the helicopter routes that will be used have been commonly used by the offshore oil and gas industry over the past 20 years. Therefore, the amount of time these vessels are near coastal habitats will be reduced. The amount of helicopter traffic will be reduced to the lowest level practical for the Project, and low-level aircraft operations will be avoided, as appropriate. Known and observed bird colonies, large aggregations of avifauna, critical habitats and protected or sensitive areas and times will also be avoided wherever possible. This includes avoidance of helicopter use near seabird breeding colonies during the period from May 1st to August 31st (with an end-date of September 30th for Northern Gannet Colonies); colony locations are shown on Figure 6-49 in Section 6.2.

During Project operations offshore, regular searches of vessel decks will be undertaken and accepted protocols for the collection and release of birds that become stranded will be implemented by qualified and experienced personnel, in accordance with applicable regulatory guidance and requirements and the CWS bird handling permit.

The predicted environmental effects of supply and servicing activities are primarily related to potential disturbance due to vessel movements, release of organic wastes leading to increased food availability, and attraction / disorientation of birds due to lighting. These may result in changes in mortality/injury levels, and the presence and abundance of avifauna. These changes are predicted to be adverse but low in magnitude, localized in extent, short-term, regular in frequency, and reversible, with these predictions being made with a high level of certainty.

9.4 Species at Risk: Overview of Potential Effects and Key Mitigation

The potential environmental interactions between the Project and bird species at risk are the same as those for the Marine and Migratory Bird VC as a whole, as are the planned mitigation measures to avoid or reduce such adverse interactions.

Additional species-specific information and analysis related to the potential for the Project to interact with and affect each of these Species at Risk is provided in the Table 9.3.

Table 9.3 Marine and Migratory Bird Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	NL ESA	SARA	COSEWIC	Summary of Presence and Potential Interactions
Barrow's Goldeneye (Eastern pop.)	Vulnerable	Special Concern (Schedule 1)	Special Concern	• Moults and winters in small numbers off the coast of Eastern Canada • Known to congregate in relatively small geographic areas in important shipping corridors, therefore considered to be particularly vulnerable to being affected by accidental spills (Schmelzer 2006) • Unlikely to be present in Project Area / LSA due to their preference for coastal habitats
Harlequin Duck (Eastern pop.)	Vulnerable	Special Concern (Schedule 1)	Special Concern	• Breed inland, but occur in the coastal marine environment throughout the fall and winter months. Some non-breeding individuals may be found year-round at Cape St. Mary's • Unlikely to be present in Project Area / LSA due to their preference for coastal habitats

Table 9.3 Marine and Migratory Bird Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	NL ESA	SARA	COSEWIC	Summary of Presence and Potential Interactions
Ivory Gull	Endangered	Endangered (Schedule 1)	Endangered	• Breeds in the far north and winters offshore; found in small numbers in the waters off Eastern Newfoundland, typically among pack ice • No critical habitat exists in the Project area • Potentially present. Ivory Gulls are most likely to occur in areas of pack ice. Refer to Figure 5-55 in Section 5.7.1 for pack ice extents in the Project Area • Ivory gulls were reported on two occasions in bird surveys conducted at the Bay de Verde Well Site in the winter of 2014-2015 (PAL 2015a)
Red-necked Phalarope	none	none	Special Concern	• Phalaropes come onshore only to breed, and occur in the coastal marine environment the rest of the year • Surface feeders, often congregating in areas such as upwellings which are associated with higher prey densities • Seen in small numbers during ECSAS surveys off eastern Newfoundland, although scarce in the winter and spring (ECSAS 2016)
Piping Plover (*Melodus* ssp.)	Endangered	Endangered (Schedule 1)	Endangered	• During the nesting season, Piping Plovers are found on sandy beaches along the coast • In Newfoundland, breeding population is concentrated in the southwest and western portions of the Island • Piping plovers are unlikely to be affected by typical Project activities due to their preference for coastal habitats, but accidental spills near breeding habitat could potentially be harmful
Red Knot (*Rufa* ssp.)	Endangered	Endangered (Schedule 1)	Endangered	• Arctic breeders. Newfoundland is not considered to be a major migratory stopover location; nonetheless, sightings have been reported around much of coastal Newfoundland • Unlikely to be present in Project Area / LSA due to their preference for coastal habitats

Table 9.3 Marine and Migratory Bird Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	NL ESA	SARA	COSEWIC	Summary of Presence and Potential Interactions
Buff-breasted Sandpiper	none	none	Special Concern	• Arctic breeders. Newfoundland is not considered to be a major migratory stopover location; nonetheless, sightings have been reported in parts of coastal Newfoundland • Unlikely to be present in Project Area / LSA due to their preference for coastal habitats
Peregrine Falcon	Vulnerable	Special Concern (Schedule 1)	Special Concern	• Migrates along the coast of Newfoundland during the fall (particularly the west coast), preying on concentrations of migrating shorebirds • Some evidence suggests they may be attracted to platforms due to the abundance of prey species • Typically found in more coastal areas, but an individual was observed near an offshore production platform in October 2015 (McTavish and Lang 2015)
Common Nighthawk	Threatened	Threatened (Schedule 1)	Threatened	• Does not breed in insular Newfoundland • Unlikely to occur regularly in the Project Area / LSA; however, a vagrant was observed offshore in November 2014 (PAL 2015a)
Gray-cheeked Thrush (*minimus* ssp.)	Threatened	none	Candidate Species (low priority)	• An inland species, therefore unlikely to be affected by offshore activities at most times of year • Unlikely to be found in the Project Area / LSA; however, during fall migration, like other nocturnal migrants, there is potential to be attracted to or disoriented by artificial light sources in the offshore environment
Olive-sided Flycatcher	Threatened	Threatened (Schedule 1)	Threatened	• An inland species, therefore unlikely to be affected by offshore activities at most times of year • Unlikely to be found in the Project Area / LSA; however, during fall migration, like other nocturnal migrants, there is potential to be attracted to or disoriented by artificial light sources in the offshore environment

Table 9.3 Marine and Migratory Bird Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	NL ESA	SARA	COSEWIC	Summary of Presence and Potential Interactions
Bobolink	Vulnerable	none	Threatened	• Uncommon in eastern Newfoundland. • An inland species, therefore unlikely to be affected by offshore activities at most times of year • Unlikely to be found in the Project Area / LSA; however, during fall migration, like other nocturnal migrants, there is potential to be attracted to or disoriented by artificial light sources in the offshore environment
Short-eared Owl	Vulnerable	Special Concern (Schedule 1)	Special Concern	• Typically nests in coastal barrens and grasslands, and suitable habitat occurs in much of coastal Newfoundland • Unlikely to occur regularly in the Project Area / LSA; however, a vagrant was observed near an offshore production platform in October 2015 (McTavish and Lang 2015)

There is no designated Critical Habitat for avian SAR in the Project Area. The only marine-associated avian SAR that have a degree of potential to occur in the Project Area / LSA are the ivory gull and red-necked phalarope, although because the former spends most of its time on pack ice, interactions with the Project are likely to be infrequent. Ivory gull and red-necked phalarope may be attracted by increased food availability from organic wastes generated by the drilling installation and support vessels; however, these species are not known to be susceptible to disorientation by artificial light sources, and no strandings of ivory gull or red-necked phalarope were reported in the survey reports provided by Statoil.

During fall migration, there is some potential for peregrine falcons to be attracted to platforms because of the increase in prey availability, as they are attracted to flocks of migrating birds, and some nocturnally migrating landbird species at risk may be attracted by the Project lighting; however, because it is situated hundreds of kilometres from shore, these landbird species are unlikely to occur with regularity in the Project Area / LSA.

As a result of the above analysis, and with the implementation of the various mitigation measures outlined in Sections 9.3.2 the Project is not considered likely to interact with or result in adverse effects upon SAR. The Project will not affect critical habitat for these species, nor is it likely to result in disturbance of coastal breeding colonies given its offshore location.

9.5 Significance of Residual Environmental Effects

This section summarizes the residual effects of the Project on Marine and Migratory Birds and presents a determination of significance for the environmental effects assessment for this VC.

9.5.1 Residual Environmental Effects Summary

Table 9.4 summarizes the environmental effects assessment for the Project as a whole, including characterization of potential effects from potential Project interactions and applicable mitigation measures relating to Marine and Migratory Birds. Tables 9.5 to 9.10 then provide individual environmental effects assessment summaries for planned Project activities on each of the ELs that comprise the Project being assessed under CEAA 2012. As described above and summarized in Table 9.4, with the implementation of the various mitigation measures outlined in the preceding sections, the Project is not likely to result in adverse environmental effects on Marine and Migratory Birds. Presence and operation of the drilling installation, drilling and marine discharges, formation testing with flaring, vertical seismic profiling, geophysical / geohazard / wellsite / seabed surveys, and supply and servicing activities may result in adverse effects on avifauna, primarily through drilling installation and vessel attraction or avoidance associated with lighting and other potential environmental interactions and emissions leading to some increased potential for changes in individual bird mortality / injury (particularly in the spring and fall migration periods and during specific meteorological conditions) or other health effects. However, these will be avoided or reduced through the various mitigation measures identified herein, and will not result in population-level effects.

The ivory gull and red-necked phalarope are the only avian SAR that are likely to be found in the Project Area. Neither species is known to be especially prone to disorientation effects from artificial lighting, although there is potential for attraction due to increased foraging opportunities. During fall migration, there is some potential for predatory peregrine falcons and nocturnally migrating landbird species at risk to be attracted to the Project, but due to the great distance of the Project Area / LSA from shore, presence of these species is expected to be extremely rare. Potential effects on SAR will be avoided or reduced through the various mitigations identified earlier.

Table 9.4 Environmental Effects Assessment Summary: Marine and Migratory Birds – Overall Project

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY	
Summary of Existing Conditions and Ecological and Social Context: Project Area / LSA • A variety of avifauna species occur within the marine and coastal environments off Eastern Newfoundland at various times of the year, including seabirds and other avifauna that inhabit the region at particular or extended periods for breeding, feeding, migration and other activities according to their individual life histories and habitat requirements. • Birds are highly mobile, and so information on their presence and distribution (spatially and temporally) is is inherently regional in nature. • A number of important habitats for birds have also been identified at locations along the coastline of Newfoundland and Labrador, well outside of the area within which exploration drilling and associated activities are planned to occur.	**Summary of Key Mitigation** • Low-level aircraft operations will be avoided where it is not required per Transport Canada protocols • Operational discharges will be treated prior to release in accordance with the OWTG (2016) and other applicable regulations and standards. • The selection and screening of chemicals to be discharged, including drilling fluids, will be in accordance with the Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands • During formation flow testing with flaring, produced hydrocarbons and produced water will be flared. If there is a large amount of produced water encountered, it will be treated in accordance with the relevant regulatory requirements prior to ocean discharge, or shipped to shore for appropriate disposal • The Operator will avoid, where possible, established bird colonies. Helicopters will avoid known coastal seabird colonies per requirements of the NL Seabird Ecological Reserve Regulations, 2015 • During drilling operations, routine observations of seabirds, following the CWS protocols will be undertaken from the drilling installation • Routine searches for stranded birds will be conducted on the platform and supply vessels, and appropriate programs and protocols for the collection and release of marine and migratory birds will be implemented for birds that become stranded (i.e., "ECCC-CWS's Oiled Birds Protocol and Protocol for Collecting Dead Birds from Platforms. Best Practices for Stranded Birds Encountered Offshore Atlantic Canada (Draft 2)" and Williams and Chardine (n.d.): The Leach's storm-petrel: General Information and Handling Instructions) • The Operator will obtain a Seabird Handling permit from ECCC-CWS • Maceration of sewage and kitchen waste, in accordance with the OWTG to 6 mm particle size • Operators are required to notify the C-NLOPB for plans to flare associated with formation flow testing for exploration drilling. The C-NLOPB then consults with ECCC-CWS to determine a safe timeline to proceed to reduce effects on migrating birds

Table 9.4 Environmental Effects Assessment Summary: Marine and Migratory Birds – Overall Project

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature / Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of Drilling Installation	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance • Change in habitat availability and quality • Change in food availability or quality	A	L	L-PA	S-M	R	R	M
Drilling and Associated Marine Discharges	• Change in mortality / injury levels and bird health • Change in food availability or quality	A	L	L	S	S	R	M
Formation Flow Testing with Flaring	• Change in mortality / injury levels and bird health	A	L	L-PA	S	S	R	M
Wellhead Decommissioning	• None expected	N	-	-	-	-	-	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance	A	N	L - PA	S	S	R	H

Table 9.4 Environmental Effects Assessment Summary: Marine and Migratory Birds – Overall Project

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
	• Change in habitat availability and quality							
Geological, Geotechnical and Environmental Surveys	• None expected	N	-	-	-	-	-	H
Supply and Servicing	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance	A	L	L	S	R	R	H

Evaluation of Significance

- Based on the nature and characteristics of the Project and the existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Project is not likely to result in significant adverse effects on Marine and Migratory Birds.
- Although Project-related components, activities and emissions may result in some localized, short-term interactions with marine-associated avifauna in parts of the LSA, including bird attraction to offshore lighting and other components, the number of individuals that may be affected, and the temporary and reversible nature of these interactions, means that the Project will not have any overall ecological or population-level effects, and particularly, will not result in a detectable decline in overall bird abundance or changes in the spatial and temporal distributions of bird populations within this area
- With regard to avifauna species at risk, ivory gull and red-necked phalarope are the only such species that are likely to be found in the Project Area. During fall migration, there is some potential for Peregrine Falcons and nocturnally migrating landbird species at risk to be present and to be attracted to the Project. However, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA or RSA. The Project will therefore not have implications for the overall abundance, distribution, or health of such species at risk nor its eventual recovery. The Project is therefore not likely to result in significant adverse effects on avian species at risk.

NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.

Table 9.4 Environmental Effects Assessment Summary: Marine and Migratory Birds – Overall Project

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY		
KEY		
Nature / Direction:	Frequency:	Certainty in Predictions:
P Positive	O Occurs once	L Low level of confidence
A Adverse	S Occurs sporadically	M Moderate level of confidence
N Neutral (or No Effect)	R Occurs on a regular basis	H High level of confidence
	C Occurs continuously	
Magnitude:		N/A Not Applicable
N Negligible	Duration:	
L Low	S Short term (For duration of the activity)	
M Medium	M Medium term (Beyond duration of the activity – weeks or months)	
H High	L Long term (Beyond duration of the activity – years)	
Geographic Extent:	P Permanent (Recovery unlikely)	
L Localized, In Immediate Vicinity of Activity		
PA Within Project Area	Reversibility:	
LSA Within LSA	R Reversible (Will recover to baseline)	
RSA Within RSA or Beyond	I Irreversible (Permanent)	

Table 9.5 Environmental Effects Assessment Summary: Marine and Migratory Birds – EL 1135

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Summary of Existing Conditions and Ecological and Social Context: EL 1135 • See Table 9.4 for an overview of the Project Area / LSA as a whole. • Birds are highly mobile, and so information on their presence and distribution (spatially and temporally) is inherently regional in nature. • The potential vessel traffic route associated with this EL passes within approximately 5 km of the northern end of the Eastern Avalon Coast EBSA, which supports a diverse assemblage of foraging seabirds during the breeding season (spring to fall).								**Summary of Key Mitigation** See Table 9.4
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature / Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of Drilling Installation	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance • Change in habitat availability and quality • Change in food availability or quality	A	L	L-PA	S-M	R	R	M
Drilling and Associated Marine Discharges	• Change in mortality / injury levels and bird health • Change in food availability or quality	A	L	L	S	S	R	M
Formation Flow Testing with Flaring	• Change in mortality / injury levels and bird health	A	L	L-PA	S	S	R	M
Wellhead Decommissioning	• None expected	N	-	-	-	-	-	H

Table 9.5 Environmental Effects Assessment Summary: Marine and Migratory Birds – EL 1135

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance • Change in habitat availability and quality	A	N	L - PA	S	S	R	H
Geological, Geotechnical and Environmental Surveys	• None expected	N	-	-	-	-	-	H
Supply and Servicing	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance	A	L	L	S	R	R	H

Table 9.5 Environmental Effects Assessment Summary: Marine and Migratory Birds – EL 1135

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY
Evaluation of Significance • Based on the nature and characteristics of the Project and the existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Project is not likely to result in significant adverse effects on Marine and Migratory Birds. • Although Project-related components, activities and emissions may result in some localized, short-term interactions with marine-associated avifauna in parts of the LSA, including bird attraction to offshore lighting and other components, the number of individuals that may be affected, and the temporary and reversible nature of these interactions, means that the Project will not have any overall ecological or population-level effects, and particularly, will not result in a detectable decline in overall bird abundance or changes in the spatial and temporal distributions of bird populations within this area • With regard to avifauna species at risk, ivory gull and red-necked phalarope are the only such species that are likely to be found in the Project Area. During fall migration, there is some potential for Peregrine Falcons and nocturnally migrating landbird species at risk to be present and to be attracted to the Project. However, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA or RSA. The Project will therefore not have implications for the overall abundance, distribution, or health of such species at risk nor its eventual recovery. The Project is therefore not likely to result in significant adverse effects on avian species at risk. NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.
KEY: See Table 9.4

Table 9.6 Environmental Effects Assessment Summary: Marine and Migratory Birds – EL 1137

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Summary of Existing Conditions and Ecological and Social Context: EL 1137 • See Table 9.4 for an overview of the Project Area / LSA as a whole. • Birds are highly mobile, and so information on their presence and distribution (spatially and temporally) is inherently regional in nature. • The potential vessel traffic route associated with this EL passes through the northern end of the Eastern Avalon Coast EBSA, which supports a diverse assemblage of foraging seabirds during the breeding season (spring to fall).							**Summary of Key Mitigation** See Table 9.4	
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature / Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of Drilling Installation	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance • Change in habitat availability and quality • Change in food availability or quality	A	L	L-PA	S-M	R	R	M
Drilling and Associated Marine Discharges	• Change in mortality / injury levels and bird health • Change in food availability or quality	A	L	L	S	S	R	M
Formation Flow Testing with Flaring	• Change in mortality / injury levels and bird health	A	L	L-PA	S	S	R	M
Wellhead Decommissioning	• None expected	N	-	-	-	-	-	H

Table 9.6 Environmental Effects Assessment Summary: Marine and Migratory Birds – EL 1137

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance • Change in habitat availability and quality	A	N	L - PA	S	S	R	H
Geological, Geotechnical and Environmental Surveys	• None expected	N	-	-	-	-	-	H
Supply and Servicing	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance	A	L	L	S	R	R	H

Table 9.6 Environmental Effects Assessment Summary: Marine and Migratory Birds – EL 1137

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY
Evaluation of Significance • Based on the nature and characteristics of the Project and the existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Project is not likely to result in significant adverse effects on Marine and Migratory Birds. • Although Project-related components, activities and emissions may result in some localized, short-term interactions with marine-associated avifauna in parts of the LSA, including bird attraction to offshore lighting and other components, the number of individuals that may be affected, and the temporary and reversible nature of these interactions, means that the Project will not have any overall ecological or population-level effects, and particularly, will not result in a detectable decline in overall bird abundance or changes in the spatial and temporal distributions of bird populations within this area • With regard to avifauna species at risk, ivory gull and red-necked phalarope are the only such species that are likely to be found in the Project Area. During fall migration, there is some potential for Peregrine Falcons and nocturnally migrating landbird species at risk to be present and to be attracted to the Project. However, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA or RSA. The Project will therefore not have implications for the overall abundance, distribution, or health of such species at risk nor its eventual recovery. The Project is therefore not likely to result in significant adverse effects on avian species at risk. NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.
KEY: See Table 9.4

Table 9.7 Environmental Effects Assessment Summary: Marine and Migratory Birds – EL 1139

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Summary of Existing Conditions and Ecological and Social Context: EL 1139 • See Table 9.4 for an overview of the Project Area / LSA as a whole. • • Birds are highly mobile, and so information on their prence and distribution (spatially and temporally) is inherently regional in nature. • ELs in the northernmost region of the Project Area, including this one, are more likely to experience pack ice in the winter months; therefore, there is a somewhat greater potential for the Ivory Gull to be present in this EL..								**Summary of Key Mitigation** See Table 9.4
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature / Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of Drilling Installation	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance • Change in habitat availability and quality • Change in food availability or quality	A	L	L-PA	S-M	R	R	M
Drilling and Associated Marine Discharges	• Change in mortality / injury levels and bird health • Change in food availability or quality	A	L	L	S	S	R	M
Formation Flow Testing with Flaring	• Change in mortality / injury levels and bird health	A	L	L-PA	S	S	R	M
Wellhead Decommissioning	• None expected	N	-	-	-	-	-	H

Table 9.7 Environmental Effects Assessment Summary: Marine and Migratory Birds – EL 1139

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance • Change in habitat availability and quality	A	N	L - PA	S	S	R	H
Geological, Geotechnical and Environmental Surveys	• None expected	N	-	-	-	-	-	H
Supply and Servicing	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance	A	L	L	S	R	R	H

Table 9.7 Environmental Effects Assessment Summary: Marine and Migratory Birds – EL 1139

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY
Evaluation of Significance • Based on the nature and characteristics of the Project and the existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Project is not likely to result in significant adverse effects on Marine and Migratory Birds. • Although Project-related components, activities and emissions may result in some localized, short-term interactions with marine-associated avifauna in parts of the LSA, including bird attraction to offshore lighting and other components, the number of individuals that may be affected, and the temporary and reversible nature of these interactions, means that the Project will not have any overall ecological or population-level effects, and particularly, will not result in a detectable decline in overall bird abundance or changes in the spatial and temporal distributions of bird populations within this area • With regard to avifauna species at risk, ivory gull and red-necked phalarope are the only such species that are likely to be found in the Project Area. During fall migration, there is some potential for Peregrine Falcons and nocturnally migrating landbird species at risk to be present and to be attracted to the Project. However, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA or RSA. The Project will therefore not have implications for the overall abundance, distribution, or health of such species at risk nor its eventual recovery. The Project is therefore not likely to result in significant adverse effects on avian species at risk. NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.
KEY: See Table 9.4

Table 9.8 Environmental Effects Assessment Summary: Marine and Migratory Birds – EL 1140

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Summary of Existing Conditions and Ecological and Social Context: EL 1140 • See Table 9.4 for an overview of the Project Area / LSA as a whole. • Birds are highly mobile, and so information on their presence and distribution (spatially and temporally) is inherently regional in nature. • ELs in the northernmost region of the Project Area, including this one, are more likely to experience pack ice in the winter months; therefore, there is a somewhat greater potential for the Ivory Gull to be present in this EL.							**Summary of Key Mitigation** See Table 9.4	
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature / Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of Drilling Installation	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance • Change in habitat availability and quality • Change in food availability or quality	A	L	L-PA	S-M	R	R	M
Drilling and Associated Marine Discharges	• Change in mortality / injury levels and bird health • Change in food availability or quality	A	L	L	S	S	R	M
Formation Flow Testing with Flaring	• Change in mortality / injury levels and bird health	A	L	L-PA	S	S	R	M
Wellhead Decommissioning	• None expected	N	-	-	-	-	-	H

Table 9.8 Environmental Effects Assessment Summary: Marine and Migratory Birds – EL 1140

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance • Change in habitat availability and quality	A	N	L - PA	S	S	R	H
Geological, Geotechnical and Environmental Surveys	• None expected	N	-	-	-	-	-	H
Supply and Servicing	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance	A	L	L	S	R	R	H

Table 9.8 Environmental Effects Assessment Summary: Marine and Migratory Birds – EL 1140

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY
Evaluation of Significance • Based on the nature and characteristics of the Project and the existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Project is not likely to result in significant adverse effects on Marine and Migratory Birds. • Although Project-related components, activities and emissions may result in some localized, short-term interactions with marine-associated avifauna in parts of the LSA, including bird attraction to offshore lighting and other components, the number of individuals that may be affected, and the temporary and reversible nature of these interactions, means that the Project will not have any overall ecological or population-level effects, and particularly, will not result in a detectable decline in overall bird abundance or changes in the spatial and temporal distributions of bird populations within this area • With regard to avifauna species at risk, ivory gull and red-necked phalarope are the only such species that are likely to be found in the Project Area. During fall migration, there is some potential for Peregrine Falcons and nocturnally migrating landbird species at risk to be present and to be attracted to the Project. However, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA or RSA. The Project will therefore not have implications for the overall abundance, distribution, or health of such species at risk nor its eventual recovery. The Project is therefore not likely to result in significant adverse effects on avian species at risk. NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.
KEY: See Table 9.4

Table 9.9 Environmental Effects Assessment Summary: Marine and Migratory Birds – EL 1141

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Summary of Existing Conditions and Ecological and Social Context: EL 1141 • See Table 9.4 for an overview of the Project Area / LSA as a whole. • Birds are highly mobile, and so information on their presence and distribution (spatially and temporally) is inherently regional in nature. • ELs in the northernmost region of the Project Area, including this one, are more likely to experience pack ice in the winter months; therefore, there is a somewhat greater potential for the Ivory Gull to be present in this EL.							**Summary of Key Mitigation** See Table 9.4	
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature / Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of Drilling Installation	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance • Change in habitat availability and quality • Change in food availability or quality	A	L	L-PA	S-M	R	R	M
Drilling and Associated Marine Discharges	• Change in mortality / injury levels and bird health • Change in food availability or quality	A	L	L	S	S	R	M
Formation Flow Testing with Flaring	• Change in mortality / injury levels and bird health	A	L	L-PA	S	S	R	M
Wellhead Decommissioning	• None expected	N	-	-	-	-	-	H

Table 9.9 Environmental Effects Assessment Summary: Marine and Migratory Birds – EL 1141

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance • Change in habitat availability and quality	A	N	L - PA	S	S	R	H
Geological, Geotechnical and Environmental Surveys	• None expected	N	-	-	-	-	-	H
Supply and Servicing	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance	A	L	L	S	R	R	H

Table 9.9 Environmental Effects Assessment Summary: Marine and Migratory Birds – EL 1141

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY
Evaluation of Significance • Based on the nature and characteristics of the Project and the existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Project is not likely to result in significant adverse effects on Marine and Migratory Birds. • Although Project-related components, activities and emissions may result in some localized, short-term interactions with marine-associated avifauna in parts of the LSA, including bird attraction to offshore lighting and other components, the number of individuals that may be affected, and the temporary and reversible nature of these interactions, means that the Project will not have any overall ecological or population-level effects, and particularly, will not result in a detectable decline in overall bird abundance or changes in the spatial and temporal distributions of bird populations within this area • With regard to avifauna species at risk, ivory gull and red-necked phalarope are the only such species that are likely to be found in the Project Area. During fall migration, there is some potential for Peregrine Falcons and nocturnally migrating landbird species at risk to be present and to be attracted to the Project. However, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA or RSA. The Project will therefore not have implications for the overall abundance, distribution, or health of such species at risk nor its eventual recovery. The Project is therefore not likely to result in significant adverse effects on avian species at risk. NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.
KEY: See Table 9.4

Table 9.10 Environmental Effects Assessment Summary: Marine and Migratory Birds – EL 1142

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Summary of Existing Conditions and Ecological and Social Context: EL 1142 • See Table 9.4 for an overview of the Project Area / LSA as a whole. • Birds are highly mobile, and so information on their presence and distribution (spatially and temporally) is inherently regional in nature. • ELs in the northernmost region of the Project Area, including this one, are more likely to experience pack ice in the winter months; there is a somewhat greater potential for the Ivory Gull to be present in this EL.							**Summary of Key Mitigation** See Table 9.4	
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature / Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of Drilling Installation	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance • Change in habitat availability and quality • Change in food availability or quality	A	L	L-PA	S-M	R	R	M
Drilling and Associated Marine Discharges	• Change in mortality / injury levels and bird health • Change in food availability or quality	A	L	L	S	S	R	M
Formation Flow Testing with Flaring	• Change in mortality / injury levels and bird health	A	L	L-PA	S	S	R	M
Wellhead Decommissioning	• None expected	N	-	-	-	-	-	H

Table 9.10 Environmental Effects Assessment Summary: Marine and Migratory Birds – EL 1142

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance • Change in habitat availability and quality	A	N	L - PA	S	S	R	H
Geological, Geotechnical and Environmental Surveys	• None expected	N	-	-	-	-	-	H
Supply and Servicing	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance	A	L	L	S	R	R	H

Table 9.10 Environmental Effects Assessment Summary: Marine and Migratory Birds – EL 1142

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY
Evaluation of Significance • Based on the nature and characteristics of the Project and the existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Project is not likely to result in significant adverse effects on Marine and Migratory Birds. • Although Project-related components, activities and emissions may result in some localized, short-term interactions with marine-associated avifauna in parts of the LSA, including bird attraction to offshore lighting and other components, the number of individuals that may be affected, and the temporary and reversible nature of these interactions, means that the Project will not have any overall ecological or population-level effects, and particularly, will not result in a detectable decline in overall bird abundance or changes in the spatial and temporal distributions of bird populations within this area • With regard to avifauna species at risk, ivory gull and red-necked phalarope are the only such species that are likely to be found in the Project Area. During fall migration, there is some potential for Peregrine Falcons and nocturnally migrating landbird species at risk to be present and to be attracted to the Project. However, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA or RSA. The Project will therefore not have implications for the overall abundance, distribution, or health of such species at risk nor its eventual recovery. The Project is therefore not likely to result in significant adverse effects on avian species at risk. NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.
KEY: See Table 9.4

9.5.2 Determination of Significance

The Project is not likely to result in significant adverse environmental effects on Marine and Migratory Birds, including SAR; this conclusion has been determined with a moderate to high level of certainty based on current understanding of the effects of similar projects on the VC. The primary mechanisms of interaction that may have negative effects on this VC include platform and vessel attraction associated with lighting and increased foraging opportunities, and potential hydrocarbon sheening. While these interactions may lead to increased potential for mortality or injury of individuals, the disturbances (and thus, effects) are anticipated to be negligible to minor and spatially and temporally limited, and thus number of individuals affected by the Project is not anticipated to have population-level effects within the RSA.

The Project is unlikely to result in significant effects on marine-associated avian SAR and their habitats. The ivory gull and red-necked phalarope are the only avian SAR that are likely to be found with any regularity in the Project Area, and could potentially be attracted by increased foraging opportunities associated with the drilling installation and support vessels. However, a review of the literature did not indicate these species to be susceptible to disorientation due to artificial lighting, and no strandings of these species were reported among the data provided by Statoil.

9.6 Environmental Monitoring and Follow-up

Although no specific follow-up related to the Marine and Migratory Birds VC is considered necessary in relation to the Project, a monitoring and observation program is proposed. A trained Environmental Observer will be onboard to record marine bird sightings during Project operations, which will be undertaken in accordance with CWS's monitoring protocol from fixed platforms. Regular searches of vessel decks will be undertaken and accepted protocols for the collection / handling of bird mortalities and release of birds that become stranded will be implemented. If a Species at Risk is found alive (stranded) or dead on the drilling installation or supply vessel, a report will be sent to CWS for identification. A seabird observations report will be submitted to the C-NLOPB within 90 days of well suspension and/or decommissioning. An annual report summarizing stranded and/or seabird handling will be submitted to the CWS in accordance with the Seabird Handling permit requirements.

9.7 References

Amec Environment and Infrastructure. 2011. 2009 Annual Report. Offshore Environmental Effects Monitoring Program ExxonMobil Canada Properties, Sable Offshore Energy Project FINAL (Revised). Report Prepared for ExxonMobil. Sable Offshore Energy Project, Halifax, NS (online). http://www.cnsopb.ns.ca/sites/default/files/pdfs/2009_annual_report_offshore_environmental_effects_monitoring_program_exxonmobil_canada_properties.pdf.

Amec Environment and Infrastructure. 2014. Eastern Newfoundland Strategic Environmental Assessment (SEA). Report prepared for C-NLOPB, August 2014.

Baillie, S.M., Robertson, G.J., Wiese, F.K. and Williams, U.P. 2005. Seabird Data Collected by the Grand Banks Offshore Hydrocarbon Industry 1999-2002: Results, Limitations and

Suggestions for Improvement. Canadian Wildlife Service Technical Report Series No. 434. Atlantic Region, Mount Pearl, NL, Canada.

Baird, P.H. 1990. Concentrations of seabirds at oil-drilling rigs. Condor, 92:768-771.

Beale, C.M. 2007. The behavioral ecology of disturbance responses. International Journal of Comparative Psychology, 20:111-120.

Belanger, L. and J. Bedard. 1990. Energetic cost of man-induced disturbance to staging in snow geese. Journal of Wildlife Management, 54(1):36-41

Bellefleur, D., Lee, P., Ronconi, R.A. 2009. The impact of recreational boat traffic on Marbled Murrelets (*Brachyramphus marmoratus*). J. Environ. Manag., 90, 531-538.

Blomqvist, S., and Peterz, M. 1984. Cyclones and pelagic seabird movements. Marine Ecology Progress Series, 20: 85-92.

Blumstein, D. Fernandez-Juricic, E., Zollner, P. and Garity, S. 2005. Inter-specific variation in avian responses to human disturbance. Journal of Applied Ecology, 42: 943-953.

Bolduc, F, and Guillemette, M. 2003. Human disturbance and nesting success of Common Eiders: ilteraction between visitors and Gulls. Biological Conservation, 110:77-83.

Bourne, W.R.P. 1979. Birds and gas flares. Mar. Pollut. Bull., 10, 124-135.

BP. 2016. Scotian Basin Exploration Drilling Project – Environmental Impact Statement. October 2016.

Bramford, A.R., Davies, S.J.J.F. and Van Delft, R. 1990. The effects of model power boats on waterbirds at Herdsman lake, Perth, Western Australia. Emu, 90:260-265.

Brown, A.L. 1990. Measuring the effect of aircraft noise on sea birds. Environment International, 16: 587 592.

Bruinzeel, L.W., van Belle, J. and Davids, L. 2009. The Impact of Conventional Illumination of Offshore Platforms in the North Sea on Migratory Bird Populations. A&W-rapport 1227. Altenburg & Wymenga Ecologisch Onderzoek, Feanwalden.

Bruinzeel, L.W. and van Belle, J. 2010. Additional Research on the Impact of Conventional Illumination of Offshore Platforms in the North Sea on Migratory Bird Populations. A&W-rapport 1439. Altenburg & Wymenga Ecologisch Onderzoek, Feanwalden.

Burger, J. 1981. Behavioral responses of Herring Gulls (*Larus argentatus*) to aircraft noise. Environmental Pollution Series A, 24: 177-184.

Burger, J., Gochfeld, M., Jenkins, C. and Lesser, F. 2010. Effect of approaching boats on nesting Black Skimmers: Using response distances to establish protective buffer zones. Journal of Wildlife Managemen,t 74:102-108.

Burke, C.M., Davoren, G.K., Montevecchi, W.A. and Wiese, F.K. 2005. Seasonal and spatial trends of marine birds along support vessel transects and at oil platforms on the Grand Banks. Pp. 587-614. In: Armsworthy, S.L., Cranford, P.J., Lee, K. (eds.), Offshore Oil and Gas Environmental Effects Monitoring: Approaches and Technologies.

Burke, C.M., Montevecchi, W.A. and Wiese, F.K. 2012. Inadequate environmental monitoring around offshore oil and gas platforms on the Grand Bank of Eastern Canada: re risks to marine birds known? J. Environ. Manag., 104, 121-126.

Butler, R.G., Peakall, D.B., Leighton, F.A., Borthwick, J. and Harmon, R.S. 1986. Effects of crude Oil exposure on standard metabolic-rate of Leach's storm-petrel. Condor, 88(2): 248-249.

Butler, R.G., Harfenist, A., Leighton, F.A. and Peakall, D.B. 1988. Impact of sublethal oil and emulsion exposure on the reproductive success of Leach's storm-petrels - Short and long-term effects. J. Appl. Ecol., 25(1): 125-143.

Carney, K. M. and Sydeman, W.J. 1999. A review of human disturbance effects on nesting colonial waterbirds. Waterbirds, 22: 68-79.

Davis, R. A. and Wiseley, A.N. 1974. Normal behavior of snow geese on the Yukon-Alaska North Slope and the effects of aircraft-induced disturbance on this behavior, p. 1-85. In W. Gunn, W. Richardson, R. Schweinsburg, and T. Wright. [Ed.], Studies on snow geese and waterfowl in the Northwest Territories, Yukon Territory and Alaska. Arctic Gas Biological Report, Vancouver, British Columbia, Canada.

Davis, R.A., Thomson, D. H., and Malme, C.I. 1998. Environmental Assessment of Seismic Exploration on the Scotian Shelf. Prepared for Mobil Oil Canada Properties Ltd., Shell Canada Ltd. and Imperial Oil Ltd. Submitted to the Canada - Nova Scotia Offshore Petroleum Board, Halifax, NS.

Delaney, D.K., Pater, L.L., Melton, R.H., MacAllister, B.A., Dooling, R.J., Lohr, B., Brittan-Powell, B.F., Swindell, L.L., Beaty, T.A., Carlile, L.D. and Spadgenske, E.W. 2002. Assessment of training noise impacts on the Red-cockaded Woodpecker: final report. US Army Construction Engineering Research Laboratories Technical Report 99/51, Fort Stewart, GA.

Dooling, R.J. and Popper, A.N. 2007. The Effects of Highway Noise on Birds. Report prepared for the California Department of Transportation Division of Environmental Analysis.

Dooling, R.R. and Therrien, S.C. 2012. Hearing in birds: What changes from air to water. Pp. 77-82. In: A.N. Popper and A. Hawkins (eds.). The Effects of Noise on Aquatic Life: Advances in Experimental Medicine and Biology, Springer, New York. pp. 77-82.

Ellis, D.H., Ellis, C.H., and Mindell, D.P. 1991. Raptor Responses to Low-Level Jet Aircraft and Sonic Booms. Environmental Pollution, 74: 53-83.

Ellis, J.I., Wilhelm, S.I., Hedd, A., Fraser, G.S., Robertson, G.J., Rail, J.F., Fowler, M., Morgan, K.H. 2013. Mortality of migratory birds from marine commercial fisheries and offshore oil and gas production in Canada. Avian Conserv. Ecol., 8.

Environment Canada. 2015. Best Practices for Stranded Birds Encountered Offshore Atlantic Canada. Draft 2 – April 17 2015. Available at: http://www.cnlopb.ca/pdfs/mg3/strandbird.pdf.

ERIN Consulting Ltd. and OCL Services Ltd. 2003. Sheens associated with produced water effluents – Review of causes and mitigation options. ERIN Consulting Ltd. and OCL Services Ltd. for Environmental Studies Research Funds, Report 142.

Evans, M.I., Symens, P. and Pilcher, C. 1993. Short-term damage to coastal bird populations in Saudi Arabia and Kuwait following the 1991 Gulf War. Marine Pollution Bulletin, 22: 157-161.

Fabi, G., Grati, F., Lucchetti, A. and Trovarelli, L. 2002. Evolution of the fish assemblage around a gas platform in the northern Adriatic Sea. Ices J. Mar. Sci., 59, S309-S315.

Fabi, G., Grati, F., Puletti, M. and Scarcella, G. 2004. Effects on fish community induced by installation of two gas platforms in the Adriatic Sea. Mar. Ecol. Prog. Ser., 273, 187-197.

Flint, P L., Reed, J.A., Franson, J.C., Hollmén, T.E., Grand, J.B., Howell, M.D., Lanctot, R.B., Lacroix, D.L. and Dau C.P. 2003. Monitoring Beaufort Sea Waterfowl and Marine Birds. US Geological Survey, Alaska Science Center, Anchorage, AK OCS Study MMS 2003-037

Gauthreaux, S.A. and C.G. Belser 2006. Effects of artificial night lighting on migrating birds. Pp. 67-93. In: C. Rich and T. Longcore (eds.). Ecological Consequences of Artificial Night Lighting. Island Press, Washington DC.

Goudie, R.I. 2006. Multivariate behavioural response of Harlequin Ducks to aircraft disturbance in Labrador. Environmental Conservation, 33: 28-35.

Government of Newfoundland and Labrador. 2015. Newfoundland and Labrador Regulation 32/15: Seabird Ecological Reserve Regulations, 2015 under the *Wilderness and Ecological Reserves Act* (O.C. 2015-092).

Hashino, E., Sokabe, M. and Miyamoto, K. 1988. Frequency specific susceptibility to acoustic trauma in the budgerigar (*Melopsittacus undulatus*). Journal of the Acoustical Society of America, 83: 2450-2453.

Hoang, T. 2013. A Literature Review of the Effects of Aircraft Disturbances on Seabirds, Shorebirds and Marine Mammals. Report Presented to NOAA, Greater Farallones National Marine Sanctuary and The Seabird Protection Network, August 2013.

Hope Jones, P. 1980. The effect on birds of a North Sea gas flare. Br. Birds, 73, 547-555.

Husky Oil. 2000. White Rose Development Environmental Comprehensive Study. Part I. Husky Oil, St. John's, NL, p. 639.

Imber M.J. 1975. Behaviour of petrels in relation to the moon and artificial lights. Notorni,s 22: 302-306.

Jones, J. and Francis, C. M. 2003. The effects of light characteristics on avian mortality at lighthouses. Journal of Avian Biology, 34:328–333.

Komenda-Zehnder, S., Cevallos, M. and Bruderer, B. 2003. Effects of Disturbance by aircraft overflight on waterbirds – An experimental approach (ISSC26/WP-LE2). Warsaw, Poland: International Bird Strike Committee.

Larkin, R.P. 1996. Effects of military noise on wildlife: a literature review. US Army Construction Engineering Research Laboratories Technical Report 96/21. January 1996.

Lynch, T.E., and Speake, D.W. 1978. Eastern wild turkey behavioral responses induced by sonic boom. Pp: 47-61. In: J. Fletcher and R.G. Busnel (eds.). Effects of Noise on Wildlife, Academic Press, New York, NY.

Mactavish, B. and Lang, A.L. 2015. Attraction of Leach's Storm-Petrels to Flares on Offshore Production Platforms and Potential Mortality – Summary Report. LGL Rep. FA0068-1. Rep. by LGL Limited, St. John's, NL, for Petroleum Research Newfoundland and Labrador, St. John's, NL. 8 pp.

Marquenie, J.M. and van de Laar, F. 2004. Protecting Migrating Birds from Offshore Production. Shell E&P Newsletter, January issue.

Marquenie, J., Donners, M., Poot, H., Steckel, W. and de Wit, B. 2013. Bird-friendly light sources: Adapting the spectral composition of artificial lighting. IEEE Ind. Appl. Mag., 19, 56-62.

MMS (Minerals Management Service). 2004. Geological and Geophysical Exploration for Mineral Resources on the Gulf of Mexico Outer Continental Shelf: Final Programmatic Environmental Assessment. United States Department of the Interior, Gulf of Mexico Outer Continental Shelf Region.

Montevecchi, W.A. 2006. Influences of artificial light on marine birds. Pages 94-113. In: C. Rich and T. Longcore (Eds). Ecological Consequences of Artificial Night Lighting. Island Press, Washington DC.

Montevecchi, W.A., Wiese, F.K., Davoren, G., Diamond, A.W., Huettmann, F., and Linke, J. 1999. Seabird Attraction to Offshore Platforms and Seabird Monitoring from Offshore Support Vessels and Other Ships: Literature Review and Monitoring Design. St. John's, NL.

Morandin, L.A. and O'Hara, P.D. 2016. Offshore oil and gas, and operational sheen occurrence: Is there potential harm to marine birds? Environmental Reviews, 24(3): 285-318

Neff, J.M. 2002. Bioaccumulation in Marine Organisms. Effects of Contaminants from Oil Well Produced Water. Elsevier Science, Oxford, UK.

O'Hara, P.D. and Morandin, L.A. 2010. Effects of sheens associated with offshore oil and gas development on the feather microstructure of pelagic seabirds. Mar. Pollut. Bull., 60, 672-678.

Pollet, I.L., Ronconi, R.A., Jonsen, I., Leonard, M.L., Taylor, P.D. and Shutler, D. 2014. Foraging movements of Leach's storm-petrels *Oceanodroma leucorhoa* during incubation. J. Avian Biol., 45(4): 305-314.

Poot, H., Ens, B.J., de Vries, H., Donners, M.A.H., Wernand, M.R., and Marquenie, J.M. 2008. Green light for nocturnally migrating birds. Ecol. Soc., 13: 47.

Reed, J.R., Sincock, J.L. and Hailman, J.P. 1985. Light attraction in endangered Procellariiform birds: reduction by shielding upward radiation. Auk, 102, 377-383.

Rojek, N.A, Parker, M.W., Carter, H.R. and McChesney, G.J. 2007. Aircraft and vessel disturbances to Common Murres Uria aalge at breeding colonies in Central California, 1997 1999. Marine Ornithology, 35:61-69.

Ronconi, R.A., Allard, K.A., and Taylor, P.D. 2015. Bird interactions with offshore oil and gas platforms: Review of impacts and monitoring techniques. J. Environ. Manage., 147: 34-45.

Ronconi, R.A. and St Clair, C.C. 2002. Management options to reduce boat disturbance on foraging black guillemots (*Cepphus grylle*) in the Bay of Fundy. Biol. Conserv., 108, 265-271.

Russell, R.W. 2005. Interactions between Migrating Birds and Offshore Oil and Gas Platforms in the Northern Gulf of Mexico. Final Report. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2005-009. 348 pp.

Ryals, B.M., Dooling, R.J., Westbrook, E., Dent, M.L., MacKenzie, A. and Larsen, O.N. 1999. Avian species differences in susceptibility to noise exposure. Hearing Research, 131:71-88.

Sage, B. 1979. Flare up over North Sea birds. New Sci., 81, 464-466.

Saunders, J. and Dooling, R. 1974. Noise-Induced Threshold Shift in the Parakeet (*Melopsittacus undulatus*). Proceedings of the National Academy of Sciences of the United States of America, 71(5):1962-1965.

Schummer, M.L. and Eddleman, W.R. 2003. Effects of disturbance on activity and energy budgets of migrating waterbirds in south-central Oklahoma. Journal of Wildlife Management, 67 (4), 789-795.

Stemp, R. 1985. Observations on the effects of seismic exploration on seabirds. Pp. 217-231. In: G.D. Greene, F.R. Engelhardt, and R.J. Paterson (eds.). Proceedings of the Workshop on the Effects of Explosives Use in the Marine Environment, 29-31 January 1985. Canada Oil and Gas Lands Administration, Environmental Protection Branch, Ottawa, ON. Tech. Rep. 5.

Tasker, M.L., Hope Jones, P., Blake, B.F., Dixon, T.J. and Wallis, A.W. 1986. Seabirds associated with oil production platforms in the North Sea, Ringing & Migration, 7:1, 7-14

Trimper, P.G., Knox, K., Shury, T., Lye, L. and Barrow, B. 2003., Response of moulting Black Ducks to jet activity, Terra Borealis, 3, 58-60.

Trivelpiece, W.Z., Butler, R.G., Miller, D.S. and Peakall, D.B. 1984. Reduced survival of chicks of oil-dosed adult Leach's stormpPetrels. Condor, 86(1): 81–82.

Weir, R.D. 1976. Annotated Bibliography of Bird Kills at Man-made Obstacles: A Review of the State of the Art and Solutions. Department of Fisheries and the Environment, Environmental Management Service, Canadian Wildlife Service, Ontario Region, Ottawa, ON.

Wiese, F.K. and Montevecchi, W.A. 2000. Marine Bird and Mammal Surveys on the Newfoundland Grand Banks from Offshore Supply Boats, 1999-2000. Report prepared for Husky Oil, St. John's, NL.

Wiese, F.K., Montevecchi, W.A., Davoren, G.K., Huettmann, F., Diamond, A.W., and Linke, J. 2001. Seabirds at risk around offshore oil platforms in the Northwest Atlantic. Marine Pollution Bulletin, 42(12):1285-1290.

10.0 MARINE MAMMALS AND SEA TURTLES: ENVIRONMENTAL EFFECTS ASSESSMENT

Marine Mammals and Sea Turtles were selected as a VC for this EIS because of the potential for these species to interact with Project components and activities, and because of the ecological, economic, cultural, and recreational importance that are often attributed to them by government departments and agencies, Indigenous and stakeholder groups and other interested parties. The assessment of potential Project effects on marine mammals and sea turtles is also required and conducted in accordance with the requirements of the EIS Guidelines.

Marine mammals and sea turtles and their habitats are protected under the federal *Fisheries Act* and SARA. The *Fisheries Act* includes provisions that prohibit serious harm to fish (i.e., the death of fish or permanent alteration to, or destruction of, fish habitat) that are part of a commercial, recreational, or Aboriginal fishery. Marine mammals and sea turtles as "marine animals" are considered "fish" for the purposes of the Act. SARA includes provisions to protect species listed on Schedule 1 of the Act as well as their critical habitat, which is defined as "habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in a recovery strategy or action plan for the species" (Section 2(1)). This VC considers species that are secure as well as those listed under SARA as SAR or identified by COSEWIC as SAR and SOCC are, however, given special attention and emphasis in the identification, analysis and evaluation of potential Project environmental effects and required mitigation measures. For the purposes of this assessment, marine mammals include baleen whales (mysticetes), toothed whales (odontocetes), and seals (phocids). Due to similarities in habitat use and the nature of potential interactions with Project components and activities, sea turtles are assessed together with marine mammals, with key differences noted where applicable.

Areas offshore Eastern Newfoundland are known to support a diversity of marine mammal and sea turtle species, many of which are designated as SAR or SOCC (see Section 6.2.4). Several Ecologically and Biologically Significant Areas (EBSAs), representing important foraging habitat and migratory routes for marine mammals and sea turtles (Templeman 2007), are also present in the region. An overview of EBSAs is presented in Section 6.4.2 of this EIS and in Section 4.2.3.6 of the Eastern Newfoundland Strategic Environmental Assessment (SEA) (Amec 2014). No critical habitat for marine mammals or sea turtles has been designated in or near the Project Area.

10.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

Spatial assessment boundaries have been defined for the environmental effects assessment for this VC to reflect the varying ways and scales in which the Project may influence marine mammals and sea turtles and their habitats. Within the Project Area itself, potential effects are expected to be direct in nature and associated with the specific environmental interactions and other disturbances that may be associated with planned Project activities. At the larger local and regional scales around the Project Area, however, the environmental effects assessment also considers the larger potential environmental zones of influence of the Project, and the characteristics, distributions and movements of the various marine mammal and sea turtle species and habitats that comprise this VC.

Three spatial Study Areas have been identified and considered in conducting the environmental effects assessment for this VC, as follows (Figure 10-1):

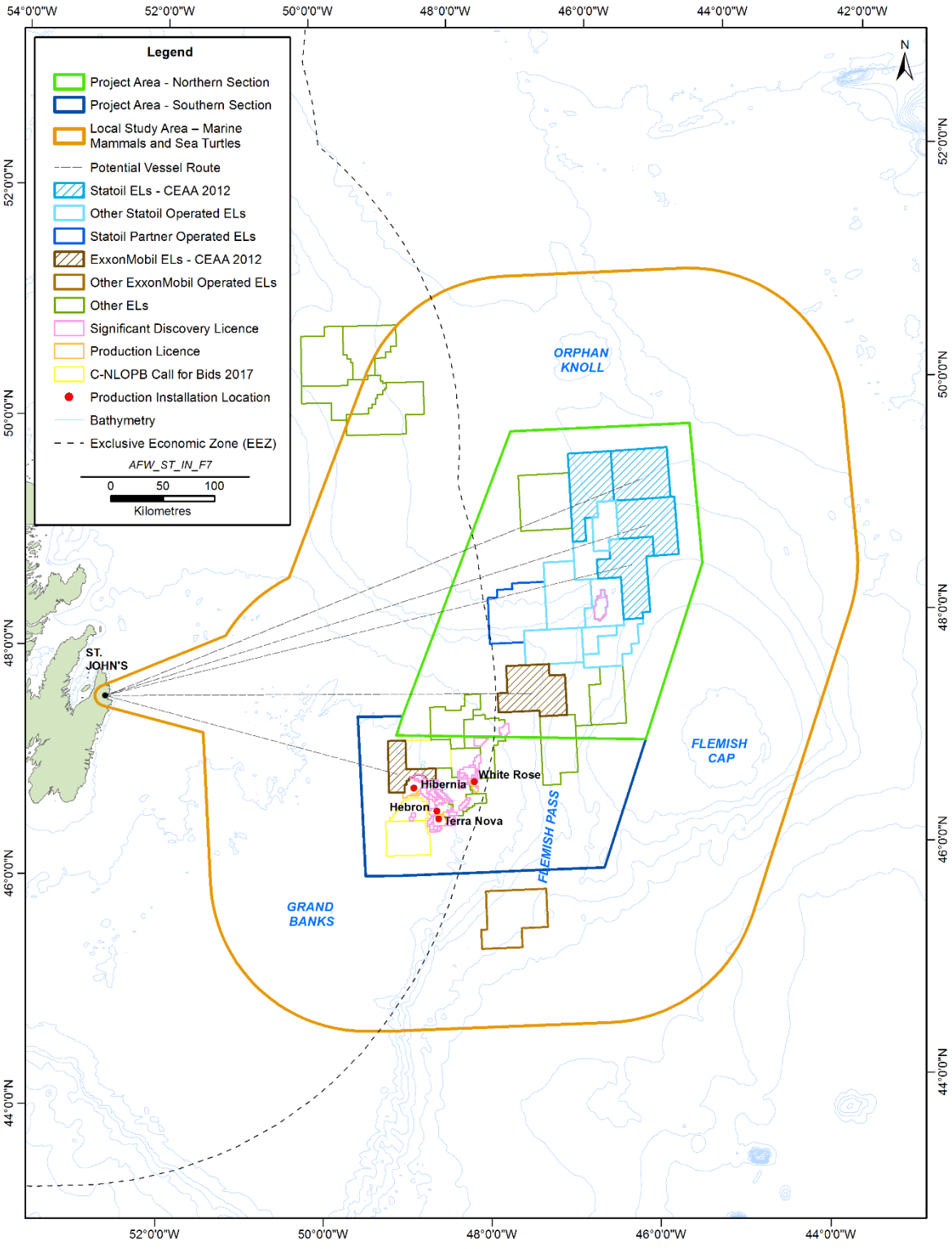


Figure 10-1 Environmental Assessment Study Areas: Marine Mammals and Sea Turtles

Project Area: This represents the overall geographic areas offshore Eastern Newfoundland within which planned Project-related activities will take place. While the Project Area is defined as overall polygons that encompass such activities over the course of the Project, the various components and activities associated with the drilling of each individual well and other planned components will occupy fairly small areas within this overall area, as described in Chapter 2. The assessment also considers related supply and support vessel and aircraft traffic to and from this offshore Project Area.

Local Study Area (LSA): This encompasses the overall geographic area over which planned Project-related environmental interactions (including emissions and other disturbances) will occur. The LSA therefore represents the anticipated environmental zone of influence of the Project's planned components and activities. As described in this chapter, the main Project-related environmental emissions and interactions that may affect marine mammals and sea turtles include the underwater noise that may be generated by the active drilling installation(s) and vessels and associated activities. While such interactions between planned Project components and activities and marine mammals and sea turtles are expected to occur primarily within the overall Project Area polygons defined above, as described in this chapter the effects of underwater noise could extend out some considerable distances from the source. As a result, the LSA is therefore (conservatively) defined as the offshore Project Area and an appropriately 150 km area around it, as well as an approximately 10 km area around the associated vessel and aircraft traffic routes to the ELs.

Regional Study Area (RSA): In addition to Project- and disturbance-related factors, from an ecological perspective, the environmental effects assessment also recognizes and considers the characteristics, distributions, and movements of the individual VCs under consideration, including the larger regional areas within which they occur. The EIS assesses potential effects to marine mammals and sea turtles (individuals and populations) which are known or likely to use the LSA, and considers the overall extent of affected individuals and populations during the time period at which they may be affected by planned Project components and activities. Key aspects of marine biota movements and distributions as they relate to the Project Area and LSA are as presented in Chapter 6 and are generally considered in assessing both potential Project-specific (this chapter) and cumulative (Chapter 14) effects upon this VC. The overall RSA for the environmental effects assessment is as defined and illustrated earlier in Section 4.3. The RSA therefore captures the marine waters of offshore Eastern Newfoundland and Labrador, to conservatively account for the overall predicted environmental zone of influence on individual marine mammal and sea turtles, recognizing that these are likely to move in and out of the smaller Project Area and LSA over the course of the Project. Generally, environmental interactions may occur entirely within the Project Area polygon itself as described above.

The temporal boundaries for the effects assessment encompass the likely timing and duration of Project-related (in-field) activities in the Project Area, as well as the likely duration of resulting environmental effects. In conducting the assessment, special consideration is also given to timing of VC presence within the Project and assessment areas, including important or sensitive periods.

Section 6.3.8 provides details of marine mammal and sea turtle species known to occur, and their timing of presence, within these areas.

It is within the above described spatial and temporal boundaries that the potential environmental effects on this VC resulting from planned Project components and activities and their significance are assessed and evaluated.

For the purposes of this EA, significant environmental effects on Marine Mammals and Sea Turtles are defined as those that are deemed likely to cause one or more of the following:

- A detectable decline in overall marine mammal or sea turtle abundance or change in the spatial and temporal distributions of populations within the overall RSA over multiple generations
- Effects to a designated (protected) species at risk or its critical habitat such that the overall abundance, distribution and health of that species and its eventual recovery within the RSA is adversely affected

10.2 Potential Environmental Changes, Effects, and Associated Parameters

The key potential environmental interactions between planned offshore oil and gas activities and marine mammals and sea turtles – including the associated environmental changes and possible resulting environmental effects on this VC – include the following (as summarized and adapted from Amec 2014):

- Temporary hearing impairment or permanent injury or mortality from exposure to loud underwater noise after coming into close contact with a Project-related underwater sound source (e.g., drilling, geophysical sound source) at or above threshold levels for onset of injury derived from published scientific literature or those used in relevant legislation
- Behavioural effects due to Project-related sound sources or other disturbances at or above threshold levels for onset of behavioural disturbance derived from published scientific literature or those used in relevant legislation. These may include alterations in the presence, abundance, and overall distribution (including avoidance) of marine mammals and sea turtles as well as modifications to their movements, feeding, communication patterns and other activities
- Interference with (and the masking of) sounds within the marine environment that originate from and/or are used by marine biota, such as in communication between individuals, the identification and detection of predators and prey, echolocation and other activities and requirements
- Potential for injury or mortality through collisions or other interactions with offshore survey and supply vessels, including possible attraction of individual animals
- Possible changes in the availability, distribution, or quality of feed sources and/or habitats for marine mammals and sea turtles

The EIS Guidelines issued by the Canadian Environmental Assessment Agency in December 2016 also identify specific issues and potential effects on this VC that require consideration in the EIS (see Section 6.3.3), including:

- Mortality and other effects from vessel collisions and disturbance
- Direct and indirect effects cause by increased disturbance (e.g., noise, light, vibrations) including mortality, physical injury and behavioural changes (e.g., habitat avoidance, disruption to feeding behaviour, deviation in migration routes, communication masking, discomfort and behavioural disturbance)

Questions and comments related to this VC were also noted during the Operators' EA-related engagement with government departments and agencies, stakeholder organizations and Indigenous groups. These include concerns regarding the potential effects of Project-related underwater noise on marine mammals species (including beluga, Atlantic bluea nd North Atlantic right whales), particularly those that are species at risk and of high cultural value (see Chapter 3 for further details).

Marine mammals require a functional underwater acoustic environment, as they use and produce sounds both passively and actively to communicate, navigate, locate prey and predators, and gather information about their surroundings (Richardson et al. 1995; Nowacek et al. 2007; Tyack 2008; Shannon et al. 2015). The introduction of anthropogenic sources of underwater noise, including that from offshore exploration activities and vessel traffic has the potential to result in adverse effects on marine mammals. Although there remains a general shortage of research on the acoustic sensitivity of sea turtles and limited understanding on the relative importance of their acoustic environment (Popper et al. 2014), there is little evidence to suggest that sea turtles would be more sensitive to underwater noise than cetaceans or fish. Depending on the nature, intensity, and proximity of the noise, as well as the species exposed and the duration of exposure, effects on marine mammals and sea turtles may vary widely. For the purposes of this assessment, potential environmental effects resulting from the introduction of underwater noise have been assessed and described based on two overall categories of associated environmental change and resulting effects: 1) potential mortality or injury, and 2) changes in habitat quality and use. These groupings have been selected to reflect currently available scientific thresholds for determining sound levels at which a certain outcome (i.e., injury or behavioural disturbance, respectively) have been set. In turn, available sound threshold levels are considered as a guide for informing the assessment of potential effects of sound, rather than an absolute measure of such effects (see Section 10.3.1 for further details on assessment approach).

The assessment of the potential for mortality or injury considers the potential for temporary changes in marine mammal or sea turtle hearing sensitivity (temporary threshold shifts, or TTS) as well as the possibility of permanent auditory injury (permanent threshold shift, or PTS), although the latter is only possible in close proximity or extended exposure to high source levels. The concept of change in habitat quality and use is used here in a relatively broad context to reflect adverse alterations in the acoustic quality of marine mammal and sea turtle habitat, and associated (sub-injurious) results. It therefore includes everything from communication masking (interference) and impaired detection of conspecifics and/or prey (which are predicted to occur at ranges beyond those defined by behavioural disturbance thresholds), to behavioural effects (which range from subtle disturbance responses such as changes in diving / breathing rate to overt responses such as habitat avoidance, and changes in migration or movement patterns or activity state). Also possible, as a result of decreases in the acoustic quality of their environment, are primary and secondary stress responses, although these are inherently more difficult to quantify and characterize, particularly at population levels.

In addition to potential noise-related issues and interactions, Project-related marine vessel traffic (including survey and supply vessels) during Project phases have the potential to result in vessel strikes with marine mammals and sea turtles, leading to an additional possible pathway for mortality or injury. For clarity in distinguishing the pathway of effect (namely, the introduction of underwater noise versus possible physical contact with a vessel), these potential interactions are also considered separately in the environmental effects assessment, although the outcome of this potential interaction is also a change in mortality, injury, or long-term health implications.

Although other Project activities may result in changes in light, vibration, or water quality, key routine effects for marine mammals are those associated with increases in underwater noise and vessel traffic (as per above). The Project may also have adverse indirect effects on marine mammal and sea turtle foraging success and prey quality should Project components and activities result in a reduction in the health, abundance, distribution, or overall availability of marine organisms on which marine mammals and sea turtles feed. Potential effects of the Project on marine mammal and sea turtle prey species (such as plankton and fish), are considered below but assessed in more detail in Chapter 8 (Marine Fish and Fish Habitat).

Project activities and components may result in the small-scale and localized releases of waste products and contaminants during routine operations. Increased exposure to contaminants and/or decreases in water quality may subsequently lead to a reduction in marine mammal and sea turtle health. Effects associated with this pathway are assessed below, these are generally considered negligible following implementation of standard management practices. Effects of potential accidental events are assessed separately in Chapter 15 of this EIS.

The environmental effects assessment for this VC considers and focuses upon the various issues and questions identified through the various issues scoping exercises, including an initial identification of the key potential environmental changes and possible environmental effects on the VC that may result. These are summarized in Table 10.1, along with the identification of key parameters through which these Project-related changes and effects may be reflected.

Table 10.1 Potential Project-Related Environmental Changes and Potential Effects: Marine Mammals and Sea Turtles

Potential Environmental Effects	Contributing Potential Environmental Changes Resulting from the Project	Associated Parameter(s)
Change in Mortality or Injury (Underwater Noise)	• Project-related activities (e.g., drilling, geophysical, vessel transiting) will introduce additional sources of underwater noise to the marine environment and associated changes in the acoustic conditions in the affected areas • Exposure to underwater noise at or above published and/or industry standard thresholds has the potential to result in injury to marine mammals and sea turtles	• Degree and extent of underwater noise relative to applicable published thresholds for onset of auditory injury in marine mammals and sea turtles, based on literature examples and modelling undertaken for other projects • Expected species occurrence in the affected areas • Qualitative estimate of individuals affected

Table 10.1 Potential Project-Related Environmental Changes and Potential Effects: Marine Mammals and Sea Turtles

Potential Environmental Effects	Contributing Potential Environmental Changes Resulting from the Project	Associated Parameter(s)
Change in Habitat Quality or Use (Behavioural Effects)	• Project-related activities (e.g., drilling, geophysical activities, vessel transiting) will introduce additional sources of underwater noise to the marine environment and associated changes in the acoustic conditions in the affected areas • Exposure to underwater noise at or above published and/or industry standard thresholds has the potential to result in behavioural changes (e.g., changes in activity, movement, or communication patterns) in marine mammals and sea turtles • Communication masking and increased stress levels may also occur across the spectrum of noise exposure, but are expected to start at levels below those for which overt behavioural responses may be observed	• Degree and extent of underwater noise relative to applicable published thresholds for behavioural change (e.g., changes in activity, movement, or communication patterns) in marine mammals and sea turtles, based on literature examples and modelling undertaken for other projects • Expected species occurrence in the affected areas • Qualitative estimate of individuals affected
Change in Mortality or Injury (Vessel Strikes)	• Project-related activities will result in increased levels of marine vessel traffic throughout Project phases • Increased vessel movement in the affected areas has the potential to result in an increase in vessel strikes with marine mammals and sea turtles	• Expected species occurrence in the affected areas • Qualitative estimate of individuals affected • Qualitative likelihood of injury or mortality from Project-related vessel strikes, based on literature
Change in Food Availability or Quality	• Project components and activities have the potential to alter the distribution, availability, health, or species composition of marine mammal and sea turtle prey • This may have secondary effects on marine mammal foraging options and success	• Understood prey availability and quality within the affected areas • Anticipated quantity of organic waste released • Degree and extent of expected changes to prey species occurrence
Change in Health (Contaminants)	• Project components and activities have the potential to introduce contaminants to the marine environment and result in altered marine water quality in the affected areas • Introduction of contaminants, has potential to adversely affect marine mammal and sea turtle short- or long-term health	• Expected species occurrence in the affected areas • Qualitative estimate of individuals affected • Degree and extent of expected changes to water quality

Table 10.2 outlines the Project components and activities that have been identified as having the potential to interact with Marine Mammals and Sea Turtles. These are discussed in detail in Section 10.3 in the context of potential effects pathways, mitigation measures and residual effects.

Table 10.2 Potential Project-VC Interactions: Marine Mammals and Sea Turtles

Project Component / Activity	Potential Environmental Effects				
	Change in Mortality or Injury (Underwater Noise)	Change in Habitat Quality or Use (Behavioural Effects)	Change in Mortality or Injury (Vessel Strike)	Change in Food Availability or Quality	Change in Health (Contaminants)
Presence and Operation of Drilling Installation (including lights, noise, air emissions, anchoring)	•	•	•	•	
Drilling and Associated Marine Discharges (including fluids and cuttings)		•		•	•
Formation Flow Testing with Flaring		•	•	•	•
Wellhead Decommissioning		•	•	•	
Geophysical, Geohazard, Wellsite and Seabed Surveys and VSP	•	•	•	•	
Geological, Geotechnical and Environmental Surveys		•	•	•	
Supply and Servicing		•	•	•	

10.3 Environmental Effects Assessment and Mitigation

The following sections provide an assessment and evaluation of the potential effects of the Project (planned components and activities) on Marine Mammals and Sea Turtles, based on the potential issues and interactions identified and described above. They describe the analytical methods used in the assessment, outline mitigation measures that will be applied and characterize the anticipated residual effects of identified Project components and activities. Mitigation measures to prevent or reduce adverse effects upon this VC are identified in Section 10.3.2 and considered integrally within and throughout the environmental effects analysis that follows, as applicable. The environmental effects assessment for accidental events for VCs, including this one, is presented in Chapter 15.

10.3.1 Approach and Methods

The assessment of Project effects on Marine Mammals and Sea Turtles is informed by an understanding of the existing environment (predicted species' occurrence and potential for overlap with Project activities is described in Section 6.3; ambient underwater noise characteristics within the Project Area are described in Section 5.6), consideration of environmental assessments conducted for similar oil and gas activities in offshore Newfoundland and Labrador, and engagement with relevant agencies, Indigenous groups, stakeholders, and other interested parties. The Eastern Newfoundland SEA (Amec 2014) has been used to provide information on the existing regional environmental setting and identify key environmental considerations for this VC.

The marine mammal and sea turtle effects assessment has been undertaken based on an understanding of the planned Project components and activities at the time of EIS filing. Estimates of marine mammal and sea turtle species' densities, relative abundance, and seasonal distributions are not available specific to the boundaries of the Project Area, LSA or RSA and are likely variable year-to-year. As such, assessment of potential for interactions and effects is based on understanding of general species' presence and distribution in the region, both spatially and temporally (namely, regional opportunistic sightings databases for offshore Newfoundland). Project activities may be carried out an any time of the year. While some marine mammal or sea turtle species may be considered common to the LSA / RSA year-round, many species are also migratory, appearing seasonally, following prey movements, or simply passing through. Even for species considered common, their exact location and distribution within the broader RSA, and in the Project Area, is likely to fluctuate on a regular basis, making likelihood of interaction predictions challenging. Therefore, the effects assessment conservatively assumes that the marine mammal and sea turtle species identified as potentially occurring in the LSA and RSA are continuously present in the Project Area, and thus are "available" for a Project-related interaction. The predicted potential for exposure therefore represents the maximum potential for and duration of effect, whereas exposures are likely to be less likely, frequent, and more transient.

With respect to assessing increased potential for vessel strikes, the change in risk is assessed by describing the estimated change in the (qualitative) likelihood of mortality or injury to marine mammals resulting from Project-related increases in marine traffic (i.e., increased potential for vessel strike). This is based primarily on an understanding of marine mammal and sea turtle strike risk as reported in scientific literature and other environmental assessments and from offshore experience with similar projects and activities off Eastern Newfoundland and elsewhere.

The potential for Project-related effects on the prey of marine mammals and sea turtles is addressed briefly below but is characterized and described in detail within the Marine Fish and Fish Habitat VC assessment (Chapter 8). The scope of this assessment captured a range of species, including (but not limited to) benthic, demersal, and pelagic species, as well as short- and long-lived species, migratory and non-migratory species, and invertebrate and fish taxa. This broad range includes many marine mammal and sea turtle prey species.

The assessment of change in health considers the (qualitative) likelihood that routine Project activities and components result in the release of marine contaminants such that marine mammals

and sea turtles experience a change in short-term or long-term health. The consequences of potential exposure to unanticipated, larger-scale releases are addressed in Chapter 15.

In order to assess the potential effects of anthropogenic sources of underwater noise on marine mammals and sea turtles, threshold criteria are commonly used. To date, the Canadian government has not developed or formally adopted guidelines or regulatory thresholds for levels of underwater sound believed to be capable of causing auditory injury (in the form of permanent threshold shifts (PTS)) or behavioural disturbances to marine mammals and sea turtles. In the absence of formal Canadian thresholds, interim regulatory guidelines applied in the United States, thresholds published in scientific literature, and recent regulatory review of other Canadian projects have been used to inform this assessment of potential injury or behavioural disturbance of marine mammals and sea turtles. Where applicable, acoustic modelling conducted for the Scotian Basin Exploration Drilling Project EIS (BP 2016; Zykov 2016) has been referenced, given its similarities in project components and activities, the location on the offshore area of Atlantic Canada, and relevancy of recent data. A review of the comparability of these two projects (in terms of source levels and sound propagation parameters) was also undertaken (Appendix C). Due to similarities in source levels, seabed geoacoustics, and sound speed profiles, the Scotian Basin modelling work is considered to provide a good reference for the expected sound levels indicated with the Project, particularly at deep water sites (approximately 3,000 m) (Martin et al. 2017).

The US National Oceanic and Atmospheric Administration (NOAA)'s National Marine Fisheries Service (NMFS) guidelines provide the most current guidance on threshold levels of underwater sound for the onset of TTS and PTS in marine mammals (NMFS 2016). Much of the basis for these guidelines comes from recommendations by Southall et al. (2007), whose criteria are commonly used for assessing potential effects of underwater noise associated with offshore activities around the world. NMFS (2016) and Southall et al. (2007) both present dual metrics for threshold values (i.e., recommend consideration of both peak sound pressure levels (SPLpeak) and cumulative (over 24 hours) sound exposure levels (SELcum), and indicate that conclusions should be based on whichever metric is first exceeded. In other words, onset of PTS (i.e., injury) is assumed to occur if a received sound exposure exceeds the peak SPL criterion, or the SEL criterion, or both criteria. Acoustic threshold levels for the onset of PTS proposed by NMFS (2016) and Southall et al. (2007) for cetaceans (i.e., whales, dolphins, and porpoises) and pinnipeds (i.e., seals, sea lions, and walruses) are summarized in Table 10.3.

Table 10.3 Acoustic Threshold Levels for Permanent Threshold Shift Onset

Hearing Group	PTS Onset Threshold Levels							
	NMFS Acoustic Guidelines (2016[a])				Acoustic Thresholds Proposed by Southall et al. (2007)			
	Impulsive Sound		Non-impulsive Sound		Impulsive Sound		Non-impulsive Sound	
	dB SPL_{peak}	dB SEL_{cum}[b]	dB SPL_{peak}	dB SEL_{cum}[b]	dB_{peak}	dB SEL_{cum}[b]	dB SPL_{peak}	dB SEL_{cum}[b]
Low-frequency Cetaceans	219	183	230	199	230	198	230	215
Mid-frequency Cetaceans	230	185	230	198	230	198	230	215
High-frequency Cetaceans	202	155	202	173	230	198	230	215
Pinnipeds	218-232	185-203	230	201-219	218	196	218	203

Notes:
dB (decibel) SPL_{peak} has a reference value of 1 µPa
dB SEL_{cum} has a reference value of 1 μPa^2s
[a] Final guidelines released by NMFS in July 2016 update their draft thresholds (NOAA 2015, 2016) and replace their previous interim dB SPL_{rms} criteria for injury (i.e., 180 dB SPL_{rms} for cetaceans and 190 dB SPL_{rms} for pinnipeds (NOAA n.d.))
[b] The dB SEL_{cum} thresholds for NMFS (2016) and Southall et al. (2007) cannot be directly compared since the weighting functions were defined differently.

NOAA's previous interim guidelines for injury (NOAA n.d.) also provided threshold root-mean-square (rms) SPLs for broadband underwater noise levels for behavioural disruption in marine mammals. Thresholds for behavioural disturbance were not updated in the more recent NMFS (2016) guidelines. Applied generically to both cetaceans and pinnipeds, these threshold levels are 120 dB re 1 µPa (rms) for non-impulsive sounds (e.g., shipping, drilling) and 160 dB re 1 µPa (rms) for impulsive sounds (e.g., geophysical surveys, VSP) (NOAA n.d.). These behavioural disturbance thresholds have commonly been used in marine mammal effects assessments of offshore geophysical programs in Atlantic Canada, as well as Pacific Canada, Arctic Canada, and the US (e.g., Stantec 2012, 2014a, 2014b; LGL 2014, BP 2016). In this assessment, available sound threshold levels are considered as a guide for informing the assessment of potential effects of sound on behavioural responses of marine mammals, rather than an absolute measure of such effects.

Threshold criteria provided by NMFS (2016) and Southall et al. (2007) were developed specifically for marine mammals. As soon as adequate data are available, NMFS intends to establish similar acoustic thresholds for onset of PTS in other species, such as sea turtles and marine fish (NOAA 2015). Under the American National Standards Institute-Accredited Committee S3, Subcommittee 1, an Animal Bioacoustics Working Group has established sound exposure guidelines for sea turtles that adopt some of Southall et al.'s (2007) approaches for marine mammals. Because little is known about hearing and the effects of underwater noise in sea turtles, the Animal Bioacoustics Working Group has thus far only developed numeric thresholds for potential sea turtle mortality in relation to explosions, airguns, and pile driving (Popper et al. 2014). Recommended thresholds for airguns are considered in this assessment of potential effects on sea turtles of underwater noise associated with VSP.

As discussed in Section 2.9.5 two assessments were used to frame the baseline and expected sound levels during operations:

- Eastern Newfoundland Drilling Noise Assessment: Qualitative Assessment of Radiated Sound Levels and Acoustic Propagation Conditions (Appendix C) – This report presents the following information in support of the assessment: (1) a summary of ambient noise levels in the Eastern Newfoundland Exploration Drilling Project Area, based on data collected along Canada's east coast in 2015 and 2016 ; (2) a summary of environmental parameters in the Eastern Newfoundland Exploration Drilling Project Area; (3) the expected Project underwater source levels based on the type of drill rig, DP systems and VSP arrays likely to be used in this Project; (4) a qualitative comparison of environmental properties and expected source levels between the Project Area and specifications and those considered in the acoustic modeling conducted for the Scotian Basin Exploration Drilling Project (Zykov 2016); and, (5) based on the first four objectives, a qualitative estimate of the radii of possible effects to marine life as a result of the Project, as compared to those predicted in the quantitative modelling exercise conducted for the Scotian Basin Exploration Drilling Project (Zykov 2016)

- Marine Mammals and Sound Sources in the Flemish Pass: Analysis from 2014 and 2015 Acoustic Recordings (Appendix D) – This report presents the results of an analysis of acoustic data collected by an underwater recorder deployed within the Project Area from June to October 2014 and from May to September 2015, during a geophysical and drilling exploration program. The data were analyzed to characterize the baseline soundscape in the Flemish Pass, the soundscape during Statoil's 2014-2016 active drilling program, and identify the presence of vocalizing marine mammals

The results of these assessments provided an overview of baseline acoustic conditions in the Project Area (Section 5.6) and indicated that:

- The water depths and geoacoustic profiles in the deep-water sites for the Project are similar to those considered in the previously modelled Scotian Basin Exploration Drilling project
- The recorded sounds associated with drilling installation in the Flemish Pass during Statoil's 2014 to 2016 exploration drilling program were similar to those measured and reported for the Stena IceMAX off Nova Scotia and to the predicted levels for the Scotian Basin Project
- Drilling operations by the semi-submersible West Hercules generated sound levels similar to those previously reported for the Stena IceMAX off Nova Scotia

Therefore, it was concluded that use of the previously conducted Scotian Basin Project modelling results was an appropriate and defensible proxy for use in the effects assessment of underwater noise for this Project. Further details on the comparability of the two project parameters are presented in Appendix C.

10.3.2 Summary of Key Mitigation

The following mitigation measures and standard practices will be implemented during Project activities to reduce the potential adverse effects on marine mammals and sea turtles. Measures to mitigate potential environmental effects on marine fish species outlined in Section 8.3.2, will also reduce the potential for effects on prey for marine mammals and sea turtles. Adverse effects on water quality will be addressed through the implementation of a chemical management system that adheres to C-NLOPB requirements and discharge treatment in accordance with the OWTG and MARPOL, where applicable.

The mitigation measures outlined below focus on reducing the potential interaction of vessel strikes and exposure to underwater noise at or above threshold levels for auditory injury and behavioural disturbance, as follows:

- Use of existing and common travel routes for vessels and helicopters will be used where possible and practicable
- Low-level aircraft operations will be avoided where it is not required per Transport Canada protocols
- Operational discharges will be treated prior to release in accordance with the OWTG (2016) and other applicable regulations and standards

- The selection and screening of chemicals to be discharged, including drilling fluids, will be in accordance with the Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands
- Project associated vessel traffic will be approximately eight to ten trips per month to service one drilling installation. Use of existing and common travel routes will be used where possible and practical. Vessels will maintain a steady course and safe vessel speed whenever possible
- Use of explosives will not be employed for removal of wellheads
- As required in the Geophysical, Geological, Environmental and Geotechnical Program Guidelines, mitigation measures applied during the Project's geophysical surveys will be consistent with those outlined in the Statement of Canadian Practice with respect to the Mitigation of Geophysical Sound in the Marine Environment (SOCP) (DFO 2007). The following is a partial list of those mitigation measures:
  - Trained MMOs will be used to monitor and report on marine mammal and sea turtle sightings during VSP and geophysical surveys where geophysical source arrays are used
  - A ramp-up of the source array (i.e., gradually increasing geophysical source elements over a period of at least 20 minutes until the operating level is achieved) starting from a single source element
  - MMOs will implement a pre-ramp up watch of 30 minutes prior to the start of the air source. Ramp-up will be delayed if marine mammal or sea turtle is sighted within the safety zone
  - Shut down of the geophysical source array if a marine mammal or sea turtle listed as endangered or threatened on SARA Schedule 1

10.3.3 Presence and Operation of Drilling Installation

As identified in Table 10.2, the potential environmental interactions for marine mammals and sea turtles associated with presence and operation of a drilling installation include change in mortality or injury (associated with both increases in underwater noise and potential for support vessel strike), change in habitat quality or use (behavioural effects), and availibilty and quality of potential prey (i.e., adverse effects on marine fish may have secondary effects on marine mammals and sea turtles).

Underwater noise produced by the operation of the drilling installation (including presence of support vessels) during drilling and the use of dynamic positioning thrusters and hydroacoustic positioning systems for station keeping may result in a change in mortality or injury for marine mammals and sea turtles in close proximity to the sound source. Exposure to underwater noise at or above published and/or industry standard threshold levels can result in temporary or permanent changes in hearing ability (TTS or PTS) (Richardson et al. 1995, Nowacek et al. 2007, Southall et al. 2007). The introduction of this source of anthropogenic noise may also adversely affect the quality of the underwater acoustic environment, and therefore, the use of this environment by marine mammals and sea turtles. Conservatively, it is assumed that DP thrusters will be continuously used for station keeping while drilling and that drilling will take approximately 35-65 days per well, depending on

water depth and well design. During the life of the Project, there may be up to two drilling installations actively engaged in drilling activities in the Project Area at any one time.

As concluded in Appendix C, the water depths and geoacoustic profiles in the deep-water sites for the proposed activity are similar to those from the Scotian Basin project. And as concluded in Appendix D, drilling operations by the semi-submersible West Hercules in the Flemish Pass generated sound levels comparable to those previously reported for the Stena IceMAX off Nova Scotia. Given this, the data are adequate for the effects assessment of underwater noise.

Source levels generated by operating drilling installations range from approximately 130 to 190 dB re 1 µPa at 1 m (peak frequency range: 10-10,000 Hz) (Richardson et al. 1995, Hildebrand 2005, OSPAR 2009) and mean sound levels from a representative operating semi-submersible drill rig have been measured at 13 dB above baseline levels in the Flemish Pass (Appendix D). Acoustic modelling conducted for the Scotian Basin Exploration Drilling Project (located in deep waters (2,100 m and 2,790 m) approximately 230-370 km off the southeast coast of Nova Scotia) conservatively assumed broadband source levels for a drillship and semi-submersible to be approximately 197 dB re 1 µPa @ 1 m RMS SPL (Zykov 2016). Based on the similarities in thruster power, propeller diameter, number of thrusters, and DP systems it is expected that the Project's drilling installation will exhibit similar source levels to those considered in Zykov (2016)'s Scotian Basin modelling (see Appendix D for a qualitative comparison between the two project locations and anticipated source levels and Appendix D for in-field sound measurements of comparable drilling equipment to that proposed for this project). Results from the Scotian Basin's modelled operating drilling installations predicted that cumulative SELs (over 24 hours) would decrease to below threshold values for potential marine mammal auditory injury at distances between 120 and 470 m from the source (depending on the species group and environmental conditions) (Zykov 2016). Marine mammals were not expected to remain within such close proximity of the operating drilling installation over the course of 24 hours. Similarly, peak SPLs were predicted to decrease to below threshold values for PTS at distances greater than 10 m from the operating drilling installation, and as such, exposure to underwater noise at levels capable of causing marine mammal auditory injury (using either the SPL or SEL metric) was deemed unlikely (Zykov 2016). Although the source levels for drilling installations for the Scotian Basin Exploration Drilling Project may be comparable to those considered in this assessment (based on number, size, and depth of dynamic thruster, propeller revolutions-per-minute at nominal power output.), it is important to note that results of acoustic modelling are highly dependent on environmental parameters within the modelled area (bathymetry, depth of water, water properties). Based on a comparison of sound speed profiles between the Scotian Basin and the Project Area, Martin et al. (2017, Appendix C) expect sound propagation extents to fall somewhere between those predicted for summer and winter in the Zykov (2016) modelling study, with less overall variation across the year. Distances to thresholds for auditory injury are also likely to be higher in shallow water sections of the Project Area. Despite potential differences in Project parameters, based on literature source levels, the results of acoustic modelling for other projects, and field measurements during comparable drilling operations (Appendix D), it is considered unlikely that marine mammals will approach or remain within the distances required to be exposed to sound levels capable of causing injury during presence and operation of the drilling installation. Far less is known about the potential effects of underwater noise on sea turtles. Popper et al. (2014) have suggested threshold levels for potential sea turtle mortality from various impulsive sound sources, but not for

continuous sources such as drilling. However, similarly to marine mammals, the relative risk of injury is expected to be unlikely, as sea turtles are not expected to approach or remain for extended periods in close proximity to intense sources of underwater noise, reducing the potential for exposure to sound levels capable of causing auditory injury or mortality.

A study by JASCO (Appendix C), which report on measured underwater sound levels in the RSA, indicated that in the very-low frequency band (10-45 Hz), background sound levels in the open ocean are in the range of 90-95 dB re 1 µPa (Figure 5-46). Fin whales were determined to be a dominant noise source four to seven months throughout fall, winter, and spring. North Atlantic fin whales emit a short pulse once every 9-18 seconds from October to March, a call recorded by non-ice covered hydrophone stations, especially those over the Scotian Shelf and Grand Banks. Another dominant noise source recorded in the very-low frequency band in the summer months was anthropogenic seismic survey sounds Platform and vessel noise were weakly detectable in this band.

While exposure to injurious sound levels is unlikely, at received sound levels above 120 dB re 1 µPa (rms) (NOAA n.d.), marine mammals may still exhibit a variety of behavioural responses. Changes in habitat use owing to a change in the underwater acoustic environment may include changes in vocal activity (Richardson et al. 1995, Southall et al. 2007, Clark et al. 2009, Popper and Hawkins 2012, Risch et al. 2012, Williams et al. 2013), respiration and dive patterns, breaching, and tail slapping (Nowacek et al. 2007, Southall et al. 2007), and avoidance behaviours (Stone and Tasker 2006, Moulton and Holst 2010), with potential effects on foraging patterns (Slotte et al. 2004, Sundermeyer et al. 2012, Tougaard et al. 2012) and migration (van Opzeeland and Slabbekoorn 2012). Mysticetes vocalize primarily at lower frequencies (i.e., 7 – 22,000 Hz) (Clark 1990, Erbe 2002) and are expected to be the most susceptible species group to potential masking from noise produced by the drilling installation. Sea turtles do not vocalize or use sound for communications. Increased levels of underwater noise have also been shown to cause stress on marine mammals (Hastings and Popper 2005, Wysocki et al. 2006, Wright and Kuczaj 2007, Rolland et al. 2012), which could lead to lowered immune response and/or reproductive effort (Southall et al. 2007; Wright et al. 2007a, 2007b, 2009, 2011).

Results for the Scotian Basin Exploration Drilling Project modelling predicted that sound levels from an operating drilling installation would attenuate to below the NOAA behavioural disturbance thresholds (120 dB re 1 µPa RMS SPL) at distances from the source ranging from 23 km (in summer) to approximately 150 km (winter). That Project's location featured a strong surface channel, created by strong winter water temperature gradients that trapped acoustic energy at the surface, thereby reducing the amount of transmission loss. The most conservative winter sound speed profile for this Project exhibits a weaker surface channel compared to the February profile used in the Scotian Basin modelling; therefore, the surface channel is not expected to be as conductive to sound, and it will likely yield shorter distances to thresholds (Appendix C). Distances to thresholds for behavioural disturbance are also likely to be lower in shallow water sections of the Project Area (Appendix C).

It is therefore reasonable to assume that marine mammals that are present within tens of kilometres of the operating drilling installation may exhibit some form of change in habitat use in response to increased levels of underwater noise. However, responses to underwater noise can be highly variable and the potential magnitude and ecological relevance of a response is expected to vary

dependent on different biological (species, age, state at the time of exposure) and other factors (e.g., location, season, characteristics of the sound source) (NRC 2005; OSPAR 2009). Sea turtles, including leatherback, loggerhead, and Kemp's ridley sea turtle, reportedly have greatest hearing sensitivity to low-frequency sounds (Office of Naval Research 2002, Environment Australia 2003, Ketten and Bartol 2005) such as those produced by the operating drilling installation. Bartol and Ketten (2006) reported that juvenile sea turtles hear within the 100 to 800 Hz bandwidth, with greatest sensitivity between 600 and 700 Hz, while adults have a bandwidth of 100 to 500 Hz, with greatest sensitivity between 200 and 400 Hz. Overall however, little is known regarding effects on sea turtles of non-impulsive sound sources such as drilling and dynamic positioning as it is unclear to what degree sea turtles may or may not passively use sound (e.g., for navigation). Potential effects of the drilling installation on change in habitat quality or use for sea turtles are generally expected to include the same potential effects discussed for marine mammals.

Project-related marine vessel traffic (support vessels) have the potential to result in mortality or injury of marine mammals and sea turtles from vessel strikes, although it is anticipated that the Project will not result in an increase in the number of vessel transits over previous levels (Section 2.5). Mysticetes are known to be more vulnerable to vessel strikes than odontocetes and pinnipeds (Laist et al. 2001, Jensen and Silber 2003, Vanderlaan and Taggart 2007), with historical records indicating that North Atlantic right whales, fin whales, humpback whales, and grey whales suffer mortalities from vessel strikes twice as frequently as any other whale species on a per capita basis (Vanderlaan and Taggart 2007). Reducing vessel speed has been shown to reduce the number of marine mammal deaths and severe injuries due to vessel strikes (Vanderlaan and Taggart 2007; Vanderlaan et al. 2008, 2009; van der Hoop et al. 2012). Lethal strikes are considered infrequent at vessel speeds less than 25.9 km/hour (i.e., 14 knots) and rare at speeds less than 18.5 km/hour (i.e., 10 knots) (Laist et al. 2001). Hazel et al. (2007) demonstrated in Australia that the proportion of green sea turtles maneuvering to avoid a vessel decreased with increased vessel speed. The distance between a maneuvering sea turtle and an approaching vessel decreased (statistically) significantly when vessels travelled at speeds greater than 11 km/hour (i.e., 6 knots) compared 4 km/hour (i.e., 2 knots) (Hazel et al. 2007). Project-related vessels will maintain a steady course and safe vessel speed and avoid concentrations of marine mammals and sea turtles whenever possible to reduce the risk of a vessel strike.

Potential effects resulting from the presence and operation of the drilling installation on the health, abundance, and distribution of marine fish species can have secondary effects on marine mammals and sea turtles in terms of food availability and quality. Food availability would be considered to be adversely affected if marine mammals and sea turtles need to travel greater distances to locate food, or if prey are distributed in a more disperse (less aggregated) manner, such that foraging efficiencies are reduced. Quality would be considered adversely affected if the health of prey species was diminished, or if the ratio of preferred to less-preferred prey items was altered. Results of the assessment presented in Chapter 8 (Marine Fish and Fish Habitat) suggest that effects from presence and operation of the drilling installation will be negligible, and as such, secondary effects on change in food availability and quality for marine mammals and sea turtles are not expected, particularly to the degree that would translate into effects on the abundance, distribution, or health of these species.

Associated with the presence and operation of the Project drilling installation, change in mortality or physical injury from underwater noise is predicted to be adverse, low in magnitude, restricted to the Project Area, continuous throughout drilling installation operations, medium-term in duration, and reversible. Change in habitat quality or use (behavioural effects) is predicted to be adverse, medium in magnitude, occur within the RSA, continuous throughout drilling installation operations, medium-term in duration, and reversible. Change in mortality or physical injury from vessel strikes is predicted to be adverse, low in magnitude, occur within the RSA, be short-term and sporadic, and reversible. Change in food availability or quality is expected to be negligible. These conclusions have been determined with a high level of confidence. Despite uncertainty regarding noise thresholds and the nature of responses exhibited by different species and individual marine mammals and sea turtles as a result of increases in underwater noise and marine vessel traffic, potential for exposure is expected to be brief and transient in nature. While this assessment conservatively assumes that marine mammals and sea turtles are consistently available for exposure at all times of the year, there are likely to be large seasonal and even daily fluctuations in abundance within the RSA and, particularly within the Project Area. The potential for interaction with the drilling installation is likely to be far more transient and temporary than presented within this assessment.

Overall, marine mammals or sea turtles are not expected to be injured or killed as a result of underwater noise introduced during presence and operation of drilling installation, nor is the quality or availability of their prey expected to be adversely affected. Some degree of change in habitat use in response to underwater noise is expected of individuals that occur within tens of kilometres of the drilling installation at the time of operation. The exact nature of behavioural response cannot be predicted but could include, for example, interference in communication, minor alterations in activity, or localized avoidance responses. However, the number of individuals affected is expected to be small relative to overall population sizes, effects will be of moderate duration (less for transient individuals), and there are no known concentration or critical habitat areas in the RSA. While vessel strikes can and do have serious consequences for individuals involved, these events are rare on a per-vessel basis and the Project will add only a small number of vessels relative to current vessel traffic volumes in the RSA.

In summary, the predicted environmental effects of presence and operation of the drilling installation are primarily related to underwater noise and vibrations. These interactions may result in potential changes in mortality or injury, habitat quality or use, and food availability or quality. These effects are predicted to be adverse, low to medium in magnitude, within the Project Area or LSA, short to medium term duration, occurring regularly to continuously, and reversible, with these predictions being made with a medium level of confidence.

10.3.4 Drilling and Associated Marine Discharges

The primary potential environmental interaction for marine mammals and sea turtles associated with drilling and associated marine discharges is change in health, as a result of contaminants related to routine discharges of drilling muds (WBM) and cuttings associated with drilling activities. Other types of wastes, such as liquid wastes, atmospheric emissions, and solid wastes (including food and sanitary waste) are expected to have limited potential to result in adverse effects on marine mammals and sea turtles as they move through the Project Area. Adverse effects of marine discharges on the

health of marine fish may have secondary effects on the quality of marine mammal and sea turtle prey.

With the implementation of standard mitigation measures and best management practices (BMPs), routine discharges of drilling muds, drilling fluid, and cuttings associated with drilling activities, or other routine discharges, are not expected to result in a measurable change in health for marine mammals and sea turtles. Chemicals used for drilling operations will be screened in accordance with a chemical management system that adheres to the C-NLOPB requirements. Prior to release overboard, discharges will be treated in accordance with the OWTG and MARPOL, where applicable (see list of mitigation measures listed in Section 8.3.2, Marine Fish and Fish Habitat). Wastes that do not meet OWTG requirements will be returned to shore for disposal at an approved facility.

Treated marine discharges will result in a localized and temporary reduction in water and sediment quality; however, muds and cuttings are unlikely to introduce heavy metals in concentrations that are harmful to marine mammals (Neff et al. 1980, cited in Hinwood et al. 1994). Marine discharges are therefore expected to have negligible environmental effects on marine mammals and sea turtles, including consideration of potential effects on prey species (see Chapter 8). None of the marine mammals that regularly occur in the Study Area are known to feed on benthos in the area. Deposition of discharged drill muds and cuttings is expected to result in some mortality of sedentary and slow moving benthic species; however, these do not represent primary prey for marine mammal and sea turtle species in or around the Project Area. Although some primary prey species (e.g., small schooling fish, suspended plankton, and other pelagic invertebrates such as squid) may be exposed to Project-related marine discharges within the Project Area, reduction in water and sediment quality is expected to be localized and temporary. For an assessment of potential effects of Project-related discharges on such prey species, see Chapter 8 (Marine Fish and Fish Habitat).

Potential effects of underwater noise and strike risk associated with the minor increase in Project-related vessels (for transportation of waste) is expected to be similar or lesser than those assessed above for presence and operation of the drilling installation (see Section 10.3.3).

With the application of mitigation measures, Project-related changes in health and in food availability or quality as a result of drilling and marine discharges are predicted to be adverse but negligible. This conclusion has been determined with a high level of confidence, based on the implementation of industry-standard guidelines and BMPs and the limited potential for exposure of marine mammals and sea turtles to marine contaminants or contaminated prey.

In summary, the predicted environmental effects of drilling and associated marine discharges are primarily related to potential for contaminant uptake. These interactions may result in potential changes in mortality or injury, habitat quality or use, food availability or quality, and change in health. These effects are predicted to be adverse, low in magnitude, within the Project Area, short term duration, occurring regularly, and reversible, with these predications beings made with a high level of confidence.

10.3.5 Formation Flow Testing with Flaring

Formation flow testing may be carried out if reservoir property data are required. In cases where formation flow testing with flaring is carried out, Project interactions with marine mammals and sea turtles will not differ from those discussed in Section 10.3.3. If produced water is encountered in amounts that cannot be managed in the flare, it will either be treated in accordance with the OWTG or shipped to shore for disposal.

Potential interactions with marine mammals and sea turtles related to discharges associated with formation flow testing with flaring will be comparable to those interactions assessed in Section 10.3.4, and effects are predicted to be negligible given adherence with OWTG requirements. No other forms of interactions are anticipated with Marine Mammals and Sea Turtles during formation flow testing.

10.3.6 Wellhead Decommissioning

The wellhead decommissioning strategy will be based on water depths (see Section 2.5.2). It is a mechanical cutting operation and will not involve the use of explosives. External cutting of the wellhead above the seafloor will involve the use of an intervention vessel using an exterior diamond wire cutting saw via ROV. It is anticipated that it may take up to two days to complete the removal for each wellhead that is decommissioned using this technique. Use of a mechanical cutter is not expected to produce underwater sound levels of an intensity or extent that could present a risk of mortality or injury to marine mammals or sea turtles, nor result in a measurable change in habitat quality or use. Disturbance during mechanical removal of wellheads and presence of the ROV may result in temporary localized avoidance by marine mammals and sea turtles within the immediate area surrounding the wellhead. Underwater noise will be produced by either the drilling installation or an alternative vessel capable of carrying out the decommissioning activity. Sound levels and vessel strike risk are likely to be equal to or less than those assessed under Section 10.3.3. Changes in marine fish health (and thus changes in marine mammal and sea turtle prey quality) are not expected (Chapter 8). As such, potential interactions with marine mammals associated with this activity will be limited to change in habitat quality or use due to increases in underwater noise during vessel transit and change in mortality or injury from vessel strike risk. At water depths greater than 1,500 m, it is planned that the wellhead will remain in place and will not be removed, and therefore no interactions with marine mammals or sea turtles are anticipated during or after the activity.

In summary, the predicted environmental effects of wellhead decommissioning are primarily related to the presence of an ROV and mechanical cutters, resulting in potential changes in mortality or injury, habitat quality or use, and food availability or quality. These effects are predicted to be adverse, negligible to low in magnitude, localized with some extension into the Project Area, short term duration, occurring sporadically, and reversible, with these predictions being made with a high level of confidence.

10.3.7 Project-Related Surveys

During the Project, various surveys may be carried out to support drilling operations. Potential interactions associated with underwater noise from survey activities (e.g., geohazard / wellsite and

seabed surveys, and VSP surveys) that could occur during Project-related activities are assessed in this section. Geohazard or site surveys can involve the mapping of the seabed through MBES, SSS, SBP, and 2D seismic equipment. Survey equipment may be mounted on the hull, or towed behind the vessel. Two-dimensional seismic surveys tend to involve a specialized vessel that tows a submerged sound source along with one to four streamers. In contrast, VSP surveys use a sound source in the wellbore, with a hydrophone that is either towed by a vessel or deployed over the side of the drilling installation.

Underwater noise produced during VSP and other geophysical surveys has the potential for injury, mortality, or behavioural changes in marine mammals and sea turtles. These surveys will be conducted as required and may occur throughout the Project Area at any time of the year. VSP and geophysical survey operations employ arrays of compressed air source elements; however, typical VSP source array volumes are usually substantially smaller, consisting of between three and six sound source elements, each 150-250 in^3 in volume. VSP and other geophysical surveys will likely emit the most intense emissions of Project-related sound sources; however, they are typically of short duration (less than 48 hours per well for VSP and five to seven days per well for wellsite surveys) and with lower source levels than what is required for 3D seismic surveys. Vertical seismic profiling operations usually take no more than one day to profile a given area for a single well. Up to 12 individual smaller sound sources may be used for VSP, each of which has a maximum volume of 250 cubic inches, generally placed 5 to 10 m below the water surface. Longer duration VSP operations are a possibility when additional characterization of an area is needed. A single VSP pulse is expected to generate a source level of approximately 220-245 dB re 1 µPa at 1 m, at 5-300 Hz (Lee et al. 2011), although this will vary based on the exact sound source array size / type used. Sound sources used during wellsite survey operations (2D) may produce peak-to-peak source SPLs of 242 to 253 dB re 1 µPa at 1 m (Thompson et al. 2013).

There are no documented occurrences of mortality from exposure of marine mammals or sea turtles to sounds from geophysical exploration surveys, although it remains possible that sub-lethal and long-term effects go undetected during the typical lengths of monitoring programs implemented during offshore activities (DFO 2004). Sound levels at the source are expected to exceed levels for auditory injury in marine mammals and sea turtles and may increase the risk for non-auditory injury at close ranges although sound levels dissipate rapidly with distance (Richardson et al. 1995; Gordon et al. 2004; Nowacek et al. 2007; Southall et al. 2007; Popper et al. 2014). Using the Schlumberger Dual Magnum 2,400 in^3 air source array as a modelled VSP sound source (six 250 in^3 source elements and six 150 in^3), the source level used for the Scotian Basin Exploration Drilling Project was 248 dB re 1 µPa at 1 m (peak SPL) in the broadside firing direction (Zykov 2016). Distance to thresholds for this Project are likely to be smaller than those from Scotian Basin (discussed below), due to broadband levels that are approximately 2 dB lower for this Project's proposed VSP array (Appendix C). This is also based on the observation that both arrays exhibit similar frequency content, with most energy at frequencies < 315 Hz. Sound levels for the Scotian Basin Exploration Drilling Project were expected to decrease below peak SPL threshold values for onset of auditory injury (as per Southall et al. 2007) at distances greater than 140 m for high-frequency cetaceans and at distances greater than 40 m for low- and mid-frequency cetaceans and pinnipeds (Zykov 2016). Sound levels were expected to decrease below SELcum threshold values for onset of PTS (as per Southall et al. 2007) at distances greater than 1.6 km for pinnipeds and distances greater than 620 m,

240 m, and 170 m for low-, mid- and high-frequency cetaceans, respectively (Zykov 2016). As such, a pinniped would likely be subject to SELcum levels greater than threshold values associated with potential auditory injury only after remaining within 1.6 km of the VSP sound source for 24 hours (Zykov 2016).

Marine mammals and sea turtles are not expected to remain for extended periods in close proximity to sound sources capable of resulting in auditory injury, and some cetaceans have shown avoidance responses to operating air guns, limiting their potential for injury. For example, harbour porpoises (considered one of the more sensitive species) have demonstrated short-term avoidance responses and decreases in densities at 10 km from commercial 2D seismic surveys in the North Sea (peak-to-peak source SPLs of 242 to 253 dB re 1 µPa at 1 m) (Thompson et al. 2013). Most harbour porpoise returned to the area within a few hours of the cessation of the geophysical activity. Although less is known about the potential effects of underwater noise from geophysical surveys on sea turtles, it is assumed that threshold levels for onset of auditory injury do not exceed those identified for cetaceans (LGL 2014). Threshold levels for potential mortality from air source arrays have been proposed at 210 dB SELcum and 207 dB peak SPL (Popper et al. 2014). The relative risk for sea turtles exposed to air source arrays has been described as “high” within tens of metres of the sound source and “low” within hundreds to thousands of metres (Popper et al. 2014). As such, it is considered unlikely that marine mammals or sea turtles will approach or remain within the distances required to be exposed to sound levels capable of causing injury during VSP and other geophysical surveys. To further reduce this likelihood, the Project will implement mitigation measures, as outlined in Section 10.3.2.

Although some degree of behavioural disturbance (such as avoidance) may be expected during VSP and geophysical surveys involving collection of 2D seismic data, this may be advantageous, as it could further reduce the likelihood of exposure of marine mammals and sea turtles to potentially injurious sound levels. Underwater noise produced during the VSP and other Project surveys may therefore result in a change in habitat quality and use by marine mammals and sea turtles (i.e., behavioural effects). Acoustic modelling conducted for the Scotian Basin Exploration Drilling Project (Zykov 2016) predicted that sounds from VSP would decrease to below 160 dB re 1 µPa RMS SPL (NOAA’s interim threshold for marine mammal sensory disturbance from an impulsive source) at distances greater than approximately 3.2 km from the sound source. Distances to thresholds for behavioural disturbance for this Project are likely to be smaller (Appendix C). As previously discussed, exposure to underwater noise at or above published and/or industry standard threshold levels can result in behavioural disturbance (NOAA n.d.) (e.g., avoidance (Richardson et al. 1995, Nowacek et al. 2007), communication masking (Dyndo et al. 2015, Veirs et al. 2016), changes in respiration and dive patterns (Nowacek et al. 2007, Southall et al. 2007)). Potential effects of noise from geophysical sound sources may therefore include masking of natural sounds, avoidance responses (Stone and Tasker 2006, Moulton and Holst 2010), and other forms of behavioural disturbance. It is well documented that mysticetes have responded to intense sound pulses from air source arrays with avoidance behaviour, and depending on the radius of avoidance, this can result in deviation from normal migration routes and/or disruption of feeding bouts (Malme et al. 1984, 1985, 1988; Richardson et al. 1986, 1995; Ljunblad et al. 1988; McCauley et al. 1998, 2000a, 2000b; Miller et al. 1999, 2005; Gordon et al. 2004; Stone and Tasker 2006; Johnson et al. 2007; Nowacek et al. 2007; Weir 2008; Moulton and Holst 2010). Large numbers of migrating grey whales, bowhead whales, and humpback whales have, for example, demonstrated avoidance behaviour in response

to received SPL pulses of approximately 160-170 dB_{rms} re 1 µPa (Richardson et al. 1995), with some migrating bowhead whales responding to sound levels between 120 and 130 dB_{rms} re 1 µPa (Miller et al. 1999, Manly et al. 2007). However, there are also reports of some mysticetes demonstrating limited avoidance and changes in behaviour in response to sound source arrays (LGL 2014). Annual migration of grey whales along the west coast of North America, for example, continued despite geophysical exploration and shipping activities in the area (Malme et al. 1984, Richardson et al. 1995). Overall trends indicate that brief exposure to sound pulses from a single geophysical survey are not likely to result in prolonged behavioural disturbance of some mysticetes (LGL 2014).

Although the response of odontocetes to sound pulses associated with geophysical activities appears similarly variable, studies suggest that odontocetes generally demonstrate some level of avoidance in response to operating air source arrays (e.g., Stone and Tasker 2006, Weir 2008, Richardson et al. 2009, Moulton and Holst 2010). Harbour porpoises have demonstrated behavioural responses to air source arrays at levels <145 dB_{rms} re 1 µPa (Bain and Williams 2006). In contrast, northern bottlenose whales in the Gully Marine Protected Area were reportedly not displaced by received sound levels of 145 dB_{rms} re 1 µPa generated by a geophysical survey that had been operating for a number of weeks more than 20 km away (Lee et al. 2005). Beaked whales generally avoid approaching vessels (Würsig et al. 1998), sometimes diving for extended periods (Kasuya 1986). Although there is a lack of data specific to geophysical surveys, it is expected that beaked whales would also demonstrate avoidance behaviours in response to geophysical activity.

Limited data exist regarding behavioural responses of pinnipeds to sound sources associated with geophysical activities. During some monitoring programs, pinnipeds did not demonstrate avoidance behaviour within a few hundred metres of the air source array (e.g., Harris et al. 2001, Moulton and Lawson 2002, Miller et al. 2005), while the opposite was reported in more extensive monitoring programs (i.e., with larger sample sizes and observations made from a vessel separate from the geophysical vessel) (LGL 2014). Southall et al. (2007) reported that pinnipeds (primarily ringed seals) exposed to multiple pulses with received SPLs > 190 dB_{rms} re 1 µPa are likely to elicit a behavioural response.

Geophysical surveys can result in short-term behavioural effects in sea turtles, including change in hearing sensitivity, and increased and erratic swimming behaviour (McCauley et al. 2000a). Exposure to low-frequency sound may lead to increased surfacing behaviour and displacement from preferred foraging areas (Atlantic Leatherback Turtle Recovery Team 2006). Weir (2007) reported a decrease in the number of individual sea turtles of several species (including olive ridley, leatherback and loggerhead) during active geophysical surveys, however, there were a number of confounding factors that may have biased the analysis. Initial responses of sea turtles appeared to be primarily in response to visual detection of an approaching object (the vessel), when within close range of the ship itself (i.e., <10 m). Threshold levels for potential sea turtle mortality from air source arrays have been proposed at 210 dB SELcum and 207 dB peak SPL (Popper et al. 2014). Numerical threshold levels for non-mortal injury of sea turtles have not been identified, however, the relative risk has again been described as “high” within tens of metres of the sound source and “low” within hundreds to thousands of metres (Popper et al. 2014). DeRuiter and Doukara (2012) also reported avoidance responses (diving behaviour) by loggerhead sea turtles at distances of up to 839 m from active geophysical sources of approximately 175-191 dB re 1 µPa peak SPL. Dive probability declined with

increasing distance from the source array (DeRuiter and Doukara 2012). In studies of penned animals, sea turtles demonstrated surfacing behaviour and changes in swim patterns when exposed to received SPLs of 166 dBrms re 1 µPa (McCauley et al. 2000a, 2000b). Penned loggerhead sea turtles exposed to air source arrays at source levels of 175-179 dB re 1 µPa at 1 m demonstrated avoidance behaviour upon first exposure (Moein et al. 1994; McCauley et al. 2000b). In contrast, Eckert et al. (1998) used GPS and Time Depth Recorder (TDRs) to track movement and behaviour of two leatherback turtles exposed to geophysical survey noise, and found no change in behaviour or movement as compared to previous sea turtles that were not exposed to geophysical survey noise.

Vessel transits associated with VSP and other Project-related survey activity will add a small amount of additional vessel traffic and an associated increase in vessel strike risk and underwater noise when travelling through the RSA. These effects are expected to be similar to or less than those assessed above for presence and operation of the drilling installation (see Section 10.3.3). The results of the assessment presented in Chapter 8 (Marine Fish and Fish Habitat) suggest that effects from VSP surveys will be negligible, and as such, secondary effects on change in food availability and quality for marine mammals and sea turtles are unexpected.

With the application of industry-standard mitigation measures and BMPs, change in mortality or injury and change in habitat quality or use because of VSP and other Project-related noise-producing survey operations is predicted to be adverse, low in magnitude, restricted to within the Project Area, to occur sporadically, be of short-term duration and reversible. This conclusion has been determined with a high level of confidence. Despite the continued degree of uncertainty regarding noise thresholds for different species of marine mammals and sea turtles, the potential for exposure is expected to be brief and transient in nature, and industry-standard mitigation measures are considered well defined and effective.

Overall, and particularly with the implementation of mitigation measures, injury or mortality is not predicted for marine mammals or sea turtles as a result of underwater noise from VSP and other geophysical surveys, nor is the quality or availability of their prey expected to be adversely affected. Some degree of change in habitat use in response to underwater noise is expected for individuals within a few kilometres of the surveys at the time of operation. The exact nature of behavioural response cannot be predicted but could include, for example, interference in communication, minor alterations in activity, and localized avoidance responses. Potential avoidance responses will further reduce the potential for injury. The number of individual marine mammal and sea turtles affected is expected to be small relative to overall population sizes, effects will be localized and of short-term duration, and there are no known concentration or critical habitat areas in the Project Area. While vessel strikes can and do have serious consequences for individuals involved, these events are rare on a per-vessel basis, will be unlikely at the slow speeds used during survey operations, and the Project will add only a small number of vessels relative to current vessel traffic volumes in the RSA.

In summary, the predicted environmental effects of Project-related surveys are primarily related to underwater noise and vibrations, and risk of vessel strike. These interactions may result in potential changes in mortality or injury, habitat quality or use, and change in food availability or quality. These effects are predicted to be adverse, negligible to low in magnitude, localized, with some extension

into the LSA, short term in duration, occurring sporadically, and reversible, with these predictions being made with a high level of confidence.

10.3.8 Supply and Servicing

Marine transportation associated with support/supply/survey vessels will result in an increase in marine vessel traffic to, from and within the LSA and RSA and an associated increase in underwater noise and vessel strike risk. Survey vessels are those associated with geophysical, geohazard, wellsite and seabed surveys, and geological, geotechnical, and environmental surveys. It is estimated that there could be an average of eight to ten return transits per month if servicing one drilling installation or up to an average of 16 return transits per month for two drilling installations, representing approximately seven percent of vessel movement within St. John's Harbour. Vessels supporting the Project will transit in an essentially straight line approach to and from a port to an operating drilling installation or survey site. Underwater sound levels produced by the transit of Project-related vessels (or from helicopter support for crew transfer) are not expected to exceed threshold levels associated with PTS for either marine mammals or sea turtles. Likewise, routine activities associated with helicopter support for crew transfers are not expected to result in a change in mortality or injury for marine mammals and sea turtles, because sound levels are not expected to reach published thresholds for onset of auditory injury. Support/supply vessels are predicted to have nominal operating source sound levels of 170-180 dB_{rms} re 1 µPa at 1 m (Hurley and Ellis 2004). Above the 120 dB_{rms} re 1 µPa threshold (NOAA n.d.), sound levels produced by transiting Project-related vessels could result in behavioural responses (see forms of behavioural change and literature examples in Section 10.3.3). Vessel-based underwater sound typically decreases with speed, as the lower the speed, the lower the propeller cavitation noise (Fischer and Brown 2005). As such, vessels operating at slow to moderate speeds during Project-related surveys are expected to contribute only small amounts of underwater noise to the Project Area. The introduction of vessel-related underwater noise during transit through the RSA will be short-term and transient in nature, and potential disturbance responses are expected to be commensurately brief.

Helicopter support will be used for crew transfers out of the St. John's International Airport. Routine transportation activities associated with helicopter support have the potential to result in change in habitat quality or use for marine mammals and sea turtles as a result of sensory disturbances from the introduction of visual cues and noise. Sounds produced by helicopters are primarily related to rotor and propeller blade revolutions, with frequencies mainly below 500 Hz (Richardson et al. 1995). Transmission of sounds produced by helicopters into the marine environment is related primarily to the aircraft altitude and sea surface conditions (Richardson et al. 1995). Underwater noise from helicopters is generally most intense just below the water surface and directly beneath the aircraft, with sounds attenuating over shorter distances than airborne sounds (Richardson et al. 1995). In a study in the Beaufort Sea, the majority of behavioural responses elicited in beluga whales and bowhead whales by an overhead helicopter occurred when the helicopter flew at altitudes below 150 m and at lateral distances less than 250 m (Patenaude et al. 2002). The degree of sensitivity of cetaceans to sounds produced by aircrafts can depend on their state of activity at the time of exposure; individuals in a resting state (as opposed to foraging, socializing, or travelling) seem to demonstrate the highest sensitivity to such disturbances (Würsig et al. 1998, Luksenburg and Parsons 2009). Cetaceans most commonly respond to sounds produced by overhead aircrafts by

diving (Luksenburg and Parsons 2009). Other behavioural responses include short surfacing periods, changes in state of activity, and breaching (Luksenburg and Parsons 2009). Sound from helicopters could be detectable by a sea turtle at or near the surface. However, sea turtles spend only a small portion (three to six percent) of their time at the surface, and research on green sea turtles suggests they may rely more on visual than auditory cues (Hazel et al. 2007). Project-related helicopters will use existing flight routes and it is estimated that there will be two transits per day on average. Potential exposures of marine mammals or sea turtles to noise or visual disturbance from helicopter overflights are therefore likely to be brief and infrequent.

Vessel transits associated with surveys and supply and servicing will add a small amount of additional vessel traffic and an associated increase in vessel strike risk when travelling through the RSA. The Project will add only a small number of vessels relative to current vessel traffic volumes in the RSA and effects are expected to be similar to those assessed above for presence and operation of the drilling installation (see Section 10.3.3).

Change in habitat quality or use as a result of marine transportation activities and helicopter-associated supply and servicing is predicted to be adverse, low in magnitude, occur on a sporadic basis within the RSA, be of short-term duration, and reversible. This conclusion has been determined with a high level of confidence. Despite uncertainty regarding noise thresholds and behavioural responses for different species of marine mammals and sea turtles, potential for exposure is expected to be brief and transient in nature.

In summary, the predicted environmental effects of supply and servicing are primarily related to underwater noise and vibrations, and risk of vessel strike. These interactions may result in potential changes in mortality or injury, habitat quality or use, and change in food availability or quality. These effects are predicted to be adverse, low in magnitude, within the LSA, short term in duration, occurring regularly, and reversible, with these predictions being made with a high level of confidence.

10.4 Species at Risk: Overview of Potential Effects and Key Mitigation

Marine mammal and sea turtles listed as species at risk are those species that are listed as endangered, threatened or of special concern under Schedule 1 of SARA (and are therefore, formally and legally protected) and/or which are otherwise designated by COSEWIC as endangered, threatened or of special concern. There are currently no marine mammal or sea turtle species listed under the NL ESA. Based on a review of scientific literature, status updates, other environmental assessments, and records from marine surveys and sightings databases, there are nine marine mammals and two sea turtle SAR/SOCC that may occur in the Project Area and RSA, including the: beluga whale, blue whale, bowhead whale, fin whale, North Atlantic right whale, harbour porpoise, killer whale, northern bottlenose whale, Sowerby's beaked whale, and leatherback and loggerhead sea turtle (see Table 10.4).

The information used in this section to describe the understood occurrence of marine mammal and sea turtle SAR in the Project Area, LSA and RSA is based on opportunistic sightings and does not represent year-round, systematic, or standardized effort, either spatially or temporally. Therefore, sightings records can support identification of potential presence of a species in the Eastern Newfoundland offshore area, but a lack of sightings should not be interpreted to represent a definite

lack of species presence. Similarly, while some marine mammal or sea turtle species may be considered common to the area year-round, many species are also migratory, appearing seasonally, following prey movements, or simply passing through. Opportunistic data should therefore not be used to assess abundance, frequency, or seasonality because effort has not been uniformly applied at all times of year (i.e., lack of winter sightings may simply represent lower numbers of observers/surveys in the region). Generalized seasonality predictions are summarized in Table 10.4 and discussed further in Section 6.3.8, along with associated figures. Most opportunistic sightings are reported from vessel-based platforms and the positive and/or negative reactions by cetaceans and sea turtles to these vessels have not been factored into the data considered. Opportunistic sightings are reported by individuals with various degrees of experience and expertise in marine mammal identification and the data have not been completely error-checked. The quality of some of the information, therefore, is unknown. Despite these caveats, this information is of value in identifying overall potential for species' presence in the region.

10.4.1 Beluga Whale

Beluga whales (Threatened) are most commonly found in the St. Lawrence Estuary and Gulf of St. Lawrence (COSEWIC 2014), and their occurrence off Eastern Newfoundland is unexpected. DFO's opportunistic marine mammal and sea turtle sightings database for offshore Newfoundland (1758-2015) includes a single record of a beluga whale in the Northern Project Area, from July 2005. Beluga whales do not regularly visit the Eastern Newfoundland offshore area, and therefore it is considered unlikely that they will occur in the Project Area or RSA or interact with Project activities.

10.4.2 Blue Whale

Blue whales (Endangered) are regularly sighted in the Gulf of St. Lawrence and St. Lawrence Estuary between April and December (COSEWIC 2002). Compared to the Gulf of St. Lawrence, low numbers of blue whales have been sighted on the Grand Banks and in the Eastern Newfoundland offshore area. There was a total of six blue whales observed during the TNASS survey off Newfoundland in 2007 (Lawson and Gosselin 2009) and a recent study using satellite telemetry determined that a single blue whale migrated south of the Project Area – Northern Section in 2013 (Lesage et al. 2016). Based on opportunistic DFO marine mammal sighting records, there are no blue whale sightings on record in the Project Area, but 14 records in the RSA. As such this species is expected to occur in the Project Area or RSA only rarely, and overall, it is relatively unlikely they will interact with Project activities.

Table 10.4 Marine Mammal and Sea Turtle Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	SARA Schedule 1 Status	COSEWIC Designation	Summary of Presence in Project Area / RSA	Potential for Occurrence and Interaction
Beluga whale (St. Lawrence Estuary population)	Threatened	Endangered	• Opportunistic Sightings in the Project Area: Rare • Opportunistic Sightings in the RSA: Rare • Timing of Presence in the Project Area: Infrequent visitor • Timing of Presence in the RSA: Infrequent visitor	• Potential for Occurrence in the Project Area: Low • Potential for Occurrence in the RSA: Low • Potential for Interaction with Project Activities: Low
Blue whale (Atlantic population)	Endangered	Endangered	• Opportunistic Sightings in the Project Area: None • Opportunistic Sightings in the RSA: Few • Timing of Presence in the Project Area: No occurrence • Timing of Presence in RSA: Infrequent visitor	• Potential for Occurrence in the Project Area: Low • Potential for Occurrence in the RSA: Low • Potential for Interaction with Project Activities: Low
Bowhead whale (Eastern Canada-West Greenland population)	Not Listed	Special Concern	• Opportunistic Sightings in the Project Area: None • Opportunistic Sightings in the RSA: Rare • Timing of Presence in the Project Area: Infrequent visitor • Timing of Presence in the RSA: Infrequent visitor	• Potential for Occurrence in the Project Area: Low • Potential for Occurrence in the RSA: Low • Potential for Interaction with Project Activities: Low
Fin whale (Atlantic Population)	Special Concern	Special Concern	• Opportunistic Sightings in the Project Area: Regular • Opportunistic Sightings in the RSA: Frequent • Timing of Presence in the Project Area: Seasonal (highest concentration from June to September) • Timing of Presence in the RSA: Seasonal (highest concentration from May to October)	• Potential for Occurrence in the Project Area: High • Potential for Occurrence in the RSA: High • Potential for Interaction with Project Activities: High

Table 10.4 Marine Mammal and Sea Turtle Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	SARA Schedule 1 Status	COSEWIC Designation	Summary of Presence in Project Area / RSA	Potential for Occurrence and Interaction
Harbour porpoise (Northwest Atlantic subspecies)	Not Listed (Threatened on Schedule 2)	Special Concern	• Opportunistic Sightings in the Project Area: Few • Opportunistic Sightings in the RSA: Regular • Timing of Presence in the Project Area: Seasonal (highest concentration from May to September) • Timing of Presence in the RSA: Seasonal (highest concentration from May to September)	• Potential for Occurrence in the Project Area: Moderate • Potential for Occurrence in the RSA: Moderate • Potential for Interaction with Project Activities: Moderate
Killer whale (Northwest Atlantic population)	Not Listed	Special Concern	• Opportunistic Sightings in the Project Area: Rare • Opportunistic Sightings in the RSA: Regular • Timing of Presence in the Project Area: Seasonal (highest concentration from May to October) • Timing of Presence in the RSA: Seasonal (highest concentration from May to October)	• Potential for Occurrence in the Project Area: Low • Potential for Occurrence in the RSA: Moderate • Potential for Interaction with Project Activities: Low
North Atlantic right whale	Endangered	Endangered	• Opportunistic Sightings in the Project Area: Rare • Opportunistic Sightings in the RSA: Rare • Timing of Presence in the Project Area: Infrequent visitor • Timing of Presence in the RSA: Infrequent visitor	• Potential for Occurrence in the Project Area: Low • Potential for Occurrence in the RSA: Low • Potential for Interaction with Project Activities: Low
Northern bottlenose whale (1: Scotian Shelf population/ 2:	1: Endangered 2: Not Listed	1: Endangered 2: Special Concern	• Opportunistic Sightings in the Project Area: Regular • Opportunistic Sightings in the RSA: Regular	• Potential for Occurrence in the Project Area: Moderate • Potential for Occurrence in the RSA: Moderate

Table 10.4 Marine Mammal and Sea Turtle Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	SARA Schedule 1 Status	COSEWIC Designation	Summary of Presence in Project Area / RSA	Potential for Occurrence and Interaction
Davis Strait-Baffin Bay-Labrador Sea population)			• Timing of Presence in the Project Area: Seasonal (highest concentration from May to August) • Timing of Presence in the RSA: Seasonal (highest concentration from May to September)	• Potential for Interaction with Project Activities: Moderate
Sowerby's beaked whale	Special Concern	Special Concern	• Opportunistic Sightings in the Project Area: Rare • Opportunistic Sightings in the RSA: • Timing of Presence in the Project Area: Infrequent visitor • Timing of Presence in the RSA: Infrequent visitor	• Potential for Occurrence in the Project Area: Low • Potential for Occurrence in the RSA: Low • Potential for Interaction with Project Activities: Low
Leatherback sea turtle	Endangered	Endangered	• Opportunistic Sightings in the Project Area: Rare • Opportunistic Sightings in the RSA: Regular • Timing of Presence in the Project Area: Infrequent Visitor • Timing of Presence in the RSA: Seasonal (highest concentration from April to October)	• Potential for Occurrence in the Project Area: Low • Potential for Occurrence in the RSA: Moderate • Potential for Interaction with Project Activities: Low

Table 10.4 Marine Mammal and Sea Turtle Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	SARA Schedule 1 Status	COSEWIC Designation	Summary of Presence in Project Area / RSA	Potential for Occurrence and Interaction
Loggerhead sea turtle	Not Listed	Endangered	• Opportunistic Sightings in the Project Area: Rare • Opportunistic Sightings in the RSA: Regular • Timing of Presence in the Project Area; Infrequent Visitor • Timing of Presence in the RSA: Seasonal (highest concentration from April to October)	• Potential for Occurrence in the Project Area: Low • Potential for Occurrence in the RSA: Moderate • Potential Interaction with Project Activities: Low

10.4.3 Bowhead Whale

Bowhead whales (Special Concern – COSEWIC) are typically found in Arctic regions and are not common in Newfoundland and Labrador waters. However, they have been sighted in the waters off the coast of Newfoundland in Rattling Brook, Trinity Bay, and Witless Bay (Ledwell et al. 2007; The Telegram 2014). The sighting of a stranded whale in Witless Bay is the southernmost occurrence of a bowhead whale on record (Ledwell et al. 2007). Based on DFO marine mammal observation records, there have been no sightings of this species in the Project Area and there has been only one sighting in the RSA (in May 2015). Bowhead whales are only rare visitors to the Eastern Newfoundland offshore area and it is not likely that this species will occur in the Project Area or RSA, nor that there will be interaction with Project activities.

10.4.4 Fin Whale

During the summer months, concentrations of fin whales (Special Concern) are known to occur in the Gulf of St. Lawrence, on the Scotian Shelf, and in the nearshore and offshore waters of Newfoundland and Labrador (COSEWIC 2005). During the TNASS survey off Newfoundland in 2007, 95 fin whales where observed (Lawson and Gosselin 2009). DFO opportunistic sightings records report 83 sightings of fin whale in the Project Area – Northern Section,115 sightings in the Project Area – Southern Section, and 369 sightings in the RSA, suggesting this species regularly occurs in these areas. There are an additional 18 potential sightings in the Project Area – Northern Section, an additional 10 sightings in the Project Area – Southern Section, and a total of 43 sightings in the RSA, where the observer was not able to distinguish between fin and sei whales due to their close morphological characteristics. Because of their seemingly regular occurrence in the Eastern Newfoundland offshore area, fin whales are considered likely to occur in the Project Area and RSA and may interact with Project activities, particularly those producing high levels of sound, such as VSP and other geophysical surveys.

10.4.5 Harbour Porpoise

In the Northwest Atlantic, harbour porpoises (Threatened – Schedule 2) occur from the Bay of Fundy north to Cape Aston, Baffin Island, but the extent of habitat in eastern Canada is not well understood (COSEWIC 2006). Observations made from by-catches in groundfish gill nets indicate that this species can be found along the entire coast of Newfoundland, especially along the south and west coasts, but they have also been caught in experimental drift nets across the entire Grand Banks, and on the continental shelf as far north as Nain, Labrador (COSEWIC 2006). There were 58 sightings of harbour porpoise during the 2007 TNASS survey conducted off Newfoundland (Lawson and Gosselin 2009). Based on DFO and Statoil marine mammal observations, there have been 27 reported sightings of harbour porpoise in the Project Area – Northern Section, seven in the Project Area – Southern Section, and 94 sightings in the RSA. Harbour porpoises are therefore considered occasional visitors to the Project Area and RSA, and may interact with Project activities, particularly those producing high levels of sound, such as VSP and other geophysical surveys.

10.4.6 Killer Whale

Killer whales (Special Concern – COSEWIC) are relatively uncommon in Eastern Canada, and while their distribution in the northwest Atlantic is not well known, sightings are regularly reported in the coastal waters of Newfoundland (COSEWIC 2009). Based on observations of killer whales in Eastern Canada from 1758 to 2012, it was determined that sightings in Newfoundland and Labrador are most common from June to September and have been more frequent over the last decade (Lawson and Stevens 2014). One killer whale was observed in the 2007 TNASS survey off Newfoundland (Lawson and Gosselin 2009). There have been nine sightings of killer whale in the Project Area – Northern Section, 21 in the Project Area – Southern Section, and 101 sightings in the RSA based on DFO and Statoil marine mammal observation records. Given that killer whales are occasional visitors to the Project Area and RSA, it is possible that they will occur in the Project Area and may interact with Project activities, particularly those producing high levels of sound, such as VSP and other geophysical surveys.

10.4.7 North Atlantic Right Whale

In Atlantic Canada, North Atlantic right whales (Endangered) are found during summer and fall in the Bay of Fundy, on the Scotian Shelf, the Gulf of St. Lawrence and, rarely, in the waters off Newfoundland (COSEWIC 2013). There were no sightings of North Atlantic right whales during the 2007 TNASS survey off Newfoundland (Lawson and Gosselin 2007). There is only one sighting (from July 2003) of a North Atlantic right whale in the Project Area reported in the DFO opportunistic sightings database, and an additional one from the RSA. Based on their rare occurrence in the Eastern Newfoundland offshore area, it is not likely that this species will occur in the Project Area or RSA and it is not likely there will be interactions with Project activities.

10.4.8 Northern Bottlenose Whale

In the Northwest Atlantic, northern bottlenose whales regularly occur in two areas; along the Scotia Shelf (Endangered), and in the Davis Strait (Special Concern – COSEWIC) (DFO 2016a). However, there is some evidence that northern bottlenose whales are also found on the edge of the Grand Banks near the Flemish Cap, although it is unclear whether these individuals are from the Scotian Shelf or Davis Strait-Baffin Bay population (DFO 2016a). There have been recent sightings (2015 and 2016) in the Sackville Spur area of the Flemish Cap and a survey team from Dalhousie University observed 50-200 individuals along the continental shelf near the Flemish Cap in the summer of 2016 (Gillis 2016). During the 2007 TNASS survey, 42 northern bottlenose whales were observed in Newfoundland waters (Lawson and Gosselin 2009). Based on DFO and Statoil marine mammal observation records, there have been 52 sightings of northern bottlenose whale in the Project Area – Northern Section, eight in the Project Area – Southern Section, and 78 sightings in the RSA. Given that northern bottlenose whales are occasional visitors to the Eastern Newfoundland offshore area, this species may occur in the Project Area and RSA and could conceivably interact with Project activities, particularly those producing high levels of sound, such as VSP and other geophysical surveys.

10.4.9 Sowerby's Beaked Whale

In the Northwestern Atlantic, Sowerby's beaked whale (Special Concern) is thought to occur as far north as the Davis Strait, although they are most frequently observed in the waters off Newfoundland, Nova Scotia, and the northeastern United States (DFO 2016b). There were no observations of this species in the 2007 TNASS survey in Newfoundland waters (Lawson and Gosselin 2009). Based on DFO and Statoil marine mammal observation records, there was one sighting of a Sowerby's beaked whale in the Project Area – Northern Section in September 2005. Additionally, there are records of three sightings of an unidentified beaked whale species in the Project Area. This species would be sensitive to Project activities that are associated with intense underwater sound, however, it is not likely that this Sowerby's beaked whale will occur in the Project Area or RSA and interaction with Project activities is likewise considered unlikely.

10.4.10 Leatherback Sea Turtle

In Atlantic Canada, leatherback sea turtles (Endangered) occur in both coastal and offshore waters, though most sightings are from the continental shelf (COSEWIC 2012). Leatherback sea turtles are the largest species of sea turtle and are the most likely to be observed in the Project Area and RSA. Based on DFO and Statoil sea turtle observation records, there is a single record of a leatherback sea turtle in the Project Area – Southern Section (September 2008), but there have been a number of sightings in the RSA southeast of the Grand Banks (Figure 6-84). There were an additional three sightings of sea turtles in the RSA that could not be identified to species.

10.4.11 Loggerhead Sea Turtle

Loggerhead sea turtles (Endangered – COSEWIC) in Atlantic Canada are concentrated in offshore areas along the Scotian Shelf, Georges Bank, and the Grand Banks from July through October (Brazner and McMilan 2008). Incidental captures of loggerhead sea turtles were reported by the Atlantic Canadian pelagic longline fleet between 1999 and 2006, but none of these sightings occurred in areas northeast of the Grand Banks, including the Project Area (Brazner and McMilan 2008). There were two sightings of loggerhead sea turtles in the Project Area reported in the DFO, OBIS and Statoil observation records, and additional sightings in the RSA southeast of the Grand Banks (Figure 6-84). Given that loggerhead sea turtles are rare in the Eastern Newfoundland offshore area, it is unlikely that they will occur in the Project Area and RSA nor interact with Project activities.

Table 10.4 summarizes information on potential presence and timing of SAR in relation to the Project Area and RSA, as well as potential for Project interactions. There are no marine mammal or sea turtle SAR designated under the NL ESA.

As indicated, marine mammal and sea turtle species at risk are known to occur in the Project Area and RSA. The potential environmental interactions between the Project and SAR are the same as those for the Marine Mammals and Sea Turtles VC, as are the planned mitigation measures to reduce such adverse interactions. SAR marine mammal and sea turtle species are highly mobile, and many have broad ranges and show large movements across annual migration routes. Large seasonal and even daily fluctuations in abundance within the Project Area and RSA are therefore likely, and

potential for overlap and interaction with Project activities is likely to be far more transient and temporary than presented within this assessment. The Project will not occur within any identified concentration areas or designated Marine Mammal or Sea Turtle critical habitat. Significance of Residual Environmental Effects

This section summarizes the residual environmental effects of the Project on Marine Mammals and Sea Turtles and presents a determination of significance for the environmental effects assessment for this VC.

10.5 Significance of Residual Environmental Effects

This section summarizes the residual environmental effects of the Project on Marine Mammals and Sea Turtles and presents a determination of significance for the environmental effects assessment for this VC.

10.5.1 Residual Environmental Effects Summary

The Project has the potential to result in interactions with Marine Mammals and Sea Turtles, including SAR. With the application of mitigation measures and adherence to published and/or industry standards and best management practices (e.g., OWTG, SOCP, and C-NLOPB guidelines), these are expected to be adverse, negligible to medium in magnitude, occur within the Project Area, LSA or RSA as regular or sporadic events (depending on the Project activity), and be short- to medium-term in duration (depending on the Project activity and phase). Resulting effects on Marine Mammals and Sea Turtles will likely be reversible. These effects will occur within an already disturbed context (i.e., existing human development and industrial activity) with additional future offshore development and activities expected within and near the Project Area, LSA, and RSA. Potential for overlap and interaction with Project activities is also likely to be highly transient and temporary for an individual marine mammal or sea turtle, especially in consideration of anticipated large-scale daily and seasonal fluctuations in presence within the assessment areas.

Table 10.5 summarizes the environmental effects assessment for the Project as a whole, including characterization of potential effects from potential Project interactions and applicable mitigation measures relating to Marine Mammals and Sea Turtles. Tables 10.6 to 10.11 then provide individual environmental effects assessment summaries for planned Project activities on each of the ELs that comprise the Project being assessed under CEAA 2012.

Table 10.5 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles – Overall Project

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY	
Summary of Existing Conditions and Ecological and Social Context: Project Area / LSA • Species that may interact with the Project include: 18 species of cetaceans, of which six species are mysticetes and 12 species are odontocetes; four species of phocids; and four species of sea turtles • While some of these species are migratory, others may be present in the Project Area and RSA year-round • Many of these species are designated at risk or have special conservation status • A number of EBSAs, some of which represent important foraging habitat and migratory routes for marine mammals and sea turtles intersect the Project Area and RSA • There is no overlap with designated critical habitat for marine mammals or sea turtles • Marine mammals and sea turtles are often particularly sensitive to environmental and anthropogenic change in the marine environment, as reflected in the fact that many species have been designated as being at risk or are otherwise of conservation concern	**Summary of Key Mitigation** • Use of existing and common travel routes for vessels and helicopters will be used where possible and practicable • Low-level aircraft operations will be avoided where it is not required per Transport Canada protocols • Operational discharges will be treated prior to release in accordance with the OWTG (2016) and other applicable regulations and standards • The selection and screening of chemicals to be discharged, including drilling fluids, will be in accordance with the Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands • Project associated vessel traffic will be approximately eight to ten trips per month to service one drilling installation. Use of existing and common travel routes will be used where possible and practical. Vessels will maintain a steady course and safe vessel speed whenever possible • Use of explosives will not be employed for removal of wellheads • As required in the Geophysical, Geological, Environmental and Geotechnical Program Guidelines, mitigation measures applied during the Project's geophysical surveys will be consistent with those outlined in the Statement of Canadian Practice with respect to the Mitigation of Geophysical Sound in the Marine Environment (SOCP) (DFO 2007). The following is a partial list of those mitigation measures: – Trained MMOs will be used to monitor and report on marine mammal and sea turtle sightings during VSP and geophysical surveys where geophysical source arrays are used – A ramp-up of the source array (i.e., gradually increasing geophysical source elements over a period of at least 20 minutes until the operating level is achieved) starting from a single source element – MMOs will implement a pre-ramp up watch of 30 minutes prior to the start of the air source. Ramp-up will be delayed if marine mammal or sea turtle is sighted within the safety zone – Shut down of the geophysical source array if a marine mammal or sea turtle listed as endangered or threatened on SARA Schedule 1

Table 10.5 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles – Overall Project

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature / Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of Drilling Installation	• Change in mortality or injury (underwater noise) • Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	L-M	PA-LSA	S-M	R	R	M
Drilling and Associated Marine Discharges	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality • Change in health (ontaminants)	A	L	L-PA	S	R	R	H
Formation Flow Testing with Flaring	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality • Change in health (ontaminants)	A	N-L	L-PA	S	S	R	H

Table 10.5 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles – Overall Project

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Wellhead Decommissioning	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	N-L	L-PA	S	S	R	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Change in mortality or injury (underwater noise) • Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	N-L	L-LSA	S-M	S	R	H
Geological, Geotechnical and Environmental Surveys	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	N	L-PA	S	S	R	H
Supply and Servicing	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	L	L-LSA	S	R	R	H

Table 10.5 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles – Overall Project

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY
Evaluation of Significance • Based on the nature and characteristics of the Project and the existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Project is not likely to result in significant adverse effects on Marine Mammals and Sea Turtles. • Although Project-related components, activities, and emissions may result in some localized, short-term interactions with individuals the number of individuals and areas that may be affected, and the temporary and reversible nature of these interactions, means that the Project will not have any overall ecological or population-level effects, and will not result in any detectable decline in overall abundance or changes in the spatial and temporal distributions of populations within the RSA. • For SAR, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA or RSA. The Project will therefore not have implications for the overall abundance, distribution, or health of any such species nor its eventual recovery within the RSA. The Project is not predicted to result in significant adverse effects on marine mammal or sea turtle SAR. NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.

KEY

Nature / Direction:

P	Positive
A	Adverse
N	Neutral (or No Effect)

Magnitude:

N	Negligible
L	Low
M	Medium
H	High

Geographic Extent:

L	Localized, In Immediate Vicinity of Activity
PA	Within Project Area
LSA	Within LSA
RSA	Within RSA or Beyond

Frequency:

O	Occurs once
S	Occurs sporadically
R	Occurs on a regular basis
C	Occurs continuously

Duration:

S	Short term (For duration of the activity)
M	Medium term (Beyond duration of the activity – weeks or months)
L	Long term (Beyond duration of the activity – years)
P	Permanent (Recovery unlikely)

Reversibility:

R	Reversible (Will recover to baseline)
I	Irreversible (Permanent)

Certainty in Predictions:

L	Low level of confidence
M	Moderate level of confidence
H	High level of confidence
N/A	Not Applicable

Table 10.6 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles – EL 1135

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY	
Summary of Existing Conditions and Ecological and Social Context: EL 1135 • See Table 10.5 for an overview of the Project Area and LSA as a whole. • These species are highly mobile, and so information on their presence and distribution (spatially and temporally) is inherently regional in nature. • In this EL and surrounding area, offshore species of marine mammals and sea turtles are expected to occur transiently. • This EL overlaps the Northeast Shelf and Slope EBSA, which has been recognized for its concentrations of cetaceans and pinnipeds.	**Summary of Key Mitigation** See Table 10.5

Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors						
		Nature / Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty
Presence and Operation of Drilling Installation	• Change in mortality or injury (underwater noise) • Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	L-M	PA-LSA	S-M	R	R	M
Drilling and Associated Marine Discharges	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality • Change in health (ontaminants)	A	L	L-PA	S	R	R	H

Table 10.6 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles – EL 1135

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Formation Flow Testing with Flaring	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality • Change in health (ontaminants)	A	N-L	L-PA	S	S	R	H
Wellhead Decommissioning	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	N-L	L-PA	S	S	R	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Change in mortality or injury (underwater noise) • Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	N-L	L-LSA	S-M	S	R	H

Table 10.6 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles – EL 1135

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Geological, Geotechnical and Environmental Surveys	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	N	L-PA	S	S	R	H
Supply and Servicing	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	L	L-LSA	S	R	R	H
Evaluation of Significance • Based on the nature and characteristics of the Project and the existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Project is not likely to result in significant adverse effects on Marine Mammals and Sea Turtles. • Although Project-related components, activities, and emissions may result in some localized, short-term interactions with individuals the number of individuals and areas that may be affected, and the temporary and reversible nature of these interactions, means that the Project will not have any overall ecological or population-level effects, and will not result in any detectable decline in overall abundance or changes in the spatial and temporal distributions of populations within the RSA. • For SAR, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA or RSA. The Project will therefore not have implications for the overall abundance, distribution, or health of any such species nor its eventual recovery within the RSA. The Project is not predicted to result in significant adverse effects on marine mammal or sea turtle SAR. NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.								
KEY: See Table 10.5								

Table 10.7 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles – EL 1137

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY	
Summary of Existing Conditions and Ecological and Social Context: EL 1137 • See Table 10.5 for an overview of the Project Area and LSA as a whole. • These species are highly mobile, and so information on their presence and distribution (spatially and temporally) is inherently regional in nature. • In this EL and surrounding area, offshore species of marine mammals and sea turtles are expected to occur transiently. • No high concentration of or designated special areas for marine mammals or sea turtles have been identified to overlap this EL.	**Summary of Key Mitigation** See Table 10.5

Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors						
		Nature / Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty
Presence and Operation of Drilling Installation	• Change in mortality or injury (underwater noise) • Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	L-M	PA-LSA	S-M	R	R	M
Drilling and Associated Marine Discharges	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality • Change in health (ontaminants)	A	L	L-PA	S	R	R	H

Table 10.7 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles – EL 1137

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Formation Flow Testing with Flaring	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality • Change in health (ontaminants)	A	N-L	L-PA	S	S	R	H
Wellhead Decommissioning	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	N-L	L-PA	S	S	R	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Change in mortality or injury (underwater noise) • Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	N-L	L-LSA	S-M	S	R	H

Table 10.7 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles – EL 1137

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Geological, Geotechnical and Environmental Surveys	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	N	L-PA	S	S	R	H
Supply and Servicing	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	L	L-LSA	S	R	R	H

Evaluation of Significance

- Based on the nature and characteristics of the Project and the existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Project is not likely to result in significant adverse effects on Marine Mammals and Sea Turtles.
- Although Project-related components, activities, and emissions may result in some localized, short-term interactions with individuals the number of individuals and areas that may be affected, and the temporary and reversible nature of these interactions, means that the Project will not have any overall ecological or population-level effects, and will not result in any detectable decline in overall abundance or changes in the spatial and temporal distributions of populations within the RSA.
- For SAR, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA or RSA. The Project will therefore not have implications for the overall abundance, distribution, or health of any such species nor its eventual recovery within the RSA. The Project is not predicted to result in significant adverse effects on marine mammal or sea turtle SAR.

NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.

KEY: See Table 10.5

Table 10.8 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles – EL 1139

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY	
Summary of Existing Conditions and Ecological and Social Context: EL 1139 • See Table 10.5 for an overview of the Project Area and LSA as a whole. • These species are highly mobile, and so information on their presence and distribution (spatially and temporally) is inherently regional in nature. • In this EL and surrounding area, offshore species of marine mammals and sea turtles are expected to occur transiently. • No high concentration of or designated special areas for marine mammals or sea turtles have been identified to overlap this EL.	**Summary of Key Mitigation** See Table 10.5

Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors						
		Nature / Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty
Presence and Operation of Drilling Installation	• Change in mortality or injury (underwater noise) • Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	L-M	PA-LSA	S-M	R	R	M
Drilling and Associated Marine Discharges	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality • Change in health (ontaminants)	A	L	L-PA	S	R	R	H

Table 10.8 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles – EL 1139

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Formation Flow Testing with Flaring	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality • Change in health (ontaminants)	A	N-L	L-PA	S	S	R	H
Wellhead Decommissioning	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	N-L	L-PA	S	S	R	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Change in mortality or injury (underwater noise) • Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	N-L	L-LSA	S-M	S	R	H

Table 10.8 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles – EL 1139

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Geological, Geotechnical and Environmental Surveys	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	N	L-PA	S	S	R	H
Supply and Servicing	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	L	L-LSA	S	R	R	H
Evaluation of Significance • Based on the nature and characteristics of the Project and the existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Project is not likely to result in significant adverse effects on Marine Mammals and Sea Turtles. • Although Project-related components, activities, and emissions may result in some localized, short-term interactions with individuals the number of individuals and areas that may be affected, and the temporary and reversible nature of these interactions, means that the Project will not have any overall ecological or population-level effects, and will not result in any detectable decline in overall abundance or changes in the spatial and temporal distributions of populations within the RSA. • For SAR, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA or RSA. The Project will therefore not have implications for the overall abundance, distribution, or health of any such species nor its eventual recovery within the RSA. The Project is not predicted to result in significant adverse effects on marine mammal or sea turtle SAR. NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.								
KEY: See Table 10.5								

Table 10.9 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles – EL 1140

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY	
Summary of Existing Conditions and Ecological and Social Context: EL 1140 • See Table 10.5 for an overview of the Project Area and LSA as a whole. • These species are highly mobile, and so information on their presence and distribution (spatially and temporally) is inherently regional in nature. • In this EL and surrounding area, offshore species of marine mammals and sea turtles are expected to occur transiently. • No high concentration of or designated special areas for marine mammals or sea turtles have been identified to overlap this EL.	**Summary of Key Mitigation** See Table 10.5

Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors						
		Nature / Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty
Presence and Operation of Drilling Installation	• Change in mortality or injury (underwater noise) • Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	L-M	PA-LSA	S-M	R	R	M
Drilling and Associated Marine Discharges	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality • Change in health (ontaminants)	A	L	L-PA	S	R	R	H

Table 10.9 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles – EL 1140

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Formation Flow Testing with Flaring	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality • Change in health (ontaminants)	A	N-L	L-PA	S	S	R	H
Wellhead Decommissioning	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	N-L	L-PA	S	S	R	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Change in mortality or injury (underwater noise) • Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	N-L	L-LSA	S-M	S	R	H

Table 10.9 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles – EL 1140

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Geological, Geotechnical and Environmental Surveys	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	N	L-PA	S	S	R	H
Supply and Servicing	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	L	L-LSA	S	R	R	H

Evaluation of Significance

- Based on the nature and characteristics of the Project and the existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Project is not likely to result in significant adverse effects on Marine Mammals and Sea Turtles.
- Although Project-related components, activities, and emissions may result in some localized, short-term interactions with individuals the number of individuals and areas that may be affected, and the temporary and reversible nature of these interactions, means that the Project will not have any overall ecological or population-level effects, and will not result in any detectable decline in overall abundance or changes in the spatial and temporal distributions of populations within the RSA.
- For SAR, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA or RSA. The Project will therefore not have implications for the overall abundance, distribution, or health of any such species nor its eventual recovery within the RSA. The Project is not predicted to result in significant adverse effects on marine mammal or sea turtle SAR.

NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.

KEY: See Table 10.5

Table 10.10 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles – EL 1141

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY	
Summary of Existing Conditions and Ecological and Social Context: EL 1141 • See Table 10.5 for an overview of the Project Area and LSA as a whole. • These species are highly mobile, and so information on their presence and distribution (spatially and temporally) is inherently regional in nature. • This EL overlaps the Sackville Spur VME and Northern Flemish Cap VME. While these VMEs were identified primarily in relation to their benthic fauna, northern bottlenose whales have also recently been reported in this area.	**Summary of Key Mitigation** See Table 10.5

Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors						
		Nature / Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty
Presence and Operation of Drilling Installation	• Change in mortality or injury (underwater noise) • Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	L-M	PA-LSA	S-M	R	R	M
Drilling and Associated Marine Discharges	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality • Change in health (ontaminants)	A	L	L-PA	S	R	R	H

Table 10.10 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles – EL 1141

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Formation Flow Testing with Flaring	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality • Change in health (ontaminants)	A	N-L	L-PA	S	S	R	H
Wellhead Decommissioning	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	N-L	L-PA	S	S	R	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Change in mortality or injury (underwater noise) • Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	N-L	L-LSA	S-M	S	R	H

Table 10.10 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles – EL 1141

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Geological, Geotechnical and Environmental Surveys	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	N	L-PA	S	S	R	H
Supply and Servicing	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	L	L-LSA	S	R	R	H

Evaluation of Significance

- Based on the nature and characteristics of the Project and the existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Project is not likely to result in significant adverse effects on Marine Mammals and Sea Turtles.
- Although Project-related components, activities, and emissions may result in some localized, short-term interactions with individuals the number of individuals and areas that may be affected, and the temporary and reversible nature of these interactions, means that the Project will not have any overall ecological or population-level effects, and will not result in any detectable decline in overall abundance or changes in the spatial and temporal distributions of populations within the RSA.
- For SAR, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA or RSA. The Project will therefore not have implications for the overall abundance, distribution, or health of any such species nor its eventual recovery within the RSA. The Project is not predicted to result in significant adverse effects on marine mammal or sea turtle SAR.

NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.

KEY: See Table 10.5

Table 10.11 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles – EL 1142

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY	
Summary of Existing Conditions and Ecological and Social Context: EL 1142 • See Table 10.5 for an overview of the Project Area and LSA as a whole. • These species are highly mobile, and so information on their presence and distribution (spatially and temporally) is inherently regional in nature. • This EL overlaps the Sackville Spur VME and Northern Flemish Cap VME. While these VMEs were identified primarily in relation to their benthic fauna, northern bottlenose whales have also recently been reported in this area.	**Summary of Key Mitigation** See Table 10.5

Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors						
		Nature / Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty
Presence and Operation of Drilling Installation	• Change in mortality or injury (underwater noise) • Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	L-M	PA-LSA	S-M	R	R	M
Drilling and Associated Marine Discharges	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality • Change in health (ontaminants)	A	L	L-PA	S	R	R	H

Table 10.11 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles – EL 1142

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Formation Flow Testing with Flaring	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality • Change in health (ontaminants)	A	N-L	L-PA	S	S	R	H
Wellhead Decommissioning	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	N-L	L-PA	S	S	R	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Change in mortality or injury (underwater noise) • Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	N-L	L-LSA	S-M	S	R	H

Table 10.11 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles – EL 1142

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Geological, Geotechnical and Environmental Surveys	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	N	L-PA	S	S	R	H
Supply and Servicing	• Change in habitat quality or use (behavioural effects) • Change in mortality or injury (vessel strikes) • Change in food availability or quality	A	L	L-LSA	S	R	R	H

Evaluation of Significance

- Based on the nature and characteristics of the Project and the existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Project is not likely to result in significant adverse effects on Marine Mammals and Sea Turtles.
- Although Project-related components, activities, and emissions may result in some localized, short-term interactions with individuals the number of individuals and areas that may be affected, and the temporary and reversible nature of these interactions, means that the Project will not have any overall ecological or population-level effects, and will not result in any detectable decline in overall abundance or changes in the spatial and temporal distributions of populations within the RSA.
- For SAR, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA or RSA. The Project will therefore not have implications for the overall abundance, distribution, or health of any such species nor its eventual recovery within the RSA. The Project is not predicted to result in significant adverse effects on marine mammal or sea turtle SAR.

NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.

KEY: See Table 10.5

10.5.2 Determination of Significance

With the application of mitigation measures and adherence to published and/or industry standards and best management practices, the Project is not likely to result in significant adverse effects on marine mammals and sea turtles, including SAR. As previously noted, the effects assessment has been conducted on the highly conservative assumption that marine mammal and sea turtle species may be continuously present in the Project Area and LSA and thus "available" for a Project-related interaction. Since all of the marine mammal and sea turtle species considered herein are highly mobile, and most show large migration or movement patterns across broad ranges, large seasonal and even daily fluctuations in abundance within the Project Area, LSA and RSA are far more likely. Potential for overlap and interaction with Project activities is therefore also likely to be highly transient and temporary for an individual. Based on the availability of data used to characterize existing conditions within the Project Area, the quality of available literature to understand the Project effect mechanisms, the nature and likely effectiveness of mitigation measures, and the expected occurrence and densities of marine mammals in the Project Area, LSA, and RSA, the level of confidence in these conclusions is high.

While there is some degree of scientific uncertainty concerning the potential effects of introduced underwater sound on sea turtles and marine mammals, there is a reasonable understanding of the overall effects of exploration drilling and VSP and 2D seismic operation on marine mammals, as well as the effectiveness of mitigation measures, including those discussed in Section 10.3.2. Project activities of relevance to marine mammals and sea turtles are predicted to be of short- to medium-term duration and occur in an area where no critical habitat for SAR has been designated, and where marine mammal and sea turtle presence is likely to be transient, with daily and seasonal fluctuations in the individuals potentially exposed. Marine mammals and sea turtles are not expected to be injured or killed as a result of Project activities and components, and adverse effects on health or prey are expected to be negligible.

The likelihood of some degree of localized and temporary behavioural responses by marine mammals and sea turtles (including species listed on Schedule 1 of SARA) is considered moderate to high for species in the immediate area of the sound source during operations. However, while predictions concerning exceedances of acoustic thresholds can lend insight into generalized areas over which a change in behaviour might occur, it is far more challenging to predict the exact nature of behavioural change. Based on the distribution and habitat use of marine mammals and sea turtles in the Project Area, LSA, and RSA and the short-term nature of most Project-related activities, confidence is high that while there may be a degree of behavioural change, amongst a small number of individual marine mammals or sea turtles in the vicinity of certain Project activities, these are unlikely to result in a detectable decline in overall abundance or change in the spatial and temporal distributions of populations within the overall RSA.

Similarly, the Project is not likely to result in significant adverse effects to a designated (protected) species at risk.

10.6 Environmental Monitoring and Follow-Up

The following operational program for marine mammals will be implemented during geophysical surveys where a sound source is used, including VSP:

- A trained MMO will be onboard to record marine mammal and sea turtle sightings during Project operations
- A marine mammal and sea turtle monitoring plan will be submitted to the applicable regulators for review at least 30 days prior to the commencement of the first geophysical survey
- Visual monitoring for the presence of marine mammals and sea turtles within a pre-determined exclusion zone will take place during geophysical operations where an air source array is used
- Observational / shutdown procedures will follow the SOCP for Marine Mammals and Sea Turtles

A report of the observational program will be submitted annually to the C-NLOPB and DFO, including documentation of marine mammal and sea turtle sightings. Any vessel strikes involving marine mammals or sea turtles will be reported to DFO within 24 hours.

Follow-up programs are those that may be required and implemented to address EA-related issues of uncertainty, such as to verify environmental effects predictions and/or the effectiveness of implemented mitigation measures. Considering the results of assessments completed (Appendices C and D) that demonstrate that the sound recorded during a drilling program (2014 to 2016) in the Flemish Pass were similar to those measured and reported for the Stena IceMAX off Nova Scotia and were similar to the predicted levels for the Scotian Basin Project, the uncertainty levels associated with predicted sound levels during operation of the drilling program are considered low. Additionally, Project activities of relevance to marine mammals and sea turtles will be short-term in nature and will occur in an area where no critical habitat for SAR has been designated and marine mammal and sea turtle presence is likely to be transient, further reducing the potential for interactions. These factors, and the planned application of key mitigations and monitoring initiatives during Project activities, means that the potential for adverse effects is likewise therefore low, and the overall level of confidence in the effects predictions and in the effectiveness of mitigation is moderate to high. No specific follow-up related to this VC is therefore considered necessary in relation to the Project.

10.7 References

Amec Environment and Infrastructure. 2014. Eastern Newfoundland Strategic Environmental Assessment. Final Report, 2014. Available at: http://www.cnlopb.ca/sea/eastern.php. Accessed March 16, 2016.

Atlantic Leatherback Turtle Recovery Team. 2006. Recovery Strategy for Leatherback Turtle (*Dermochelys coriacea*) in Atlantic Canada. *Species at Risk Act* Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa, ON. vi + 45 pp.

Bain, D.E., and Williams, R. 2006. Long-range effects of airgun noise on marine mammals: responses as a function of received sound level and distance. Paper SC/58/E35 presented to the IWC Scient. Commit., IWC Annu. Meet., 1-13 June, St. Kitts.

Bartol, S.M. and Ketten D. 2006. Tuna and Turtle Hearing. in Swimmer Y. and Brill R. (eds) Sea Turtle and Pelagic Fish Sensory Biology: Developing Techniques to Reduce Sea Turtle Bycatch in Longline Fisheries, NOAA Technical Memorandum NMFS-PIFSC-7

Brazner, J.C. and J. McMilan. 2008. Loggerhead turtle (*Caretta caretta*) bycatch in Canadian pelagic longline fisheries: relative importance in the western north Atlantic and opportunities for mitigation. Fisheries Research, 91: 310-324.

C-NLOPB (Canada-Newfoundland and Labrador Offshore Petroleum Board). 2017. Geophysical, Geological, Environmental and Geotechnical Program Guidelines. Available from: http://www.cnlopb.ca/pdfs/guidelines/ggegpg.pdf?lbisphpreq=1

Clark, C.W. 1990. Acoustic behavior of mysticete whales. Pp. 571-583. In: J. Thomas and R. Kastelein (eds.). Sensory Abilities of Cetaceans. Plenum Press.

Clark, C.W., Ellison, W.T., Southall, B.L., Hatch, L., Van Parijs, S.M., Frankel, A., and Ponirakis, D. 2009. Acoustic masking in marine ecosystems: intuitions, analysis, and implication. Mar. Ecol. Prog. Ser., 395: 201-222. Available from: http://dx.doi.org/10.3354/meps08402.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2002. COSEWIC assessment and update status report on the Blue Whale *Balaenoptera musculus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. vi + 22 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2005. COSEWIC assessment and update status report on the fin whale *Balaenoptera physalus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. ix + 37 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2006. COSEWIC assessment and update status report on the harbour porpoise *Phocoena phocoena (*Northwest Atlantic population) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. vii + 32 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2009b. COSEWIC Assessment and Update Status Report on the Killer Whale *Orcinus orca* Southern Resident population, Northern Resident population, West Coast Transient population, Offshore population and Northwest Atlantic / Eastern Arctic population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. viii + 65 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2012. COSEWIC assessment and status report on the leatherback sea turtle *Dermochelys coriacea* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. xv + 58 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2013. COSEWIC assessment and status report on the North Atlantic Right Whale *Eubalaena glacialis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. xi + 58 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2014. COSEWIC assessment and status report on the Beluga Whale *Delphinapterus leucas*, St. Lawrence Estuary population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. xii + 64 pp.

DeRuiter, S.L. and Doukara, K.L., 2012. Loggerhead turtles dive in response to airgun sound exposure. Endangered Species Research, 16(1): 55-63.

DFO (Fisheries and Oceans Canada). 2004. Review of Scientific Information on Impacts of Seismic Sound on Fish, Invertebrates, Marine Turtles and Marine Mammals. Habitat Status Report 2004/002, September 2004.

DFO (Fisheries and Oceans Canada). 2007. Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment. http://www.dfo-mpo.gc.ca/oceans/management-gestion/integratedmanagement- gestionintegree/seismic-sismique/statement-enonce-eng.asp.

DFO (Fisheries and Oceans Canada). 2016a. Recovery Strategy for the Northern Bottlenose Whale, (*Hyperoodan ampullatus*), Scotian Shelf population, in Atlantic Canadian Waters (Final*). Species at Risk Act* Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa. vii + 70 pp.

DFO (Fisheries and Oceans Canada). 2016b. Management Plan for the Sowerby's Beaked Whale (*Mesoplodon bidens*) in Canada [Proposed]. *Species at Risk Act* Management Plan Series. Fisheries and Oceans Canada, Ottawa. iv + 48 pp.

Dyndo, M., Wiśniewska, D.M., Rojano-Doñate, L. and Madsen, P.T. 2015. Harbour porpoises react to low levels of high frequency vessel noise. Scientific Reports, 5.

Eckert S.A., Bowles, A. and Berg , E. 1998. The effect of seismic airgun surveys on leatherback sea turtles (*Dermochelys coriacea*) during the nesting season. Technical report to BHP (Petroleum) Trinidad Ltd.

Environment Australia. 2003. Recovery Plan for Marine Turtles in Australia. Prepared by the Marine Species Section Approvals and Wildlife Division, Environment Australia in consultation with the Marine Turtle Recovery Team Canberra (cited 7 March 2011). Available from: www.environment.gov.au/coasts/publications/turtle-recovery/index.html.

Erbe, C. 2002. Underwater noise of whale-watching boats and potential effects on killer whales (*Orcinus orca*), based on an acoustic impact model. Mar. Mamm. Sci., 18(2): 394-418.

Finneran, J.J. 2015. Auditory Weighting Functions and TTS/PTS Exposure Functions for Cetaceans and Marine Carnivores. San Diego, CA: SSC Pacific.

Fischer, R.W. and N.A. Brown. 2005. Factors affecting the underwater noise of commercial vessels operating in environmentally sensitive areas. OCEANS 2005. Proceedings of MTS/IEEE 3: 1982–1988.

Gillis, M. 2016. Rare bottlenose whales discovered off N.L. already in jeopardy. Article in CBC News. Published Nov 30, 2016. Available at: http://www.cbc.ca/news/canada/newfoundland-labrador/bottlenose-whales-under-threat-from-seismic-blasting-1.3872342?campaign_id=A100

Gordon, J., Gillespie, D., Potter, J., Frantzis, A., Simmonds, M.P., Swift, R., and Thompson, D. 2004. A review of the effects of seismic surveys on marine mammals. Mar. Tech. Soc. J., 37(4): 16-34.

Harris, R.E., Miller, G.W., and Richardson, W.J. 2001. Seal responses to airgun sounds during summer seismic surveys in the Alaskan Beaufort Sea. Mar. Mamm. Sci., 17(4): 795-812.

Hastings, M.C., and Popper, A.N. 2005. Effects of Sound on Fish. California Department of Transportation Contract 43A0139, Task Order 1. Available from: http://www.dot.ca.gov/hq/env/bio/files/Effects_of_Sound_on_Fish23Aug05.pdf.

Hazel, J., Lawler, I.R., Marsh, H., and Robson, S. 2007. Vessel speed increases collision risk for the green sea turtle Chelonia mydas. Endang. Species Res., 3: 105-113.

Hildebrand, J.A. 2005. Impacts of anthropogenic sound. Pp. 101-124. In: J.E. Reynolds, W.F. Perrin, R.R. Reeves, S. Montgomery and T.J. Ragen (eds.). Marine Mammal Research: Conservation Beyond Crisis. John Hopkins University Press, Baltimore, MD.

Hinwood J.B., Potts, A.E., Dennis, L.R., Carey, J.M., Houridis, H., Bell, R.J., Thomson, J.R., Boudreau, P., and A.M. Ayling. 1994. Environmental Implications of Offshore Oil and Gas Development in Australia-Drilling Activities. Pp. 124-207. In: J.M. Swan, J.M. Neff and P.C. Young (eds.). Environmental Implications of Offshore Oil and Gas Development in Australia - the Findings of an Independent Scientific Review, Australian Petroleum Exploration Association.

Hurley, G., and Ellis, J. 2004. Environmental Effects of Exploratory Drilling in Offshore Canada: Environmental Effects Monitoring Data and Literature Review-Final Report. Prepared for the Canadian Environmental Assessment Agency-Regulatory Advisory Committee. 61 pp. + App.

Jensen, A.S., and Silber, G.K. 2003. Large whale ship strike database. US Department of Commerce, NOAA Technical Memorandum, NMFS-OPR-25. 37 pp.

Johnson, S.R., Richardson, W.J., Yazvenko, S.B., Blokhin, S.A., Gailey, G., Jenkerson, M.R., Meier, S.K., Melton, H.R., Newcomer, M.W., Perlov, A.S., Rutenko S.A., Würsig B., Martin C.R., andEgging D.E. 2007. A western gray whale mitigation and monitoring program for a 3D seismic survey, Sakhalin Island, Russia. Environ. Monit. Assess., 134(1-3): 1-19.

Kasuya, T. 1986. Distribution and behavior of Baird's beaked whales off the Pacific coast of Japan. Sci. Rep. Whales Res. Inst., 37: 61-83.

Ketten, D.R., and Bartol, M. 2005. Functional Measures of Sea Turtle Hearing. Woods Hole Oceanographic Institution: ONR Award No: N00014-02-1-0510.

Laist, D.W., Knowlton, A.R., Mead, J.G., Collet, A.S., and Podesta, M. 2001. Collisions between ships and whales. Mar. Mammal Sci., 17(1): 35-75.

Lawson. J.W., and Gosselin, J.-F. 2009. Distribution and preliminary abundance estimates for cetaceans seen during Canada's marine megafauna survey - A component of the 2007 TNASS. DFO Can. Sci. Advis. Sec. Res. Doc., 2009/031: vi + 28 pp.

Lawson, J., and Stevens, T. 2014. Historic and current distribution patterns, and minimum abundance of killer whales (*Orcinus orca*) in the north-west Atlantic. Journal of the Marine Biological Association of the United Kingdom, 94(6): 1253-1265

Ledwell W., Benjamins, S., Lawson, J., and J. Huntington. 20047. The most southerly record of a stranded bowhead whale, *Balaena mysticetus*, from the western North Atlantic ocean. Arctic. 60: 17-22.

Lee, K., Armsworthy, S.L., Cobanli, S.E., Cochrane, N.A., Cranford, P.J., Drozdowski, A., Hamoutene, D., Hannah, C.G., Kennedy, E., King, T., et al. 2011. Consideration of the Potential Impacts on the Marine Environment Associated with Offshore Petroleum Exploration and Development Activities. DFO. Can. Sci. Advis. Sec. Res. Doc., 2011/060: xii + 134 pp.

Lee, K., Bain, H., and Hurley, G.V. (Editors). 2005. Acoustic Monitoring and Marine Mammal Surveys in the Gully and Outer Scotian Shelf before and during Active Seismic Programs. Environmental Studies Research Funds Report, No. 151.

Lesage, V., Gavrilchuk, K., Andrews, R.D., and Sears, R. 2016. Wintering areas, fall movements and foraging sites of blue whales satellite-tracked in the Western North Atlantic. DFO Can. Sci. Advis. Sec. Res. Doc., 2016/078. v + 38 pp.

LGL Limited (LGL). 2014. Environmental Assessment of BP Exploration (Canada) Limited's Tangier 3-D Seismic Survey. BP Document No. NS-HS-REP-BP-B01-0001. March 2014.

Ljungblad, D.K., Würsig, B., Swartz, S.L., and Keene, J.M. 1988. Observations on the behavioral responses of bowhead whales (*Balaena mysticetus*) to active geophysical vessels in the Alaskan Beaufort Sea. Arctic, 41(3): 183-194.

Luksenburg, J.A., and Parsons, E.C.M. 2009. The effects of aircraft on cetaceans: implications for aerial whalewatching. International Whaling Commission, SC/61/WW2. 10pp. Available from: http://www.researchgate.net/publication/228409420_The_effects_of_aircraft_on_cetaceans_implications_for_aerial_whalewatching/file/9fcfd50b0a3b9d8a7a.pdf.

Malme, C.I., Miles, P.R., Clark, C.W., Tyack, P., and Bird, J.E. 1984. Investigations of the Potential Effects of Underwater Noise from Petroleum Industry Activities on Migrating Gray Whale Behavior / Phase II: January 1984 Migration. BBN Report 5586 from Bolt Beranek & Newman Inc., Cambridge, MA, for US Minerals Management Service, Anchorage, AK. Various pages.

Malme, C.I., Miles, P.R., Tyack, P., Clark, C.W., and Bird, J.E. 1985. Investigation of the Potential Effects of Underwater Noise from Petroleum Industry Activities on Feeding Humpback Whale Behavior. BBN Report 5851 from BBN Labs Inc., Cambridge, MA, for US Minerals Management Service, Anchorage, AK. OCS Study MMS 85-0019.

Malme, C.I., Wursig, B., Bird, J.E., and Tyack, P. 1988. Observations of feeding gray whale responses to controlled industrial noise exposure. Pp. 55-73. In: Sackinger, W.M., and Jeffries, M.O. (eds.). Port and Ocean Engineering Under Arctic Conditions. Volume II. University of Alaska, Fairbanks, AK, Geophys. Inst. 131 pp.

Manly, B.F.J., Moulton, V.D., Elliott, R.E., Miller, G.W., and Richardson, W.J. 2007. Analysis of Covariance of Fall Migrations of Bowhead Whales in Relation to Human Activities and Environmental Factors, Alaskan Beaufort Sea: Phase I, 1996-1998. LGL Rep. TA2799-2; OCS Study MMS 2005-033. Rep. from LGL Limited, King City, Ont., and WEST Inc., Cheyenne, WY, for U.S. Minerals Manage. Serv., Herndon, VA, and Anchorage, AK. 128pp.

Martin, B., J. Quijano, J., and M.-N. Matthews. 2017. Eastern Newfoundland Drilling Noise Assessment: Qualitative Assessment of Radiated Sound Levels and Acoustic Propagation Conditions. Document 01366, Version 2.0. Technical report by JASCO Applied Sciences for Stantec Consulting Ltd.

McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M.-N., Penrose, J.D., Prince, R.I.T., Adhitya, A. Murdoch, J., and McCabe, K. 2000a. Marine Seismic Surveys: Analysis of Airgun Signals and Effects of Air Gun Exposure on Humpback Whales, Sea Turtles, Fishes and Squid. Report prepared by the Centre for Marine Science and Technology (Report R99-15), Curtin University, Perth, WA, for Australian Petroleum Production Association, Sydney, NSW.

McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M.-N., Penrose, J.D., Prince, R.I.T., Adhitya, A., Murdoch, J., and McCabe, K. 2000b. Marine seismic surveys-A study of environmental implications. Australian Petroleum Producers and Exploration Association. APPEA J., 40: 692-706.

McCauley, R.D., M.-N. Jenner, C. Jenner, K.A. McCabe, and J. Murdoch. 1998. The response of humpback whales (*Megaptera novaeangliae*) to offshore seismic survey noise: preliminary results of observations about a working seismic vessel and experimental exposures. APPEA J., 38: 692-707.

Miller, G.W., R.E. Elliott, W.R. Koski, V.D. Moulton, and W.J. Richardson. 1999. Whales. p. 5-1 to 5-109 In: W.J. Richardson (ed.), Marine mammal and acoustical monitoring of Western Geophysical's open-water seismic program in the Alaskan Beaufort Sea, 1998. LGL Rep. TA2230-3. Rep. from LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for Western Geophysical, Houston, TX, and Nat. Mar. Fish. Serv., Anchorage, AK, and Silver Spring, MD. 390 pp.

Miller, G.W., Moulton, V.D., Davis, R.A., Holst, M., Millman, P., MacGillivray, A., and Hannay, D. 2005. Monitoring seismic effects on marine mammals-Southeastern Beaufort Sea, 2001-2002. Pp. 511-542. In: S.L. Armsworthy, P. Cranford and K. Lee (eds.). Offshore Oil and Gas Environmental Effects Monitoring: Approaches and Technologies. Battelle Press, Columbus, OH. 631 pp.

Moein, S.E., J.A. Musick, J.A. Keinath, D.E. Barnard, M. Lenhardt, and R. George. 1994. Evaluation of seismic sources for repelling sea turtles from hopper dredges. Rep. from Virginia Inst. Mar. Sci. (Gloucester Point), VA, for U.S. Army Corps of Engineers. 33 pp.

Moulton, V.D., and Holst, M. 2010. Effects of Seismic Survey Sound on Cetaceans in the Northwest Atlantic. ESRF Rep.182.

Moulton, V.D. and J.W. Lawson. 2002. Seals, 2001. pp. 3-1 to 3-48. In: W.J. Richardson (ed.), Marine mammal and acoustical monitoring of WesternGeco's open water seismic program in the Alaskan Beaufort Sea, 2001. Rep. from LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for WesternGeco, Houston, TX, and Nat. Mar. Fish. Serv., Anchorage, AK, and Silver Spring, MD. LGL Rep. TA2564-4.

NMFS (National Marine Fisheries Service). 2016. Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-55, 178 p.

NOAA (National Oceanic and Atmospheric Administration). No Date. Marine Mammals: Interim Sound Threshold Guidance (webpage). National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/threshold_guidance.html.

NOAA (National Oceanic and Atmospheric Administration). 2015. Draft Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Threshold Levels for Onset of Permanent and Temporary Threshold Shifts. In: National Oceanic and Atmospheric Administration and U.S. Department of Commerce. Revised version for Second Public Comment Period. 180 pp. Available at: http://www.nmfs.noaa.gov/pr/acoustics/draft%20acoustic%20guidance%20July%202015.pdf.

NOAA (National Oceanic and Atmospheric Administration). 2016. Document Containing Proposed Changes to: National Oceanic and Atmospheric Administration Draft Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing- Underwater Acoustic Threshold Levels for Onset of Permanent and Temporary Threshold Shifts. In: National Oceanic and Atmospheric Administration and U.S. Department of Commerce. 24 pp. Available at: http://www.nmfs.noaa.gov/pr/acoustics/draft_guidance_march_2016_.pdf.

Nowacek, D.P., Thorne, L.H., Johnston, D.W., and Tyack, P.L. 2007. Responses of cetaceans to anthropogenic noise. Mammal Rev., 37: 81-115.

NRC (National Research Council). 2005. Marine mammals populations and ocean noise: Determining when noise causes biologically significant effects. The National Academies Press, Washington, DC.

Office of Naval Research. 2002. Ocean Life: Green Sea Turtle-Current Research, Science and Technology Focus, Oceanography. Available from: http://www.onr.navy.mil/focus/ocean/life/turtle4.htm.

OSPAR Commission. 2009. Overview of the Impacts of Anthropogenic Underwater Sound in the Marine Environment. Publication number 441/2009. 134pp. Available from: http://qsr2010.ospar.org/media/assessments/p00441_Noise_background_document.pdf.

Patenaude, N.J., Richardson, W.J., Smultea, M.A., Koski, W.R., Miller, G.W., Wuersig, B. and Greene, C.R. Jr. 2002. Aircraft sound and disturbance to bowhead and beluga whales during spring migration in the Alaskan Beaufort Sea. Marine Mammal Science, 18, 309-355.

Popper, A.N., and Hawkins, A. (Editors). 2012. The Effects of Noise on Aquatic Life. Series: Advances in Experimental Medicine and Biology, 730. Springer. doi: 10.1007/978-1-4419-7311-5

Popper, A.N., Hawkins, A.D., Fay, R.R., Mann, D.A., Bartol, S., Carlson, T.J., Coombs, S., Ellison, W.T., Genrey, R.L., Halvorsen, M.B., Lokkeborg, S., Rogers, P.H., Southall, B.L., Zeddies, D.G., and Tavolga, W.N. 2014. Sound Exposure Guidelines for Fishes and Sea Turtles. A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI.

Richardson, W.J., Greene, Jr., C.R., Malme, C.I., and Thomson, D.H. 1995. Marine Mammals and Noise. Academic Press, San Diego, CA. 576 pp.

Richardson, W.J., M. Holst, W.R. Koski and M. Cummings. 2009. Responses of cetaceans to large-source seismic surveys by Lamont-Doherty Earth Observatory. p. 213 In: Abstr. 18th Bienn. Conf. Biol. Mar. Mamm., Québec, Oct. 2009. 306 pp.

Richardson, W.J., Würsig, B., and Greene, C.R. 1986. Reactions of bowhead whales, *Balaena mysticetus*, to seismic exploration in the Canadian Beaufort Sea. J. Acoust. Soc. Am., 79(4): 1117-1128.

Risch, D., Corkeron, P.J., Ellison, W.T., and van Parijs, S.M. 2012. Changes in humpback whale song occurrence in response to an acoustic source 200 km away. PLoS ONE, 7(1): e29741, 29741-29746. Available from: http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0029741.

Rolland, R.M., Parks, S.E., Hunt, K.E., Castellote, M., Corkeron, P.J., Nowacek, D.P., Wasser, S.K., and Kraus, S.D. 2012. Evidence that ship noise increases stress in right whales. Proc. R. Soc. B., doi:10.1098/rspb.2011.2429.

Shannon, G., M.F. McKenna, L.M. Angeloni, K.R. Crooks, K.M. Fristrup, E. Brown, K.A. Warner, M.D. Nelson, C. White and J. Briggs. 2015. A synthesis of two decades of research documenting the effects of noise on wildlife. Biological Reviews, 000-000.

Slotte, A., Hansen, K., Dalen, J., and Ona, E. 2004. Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast. Fish. Res., 67: 143-150.

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene, Jr., C.R., Lastal, D., Ketten, D.R., Miller, J.H., and Nachitgall, P.E. 2007. Special Issue: Marine mammal noise exposure criteria: Initial scientific recommendations. Aquat. Mammals, 33(4): 411-521.

Stantec Consulting Ltd. 2012. Strategic Environmental Assessment for Offshore Petroleum Activities. Eastern Scotian Slope (Phase 1B). v +194 pp.

Stantec Consulting Ltd. (Stantec). 2014a. Shelburne Basin Venture Exploration Drilling Project Environmental Impact Statement. Prepared for Shell Canada Limited.

Stantec Consulting Ltd. 2014b. Strategic Environmental Assessment for Offshore Petroleum Exploration Activities. Western Scotian Slope (Phase 3B). Prepared for the Canada-Nova Scotia Offshore Petroleum Board, Halifax, NS. iv + 282 pp.

Stantec Consulting Ltd. 2016. Scotian Basin Exploration Drilling Project – Environmental Impact Statement. Prepared for BP Canada Energy Group ULC.

Stone, C.J., and Tasker, M.L. 2006. The effects of seismic airguns on cetaceans in UK waters. J. Cetac. Res. Manage., 8(3): 255-263.

Sundermeyer, J.K., Lucke, K., Dahne, M., Gallus, A., Krugel, K., and Siebert, U. 2012. Effects of underwater explosions on presence and habitat use of harbor porpoises in the German Baltic Sea. Pp. 289-291. In: A.N. Popper and A. Hawkins (eds.). Effects of Noise on Aquatic Life. Vol. 730.

Templeman, N. 2007. Placentia Bay-Grand Banks Large Ocean Management Area Ecologically and Biologically Significant Areas. DFO. Can. Sci. Advis. Sec. Res. Doc., 2007/052.

The Telegram. 2014. Bowhead Whale Sighted in Trinity Bay. Available from: http://www.thetelegram.com/news/regional/2014/8/11/bowhead-whale-sighted-in-trinity-bay-3830982.html. Accessed: April 2017.

Thompson, P.M., Brookes, K.L., Graham, I.M., Barton, T.R., Needham, K., Bradbury, G. and Merchant, N.D.2013. Short-term disturbance by a commercial two-dimensional seismic survey does not lead to long-term displacement of harbour porpoises. Proceedings of the Royal Society of London B: Biological Sciences, 280(1771):20132001.

Tougaard, J., Kyhn, L.A., Amundin, M., Wennerberg, D., and Bordin, C. 2012. Behavioral reactions of harbor porpoises to pile-driving noise. Pp. 277-280. In: A.N. Popper and A. Hawkins (eds.), The Effects of Noise on Aquatic Life. Vol. 730.

Tougaard, J., Wright, A.J., and Madsen, P.T. 2015. Cetacean noise criteria revisited in the light of proposed exposure limits for harbour porpoise. Mar. Poll. Bull., 90: 196-208. doi:10.1016/j.marpolbul.2014.10.051.

Tyack, P.L. 2008. Implications for marine mammals of large-scale changes in the marine acoustic environment. Journal of Mammalogy, 89(3):549-558.

van der Hoop, J.M., Vanderlaan, A.S.M., and Taggart, C.T. 2012. Absolute probability estimates of lethal vessel strikes to North Atlantic right whales in Roseway Basin, Scotian Shelf. Ecolog. Applic., 22(7): 2021-2033.

van Opzeeland, I., and Slabbekoorn, H. 2012. Importance of underwater sounds for migration of fish and aquatic mammals. Pp. 357-359. In: A.N. Popper and A Hawkins (eds.). The Effects of Noise on Aquatic Life. Vol. 730.

Vanderlaan, A.S.M., and Taggart, C.T. 2007. Vessel collisions with whales: The probability of lethal injury based on vessel speed. Mar. Mammal Sci., 23: 144-156.

Vanderlaan, A.S.M., Taggart, C.T., Serdynska, A.R., Kenney, R.D., and Brown, M.W. 2008. Reducing the risk of lethal encounters: Vessels and right whales in the Bay of Fundy and on the Scotian Shelf. Endang. Species Res., 4: 282-297.

Vanderlaan, A.S.M., Corbett, J.J., Green, S.L., Callahan, J.A., Wang, C. Kenney, R.D., Taggart, C.T., and Firestone, J. 2009. Probability and mitigation of vessel encounters with North Atlantic right whales. Endang. Species Res., 6: 273-285.

Veirs, S., Veirs, V., and Wood, J.D. 2016. Ship noise extends to frequencies used for echolocation by endangered killer whales. Peer J., 4:e1657.

Weir, C.R. 2007. Observations of marine turtles in relation to seismic airgun sound off Angola. Mar. Turtle Newsl., 116:17-20.

Weir, C.R. 2008. Overt responses of humpback whales (*Megaptera novaeangliae*), sperm whales (*Physeter macrocephalus*), and Atlantic spotted dolphins (*Stenella frontalis*) to seismic exploration off Angola. Aquat. Mamm., 34(1): 71-83.

Williams, R., Clark, C.W., Ponirakis, D., and Ashe, E. 2013. Acoustic quality of critical habitats for three threatened whale populations. Anim. Conserv., 17(2): 174-185.

Wright, A.J. 2015. Sound Science: Maintaining Numerical and Statistical Standards in the Pursuit of Noise Exposure Criteria for Marine Mammals. Front. Mar. Sci., 2: 99.

Wright, A.J., and Kuczaj, S. 2007. Noise-related stress and marine mammals: An introduction. Intern. J. Comp. Psychol., 20(2-3): iii-viii.

Wright, A.J., Aguilar Soto, N., Baldwin, A.L., Bateson, M., Beale, C.M., Clark, C., Deak, T., Edwards, E.F., Fernández, A., and Godinho, A. 2007a. Do marine mammals experience stress related to anthropogenic noise? Intern. J. Comp. Psychol., 20(2-3): 274-316.

Wright, A.J., Aguilar Soto, N., Baldwin, A.L., Bateson, M., Beale, C.M., Clark, C., Deak, T., Edwards, E.F., Fernández, A., and Godinho, A. 2007b. Anthropogenic noise as a stressor in animals: A multidisciplinary perspective. Intern. J. Comp. Psychol., 20(2-3): 250-273.

Wright, A.J., Deak, T., and Parsons, E.C.M. 2009. Concerns related to chronic stress in marine mammals. IWC Working Pap. SC/61/E16: 7 pp.

Wright, A.J., Deak, T., and Parsons, E.C.M. 2011. Size matters: management of stress responses and chronic stress in beaked whales and other marine mammals may require larger exclusion zones. Mar. Pollut. Bull., 63(1-4): 5-9.

Würsig, B., Lynn, S.K., Jefferson, T.A., and Mullin, K.D. 1998. Behaviour of cetaceans in the northern Gulf of Mexico relative to survey ships and aircraft. Aquat. Mamm., 24(1):41-50.

Wysocki, L.E., Dittami, J.P., and Ladich, F. 2006. Ship noise and cortisol secretion in European freshwater fishes. Biol.Conserv., 128: 501-508.

Zykov, M.M. 2016. Modelling Underwater Sound Associated with Scotian Basin Exploration Drilling Project: Acoustic Modelling Report. JASCO Document 01112, Version 2.0. Technical report by JASCO Applied Sciences for Stantec Consulting Ltd.

11.0 SPECIAL AREAS: ENVIRONMENTAL EFFECTS ASSESSMENT

Certain marine and coastal areas in Newfoundland and Labrador have been designated as protected under provincial, federal, or other legislation and processes, or have otherwise been identified as being special or sensitive due to their ecological, historical, and/or socio-cultural characteristics and importance. Special areas have been selected as a VC for this EIS due to their importance for environmental, economic, and/or socio-cultural reasons, and associated regulatory and Indigenous and stakeholder interest in these areas and their intrinsic ecological or anthropogenic value.

Most of the special areas identified in Eastern Newfoundland are located on land or in coastal and nearshore areas, outside of the Project Area. Special areas in offshore locations off Eastern Newfoundland include various Fishing Closure Areas (FCAs) that protect sensitive benthic habitats from bottom fishing activities, but with no associated prohibitions of petroleum exploration and development activities within their boundaries. Other identified special areas include Vulnerable Marine Ecosystem (VME) areas identified by the Northwest Atlantic Fisheries Organization (NAFO) for their high ecological or biological activity, portions of which may eventually be designated as FCAs. In addition, Ecologically and Biologically Significant Areas (EBSAs) are ecologically important or sensitive areas identified through the Canadian *Oceans Act.* These and other types of special areas, were identified, mapped, and described in detail in Section 6.4 of this EIS, and in other sections that describe the existing biophysical and socioeconomic environments (Chapters 6 and 7).

11.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

This section defines the Study Areas (spatial and temporal boundaries) for the environmental effects assessment for special areas. Three spatial Study Areas have been identified and considered in conducting the environmental effects assessment for this VC (Figure 11-1), as follows:

Project Area: This represents the overall geographic areas offshore Eastern Newfoundland within which planned Project-related exploration activities will take place. While the Project Area is defined as overall polygons that encompass such activities over the course of each Project the various components and activities associated with the drilling of each individual well and other planned components will occupy fairly small areas within this overall area, as described in Chapter 2. The assessment also considers related supply and support vessel and aircraft traffic to and from this offshore Project Area.

Local Study Area (LSA): This encompasses the overall geographic area over which planned Project-related environmental interactions (including emissions and other disturbances) will occur. The LSA therefore represents the anticipated environmental zone of influence of the Project's planned components and activities. As described for the preceding biological VCs, the environmental zones of influence for planned Project components and activities are therefore expected to occur primarily within the overall Project Area polygons defined above, with the exception of Project activities that could conceivably occur on the edges of the Project Area boundary. For this VC, the LSA is therefore also (conservatively) defined as the offshore Project Area and an appropriately 10 km area around it as well as the potential vessel and aircraft traffic routes to the ELs.

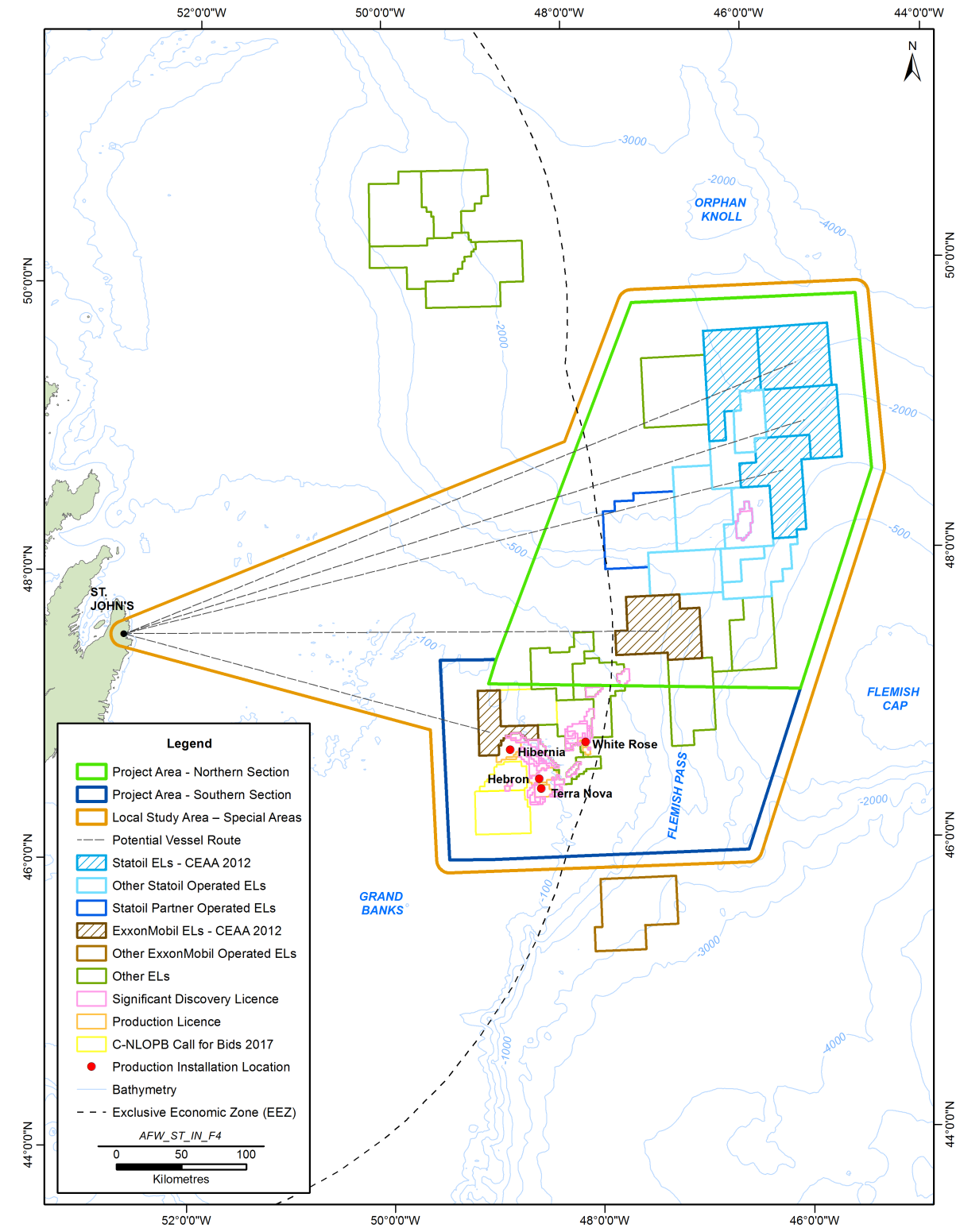


Figure 11-1 Environmental Assessment Study Areas: Special Areas

Regional Study Area (RSA): In addition to Project- and disturbance-related factors, from an ecological perspective the environmental effects assessment also recognizes and considers the characteristics and distributions of the individual VCs under consideration, including the larger regional areas and geographic and environmental contexts within which they occur. This includes consideration of the various ecological boundaries for marine biota which are known or likely to use the LSA and which are relevant to the identification and designation of the special areas under consideration, as well as applicable human uses. Key aspects of these environmental components and their distributions as they relate to the Project Area / LSA are as presented in Chapter 6 and are generally considered in assessing both potential Project-specific (this Chapter) and cumulative (Chapter 14) effects upon this VC. The overall RSA for the environmental effects assessment is therefore as defined and illustrated earlier in Section 4.3. The environmental effects assessment therefore generally encompasses the marine waters in offshore eastern Newfoundland and the various special areas located within this overall geographic region.

The temporal boundaries for the effects assessment encompass the likely timing and duration of Project-related (in-field) activities in the Project Area, as well as the likely duration of resulting environmental effects. In conducting the assessment, special consideration is also given to important or sensitive periods for the environmental features and processes and associated human uses of the special areas that comprise this VC.

It is within the above described spatial and temporal boundaries that the Project's potential environmental effects on this VC and their significance are assessed and evaluated.

Significant environmental effects for the Special Areas VC are defined as those that would cause:

- An adverse change in one or more of the important and defining ecological and sociocultural characteristics of such an area, resulting in a decrease in its overall integrity, value or use

Many of the special areas discussed and assessed here have been identified and/or designated based on their biophysical characteristics and processes or human uses and values. Thus, these special areas are inherently discussed and considered (either directly or indirectly) in various other effects assessment chapters, including Chapter 8: Marine Fish and Fish Habitat, Chapter 9: Marine and Migratory Birds, and Chapter 10: Marine Mammals and Sea Turtles. Special areas and their use are also considered in assessing the potential effects of the Project on cultural, tourism or recreational resources and activities in Chapter 13: Commercial Fisheries and Other Ocean Users.

This Chapter provides an assessment and evaluation of the potential effects of the Project on these identified special areas as a whole, including the overall biophysical and socioeconomic features, values, and uses that form a key part of the rationale for their identification and designation. It therefore considers the potential for Project-related environmental changes to affect the overall and underlying characteristics, integrity, and value of these areas.

11.2 Potential Environmental Changes, Effects, and Associated Parameters

Changes to the environment as a result of offshore oil and gas activities and their potential effects on identified special areas may be both direct and indirect in nature and cause. The conduct of oil and gas exploration activities directly within or near such areas may, for example, have adverse implications for these locations and their important and defining ecological and sociocultural characteristics. These interactions may occur through the possible presence of oil and gas exploration equipment, personnel, and activities within the special area in question, as well as the associated emissions and discharges from Project activities. Biophysical effects resulting from oil and gas or other human activities within the environmental assessment Study Areas may also spread to adjacent special areas by affecting the marine fish, birds, mammals, or other environmental components that move to and through these areas. Any resulting decrease in the real or perceived integrity of these areas in the short-or long-term may also affect their ecological and/or societal importance, use and value.

The EIS Guidelines issued by the Canadian Environmental Assessment Agency in December 2016 identify and specify certain issues and potential effects on this VC, which require consideration in the EIS, including:

> *The EIS will describe special areas (e.g. species at risk critical habitat that has been designated and that has been proposed or that may be under consideration, Important Bird Areas, Migratory Bird Sanctuaries, ecological reserves at the project site and within areas that could be affected by routine project operations or accidents and malfunctions, such as:*
>
> - Ecologically and Biologically Significant Areas (e.g. The Southeast Shoal and Tail of the Banks, The Northeast Shelf and Slope, Lily Canyon-Carson Canyon, and The Virgin Rocks)
> - Fishery Closure Areas (e.g. Northwest Atlantic Fisheries Organization Coral Closures, Orphan Knoll Seamount)
> - Preliminary Representative Marine Areas (South Grand Bank Area)
>
> *The EIS will describe the distances between the edge of the project area (i.e. drill sites and marine transportation routes) and special areas. It shall state the rationale for designating specific areas as "special" (i.e. the defining environmental features of the special area).*

The EIS is also to describe "*effects on special areas, including, but not limited to: use of dispersants, and change to habitat quality (e.g. noise, light, water, sediment quality)"* (Section 6.3.8.3).

This chapter assesses and evaluates the potential effects of planned Project components and activities on this VC, whereas those that may result from possible accidental events (and associated spill response measures) are described in Chapter 15: Accidental Events.

The environmental effects assessment for this VC considers and focuses upon the issues and questions identified through these various issues scoping exercises, including an initial identification of the key potential environmental changes and possible environmental effects on the VC that may result from these. These are summarized in Table 11.1, along with the key parameters through which these Project-related changes and effects may be reflected.

Table 11.1 Potential Project-Related Environmental Changes and Potential Effects: Special Areas

Potential Environmental Effects	Contributing Potential Environmental Changes Resulting from the Project	Associated Parameter(s) (Where relevant to the underlying rationale for an area's identification as a Special Area)
Change in Environmental Features and/or Processes	Special areas have been identified under provincial, federal, and/or other legislation and processes as a result of their ecological, biological, historical, and/or socio-cultural characteristics and importance. Any direct or indirect changes to the existing natural or human environments in the area as a result of Project-related interactions may affect the key environmental characteristics and processes that define and distinguish these areas, and thus, affect their overall and underlying characteristics, integrity, and value.	Number, diversity, and health of marine biota using the area Marine habitat availability and quality within the area Overall functioning, health, and integrity of integral and defining ecological processes and features Nature, intensity, quality, and value of existing and defining human uses and activities within the special area Type and degree of societal value placed on the special area and its defining characteristics
Change in Human Use and/or Societal Value		

An overview of the potential for interactions between each of the Project's planned components and activities and special areas, and specifically the potential for these to result in environmental changes and eventual, detectable effects to the various aspects of this VC, is presented in Table 11.2.

Table 11.2 Potential Project-VC Interactions: Special Areas

Project Component / Activity	Potential Environmental Effects	
	Change in Environmental Features and/or Processes	Change in Human Use and/or Societal Value
Presence and Operation of Drilling Installation (including lights, noise, air emissions, anchoring)	•	•
Drilling and Associated Marine Discharges (including fluids and cuttings)	•	•
Formation Testing with Flaring	•	
Wellhead Decommissioning	•	
Geophysical, Geohazard, Wellsite and Seabed Surveys and VSP	•	•
Geological, Geotechnical and Environmental Surveys	•	•
Supply and Servicing	•	•

11.3 Environmental Effects Assessment and Mitigation

This Special Areas VC focuses on marine and coastal areas in and off Eastern Newfoundland and Labrador that have been identified under various legislation or processes, as discussed in Section 6.4.1. The effects of Project components and activities on other areas that have been identified as being important or sensitive from a biological perspective (e.g., fish spawning areas, bird colonies,) have been considered and assessed within other relevant Chapters of this EIS.

11.3.1 Approach and Methods

The effects assessment for this VC involved identifying and mapping the various types of special areas, describing the rationale for their identification (and possible protection, where applicable) and obtaining the most comprehensive and current data including their current boundaries and characteristics including known upcoming or recent changes to the status of these areas or their defined boundaries. Geo-spatial data related to each of the types of marine and coastal special areas were incorporated into a geodatabase in a GIS to measure and illustrate their location and extents in relation to the Project Area (marine areas and associated potential vessel and aircraft traffic routes). The effects also considered the nature and anticipated geographic extent of Project-related changes to the environment (as defined by the LSA), as described in the other relevant VC Chapters and elsewhere in the EIS.

11.3.2 Summary of Key Mitigation

The environmental mitigation initiatives identified throughout this EIS are indirectly applicable to special areas, and their implementation will serve to help avoid or reduce associated effects on special areas.

11.3.3 Environmental Effects Assessment (All Project Components and Activities)

Some of the key components and activities and potential Project – environment interactions, that are relevant to the environmental effects analysis for special areas, include:

- The presence and movement of drilling installation(s) and supporting supply vessels / aircraft and equipment
- Drilling activities and the associated discharges and emissions
- Formation flow testing with flaring
- Vertical seismic profiling and wellsite surveys
- Other survey activities including geophysical / geohazard and seabed surveys, geological surveys, geotechnical surveys, and environmental surveys
- Management of solid and liquid wastes
- Well abandonment activities

Based on these various components and activities, some of the key potential environmental issues and potential environmental changes that may be associated with the Project are:

- The general presence of Project components (drilling installations, vessels, other equipment) and undertaking of exploration activities in the offshore environment resulting in noise and lighting emissions and associated environmental changes
- Possible effects on water quality and on the seabed (benthic) environment due to physical disturbance of the substrate (and associated sedimentation), the discharge and deposition of drill cuttings and fluids, and other drilling installation or vessel discharges
- Potential changes in the presence, abundance, diversity, and health of marine biota in the area due to potential behavioral effects or potential injury or mortality. This may include possible temporary avoidance of areas by marine fish, birds, mammals, and sea turtles due to underwater noise or other disturbances, which may alter their presence and abundance as well as disturbing movements / migration, feeding or other activities. There may also be possible attraction of marine fish, birds, mammals, and sea turtles to drilling installations and vessels, with increased potential for injury, mortality, or health effects

These or other environmental changes and potential biophysical effects resulting from planned Project components and activities may, in turn, have adverse effects on special areas by affecting their overall ecological characteristics, integrity, use and value. Project activities may also result in direct interference with, and possible reduced human access to, important and valued marine areas during Project activities in certain locations, with possible decreases in these activities and their success, efficiency, value, or enjoyment.

A description of each of the marine and coastal areas within and adjacent to the Project Area / LSA and RSA that have been designated as protected or identified as otherwise special or sensitive was provided in Section 6.4. The following sections provide an assessment and evaluation of the potential effects of the Project on these special areas. The previously identified mitigation measures are considered integrally within the environmental effects analysis, as relevant.

Table 11.3 provides a summary of the minimum distance between the edge of the Project Area (Northern and Southern Sections) and identified potential vessel and aircraft traffic routes and the various relevant special areas identified and mapped in Section 6.4. For the purposes of these "calculations:" the focus is on the Project Area itself, as the primary issue of interest is whether and how planned Project activities themselves will or may interact and overlap directly with an identified special area in this region. As indicated, planned Project exploration activities will occur in an offshore marine area that is several hundred kilometres from the shoreline of Eastern Newfoundland. These planned Project components and activities will therefore not occur within, or otherwise interact directly with, the existing provincially-defined special areas (such as provincial ecological reserves, parks and protected areas and historic sites), each of which are over 300 km away from the closest part of the Project Area / LSA boundary. Likewise, the Project will not have a direct interaction with most federally designated areas (i.e., marine protected areas, fisheries closures within Canada's EEZ, migratory bird sanctuaries, national parks, and historic sites). International designations such as Important Bird Areas will also not be directly affected by the Project. These areas, most regularly used by humans for recreation, subsistence, or tourism activities, are located in coastal and onshore areas which are at least 230 km from the Project Area / LSA boundary.

Table 11.3 Special Areas: Summary of Minimum Distances from the Project Area and Closest Vessel and Aircraft Traffic Routes

Special Area	Minimum Distance (in km)			
	Project Area		Traffic Route	
	Northern	Southern	Northern	Southern
Ecologically and Biologically Significant Areas (EBSAs)				
Northeast Shelf and Slope	Overlaps	Overlaps	Overlaps	Overlaps
Virgin Rocks	90	42	115	30
Orphan Spur	124	210	88	188
Lilly Canyon-Carson Canyon	180	47	293	152
Southeast Shoal and Tail of the Banks	247	111	310	209
Eastern Avalon Coast	257	219	5	Overlaps
Notre Dame Channel	341	340	211	235
Smith Sound	356	315	93	93
Fogo Shelf	362	340	185	191
Placentia Bay Extension	366	328	85	85
Labrador Slope	418	588	473	547
Southwest Shelf Edge and Slope	422	312	294	294
Grey Islands	464	447	282	282
Labrador Marginal Trough	515	650	539	569
St. Pierre Bank	574	535	311	311
Laurentian Channel and Slope	609	550	370	370
Gilbert Bay	648	715	580	581
Hamilton Inlet	687	794	674	680
Marine Protected Areas (MPAs)				
Eastport – Duck Islands	387	348	149	149
Eastport – Round Island	391	351	140	140
Gilbert Bay	676	744	607	607
Federal Fisheries Closure Areas (FCAs)				
Funk Island Deep Box	339	338	209	234
Eastport Peninsula Lobster Management Area	373	334	136	136
Hawke Box	510	631	550	550
Preliminary Representative Marine Areas (RMAs)				
Virgin Rocks	97	52	102	17
South Grand Bank Area	242	104	327	205
Northwestern Conception Bay	293	252	39	40
Southern Coast of Burin Peninsula and Southeastern Placentia Bay	478	442	205	205

Table 11.3 Special Areas: Summary of Minimum Distances from the Project Area and Closest Vessel and Aircraft Traffic Routes

Special Area	Minimum Distance (in km)			
	Project Area		Traffic Route	
	Northern	Southern	Northern	Southern
Migratory Bird Sanctuaries (MBSs)				
Terra Nova	400	360	149	149
Île aux Canes	586	580	407	407
Shepherd Island	590	585	413	413
National Parks and Historic Site				
Cape Spear National Historic Site	277	238	6	3
Signal Hill National Historic Site	282	243	1	1
Ryan Premises National Historic Site	344	305	122	124
Castle Hill National Historic Site	377	340	101	101
Terra Nova National Park	380	343	137	135
Provincial Ecological Reserves				
Witless Bay Seabird Ecological Reserve	288	251	39	38
Baccalieu Island Seabird Ecological Reserve	304	263	61	63
Mistaken Point Fossil Ecological Reserve	327	287	109	109
Funk Island Seabird Ecological Reserve	388	380	237	246
Cape St. Mary's Seabird Ecological Reserve	398	361	141	141
Lawn Bay Seabird Ecological Reserve (Middle Lawn, Swale, and Colombier Islands)	504	467	232	231
Fortune Head Fossil Ecological Reserve	521	485	244	244
Provincial Parks and Protected Areas				
Marine Drive Provincial Park Reserve	294	254	21	21
Chance Cove Provincial Park	311	273	91	91
Dungeon Provincial Park	342	304	123	125
Bellevue Beach Provincial Park Reserve	363	324	79	79
Gooseberry Cove Provincial Park	387	351	118	118
Windmill Bight Provincial Park Reserve	396	368	199	199
Deadman's Bay Provincial Park	408	380	209	209
Frenchman's Cove Provincial Park	486	449	207	207
Dildo Run Provincial Park	486	456	264	264
Provincial Historic Sites				
Cape Bonavista Lighthouse Historic Site	338	306	127	129
Heart's Content Cable Station Historic Site	344	298	61	61
Vulnerable Marine Ecosystems (VMEs)				
Northeast Shelf and Slope (within Canadian EEZ)	Overlaps	63	Overlaps	22

Table 11.3 Special Areas: Summary of Minimum Distances from the Project Area and Closest Vessel and Aircraft Traffic Routes

Special Area	Minimum Distance (in km)			
	Project Area		Traffic Route	
	Northern	Southern	Northern	Southern
Sackville Spur	Overlaps	130	Overlaps	94
Northern Flemish Cap	Overlaps	126	13	145
Southern Flemish Pass to Eastern Canyons	17	Overlaps	159	61
Beothuk Knoll	68	Overlaps	219	124
Deep Water Coral Area	124	73	273	222
Flemish Cap East	159	174	238	284
South East Shoal and Adjacent Shelf Edge / Canyons	279	141	340	242
Division 3O Coral Closure	459	342	328	328
NAFO Fisheries Closure Areas (FCAs)				
High Sponge and Coral Concentration Areas				
Northwest Flemish Cap (10)	Overlaps	76	46	71
Northwest Flemish Cap (11)	Overlaps	35	112	58
Northwest Flemish Cap (12)	Overlaps	122	35	124
Flemish Pass / Eastern Canyon (2)	Overlaps	Overlaps	139	43
Sackville Spur (6)	Overlaps	132	Overlaps	98
Northern Flemish Cap (7)	Overlaps	146	46	170
Northern Flemish Cap (8)	Overlaps	173	38	185
Northern Flemish Cap (9)	Overlaps	154	17	159
Northeast Flemish Cap (5)	44	169	106	238
Beothuk Knoll (13)	81	13	243	159
Eastern Flemish Cap (14)	93	152	161	240
Beothuk Knoll (3)	122	9	279	185
Eastern Flemish Cap (4)	139	140	233	257
Tail of the Bank (1)	316	182	417	280
3O Coral Area Closure				
Seamount Closures				
Orphan Knoll Seamount	21	318	74	276
Newfoundland Seamounts	342	221	492	367
Fogo Seamounts (1)	592	460	560	541
Fogo Seamounts (2)	709	570	715	673
Important Bird Areas (IBAs)				
Quidi Vidi Lake	281	242	1	1
Witless Bay Islands	284	247	31	31

Table 11.3 Special Areas: Summary of Minimum Distances from the Project Area and Closest Vessel and Aircraft Traffic Routes

Special Area	Minimum Distance (in km)			
	Project Area		Traffic Route	
	Northern	Southern	Northern	Southern
Cape St. Francis	288	248	22	23
Baccalieu Island	301	259	56	58
Grates Point	307	266	61	61
Mistaken Point	318	278	106	106
The Cape Pine and St. Shotts Barren	350	310	120	120
Placentia Bay	368	330	91	91
Terra Nova National Park	381	341	129	129
Funk Island	382	373	231	240
Cape Freels Coastline and Cabot Island	383	352	173	173
Cape St. Mary's	388	351	130	130
Wadham Islands and adjacent Marine Area	419	397	231	231
Corbin Island	472	436	199	199
Middle Lawn Island	504	468	232	232
Green Island	540	503	266	266
UNESCO World Heritage Sites (WHSs)				
Mistaken Point	325	285	111	111
Red Bay Basque Whaling Station	674	697	535	535
L'Anse aux Meadows	611	636	488	482
Gros Morne	675	636	410	410

The Project Area - Northern Section overlaps with portions of one EBSA, three VMEs and eight NAFO FCAs, none of which have associated prohibitions of offshore exploration activities. In addition, a number of special areas (EBSAs, VMEs, NAFO FCAs and PRMAs) are located in the general vicinity, some within approximately 17 km of the Project Area / LSA boundary. These areas are not regularly used by humans but are valued for their biological and ecological characteristics and their importance for human activities such as the fishing industry.

The Project Area - Southern Section overlaps with the same EBSA, two VMEs and one NAFO FCA, which have no prohibitions of oil and gas exploration activities. Some of the VME areas and FCAs overlapping with the Project Area. Similar to the Northern Section, there are also various other VMEs and FCAs, and to a lesser extent EBSAs, located in the general vicinity of the Project Area - Southern Section and one is within 10 km.

Potential vessel and aircraft traffic routes to the Project Area - Northern Section cross an EBSA, two VMEs and an FCA, while those to the Southern Section cross two EBSAs one of which is also crossed by routes to the Northern Section.

Figure 11-2 illustrates the various special areas that overlap with the Project Area and/or with one or more of the potential vessel and aircraft traffic routes.

The overall and defining environmental features and characteristics of the Northeast Shelf and Slope EBSA and the five VMEs – Sackville Spur, Northern Flemish Cap, Northeast Shelf and Slope (within Canadian EEZ), Beothuk Knoll and Southern Flemish Pass to Eastern Canyons – that overlap with the Project Area will not be adversely affected by the Project. The small environmental footprints and short-term nature of the planned exploration activities will mean that activity will occur at any one location for a short period of time. Moreover, the implementation of the various mitigation measures outlined throughout this EIS will serve to help address direct or indirect potential environmental effects that may have implications for overlapping or adjacent special areas.

The Project Area also overlaps with portions of eight FCAs, including the Sackville Spur (6), Northern Flemish Cap (7, 8, and 9), Northwest Flemish Cap (10, 11, and 12) and Flemish Pass / Eastern Canyon (2). These areas have been designated as such to protect important and sensitive benthic components and habitats from further disturbance due to certain types of bottom-dragging fishing activity, but their designations do not prohibit petroleum exploration activities in these areas. As discussed in Chapter 2, the planned drilling and associated activities will be characterized by a relatively small and temporary footprint, with mitigation measures proposed to reduce potential effects the marine benthic environment. The Operator proposes to complete a pre-drilling coral identification/mapping program and risk assessment based on the NOROG guideline approach, as it is considered an industry best practice approach in areas with potentially high concentrations of corals (i.e. the Vulnerable Marine Ecosystem (VME) or Fisheries Closure Areas (FCAs) within the ELs) and has been demonstrated to be effective in other areas with cold water corals.

Many of the other offshore survey activities that are planned to be undertaken as part of this Project will not result in direct contact with the seabed, and will therefore not physically disturb benthic animals or their habitats. Seabed geological, geochemical, or geotechnical sampling activities will likewise have a short duration, and those that involve contact with the seabed will have a small footprint.

Notwithstanding the overall size and extent of the Project Area itself, exploration drilling activity carried out as part of this Project will occur within the boundaries of an EL, as defined in Section 2.3. Table 11.4 provides a summary of the identified special areas that overlap with any portion of the various ELs that comprise the Project.

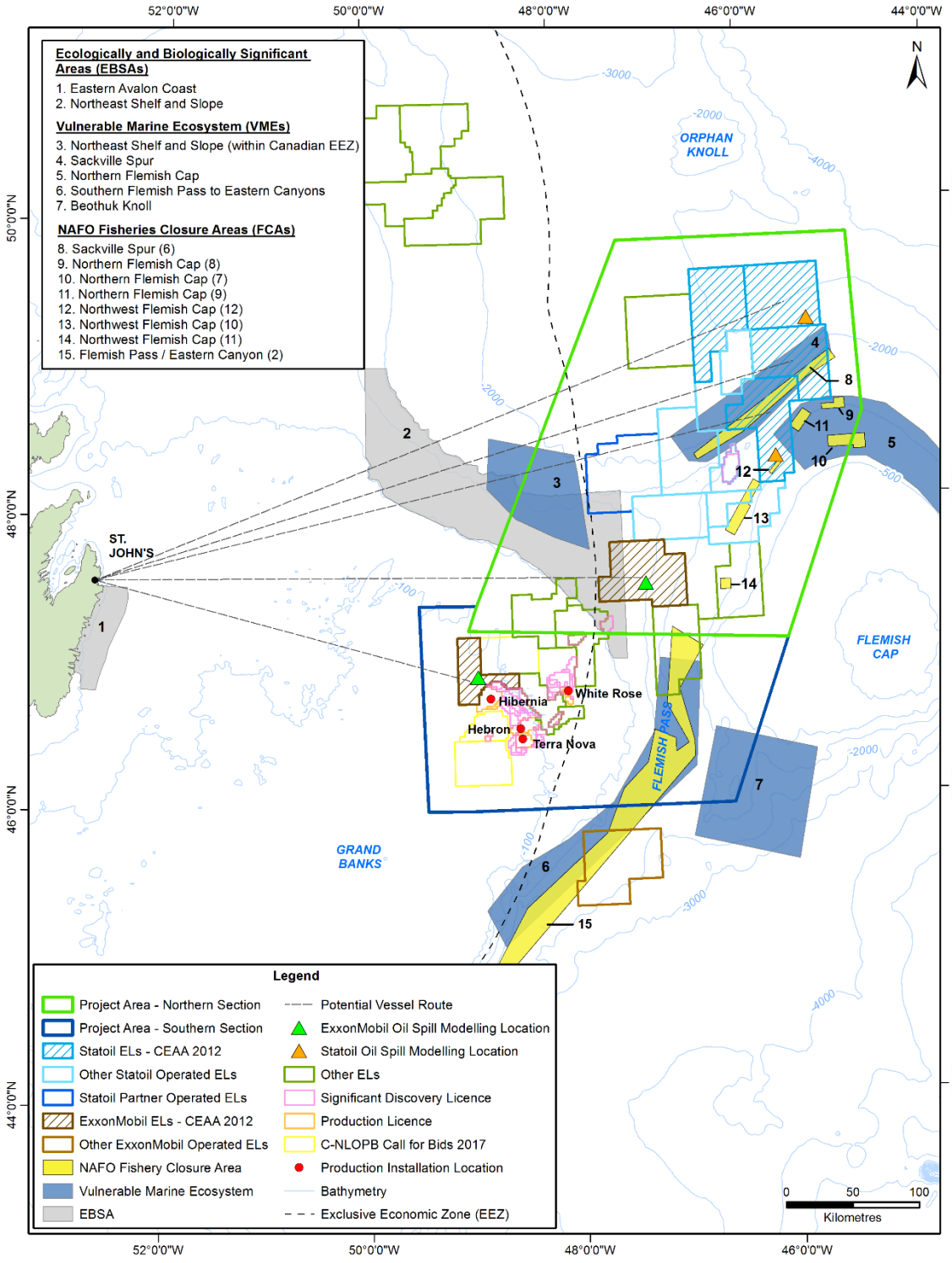


Figure 11-2 Overview of Special Areas that Overlap with the Project Area and Potential Vessel and Aircraft Traffic Routes

Table 11.4 Special Areas Overlapping with Project Exploration Licences

Exploration Licence	Overlapping Special Areas
EL 1135	• Northeast Shelf and Slope EBSA
EL 1137	• None
EL 1139	• None
EL 1140	• None
EL 1141	• Sackville Spur (6) NAFO Closure • Northern Flemish Cap VME • Sackville Spur VME
EL 1142	• Sackville Spur (6) NAFO Closure • Northern Flemish Cap (9) NAFO Closure • Northwest Flemish Cap (12) NAFO Closure • Northern Flemish Cap VME • Sackville Spur VME

The offshore vessel and aircraft activity within the Project Area and to and from Eastern Newfoundland will be generally in keeping with, and may make a relatively minor contribution to, the overall marine vessel activity occurring in the region for many years. Supporting vessels that are involved in Project activities will travel in an essentially straight line between a drilling installation operating within an EL (see Section 2.5.2) in the Project Area and the established supply facility in Eastern Newfoundland, recognizing that specific routes may vary at times based on the location of the active drilling installation(s) and to avoid sea-ice. The planning and conduct of Project-related vessel traffic will be undertaken in consideration of these factors, relevant regulatory requirements, and through established cooperative processes that involve discussions and communications between the oil and gas sector, fishing industry and other ocean users.

As described for the various preceding biophysical VCs (Chapters 8 to 10), the Project is not expected to result in significant adverse effects upon marine fish, birds, mammals, sea turtles, species at risk or their habitats. It will therefore not adversely affect the ecological features, processes, and integrity of marine or coastal locations that are designated as Special Areas, nor their human use and societal value.

11.4 Significance of Residual Environmental Effects

This section summarizes the residual effects of the Project on Special Areas and presents a definition and determination of significance for the environmental effects assessment for this VC.

11.4.1 Residual Environmental Effects Summary

Table 11.5 summarizes the environmental effects assessment for the Project as a whole, including characterization of potential effects from potential Project interactions and applicable mitigation measures relating to Special Areas. Tables 11.6 to 11.11 then provide individual environmental effects assessment summaries for planned Project activities on each of the ELs that comprise the Project being assessed under CEAA 2012. In terms of the various special areas that overlap with the Project Area and potential vessel and aircraft traffic routes, the overall and defining physical, biological, and socioeconomic environments within these areas will not be adversely affected by the Project. Again, many of the offshore activities and associated disturbances that will occur as a result of this Project will be relatively localized and of a short-term nature at a specific location, and the implementation of the various mitigation measures outlined throughout this EIS will reduce direct or indirect potential effects on the existing environmental characteristics and conditions of these special areas (Table 11.5).

11.4.2 Determination of Significance

Oil and gas exploration activities such as those being proposed as part of this Project are not prohibited within special areas that overlap with the Project Area or planned vessel and Aircraft traffic routes. For the special areas that do overlap or otherwise interact with planned Project activities and emissions, the overall and defining physical, biological, and socioeconomic environments within these areas will not be adversely affected by the Project.

As described and summarized above, the Project is therefore not likely to result in significant adverse residual environmental effects on special areas.

11.5 Environmental Monitoring and Follow-up

The various environmental monitoring and follow-up initiatives outlined earlier in relation to relevant components of the biophysical environment will be indirectly applicable to Special Areas.

Follow-up monitoring will occur if drilling is undertaken in the following circumstances:

1) Within an identified VME or FCA
2) Adjacent / near to an identified VME or FCA, such that drill cuttings dispersion model predicts that drill cuttings deposition may occur within the VME or FCA at levels above the biological effects threshold, or
3) In an area where the results of the pre-drill coral survey and risk assessment (DFO/C-NLOPB reviewed and accepted) indicate that monitoring is required

The purpose of the follow-up monitoring program would be to determine the effectiveness of mitigation measures in protecting the sensitive benthic habitat. Please refer to Section 17.4 for more information on the proposed follow-up program

Table 11.5 Environmental Effects Assessment Summary: Special Areas – Project Overall

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY	
Summary of Existing Conditions and Ecological and Social Context – Project Area / LSA • A number of marine and coastal areas in Newfoundland and Labrador have been designated as protected under provincial, federal and/or other legislation or agreements due to their biological/ecological or socio-cultural characteristics and importance, and other areas have been formally identified as being special or sensitive through relevant processes and initiatives. • Special areas designation or identification is often directly related to the existing physical and biological environment, including marine fish and fish habitat, marine and migratory birds and marine mammals and sea turtles (including species at risk) or socio-cultural values such as economy, culture, history or recreation, which are also covered in other sections. • A number of these special areas are located on land or in coastal areas. Those located within the offshore environment include EBSAs, Preliminary RMAs, VMEs and NAFO FCAs.	**Summary of Key Mitigation** • Mitigation measures that are designed to avoid or reduce the effects of planned Project components and activities on marine biota, habitats and other marine users will also reduce effects on to special areas • Pre-drilling coral survey and risk assessment based on the NOROG guideline. Industry best practice approach in areas with potentially high concentrations of cold water corals

Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors						
		Nature / Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty
Presence and Operation of Drilling Installation	• Possible direct interactions with special areas • Possible effects through associated changes to the biophysical environment • Possible interactions (interference or disturbances) with other human activities	A	N-L	L-PA	S-M	R	R	H
Drilling and Associated Marine Discharges		A	N-L	L-PA	S-M	R	R	H
Formation Flow Testing with Flaring		N	-	-	-	-	-	H
Wellhead Decommissioning		A	N-L	L	S	S	R	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys		A	N-L	L-PA	S	S	R	H

Table 11.5 Environmental Effects Assessment Summary: Special Areas – Project Overall

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Geological, Geotechnical and Environmental Surveys		N	-	-	-	-	-	H
Supply and Servicing		N	-	-	-	-	-	H

Evaluation of Significance

- Oil and gas exploration activities are not prohibited within special areas that overlap with the Project Area.
- For the various special areas that overlap with the Project Area (offshore and associated vessel traffic routes), the overall and defining physical, biological, and socioeconomic environments within these areas will not be adversely affected by the Project.

NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.

KEY

Nature / Direction:
- P Positive
- A Adverse
- N Neutral (or No Effect)

Magnitude:
- N Negligible
- L Low
- M Medium
- H High

Geographic Extent:
- L Localized, In Immediate Vicinity of Activity
- PA Within Project Area
- LSA Within LSA
- RSA Within RSA or Beyond

Frequency:
- O Occurs once
- S Occurs sporadically
- R Occurs on a regular basis
- C Occurs continuously

Duration:
- S Short term (For duration of the activity)
- M Medium term (Beyond duration of the activity – weeks or months)
- L Long term (Beyond duration of the activity – years)
- P Permanent (Recovery unlikely)

Reversibility:
- R Reversible (Will recover to baseline)
- I Irreversible (Permanent)

Certainty in Predictions:
- L Low level of confidence
- M Moderate level of confidence
- H High level of confidence

N/A Not Applicable

Table 11.6 Environmental Effects Assessment Summary: Special Areas – EL 1135

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Summary of Existing Conditions and Ecological and Social Context: EL 1135 • See Table 11.5 for an overview of the Project Area / LSA as a whole. • This EL overlaps with the Northeast Shelf and Slope EBSA, Northeast Shelf and Slope (within Canadian EEZ) VME, Southern Flemish Pass to Eastern Canyons VME, Northwest Flemish Pass (10) FCA, Northwest Flemish Pass (11) FCA and Flemish Pass/Eastern Canyon (2) FCA.								**Summary of Key Mitigation** See Table 11.5
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature / Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of Drilling Installation	• Possible direct interactions with special areas • Possible effects through associated changes to the biophysical environment • Possible interactions (interference or disturbances) with other human activities	A	N-L	L-PA	S-M	R	R	H
Drilling and Associated Marine Discharges		A	N-L	L-PA	S-M	R	R	H
Formation Flow Testing with Flaring		N	-	-	-	-	-	H
Wellhead Decommissioning		A	N-L	L	S	S	R	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys		A	N-L	L-PA	S	S	R	H
Geological, Geotechnical and Environmental Surveys		N	-	-	-	-	-	H
Supply and Servicing		N	-	-	-	-	-	H

Table 11.6 Environmental Effects Assessment Summary: Special Areas – EL 1135

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY
Evaluation of Significance • Oil and gas exploration activities are not prohibited within special areas that overlap with the Project Area. • For the various special areas that overlap with the Project Area (offshore and associated vessel traffic routes), the overall and defining physical, biological, and socioeconomic environments within these areas will not be adversely affected by the Project. NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.
KEY: See Table 11.5

Table 11.7 Environmental Effects Assessment Summary: Special Areas – EL 1137

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Summary of Existing Conditions and Ecological and Social Context: EL 1137 • See Table 11.5 for an overview of the Project Area / LSA as a whole. • This EL overlaps with the Eastern Avalon Coast EBSA.								**Summary of Key Mitigation** See Table 11.5
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature / Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of Drilling Installation	• Possible direct interactions with special areas • Possible effects through associated changes to the biophysical environment • Possible interactions (interference or disturbances) with other human activities	A	N-L	L-PA	S-M	R	R	H
Drilling and Associated Marine Discharges		A	N-L	L-PA	S-M	R	R	H
Formation Flow Testing with Flaring		N	-	-	-	-	-	H
Wellhead Decommissioning		A	N-L	L	S	S	R	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys		A	N-L	L-PA	S	S	R	H
Geological, Geotechnical and Environmental Surveys		N	-	-	-	-	-	H
Supply and Servicing		N	-	-	-	-	-	H

Table 11.7 Environmental Effects Assessment Summary: Special Areas – EL 1137

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY
Evaluation of Significance • Oil and gas exploration activities are not prohibited within special areas that overlap with the Project Area. • For the various special areas that overlap with the Project Area (offshore and associated vessel traffic routes), the overall and defining physical, biological, and socioeconomic environments within these areas will not be adversely affected by the Project. NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.
KEY: See Table 11.5

Table 11.8 Environmental Effects Assessment Summary: Special Areas – EL 1139

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Summary of Existing Conditions and Ecological and Social Context: EL 1139 • See Table 11.5 for an overview of the Project Area / LSA as a whole. • This EL overlaps with the Northeast Shelf and Slope EBSA, Northeast Shelf and Slope (within Canadian EEZ) VME, Sackville Spur VME and Sackville Spur (6) FCA.							**Summary of Key Mitigation** See Table 11.5	
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature / Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of Drilling Installation	• Possible direct interactions with special areas • Possible effects through associated changes to the biophysical environment • Possible interactions (interference or disturbances) with other human activities	A	N-L	L-PA	S-M	R	R	H
Drilling and Associated Marine Discharges		A	N-L	L-PA	S-M	R	R	H
Formation Flow Testing with Flaring		N	-	-	-	-	-	H
Wellhead Decommissioning		A	N-L	L	S	S	R	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys		A	N-L	L-PA	S	S	R	H
Geological, Geotechnical and Environmental Surveys		N	-	-	-	-	-	H
Supply and Servicing		N	-	-	-	-	-	H

Table 11.8 Environmental Effects Assessment Summary: Special Areas – EL 1139

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY
Evaluation of Significance • Oil and gas exploration activities are not prohibited within special areas that overlap with the Project Area. • For the various special areas that overlap with the Project Area (offshore and associated vessel traffic routes), the overall and defining physical, biological, and socioeconomic environments within these areas will not be adversely affected by the Project. NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.
KEY: See Table 11.5

Table 11.9 Environmental Effects Assessment Summary: Special Areas – EL 1140

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Summary of Existing Conditions and Ecological and Social Context: EL 1140 • See Table 11.5 for an overview of the Project Area / LSA as a whole. • This EL overlaps with the Northeast Shelf and Slope EBSA, Northeast Shelf and Slope (within Canadian EEZ) VME, Sackville Spur VME and Sackville Spur (6) FCA							**Summary of Key Mitigation** See Table 11.5	
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature / Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of Drilling Installation	• Possible direct interactions with special areas • Possible effects through associated changes to the biophysical environment • Possible interactions (interference or disturbances) with other human activities	A	N-L	L-PA	S-M	R	R	H
Drilling and Associated Marine Discharges		A	N-L	L-PA	S-M	R	R	H
Formation Flow Testing with Flaring		N	-	-	-	-	-	H
Wellhead Decommissioning		A	N-L	L	S	S	R	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys		A	N-L	L-PA	S	S	R	H
Geological, Geotechnical and Environmental Surveys		N	-	-	-	-	-	H
Supply and Servicing		N	-	-	-	-	-	H

Table 11.9 Environmental Effects Assessment Summary: Special Areas – EL 1140

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY
Evaluation of Significance • Oil and gas exploration activities are not prohibited within special areas that overlap with the Project Area. • For the various special areas that overlap with the Project Area (offshore and associated vessel traffic routes), the overall and defining physical, biological, and socioeconomic environments within these areas will not be adversely affected by the Project. NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.
KEY: See Table 11.5

Table 11.10 Environmental Effects Assessment Summary: Special Areas – EL 1141

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Summary of Existing Conditions and Ecological and Social Context: EL 1141 • See Table 11.5 for an overview of the Project Area / LSA as a whole. • This EL overlaps with the Northeast Shelf and Slope EBSA, Northeast Shelf and Slope (within Canadian EEZ) VME, Sackville Spur VME, Northern Flemish Cap VME, Sackville Spur (6) FCA, Northern Flemish Cap (8) FCA and Northern Flemish Cap (9) FCA.								**Summary of Key Mitigation** See Table 11.5
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature / Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of Drilling Installation	• Possible direct interactions with special areas • Possible effects through associated changes to the biophysical environment • Possible interactions (interference or disturbances) with other human activities	A	N-L	L-PA	S-M	R	R	H
Drilling and Associated Marine Discharges		A	N-L	L-PA	S-M	R	R	H
Formation Flow Testing with Flaring		N	-	-	-	-	-	H
Wellhead Decommissioning		A	N-L	L	S	S	R	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys		A	N-L	L-PA	S	S	R	H
Geological, Geotechnical and Environmental Surveys		N	-	-	-	-	-	H
Supply and Servicing		N	-	-	-	-	-	H

Table 11.10 Environmental Effects Assessment Summary: Special Areas – EL 1141

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY
Evaluation of Significance • Oil and gas exploration activities are not prohibited within special areas that overlap with the Project Area. • For the various special areas that overlap with the Project Area (offshore and associated vessel traffic routes), the overall and defining physical, biological, and socioeconomic environments within these areas will not be adversely affected by the Project. NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.
KEY: See Table 11.5

Table 11.11 Environmental Effects Assessment Summary: Special Areas – EL 1142

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Summary of Existing Conditions and Ecological and Social Context: EL 1142 • See Table 11.5 for an overview of the Project Area / LSA as a whole. • This EL overlaps with the Northeast Shelf and Slope EBSA, Northeast Shelf and Slope (within Canadian EEZ) VME, Sackville Spur VME, Northern Flemish Cap VME, Sackville Spur (6) FCA, Northern Flemish Cap (7) FCA, Northern Flemish Cap (8) FCA, Northern Flemish Cap (9) FCA, Northwest Flemish Cap (10) FCA and Northwest Flemish Cap (11) FCA.							**Summary of Key Mitigation** See Table 11.5	
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature / Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of Drilling Installation	• Possible direct interactions with special areas • Possible effects through associated changes to the biophysical environment • Possible interactions (interference or disturbances) with other human activities	A	N-L	L-PA	S-M	R	R	H
Drilling and Associated Marine Discharges		A	N-L	L-PA	S-M	R	R	H
Formation Flow Testing with Flaring		N	-	-	-	-	-	H
Wellhead Decommissioning		A	N-L	L	S	S	R	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys		A	N-L	L-PA	S	S	R	H
Geological, Geotechnical and Environmental Surveys		N	-	-	-	-	-	H
Supply and Servicing		N	-	-	-	-	-	H

Table 11.11 Environmental Effects Assessment Summary: Special Areas – EL 1142

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY
Evaluation of Significance • Oil and gas exploration activities are not prohibited within special areas that overlap with the Project Area. • For the various special areas that overlap with the Project Area (offshore and associated vessel traffic routes), the overall and defining physical, biological, and socioeconomic environments within these areas will not be adversely affected by the Project. NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.
KEY: See Table 11.5

12.0 INDIGENOUS COMMUNITIES AND ACTIVITIES: ENVIRONMENTAL EFFECTS ASSESSMENT

This Chapter assesses and evaluates the potential effects of the Project's planned components and activities on Indigenous communities and their activities. Indigenous communities are identified and described in Sections 3.3 and 7.3. The environmental effects assessment focuses on and addresses each of the associated factors specified in and required under CEAA 2012, as follows:

> *5 (1) For the purposes of this Act, the environmental effects that are to be taken into account in relation to an act or thing, a physical activity, a designated project or a project are…*
>
> > *(c) with respect to aboriginal peoples, an effect occurring in Canada of any change that may be caused to the environment on*
> >
> > *(i) health and socio-economic conditions,*
> >
> > *(ii) physical and cultural heritage,*
> >
> > *(iii) the current use of lands and resources for traditional purposes, or*
> >
> > *(iv) any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.*

The EIS Guildelines identified a number of Indigenous groups in Newfoundland and Labrador, and required that the EIS provide a "description and analysis of how changes to the environment caused by the project will affect activities exercised by each Indigenous group, as applicable to the proposed project" (Section 6.3.7 of the EIS Guidelines). This included the:

1) Labrador Inuit (Nunatsiavut Government)
2) Labrador Innu (Innu Nation)
3) NunatuKavut Community Council
4) Miawpukek First Nation
5) Qalipu Mi'kmaq First Nation Band

In April 2017 and July 2017, the Canadian Environmental Assessment Agency notified the Operator that the EIS must consider and address the potential effects of the Project on an additional 36 Indigenous groups in Eastern Canada with regard to "the migration of Atlantic salmon between the Project area and areas where Indigenous groups have potential or established section 35 rights, and commercial-communal swordfish licences held by Indigenous groups within North Atlantic Fisheries Organization (NAFO) divisions, which overlap with the Project area". For these Indigenous groups, the analysis is focussed primarily on the potential effects of the Project on Atlantic salmon populations that are currently used for traditional purposes, as well as commercial swordfishing activity by some communities pursuant to their commercial-communal swordfish licences.

For all communities identified by the Agency as being potentially affected by the Project, in regards to the nature and extent of the potential or established Aboriginal and Treaty rights of the communities identified and the potential adverse impacts of the Project on those rights, the CEA

Agency's preliminary determination regarding the depth of the duty to consult was on the low end of the spectrum. Communities were provided a variety of information pertaining to the Project, such as direct linkages to the Project Description, Project Overview summaries which also referenced specific species of concern dependent upon the community (e.g. Atlantic salmon, swordfish, and others), as well as summary reports referencing research pertaining to species of concern (Atlantic salmon report). Indigenous groups were asked, upon review of the Project, to provide additional information, including any cultural, traditional or historical information, that would contribute to the analysis. In addition, the CEA Agency, in its preliminary analysis and dependent upon a specific community's potential or established Aboriginal and/or Treaty right, recognized that, "the potential impacts of the Project on potential or established aboriginal and treaty rights include impacts to harvesting due to: a) potential exclusion from Swordfish fishing areas within a prescribed safety zone around drilling units, (b) potential routine effects on Swordfish and Atlantic Salmon, and (c) potential effects on Atlantic Salmon, Swordfish, and Swordfish fisheries in the unlikely event of a large spill or blowout."

Through the Operators' engagement with Indigenous Groups, as described in Chapter 3, including some Traditional Knowledge and information described in Chapter 7.3, feedback was provided which resulted in the expansion of the scope of the EIS to capture additional concerns and interests of the Indigenous Groups. The increased scope contemplates the potential environmental effects (CEAA 2012 5(1)(c) that the Project may have on Indigenous Groups as well as the possible impacts to asserted or established Aboriginal and Treaty rights. Some of these interests and concerns include additional migrating species (beyond Atlantic salmon) of commercial, cultural and/or subsistence importance, such as American eel and harp seals, as well as species of cultural significance, such as the North Atlantic right whale. A number of Indigenous Groups also sought additional information on the potential effects of the Project on other commercial species beyond swordfish, such as cod, turbot and snow crab. In some cases, an Indigenous group referenced the importance of all species to the community from a commercial and traditional perspective.

During ongoing engagement with Indigenous Groups, and within the EIS, the Operators have considered these additional interests and concerns by responding directly to groups and ensuring the interests and concerns are addressed within the appropriate sections of the EIS (e.g. marine fish and fish habitat, marine and migratory birds, marine mammals).

As noted, the Operator remains committed to continuing to engage with Indigenous Groups. A key focus of this VC analysis is on assessing and evaluating the potential for the Project, and the various changes to the environment that may be associated with it, to interact with and affect Indigenous communities and their activities, including each of the socio-cultural aspects identified in Section 5(1)(c) of CEAA 2012 and listed above. This VC also relates to and overlaps with other components of the biophysical and socioeconomic environments, including several of the other VCs being considered in this assessment. For example, potential effects to Indigenous communities and their activities may result from Project-related changes in air quality and noise levels (Section 2.9), in the availability and quality of marine resources and other components of the biophysical environment (Chapter 6), and other human components and activities (Chapter 7). These potential inter-relationships are considered within the environmental effects assessment for this VC, both in terms of the potential for the environmental changes associated with the Project to extend to and interact directly with Indigenous communities and their activities, as well as an analysis of the geographic extent and movement patterns of marine-associated resources that are used by these groups and

their potential to move through, and interact with, the Project's anticipated environmental zone of influence (LSA, see below).

This chapter assesses and evaluates the potential effects of planned Project components and activities on this VC. Those which may result from possible accidental events (and associated spill response measures) are discussed in Chapter 15.

12.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

This section defines the Study Areas (spatial and temporal boundaries) for the environmental effects assessment for this VC. Three spatial Study Areas have been identified and considered in this EIS (Figure 12-1), as follows:

Project Area: This represents the overall geographic areas offshore Eastern Newfoundland within which planned Project-related exploration activities will take place. While the Project Area is defined as an overall polygon that encompass such activities over the course of the Project, the various components and activities associated with the drilling of each individual well and other planned components will occupy fairly small areas within this overall area, as described in Chapter 2. The assessment also considers related potential vessel and aircraft traffic routes to and from this offshore Project Area.

Local Study Area (LSA): This area represents the anticipated environmental zone of influence of the Project's planned components and activities, and therefore, encompasses the overall geographic area over which planned Project-related environmental interactions (including emissions and other disturbances) will occur. These are expected to occur primarily within the overall Project Area polygons defined above, with the exception of Project activities that could conceivably occur on the edges of the Project Area boundary. For this VC, the LSA is therefore (conservatively) defined as the offshore Project Area and an appropriately 10 km area around it as well as the associated potential vessel and aircraft traffic routes to the ELs.

Regional Study Area (RSA): In addition to these Project- and disturbance-related factors, the environmental effects assessment for this VC also recognizes and considers the spatial distribution and overall geographic extent of the various Indigenous communities and activities under consideration, as well as the distribution and movements of the various marine-associated resources that are used for traditional purposes by these communities. As noted above, this includes the location of a number of Indigenous communities and their activities throughout Eastern Canada.

The temporal boundaries for the effects assessment for this VC also encompass the likely timing and duration of Project-related (in-field) exploration activities in the Project Area, as well as the likely duration of potential environmental effects. In conducting the assessment, special consideration is also given to important or sensitive periods for the environmental and socio-cultural features, processes and activities that comprise or are associated with this VC.

It is within the above described spatial and temporal boundaries that the Project's potential environmental effects on this VC and their significance are assessed and evaluated.

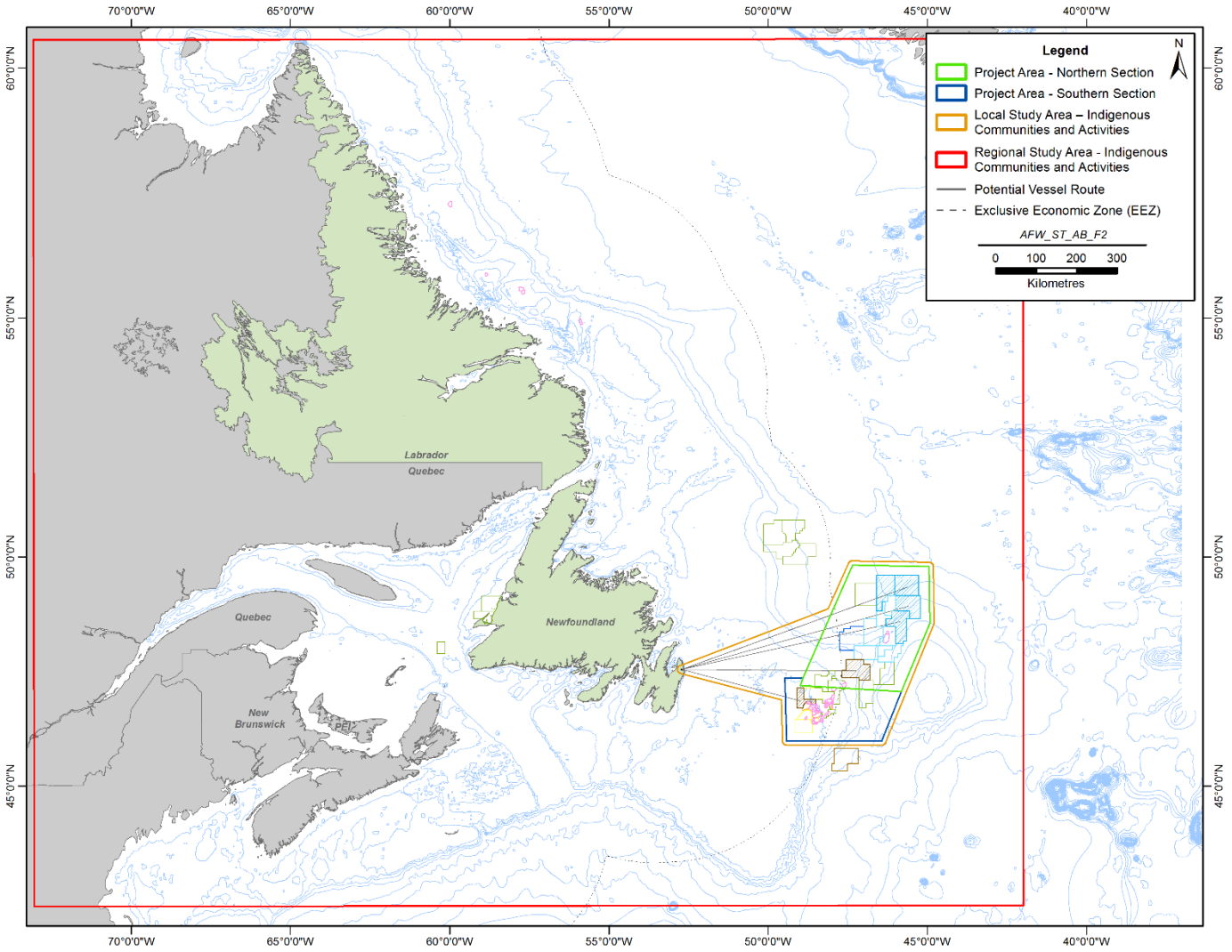


Figure 12-1 Environmental Assessment Study Areas: Indigenous Communities and Activities

Significant environmental effects for this VC are defined as those that would result from the Project and cause one or more of the following outcomes:

- A negative change in the overall nature, location or timing of current land and resource use activities for traditional purposes by one or more Indigenous communities, resulting in a reduction in overall activity levels and/or the cultural value of such activities
- A reduction in the quality of ambient air, water, fish, wildlife, or other resources at concentrations that will result in human health risks, with an associated and detectable increase in the incidence of human (physical) health issues. Note that given the distance to the Project Area (more than 300 km offshore Newfoundland and Labrador), a human health risk assessment was not required (see Section 7.4.2)
- Adverse effects on the social health and well-being and other socioeconomic conditions of affected Indigenous communities, such that there are associated, detectable and sustained decreases in the real or perceived quality of life of a population
- A decrease in established employment and business activity in one or more economic sectors such that there is a detectable adverse effect upon the economy of the affected Indigenous community over multiple years
- The destruction or disturbance of a structure, site or thing that is of historical, archaeological, paleontological, or architectural significance to an Indigenous community without the appropriate documentation or salvage and retrieval of the culture and the information it contains, and without prior approval from the relevant regulatory authority

12.2 Potential Environmental Changes, Effects, and Associated Parameters

A project EA first examines changes to the environment that may be caused by the Project that is under assessment, and then subsequently considers how these changes to the environment may affect the VC in question, or aspects of it, such as heritage or any structure, site, or thing (Canadian Environmental Assessment Agency 2015a). Changes to the environment as a result of offshore oil and gas exploration activities and their potential, resulting effects on Indigenous communities and their activities may be both direct and indirect in nature and cause.

The presence of a drilling installation, vessels and other equipment, and the conduct of these exploration activities within or near Indigenous communities or in proximity to the areas that are inhabited or used by these groups may, for example, result in reduced access for defined periods due to safety zones. Project-related components and their “footprints” and discharges and emissions may also affect areas, times and other components of the environment that are used or valued by Indigenous people, with associated implications for these groups and their health and well-being (physical or social), heritage and land and resource use. Indirect effects may also occur when projects and activities adversely affect fish and wildlife, as these biophysical effects may in turn reduce the availability or quality of such resources and their use for traditional purposes.

The EIS Guidelines issued by the Canadian Environmental Assessment Agency in December 2016, and updated in April 2017, identify a number of issues and potential effects on this VC which require consideration in the EIS (see Section 6.3.7 of the EIS Guidelines), essentially expanding on and providing further Project-specific definition and specificity on the various environmental changes and effects that are required under Section 5(1)(c) of CEAA 2012.

An overview of the nature and spirit of, and the results from, the Indigenous engagement initiatives undertaken for this EIS were described in some detail in Chapter 3. As noted therein, the Operator is committed to continuing meaningful communication and engagement with potentially affected Indigenous groups to keep them informed and engaged regarding the company's planned and on-going activities. Given the distance of the Project to the indigenous Groups identified, much of the engagement has focused on potential effects to migratory species and the environment generally, during both operational activity and in the unlikely event of a large accidental event, such as an oil spill.

A number of questions and comments related to this VC were noted during the Operator's Project-related engagements with identified Indigenous groups, as well as in related discussions with relevant government departments and agencies and other organizations (see Chapter 3).

The environmental effects assessment for this VC considers and focuses upon the issues and questions identified through these various issues scoping exercises, including an initial identification of the key potential environmental changes and possible, resulting environmental effects on the VC that may result from these changes. These are summarized in Table 12.1 and have been used to focus and frame the environmental effects assessment for this VC.

Table 12.1 Potential Project-Related Environmental Changes and Potential Effects: Indigenous Communities and Their Activities

Potential Environmental Effects	Contributing Potential Environmental Changes Resulting from the Project	Associated Parameter(s)
Change in Health and Socio-Economic Conditions	• In terms of physical health, exploration drilling and associated activities will result in environmental emissions that may result in changes to the nature and quality of, air, water or consumed fish and wildlife • With sufficient types, levels and durations of exposure, environmental contaminants may affect the physical health of persons who come into contact with these, through either direct exposure with the contaminants or through consumption of affected fish and wildlife • In terms of social health and associated socioeconomic components and characteristics, Project components and activities may interact with Indigenous communities and their activities directly or indirectly (such as through noise, lights, visibility, access restrictions) which can result in environmental changes that may have an adverse effect on perceptions of quality of life and well-being	Air and water quality Quality and availability of used marine fish and wildlife Self-assessed quality of life and well-being Availability, cost, and quality of community services and infrastructure Employment and business activity and income levels / revenues

Table 12.1 Potential Project-Related Environmental Changes and Potential Effects: Indigenous Communities and Their Activities

Potential Environmental Effects	Contributing Potential Environmental Changes Resulting from the Project	Associated Parameter(s)
Change in the Current Use of Lands and Resources for Traditional Purposes	• In cases where Indigenous groups and their current land and resource use for traditional purposes occurs within or near the Project Area / LSA, these may be affected by Project-related environmental changes that may make certain areas / times unsuitable or undesirable for these activities, with a resulting effect on the nature and value (economic and/or cultural) of these activities for the group • Biophysical environmental changes and resulting effects that influence the availability or quality of the water, air, vegetation, fish, or wildlife used by identified Indigenous peoples may also indirectly affect these groups through various pathways	Land / marine areas, times, and resources available and used for traditional activities by each group Nature, location, timing and frequency of traditional land and resource use activities by each group Overall community participation rates in traditional land and resource activities Degree of cultural value / fulfillment associated with traditional land and resource activities by a community
Change in Physical and Cultural Heritage and Change in any Structure, Site, or Thing that is of Historical, Archaeological, Paleontological or Architectural Significance	• Heritage is an inclusive term that is associated with important aspects of human history and culture. Current perceptions of heritage tend to be quite broad and include various social, economic, political, environmental, scientific, natural, and cultural dimensions (Canadian Environmental Assessment Agency 2015a) • The cultural value of heritage or of any structure, site or thing originates from its: 1) Association with important aspects of human history or culture; 2) Historical, archaeological, paleontological, or architectural significance; and 3) Association with a group's practices, traditions, or customs, which are defined as follows: – *Practice*: A way of doing something that is common, habitual or expected – *Tradition*: A custom, opinion or belief handed down orally or by practice – *Custom*: A particular, established way of behaving (Canadian Environmental Assessment Agency 2015a)	Number of structures, site, or thing of historical, archaeological, paleontological, or architectural significance lost or disturbed Degree of cultural value associated with an identified aspect of physical / cultural heritage (tangible, intangible, or otherwise) by a community

Table 12.1 Potential Project-Related Environmental Changes and Potential Effects: Indigenous Communities and Their Activities

Potential Environmental Effects	Contributing Potential Environmental Changes Resulting from the Project	Associated Parameter(s)
	• Physical heritage components may be affected if they are present within the Project footprint or otherwise come into contact with Project-related components, activities or emissions and associated environmental changes • Aspects of cultural heritage, both tangible (such as artifacts, structures) and intangible (traditions, language, and knowledge) may be affected by direct and indirect environmental changes resulting from petroleum exploration projects	

The assessment of potential Project effects on this VC was based on an extensive review of existing publicly available information, related to the identified Indigenous groups (Section 7.3). Additional information, including traditional, historical and culturally important information, was also provided or made available by Indigenous communities and organizations during the Operator's engagement initiatives (Chapter 3). The environmental effects assessment for this VC focuses primarily upon the key potential issues and interactions identified above, with a series of Associated Parameters being defined which represent key and relevant aspects of the VC to which project-related changes could possibly be detected (although these are primarily used as key concepts and considerations upon which to focus the effects assessment, rather than to generate quantitative effects predictions).

An overview of the potential for interactions between each of the Project's planned components and activities and Indigenous communities and their activities, and specifically the potential to result in environmental changes and eventual detectable effects to the various aspects of this VC, is presented in Table 12.2.

Table 12.2 Potential Project-VC Interactions: Indigenous Communities and Their Activities

Project Component / Activity	Potential Environmental Effects		
	Change in Health and Socio-Economic Conditions	Change in the Current Use of Lands and Resources for Traditional Purposes	Change in Physical and Cultural Heritage and Change in a Structure, Site or Thing that is of Historical, Archaeological, Paleontological or Architectural Significance
Presence and Operation of Drilling Installation (including lights, noise, air emissions, anchoring)	•	•	•

Table 12.2 Potential Project-VC Interactions: Indigenous Communities and Their Activities

Project Component / Activity	Potential Environmental Effects		
	Change in Health and Socio-Economic Conditions	Change in the Current Use of Lands and Resources for Traditional Purposes	Change in Physical and Cultural Heritage and Change in a Structure, Site or Thing that is of Historical, Archaeological, Paleontological or Architectural Significance
Drilling and Associated Marine Discharges	•	•	•
Formation Testing with Flaring		•	
Wellhead Decommissioning		•	
Geophysical, Geohazard, Wellsite and Seabed Surveys and VSP		•	•
Geological, Geotechnical and Environmental Surveys		•	•
Supply and Servicing	•	•	•

In general, Project components or activities that may result in restricted access to lands and resources, emissions to the atmospheric environment, or discharges to the marine environment, have the potential to (directly or indirectly) affect Indigenous communities and their activities where these occur within or near the Project Area and its expected environmental zone of influence (LSA). These possible interactions and potential effects have been brought forward into the following sections for further analysis.

12.3 Environmental Effects Assessment and Mitigation

This VC includes an assessment and evaluation of whether and how planned Project components and activities and the various environmental interactions and changes that may be associated with these, may ultimately affect Indigenous communities and their activities, including each of the socio-cultural aspects identified in Section 5(1)(c) of CEAA 2012 and discussed above.

12.3.1 Approach and Methods

The assessment of potential Project effects on this VC included a general approach of “overlaying” the Project components and activities (Chapter 2) and the anticipated environmental zones of influence associated with these (the LSA) with input from Indigenous communities, including historical/traditional and cultural information and publicly available information to identify potential interactions with and resulting effects on this VC. Potential interactions between the Project and the VC are identified and analysed, the need for mitigation considered, and the significance of residual effects determined and evaluated.

A variety of publicly available information sources and engagement with communities were used to understand and describe the various Indigenous communities and activities that may potentially be affected by the Project (Section 7.3). As described in Chapter 3, the Operator engaged with each of the identified Indigenous groups to provide information on the Project and seek input about their activities, any traditional knowledge, community issues and concerns regarding the Project and its potential effects, for consideration and incorporation into the EIS. In some cases, a number of Indigenous Groups did not respond to the Operators' numerous engagement efforts. Where Indigenous groups have chosen to participate in this engagement, the information and insights obtained through these processes have been incorporated throughout the EIS to better inform the assessment. In other cases, the EIS has been conducted on the basis of existing and publicly available information. The Operator respects and values the input received from Indigenous communities and remains committed to further engagement as is evident in the record of engagement (Chapter 3). It also encourages identified Indigenous groups to provide input and information that they may have as part of their involvement in EA-related engagement processes and opportunities provided by the CEAA 2012 EA process.

12.3.2 Environmental Effects Assessment (All Project Components and Activities)

This section assesses and evaluates the potential effects of the Project's planned components and activities on Indigenous communities and their activities, including the socio-cultural components and activities specified in Section 5(1)(c) of CEAA 2012. Differences in potential interactions and effects between the various elements of the Project are, however, highlighted as part of the analysis.

The mitigation measures outlined elsewhere in this EIS will serve to avoid or reduce Project-related environmental emissions, disturbances and resulting environmental changes by minimizing reducing the nature, degree, extent, and duration of these changes, and therefore, reducing the potential for these to interact with and adversely affect the various components and activities that comprise this VC. These are listed and described in detail in the various environmental effects assessment chapters for other VCs (see Chapters 8-11, 13 and 17).

12.3.2.1 Health and Socioeconomic Conditions

As described throughout this EIS, the Project will be characterized by offshore exploration drilling and supply and service activities which will occur within a small and localized area over a short timeframe (35-65 days per wellsite for drilling). Offshore exploration activities must meet and adhere to standard regulatory requirements and implement mitigation measures designed to avoid or reduce potential environmental effects. Moreover, these exploration activities will take place in the marine environment over 300 km from the Island of Newfoundland, and even further from Labrador, mainland Quebec and the Maritime Provinces. The geographic extent (zone of influence) of Project-related environmental emissions or discharges will be localized to the Project Area and therefore unlikely to extend to or affect the physical or social health and well-being of Indigenous persons or communities.

Project components and activities will therefore not interact negatively with Indigenous persons or communities, either directly or indirectly. The Project and associated environmental changes that may result from it will not overlap directly with relevant socioeconomic components or activities, and

given the offshore location will not likely be seen or heard by anyone. The Project will also not place direct or indirect demands on community services and infrastructure used by Indigenous persons and / or their communities, nor will it result in other types of adverse social and economic effects such as interference with other commercial or recreational activities.

As outlined above, the various components and activities that are being planned as part of this Project will not have adverse interactions with or effects upon the health or socioeconomic conditions of Indigenous people and communities.

The potential effects of the Project on commercial fishing activities by Indigenous groups are addressed as part of the Commercial Fisheries and Other Ocean Users VC (Chapter 13).

12.3.2.2 Current Use of Lands and Resources for Traditional Purposes

Traditional uses are often considered to refer to the practices, traditions and customs that define and distinguish the distinctive culture of an Indigenous community, and which were practiced prior to European contact. These "uses of lands and resources" can include, for example, hunting, fishing and gathering food for subsistence and ceremonial purposes, as well as associated time on and travel across the land, associated ceremonies and customs, cultural practices, and other tangible and intangible activities and values (Canadian Environmental Assessment Agency 2015b). In addition, "current use for traditional purposes" is considered to include:

> *Uses by Indigenous peoples that are actively being carried out at the time of the assessment and uses that are likely to occur in a reasonably foreseeable future provided that they have continuity with traditional practices, traditions or customs*
>
> *Traditional purposes typically relates to activities that are integral to a community's way of life and culture, and have continuity with historic practices, customs and traditions of the community (Canadian Environmental Assessment Agency 2015b).*

The term "current use of lands and resources" is also often expressed by Indigenous groups as being analogous to "aboriginal rights" or "treaty rights" (Canadian Environmental Assessment Agency 2015b). Section 35 of the *Constitution Act* (1982) recognizes and affirms the existing Aboriginal and Treaty Rights of the Indian, Inuit, and Métis peoples of Canada, the nature, scope, and existence of which have been further defined through various legal decisions as well as through Land Claims Agreements (treaties) between governments and Indigenous groups in specific areas.

It is recognized that several Indigenous Groups claim Aboriginal Rights and/or Title to areas of Newfoundland and Labrador, and the rights assertions and land claims of several groups residing in the Labrador portion of the province are at varying stages of progress, negotiation, and settlement. This includes the Labrador Inuit (*Labrador Inuit Lands Claims Agreement* finalized and in effect for the treaty area in Northern Labrador), Labrador Innu (Land Claims *Agreement-in-Principle* concluded, with associated land selection in Labrador completed), and the NunatuKavut Community Council (whose land claim application covers much of Southern Labrador but has not been accepted for negotiation by the federal or provincial governments). Mi'kmaq First Nations also reside on the Island of Newfoundland, including the Miawpukek First Nation which is based on the Samiajij

Miawpukek Reserve in the Bay D'Espoir area in the southern part of the Island (located several hundred kilometres west of the Project Area) and the Qalipu First Nation Band, a landless band whose members reside in approximately 70 communities throughout the Island of Newfoundland and elsewhere. In addition, each of the previously identified Indigenous groups in New Brunswick, Nova Scotia, PEI and Quebec assert and/or have established rights to specific lands and resources within their traditional territories, which are likewise at varying stages of recognition and settlement. Although the traditional territories of these groups are not known to extend to the Eastern Newfoundland offshore area, it is acknowledged that several groups in the Maritime Provinces hold commercial-communal licences for species such as swordfish that include various NAFO Divisions (3O, 3M, 3N) that encompass the Project Area and LSA.

The EIS Guidelines include extensive reference to possible effects on the current use of lands and resources for traditional purposes, including "potential adverse impacts on potential or established Indigenous or treaty rights protected under section 35 of the *Constitution Act*, 1982" (see Sections 2.3, and elsewhere in the EIS Guidelines). As discussed and illustrated in Section 7.3, the components and activities that comprise this Project (and the LSA) will be located a considerable distance (hundreds of kilometers) from Indigenous communities, and from the traditional territories associated with each of these groups. The Operator is not aware that these or other Indigenous groups undertake traditional activities within or near the Project Area and LSA, pursuant to rights recognized under Section 35 of the *Constitution Act, 1982*.

12.3.2.2.1 Indigenous Commercial Fish Harvesting

Although fishing enterprises associated with several of these organizations currently undertake commercial fishing activity for various species within NAFO Divisions that overlap parts of the Project Area (see Section 7.3), it is understood that most of these organizations undertake fishing activities off Eastern Newfoundland through commercial licences issued by the federal government under the *Fisheries Act* and its associated *Aboriginal Communal Fisheries Licencing Regulation*, as well as other government policies and strategies that are designed to involve Indigenous groups in commercial fisheries in Canada. While it is evident that aspects of the commercial fishing activity for some Indigenous Groups is a recognition of a Treaty Right, and this in turn has resulted in some Indigenous commercial fishing licences overlapping with the Project Area or LSA, this does not suggest that the Indigenous Group was or is currently traditionally harvesting within the Proejct Area or LSA. As "traditional use" is (as outlined above) generally understood to mean activities that have been exercised (and are being exercised) by an identifiable Indigenous community since before European contact or control of a specific area, given the location of the Project Area from the Indigenous groups (350 km – 1,100 km), it is unlikely that traditional fish harvesting activities took place in the LSA.

12.3.2.2.2 Indigenous Subsistence Harvesting

The Project, including its planned components and activities and potential vessel and aircraft traffic routes, and the environmental emissions / disturbances and associated environmental changes resulting from these will be highly localized and limited to the immediate vicinity of the Project (as defined through the LSA) and will therefore not directly interfere with or otherwise interact with the

current use of lands and resources for traditional purposes by Indigenous communities given their distances from the Project as described throughout. The Project will not have adverse effects on such activities as they do not occur within or near the LSA at any time of the year. For those groups in the Maritime Provinces that hold commercial-communal licences for swordfish in the various NAFO Divisions that encompass the Project Area and LSA, a further analysis is provided in a separate subsection later in this Chapter.

In terms of potential indirect effects on such activities, the environmental effects assessment for this VC also considers whether and how Project-related changes in and effects on the biophysical environment off Eastern Newfoundland (within the LSA) may affect resources that are known to be used for traditional purposes by Indigenous groups, as a result of the known migration and movement patterns of marine-associated biota used for these purposes. Specifically, the assessment considers whether marine species that have been identified as being used for traditional purposes by identified Indigenous communities (Chapter 3) are present in and migrate to and from the LSA and may therefore be affected by the Project, with possible resulting implications for their eventual availability or quality for traditional harvesting and consumption by communities.

Table 12.3 provides a listing of the various marine-associated species that have been identified through engagement (Chapter 3) as being used for traditional purposes by each Indigenous group listed in the EIS Guidelines, as well as an evaluation of whether (based on existing and available scientific literature) individuals from these species are known or likely to be present within the LSA at any time of year before making their way into areas of traditional use by one or more Indigenous communities.

Table 12.3 Marine-Associated Species Used by Indigenous Groups (As Identified Through Engagement) and their Potential for Interaction with the Project

Province	Group	Identified Species (See Chapter 3)	Potential for These Resources to Spend Time Within the LSA
Newfoundland and Labrador	Nunatsiavut Government	Cod Turbot Snow crab Atlantic blue whale North Atlantic right whale	• Atlantic cod: Occasional presence in LSA, inhabits offshore shelf areas in winter and onshore areas in summer (Scott and Scott 1988). Resident offshore populations are distinct from inshore populations (Beacham et al. 2002) (See Section 6.1.7) • Rock cod: Do not occur in LSA, inhabits inshore regions and is less common offshore (Scott and Scott 1988) (See Section 6.1.7) • Turbot: Occurs within the LSA from shallow depth zones to deeper habitats. Mainly occurs on the slopes of the Grand Banks and on shelf areas off Newfoundland (north of the Avalon). Known to migrate between the Davis Strait and Eastern Newfoundland

Table 12.3 Marine-Associated Species Used by Indigenous Groups (As Identified Through Engagement) and their Potential for Interaction with the Project

Province	Group	Identified Species (See Chapter 3)	Potential for These Resources to Spend Time Within the LSA
			indicating potential for long distance migrations (Bowering 1984; Vis et al 1997) (See Section 6.1.7) • Snow crab: Occur in parts of the LSA and elsewhere off Eastern Newfoundland, but with limited home ranges / movements by adult individuals (Puebla et al. 2008; Christian et al. 2010) (See Section 6.1.6) • Atlantic blue whale: Regularly sighted in the Gulf of St. Lawrence and St. Lawrence Estuary between April and December (COSEWIC 2002). Low numbers have been sighted in the Eastern Newfoundland offshore area (Lawson and Gosselin 2009; Lesage et al. 2016; DFO sightings database, see Section 6.3) and occurrence of this species in the Project Area, LSA or RSA is considered rare (See Section 6.3.3) • North Atlantic right whale: In Atlantic Canada, North Atlantic right whales are found during summer and fall primarily in the Bay of Fundy, on the Scotian Shelf and the Gulf of St. Lawrence, and only rarely observed in the waters off Newfoundland (COSEWIC 2013). Occurrence of this species in the Project Area, LSA or RSA is considered rare (See Section 6.3.3.
	Innu Nation	None identified	• n/a
	NunatuKavut Community Council	None identified	• n/a
	Miapuwkek Mi'kamawey Mawi'omi	Atlantic salmon	• See Section 12.3.2.2.3
	Qalipu Mi'kmaq First Nation	None identified	• n/a
Prince Edward Island	Abegweit First Nation	Atlantic salmon Swordfish	• See Sections 12.3.2.2.3 and 12.3.2.2.4
	Lennox Island First Nation	Atlantic salmon Swordfish	

Table 12.3 Marine-Associated Species Used by Indigenous Groups (As Identified Through Engagement) and their Potential for Interaction with the Project

Province	Group	Identified Species (See Chapter 3)	Potential for These Resources to Spend Time Within the LSA
New Brunswick	Mi'gmawe'l Tplu'taqnn Inc. (MTI) (Not group specific)	Atlantic salmon Swordfish American eel Right whale	• See Sections 12.3.2.2.3 and 12.3.2.2.4 • American eel: Occasional presence in LSA, adults migrate from coastal areas to the Sargasso Sea (Scott and Scott 1988). Migrations of adults and larvae generally follow continental shelf areas (Wang and Tzeng 1998), reducing likelihood of passing through the LSA. (See Section 6.1.7) • North Atlantic right whale: In Atlantic Canada, North Atlantic right whales are found during summer and fall primarily in the Bay of Fundy, on the Scotian Shelf and the Gulf of St. Lawrence, and only rarely observed in the waters off Newfoundland (COSEWIC 2013). Occurrence of this species in the Project Area, LSA or RSA is considered rare (See Section 6.3.3)
	Wolastoqey Nation in New Brunswick (not group spscific)	Atlantic salmon Swordfish	• See Sections 12.3.2.2.3 and 12.3.2.2.4
	Elsipogtog First Nation	Atlantic salmon	
	Buctouche First Nation	Atlantic salmon	
	Eel Ground First Nation	Atlantic salmon	
	Eel River Bar First Nation	Atlantic salmon	
	Esgenoôpetitj First Nation	Atlantic salmon	
	Fort Folly First Nation	Atlantic salmon Swordfish	
	Indian Island First Nation	Atlantic salmon	
	Metepenagiag Mi'kmaq Nation	Atlantic salmon	

Table 12.3 Marine-Associated Species Used by Indigenous Groups (As Identified Through Engagement) and their Potential for Interaction with the Project

Province	Group	Identified Species (See Chapter 3)	Potential for These Resources to Spend Time Within the LSA
	Pabineau First Nation	Atlantic salmon	
	Kingsclear First Nation	Atlantic salmon	
	Madawaska Maliseet First Nation	Atlantic salmon	
	Oromocto First Nation	Atlantic salmon	
	St. Mary's First Nation	Atlantic salmon Swordfish	
	Tobique First Nation	Atlantic salmon	
	Woodstock First Nation	Atlantic salmon Swordfish	
	Passamaquoddy of New Brunswick	Atlantic salmon	
Nova Scotia	Kwilmu'kw Maw-Klusuaqn Negotiation Office (KMKNO) (Not group specific)	Atlantic salmon Swordfish American eel	• See Sections 12.3.2.3 and 12.3.2.4 • American eel: Occasional presence in LSA, adults migrate from coastal areas to the Sargasso Sea (Scott and Scott 1988). Migrations of adults and larvae generally follow continental shelf areas (Wang and Tzeng 1998), reducing likelihood of passing through the LSA.
	Paq'tnkek Mi'kmaw Nation	Atlantic salmon Swordfish	• See Sections 12.3.2.2.3 and 12.3.2.2.4
	Pictou Landing First Nation	Atlantic salmon Swordfish	• See Sections 12.3.2.2.3 and 12.3.2.2.4
	Wagmatcook First Nation	Atlantic salmon Swordfish	• See Sections 12.3.2.2.3 and 12.3.2.2.4
	Millbrook First Nation	Atlantic salmon Swordfish	• See Sections 12.3.2.2.3 and 12.3.2.2.4
	Acadia First Nation	Atlantic salmon Swordfish	• See Sections 12.3.2.2.3 and 12.3.2.2.4
	Annapolis Valley First Nation	Atlantic salmon	
	Bear River First Nation	Atlantic salmon	

Table 12.3 Marine-Associated Species Used by Indigenous Groups (As Identified Through Engagement) and their Potential for Interaction with the Project

Province	Group	Identified Species (See Chapter 3)	Potential for These Resources to Spend Time Within the LSA
	Eskasoni First Nation	Atlantic salmon	
	Glooscap First Nation	Atlantic salmon Swordfish	
	Membertou First Nation	Atlantic salmon	
	Paq'tnkek Mi'kmaw Nation	Atlantic salmon	
	Pictou Landing First Nation	Atlantic salmon	
	Potlotek First Nation	Atlantic salmon	
	Wagmatcook First Nation	Atlantic salmon	
	We'koqma'q First Nation	Atlantic salmon	
	Millbrook First Nation	Atlantic salmon	
	Sipekne'katik First Nation	Atlantic salmon Swordfish	
Quebec	Conseil des Montagnais de Natashquan	Atlantic salmon	• See Section 12.3.2.2.3
	Conseil des Innus de Ekuanitshit	Atlantic salmon Seals Migratory birds and eggs (unspecified)	• See Section 12.3.2.2.3 • Seals: Of the six species of seal known to occur in the Newfoundland and Labrador region, it is possible for two of these species, harp, and hooded seal, to occur in the LSA based on their annual migration patterns and distances covered (Stenson and Sjare 1997; Anderson et al. 2009). It is unlikely the other four species would occur in the LSA. Harbour and grey seals are considered non-migratory and tagging studies have shown they do not travel through the LSA (Lesage et al. 2004; Harvey et al. 2008). Ringed and bearded seals are primarily Arctic species that rarely venture further south than coastal Labrador (Gosselin and Boily 1994; DFO 2011) (See Section 6.3.5)

Table 12.3 Marine-Associated Species Used by Indigenous Groups (As Identified Through Engagement) and their Potential for Interaction with the Project

Province	Group	Identified Species (See Chapter 3)	Potential for These Resources to Spend Time Within the LSA
	La Nation Micmac de Gespeg	Atlantic salmon	• See Section 12.3.2.2.3
	Listuguj Mi'gmaq Government	Atlantic salmon	
	Micmacs of Gesgapegiag	Atlantic salmon	
Atlantic salmon populations known to be or potentially used by these groups are as follows: New Brunswick: Atlantic salmon (Outer Bay of Fundy population, Inner Bay of Fundy population, Gaspe-Southern Gulf of St. Lawrence population) Nova Scotia: Atlantic salmon (Southern Upland population, Eastern Cape Breton population, Gaspe-Southern Gulf of St. Lawrence population Prince Edward Island: Gaspe-Southern Gulf of St. Lawrence population Quebec: Atlantic salmon (Anticosti Island population, Quebec Eastern North Shore population, Quebec Western North Shore population, Inner St. Lawrence population, Gaspe-Southern Gulf of St. Lawrence population)			

As illustrated in Table 12.3, existing and available biological information indicates that a limited number of the marine-associated species that are known to currently be used for traditional purposes by these Indigenous groups (as identified through engagement with these groups, see Chapter 3) have potential to be present in the Project Area / LSA and thus to be affected negatively by planned Project activities. While it is not possible to determine with absolute certainty whether an individual of any species (in any life history stage) used by one or more of these Indigenous groups may be present in the LSA before moving to an area that is the subject of traditional harvesting activity (particularly for juvenile stages of some species with extensive dispersion), the potential is extremely remote for any degree of connection between individuals within the LSA and those which would be harvested by these Indigenous communities for traditional purposes. Moreover, as described for the preceding biophysical VCs (Chapter 8 to 10), the Project is not expected to result in significant adverse effects upon marine fish, birds, or mammals, and the various mitigation measures identified throughout this EIS will help avoid or reduce associated effects on these species.

There is therefore essentially no potential for the biophysical effects of the Project to have an adverse effect on the presence, abundance, distribution, or quality of these resources in any area, and thus, their overall availability for resource use activities by these groups within their traditional harvesting areas several hundred kilometers away. There will be no potential for such biophysical effects (should they occur) to translate into a decrease in the overall nature, intensity, distribution (location or timing), quality or cultural value of these traditional activities by any Indigenous community.

12.3.2.2.3 Atlantic Salmon

As noted previously, in April 2017, the CEA Agency indicated to the Operator that there were "*additional potential impacts of the Project on potential or established rights of Aboriginal peoples under section 35 of the Constitution Act, 1982, and potential effects of changes to the environment on Aboriginal peoples pursuant to paragraph 5(1)(c) of the Canadian Environmental Assessment Act, 2012 (CEAA 2012) related to: the migration of Atlantic salmon between the Project area and areas where Indigenous groups have potential or established section 35 rights …*". Due to an awareness of the importance of this species for a number of Indigenous groups, a more detailed information and biological analysis related to that species and its associated populations and movements is provided in the following sections.

North American Atlantic Salmon Populations

Using available data, habitat use and distribution of each identified salmon population (as defined under COSEWIC) are summarized to identify the specific populations that may interact with the Project. Provided below is a summary of each Atlantic salmon population throughout the eastern North American range. Populations are based on those described in the 2010 COSEWIC Assessment and Status Report on Atlantic salmon (COSEWIC 2010) and include populations identified as endangered by COSEWIC. While each population is described separately, several have been grouped based on similar geographic region because resolution of available data suggests regional marine habitat use and distributions. In 2003, SARA was proclaimed to protect wildlife species at risk in Canada. Within the Act, COSEWIC was established as an independent body of experts responsible for identifying and providing the initial assessment of wildlife species considered to be at risk (COSEWIC 2017). The initial assessment and COSEWIC designation is considered the first step towards protecting wildlife species at risk. Wildlife species that have been considered by COSEWIC may then qualify for legal protection and recovery under SARA although COSEWIC species designations are not automatically adopted within SARA. The Act itself applies only to wildlife species on the SARA legal list.

The 2010 COSEWIC Assessment and Status Report on Atlantic salmon outlines a total of 16 Atlantic salmon populations (COSEWIC 2010). Each of these populations has been delineated in terms of natal river destination within Designatable Units (DU) (Figure 12-2). The general criteria used by COSEWIC to recognize DUs, and therefore populations, is groups of individuals likely exhibiting unique adaptations that are largely component of the species' biodiversity (COSEWIC 2010). Summary information regarding the Atlantic salmon population within each DU is provided primarily from COSEWIC (2010) with updates since the COSEWIC assessment, where applicable.

Nunavik and Labrador Populations

Nunavik Population – Designatable Unit 1: The Nunavik population is within DU1 and is currently considered data deficient by COSEWIC (COSEWIC 2010). Under SARA, this population is not listed. The DU extends from the tip of Labrador west along Ungava Bay to the western extent of the species range and represents the most northerly known population of Atlantic salmon in North America (COSEWIC 2010c). Genetic data suggest that the population is distinct from their nearest neighbour and there is little genetic evidence of straying between Ungava and other regions (COSEWIC 2010).

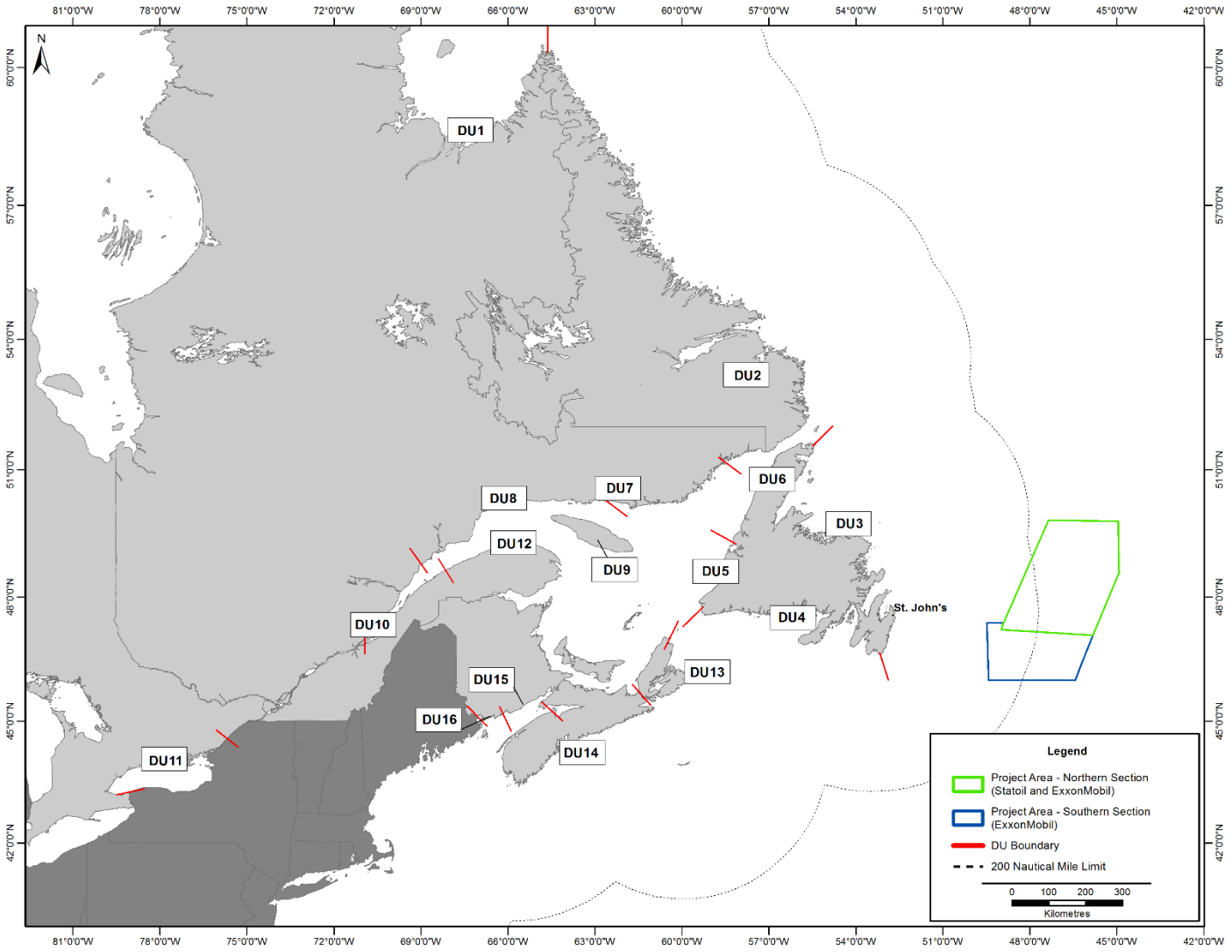


Figure 12-2 Designatable Units (DU) for Atlantic Salmon in Eastern Canada (Reproduced from COSEWIC 2010)

Labrador Population – Designatable Unit 2: The Labrador population is within DU2 and is currently considered Not at Risk by COSEWIC (COSEWIC 2010) and is not listed under SARA (Species at Risk Public Registry 2017). The DU extends from the northern tip of Labrador south along the coast of Labrador to the Napitipi River in Quebec. Given the large size of this geographic region there is substantial potential for smaller regional groupings within the DU, however the available information only supports a clear separation from other regions at the southern portion of the DU (COSEWIC 2010). Genetic data suggest reasonable potential for gene flow and hence re-colonization throughout much of the southern portion of the unit. There is evidence from tagging studies, however, that salmon from the southern portion of this unit do not migrate north of Lake Melville.

Newfoundland Populations Including Southern Newfoundland

Northeast Newfoundland Population - Designatable Unit 3: The Northeast Newfoundland population is within DU3 and is currently considered Not at Risk by COSEWIC (COSEWIC 2010) and is not listed under SARA (Species at Risk Public Registry 2017). The DU extends from the northern tip of Newfoundland south and east along the northeast coast of the Island to the southeast tip of the Avalon Peninsula (COSEWIC 2010). The salmon of the northeast coast of Newfoundland are unique in North America, in that they appear to have genetic profiles intermediate to European and North American salmon. Mean age of smoltification was intermediate between Labrador and the rest of Newfoundland (3-5 years versus 5-7 in Labrador and 2-4 in southern Newfoundland DUs). The proportion of grilse that were smaller 1SW females was relatively high as was the incidence of repeat spawners. The Exploits and Terra Nova Rivers were stocked extensively in the 1980s and 1990s after new habitat was made accessible with fishways.

South Newfoundland Population - Designatable Unit 4: The South Newfoundland population is within DU4 and is currently considered Threatened by COSEWIC (COSEWIC 2010) and listed as No Status under SARA (Species at Risk Public Registry 2017). The DU extends from the southeast tip of the Avalon Peninsula (Mistaken Point) westward along the south coast of Newfoundland to Cape Ray. Unlike DU3, freshwater habitat in DU4 tends to have relatively low pH values (5.0-6.0). Genetic data suggest that populations along this coast have reduced gene flow among local rivers and between DU4 and other regions of the Island (COSEWIC 2010). Salmon in DU4 experience substantially different ocean conditions than fish in DUs 2-3, entering an area influenced by the Gulf Stream compared to the Labrador Current (COSEWIC 2010). Population trends for south coast rivers also appear to be distinct from the other DUs in Newfoundland.

Southwest Newfoundland (Bay St. George Region) Population – Designatable Unit 5: The Southwest Newfoundland population is within DU5 and is currently considered Not at Risk by COSEWIC (COSEWIC 2010) and is not listed under SARA (Species at Risk Public Registry 2017). The DU extends from Cape Ray northwards along the west coast of Newfoundland to approximately 40° 24'N, 58° 15' W. This DU is the only region in insular Newfoundland with large numbers of MSW salmon and minimal lacustrine habitat. Genetic comparisons of populations in this region with those in the rest of the Island suggest the populations here represent a distinct group, but that within the region gene flow appears to be higher than in DUs 3 and 4. DU5 also has the youngest mean smolt ages (3 years) on insular Newfoundland and the lowest proportion of female grilse (COSEWIC 2010). DU5 is separated from mainland DUs by the Gulf of St. Lawrence and genetic data suggest low levels of gene flow between insular populations and the mainland (COSEWIC 2010).

Northwest Newfoundland Population – Designatable Unit 6: The Northwest Newfoundland population is within DU6 and is currently considered Not at Risk by COSEWIC (COSEWIC 2010) and is not listed under SARA (Species at Risk Public Registry 2017). The DU extends from approximately 40° 24'N, 58° 15' W to the tip of the Great Northern Peninsula. Smolts from populations of DU6 most likely migrate northward through the Strait of Belle Isle (COSEWIC 2010). Freshwater habitat in DU6 is significantly more alkaline than the rest of insular Newfoundland due to a large amount of limestone in the region's geology (COSEWIC 2010). Genetic data for this DU are sparse.

Gulf of St. Lawrence Populations

Quebec Eastern North Shore Population – Designatable Unit 7: The Quebec Eastern North Shore population is within DU7 and is currently listed as Special Concern by COSEWIC (COSEWIC 2010) but has No Status under SARA (Species at Risk Public Registry 2017). The DU extends from the Napitipi River (not inclusive) westward along the north shore of the St. Lawrence to the Kegaska River (inclusive) in the west. DU7 is characterized by populations with high proportions of 1SW salmon and rivers with lower temperature regimes than DU8. The genetic data also suggest these populations have lower levels of gene flow within the DU than within other areas of the North Shore (COSEWIC 2010).

Quebec Western North Shore Population – Designatable Unit 8: The Quebec Western North Shore population is within DU8 and is currently considered Special Concern by COSEWIC (COSEWIC 2010) but has No Status under SARA (Species at Risk Public Registry 2017). The DU extends eastward from the Natashquan River (inclusive) along the Quebec North Shore to the Escoumins River in the west (inclusive). The salmon of DU8 have the highest proportion of MSW salmon by a wide margin relative to the other populations in the North Shore DUs (COSEWIC 2010) and stocking in this DU was substantial and has occurred in multiple rivers.

Anticosti Island Population – Designatable Unit 9: The Anticosti Island population is within DU9 and is currently considered Endangered by COSEWIC (COSEWIC 2010) but has No Status under SARA (Species at Risk Public Registry 2017). The DU encompasses Anticosti Island.

Inner St. Lawrence Population – Designatable Unit 10: The Inner St. Lawrence population is within DU10 and is currently considered Special Concern by COSEWIC (COSEWIC 2010) but has No Status under SARA (Species at Risk Public Registry 2017). The DU extends west along the northern shore of the St. Lawrence from the Escoumins River (not included) into the lower St. Lawrence River and returns eastward along the southern shore of the St. Lawrence to the Ouelle River (included). DU10 is characterized by a higher proportion of 1SW salmon than the Quebec Western North Shore (DU8) and a lower mean age at smoltification. Freshwater habitat is also the warmest along the Quebec North Shore (COSEWIC 2010).

Lake Ontario Population – Designatable Unit 11: The Lake Ontario population is within DU11 and is currently considered Extinct by COSEWIC (COSEWIC 2010) and has No Status under SARA (Species at Risk Public Registry 2017). Approximately 67 tributaries of Lake Ontario were known to support runs of Atlantic salmon (COSEWIC 2010). Scales obtained from two adult museum specimens indicate an exclusively freshwater growth history, suggesting that at least some salmon populations that originally inhabited Lake Ontario were freshwater resident and did not migrate to

sea (COSEWIC 2010). COSEWIC (2010) suggests that Lake Ontario Atlantic salmon populations were likely reproductively isolated from other Atlantic salmon populations in North America.

Gaspe-southern Gulf of St. Lawrence Population – Designatable Unit 12: The Gaspe-southern Gulf of St. Lawrence population is within DU12 and is currently considered Special Concern by COSEWIC (COSEWIC 2010) but has No Status under SARA (Species at Risk Public Registry 2017). The DU extends from the Ouelle River (excluded) in the western Gaspe to the northern tip of Cape Breton. Genetic data are not available for Atlantic salmon on PEI; however, it is thought that salmon in small streams probably reflect the province's original populations, those in larger PEI streams are heavily influenced by stocking from eastern New Brunswick (COSEWIC 2010). PEI has also provided salmon eggs for other rivers in the Maritimes and received substantial numbers of eggs and juveniles from mainland rivers; for most of this DU, stocking events have been common for at least the past 100 years (COSEWIC 2010). For these reasons, PEI salmon are placed within DU12.

Eastern - Southern Nova Scotia and Outer Bay of Fundy Populations

Eastern Cape Breton Population – Designatable Unit 13: The Eastern Cape Breton population is within DU13 and is currently considered Endangered by COSEWIC (COSEWIC 2010) but has No Status under SARA (Species at Risk Public Registry 2017). The DU extends from the northern tip of Cape Breton Island to northeastern Nova Scotia (approximately 45° 21'N, 61° 28'W). The salmon in this DU appear to be genetically distinct from its southern neighbour, DU14 (Nova Scotia Southern Upland).

Nova Scotia Southern Upland Population – Designatable Unit 14: The Nova Scotia Southern Upland population is within DU14 and is currently considered Endangered by COSEWIC (COSEWIC 2010) but has No Status under SARA (Species at Risk Public Registry 2017). The DU extends from northeastern mainland Nova Scotia (approximately 45° 21'N, 61° 28'W) southward and into the Bay of Fundy to Cape Split. Many rivers in DU14 have freshwater habitat with relatively low pH. They also have lower proportions of MSW fish than their northern neighbours. Southerly populations in DU14 also have some of the youngest smolt ages reported in Canada (COSEWIC 2010). This DU also has an extensive history of stocking, including recent efforts to slow the decline of a few of the severely depressed populations in the DU.

Outer Bay of Fundy Population – Designatable Unit 16: The Outer Bay of Fundy population is within DU16 and is currently considered Endangered by COSEWIC (COSEWIC 2010) but has No Status under SARA (Species at Risk Public Registry 2017). This DU extends westward from just east of the Saint John River estuary to the border with the United States (US). Within this DU, there is a higher proportion of MSW salmon migrating to the North Atlantic than DU15. While the DU terminates at the US border, from a biological perspective, the US populations may be included in the DU (COSEWIC 2010).

Inner Bay of Fundy Population – Designatable Unit 15

The Inner Bay of Fundy population is within DU15 and is currently considered Endangered by both COSEWIC (COSEWIC 2010) and under SARA (Species at Risk Public Registry 2017). This DU extends from Cape Split around the Inner Bay of Fundy to a point just east of the Saint John River estuary. This DU has strong genetic differentiation from nearby DUs and appears to exhibit unique

migratory behaviour (within the Bay of Fundy / Gulf of Maine (COSEWIC 2010). Over 40 million salmon of differing ages have been stocked into rivers of this region since the turn of the 20th century. Early sources of stockings are unclear, but recent stocking has been done with Inner Bay of Fundy progeny (COSEWIC 2010). Recent stocking events, intended to maximize exposure of salmon to wild environmental conditions are part of a captive-rearing program thought to have prevented, at least temporarily, the extinction of salmon in this DU (COSEWIC 2010).

Habitat Use and Potential Interaction of Each Salmon Population

As described in Chapter 6, post-smolt and adult salmon are concentrated throughout the year in the Labrador Sea where they feed and overwinter. Adult salmon, primarily multi-sea-winter (MSW) fish, are also located off west Greenland during summer and fall. In the spring, both grilse and MSW adults appear to congregate in two general locations; near the eastern slope of the Grand Bank of Newfoundland and approximately 480 km east of the Strait of Belle Isle (Reddin and Friedland 1993; Reddin 2006) prior to their spawning migrations back to their natal rivers. Also noted earlier, smolt ages indicate that salmon congregating off the east Grand Bank area indicate that they are from more southern populations of South Newfoundland, the Maritimes, and Maine.

Labrador and Nunavik Populations

There are 89 rivers in Labrador with known salmon populations, although it is noted that many rivers with unknown status have never been surveyed (Reddin et al. 2010). Marine survival of smolt to adult small salmon returning to Sand Hill River in 2013 has been estimated at two percent, which included both natural mortality as well as that from Indigenous and subsistence fisheries at sea (CSAS 2015). The degree of post-smolt migration to the Labrador Sea varies by population and geographic location of their home river; however, age analysis of salmon captured in the Labrador Sea, West Greenland, and off the east Grand Banks, indicate that post-smolt and adult salmon from Labrador generally feed and overwinter in the Labrador Sea and are not known to travel south as they return to natal rivers, likely follow the coast. Multi-sea winter salmon also migrate to the north Labrador Sea and west Greenland during their second year to complete their growth prior to returning to home rivers to spawn. Genetic analysis of Atlantic salmon captured in coastal Labrador by Labrador Indigenous and subsistence fisheries indicated that the majority (85-98 percent) of individuals harvested over 2006-2011 were of Labrador origin and that those from more southern non-local populations (e.g., Maritimes and Gaspe Peninsula) were rare and occurred primarily in southern Labrador, consistent with discrete migrations pathways through the Strait of Belle Isle (CSAS 2015).

Given that the river ages of salmon located off the east Grand Bank are younger than those typical from Labrador rivers, the data suggest that most salmon from the Labrador region do not likely migrate to the more southern area of congregation and therefore interaction of these populations with the Project Area / LSA can be considered negligible.

Insular Newfoundland Populations

There are a total of 305 rivers with known salmon populations in Newfoundland (Reddin et al. 2010). River age data suggest that salmon along the eastern edge of the Grand Bank would at least be partially of Newfoundland origin (particularly the southern portion of the Island).

This indicates that salmon of Newfoundland origin would likely feed and overwinter in the Labrador Sea and a portion of them may congregate off the eastern edge of the Grand Bank in spring prior to completing their spawning migration back to their natal rivers. Catch data indicate that post-smolt do not likely overwinter in the Flemish Pass area (Reddin and Friedland 1993; Reddin 2006); however, mapping in Reddin (2006) shows some potential for this. In terms of initial post-smolt migration from their natal river to feeding areas in the Labrador Sea, prevailing currents along eastern Newfoundland and the Grand Bank are generally a southern flow, therefore smolt energy expenditure would be higher, particularly in the higher southerly flows of the Flemish Pass. It is likely that smolt would avoid these areas of increased southern flow while migrating north to the Labrador Sea and follow a generally coastal route (CSAS 2013) before moving offshore. Acoustic tracking of smolt and kelt (CSAS 2013) from Conne River Newfoundland confirms this route before moving offshore. Based on tag recaptures, post-smolt from rivers in Newfoundland migrate near the coast of eastern Newfoundland, arriving in the southern Labrador Sea in early August (Reddin and Friedland 1993). Tagging studies show that adult salmon migrating southward from feeding and overwintering areas to southern Newfoundland rivers in the spring first move into Newfoundland coastal waters and then move coastwise in a southerly and then westerly direction along the Newfoundland coast (Reddin and Friedland 1993).

In terms of habitat preferences, it has been shown that avoidance of lower water temperatures, particularly below 3°C, can play a predictive role in habitat use near the Grand Bank and Flemish Pass. Statistical summaries of sea temperature were derived from the ODI of the Bedford Institute of Oceanography (DFO 2016) for a rectangular area surrounding the Project Area, querying the period 1900 to 2016 for depths down to 3,000 m. Tables 5.25 and 5.27 (see Chapter 5, Existing Physical Environment) presents monthly depth profile statistics of mean, minimum and maximum sea temperature together with a count of the number of months for which there are data for the given month and depth range. Mean SSTs range from 1.6°C in March to 5.3°C in October. Minimum temperatures at the surface range from -1.8°C in January to 1.1°C in August and September. Maximum sea surface temperatures range from 4.0°C in March to 11.8°C in August. This seasonal temperature cycle is observed down to 250 m, where temperatures are higher in the summer than in winter. As shown, mean sea surface temperature values greater than 3°C occur between July and November and the preferred range (4°C-8°C) can occur between July and October. Minimum SSTs for every month are below 3°C.

The summary of available data regarding insular Newfoundland populations indicates that a portion of 1SW and MSW adults, primarily from the southern Newfoundland population, congregate off the east Grand Bank prior to their spring spawning migration back to their natal river. Since the majority of known post-smolt overwintering occurs in the Labrador Sea, migration to the east Grand Bank area must occur; however, the exact migration route is not known and may be influenced by SST during the time of migration. For example, the monthly SST values around the Project area are a general indication that Atlantic salmon would not use it outside the months July through to November and based on the SST temperatures recorded, if salmon use it during the summer/autumn period (22 June – 22 December), that it would be restricted and most likely limited.

As shown in Reddin and Shearer (1987), Atlantic salmon captures during the spring were low (0.0-1.0 fish per nautical mile of drift gillnet fished per hour) while efforts during winter had no catches near the Project Area (see Figure 6-40). No life stage of Atlantic salmon is dependent upon the Project Area and use is likely restricted to limited migration at low densities in those years when spring water temperatures exceed 3°C. However, it should be noted that surveys of the area are limited, and regional variations in abundance have been reported (DFO pers. comm.).

Given the available data, spring migration of adults within and near the Project Area is possible and therefore interaction between these populations and the Project is considered possible but of low likelihood.

Gulf of St. Lawrence Populations

As noted above, post-smolt are distributed according to prevailing surface currents and strong currents act as transportation vectors that facilitate migration to marine feeding areas (Jonsson et al. 1993) to reduce energy needs. This process appears to influence the migratory pathway for post-smolt within the Gulf of St. Lawrence region. For example, post-smolt from the north shore of the Gulf of St. Lawrence, as well as the Miramichi, Restigouche, and Cascapedia rivers, follow the coast eastward and use the Strait of Belle Isle as their major pathway during emigration to the North Atlantic (Lefevre et al. 2012; Strom et al. 2017). Post-smolt from other rivers farther south on the Gaspe Peninsula have been recaptured near both the Strait of Belle Isle and Cabot Strait.

Caron (1983) and Dutil and Coutu (1988) concluded that some Gulf of St. Lawrence stocks delayed migration from the Gulf and that at least some post-smolt remained there until late autumn. Post-smolt have been captured as bycatch in herring gear in the northern Gulf of St. Lawrence in late summer (COSEWIC 2010; CSAS 2012) and the winter destination of these late migrations remains unknown. Post-smolt within the Gulf of St. Lawrence were also recorded as spending more time in near-shore coastal habitat than smolt from other regions, which spend little time in or near estuary habitat (COSEWIC 2010). Once moving to open sea, post-smolt from the Gulf tend to head in a general northward direction (COSEWIC 2010; Strom et al. 2017). This suggests that post-smolt from the Gulf of St. Lawrence travel to the Labrador Sea primarily in a northerly route through the Strait of Belle Isle and eastward around the Island of Newfoundland. They may also delay migration away from estuary habitat and the Gulf in general until late fall and may overwinter in the Gulf area for their first winter.

CSAS (2012) indicates that the west Greenland fishery has captured salmon from Gulf of St. Lawrence rivers with an estimated harvest of 3-10% of total sea winter salmon being from the region (2006-2011). River age data suggest that salmon along the eastern edge of the Grand Bank (see Figure 12-2) would at least be partially of Gulf of St. Lawrence origin (particularly the southern portion of the Gulf of St. Lawrence).

Similar to Atlantic salmon from the Southern Newfoundland population, salmon of Gulf of St. Lawrence origin would likely feed and overwinter in the Labrador Sea and a portion of them may congregate off the eastern edge of the Grand Bank in spring prior to completing their spring spawning migration back to natal rivers. Post-smolt from this region would also be similar to those of insular Newfoundland in that they are not known to overwinter in the Flemish Pass area (Reddin and

Friedland 1993); however, mapping in Reddin (2006) shows some potential for this. In terms of initial post-smolt migration from their natal river to feeding areas in the Labrador Sea, it would also be likely that they follow a generally coastal route along the coast of Newfoundland (Reddin and Friedland 1993; CSAS 2013) before moving offshore. Returning adults to the Gulf of St. Lawrence in the spring would also tend to move into Newfoundland coastal waters and then move coastwise in a southerly and then westerly direction along the Newfoundland coast (Reddin and Friedland 1993).

While spring migration through and near the Project Area is possible, salmon from the Gulf of St. Lawrence would be influenced by SST similar to other Atlantic salmon populations previously noted. Monthly SST values around the Project Area are a general indication that Atlantic salmon would not use the area outside the months July through to November and based on the SST temperatures recorded, if Gulf of St. Lawrence salmon use the area, that it would be restricted and most likely limited. However, it should be noted that surveys of the area are limited, and regional variations in abundance have been reported (DFO pers. comm.).

As shown in Reddin and Shearer (1987), Atlantic salmon captures during the spring were low (0.0-1.0 fish per nautical mile of drift gillnet fished per hour) while efforts near the Project Area during winter produced no catches (see Figure 6-40 in Section 6.1.7.4). No life stage of Atlantic salmon is dependent upon the Project Area and use is likely restricted to limited migration at low densities in those years when spring water temperatures exceed 3ºC.

Given the available data, spring migration of adults within and near the Project Area is possible and therefore interaction between these populations and the Project Area is considered possible but of low likelihood.

Eastern - Southern Nova Scotia and Outer Bay of Fundy Populations

In terms of marine use and distribution data, the Eastern – Southern Nova Scotia and Outer Bay of Fundy Atlantic salmon populations cannot be differentiated from that of Southern Newfoundland or the Gulf of St. Lawrence populations. Post-smolt migrating to the Labrador Sea and adults returning to natal streams in the spring would follow similar patterns of movement as described above; however, there is no evidence that post-smolt delay migration to the Labrador Sea.

Therefore, it can be assumed that salmon of this region feed and overwinter in the Labrador Sea and a portion of them may congregate off the eastern edge of the Grand Bank in spring prior to completing their spring spawning migration back to natal rivers. Post-smolt from this region would not likely overwinter in the Flemish Pass area (Reddin and Friedland 1993); however, mapping in Reddin (2006) show some potential for this. In terms of initial post-smolt migration from their natal river to feeding areas in the Labrador Sea, it is also likely that they follow a generally coastal route along the coast of Newfoundland (CSAS 2013; Reddin and Friedland 1993) before moving offshore. Returning adults to the Gulf of St. Lawrence in the spring will also tend to move into Newfoundland coastal waters and then move coastwise in a southerly and then westerly direction along the Newfoundland coast (Reddin and Friedland 1993).

While spring migration through and near the Project Area is possible, salmon from the Eastern – Southern Nova Scotia and Outer Bay of Fundy populations would be influenced by SST similar to other Atlantic salmon populations previously noted. Monthly SST values around the Project Area are a general indication that Atlantic salmon do not use the area outside the months July through to November and based on the SST temperatures recorded, if Gulf of St. Lawrence salmon use the area, that it is be restricted and most likely limited.

As shown in Reddin and Shearer (1987), Atlantic salmon captures during the spring were low (0.0-1.0 fish per nautical mile of drift gillnet fished per hour) while efforts near the Project Area during winter produced no catches (see Figure 6-40). No life stage of Atlantic salmon is dependent upon the Project Area and use is likely restricted to limited migration at low densities in those years when spring water temperatures exceed 3ºC. However, it should be noted that surveys of the area are limited, and regional variations in abundance have been reported (DFO pers. comm.).

Given the available data, spring migration of adults within and near the Project Area is possible and therefore interaction between these populations and the Project Area is considered possible but of low likelihood.

Inner Bay of Fundy Population

The Atlantic salmon population of the inner Bay of Fundy (iBoF) have been listed as Endangered on Schedule 1 of SARA (CSAS 2016) and is the only population listed under the Act. Post-smolt from rivers in the iBoF have been observed to remain in the Bay of Fundy until late summer and while the exact overwintering location is unknown, lack of tag recoveries from distant intercept fisheries indicate the iBoF salmon do not go as far north as other salmon stocks and few are caught outside the Bay itself (COSEWIC 2010c). In 2013, DFO reviewed and evaluated the available iBoF salmon data to identify important marine and estuarine habitat needed to complete all life history stages (DFO 2013).

While the data available to determine habitat important for overwintering for all stages (November – April) is limited, it is now suggested that overwintering occurs off the Scotian Shelf or the southern portion of the Gulf of Maine (CSAS 2016). As a result, interaction with the Project Area does not occur.

Summary

While it is not possible to say with certainty whether an individual of this species may migrate to and through the LSA before moving to an area that is the subject of traditional harvesting activity, as reflected in the above discussion, it is possible that a portion of the southern Newfoundland, Gulf of St. Lawrence, Eastern - Southern Nova Scotia and Outer Bay of Fundy populations may migrate through the Project Area as they migrate between the Labrador Sea feeding / overwintering area and the southern slopes of the Grand Bank at the beginning of spring spawning migrations. Catch data in Reddin and Friedland (1993) indicate post-smolt do not overwinter in the Grand Bank area during the period 23 December-21 March. Reddin (2006) notes that post-smolt may overwinter off the Grand Bank but states that corroborative evidence from directed research or indirectly by commercial vessels fishing during the winter is lacking. As shown by the available data, large concentrations are not likely, and sea surface temperatures would likely limit habitat use to temporary movement

corridors during times of favourable water temperatures. Moreover, given the relatively small area within which the planned Project activities and their potential environmental zones of influence would occur, and the short-term nature of these activities, there is a very low likelihood of interactions.

As described for the various preceding biophysical VCs (Chapter 8 to 10), the Project is not expected to result in significant adverse residual effects upon marine fish, birds, or mammals, with the implementation of mitigation measures identified in the EIS. The Project will not have a significant effect on the presence, abundance, distribution, or quality such resources in the area, and thus, their availability for resource use activities by these groups within their traditional harvesting areas. There will be no potential for such direct and/or indirect effects on Atlantic salmon to translate into a decrease in the overall nature, intensity, distribution, quality, or cultural value of these traditional activities by Indigenous communities.

12.3.2.2.4 Swordfish

In addition to Atlantic salmon and the potential effects of the Project on this species and its associated use by Indigenous communities, a number of Indigenous groups in Eastern Canada hold commercial-communal swordfish licences in NAFO Divisions that overlap with the Project Area, LSA and/or larger RSA (see Section 7.3). As noted in Chapter 3, these commercial fisheries activities formed the basis of a number of groups' stated interest in the Project and its EIS, and so potential effects on this species and these commercial fishing activities are given specific focus in the effects assessment for this VC.

Although swordfish comprise a relatively limited amount of the overall commercial fisheries off Eastern Newfoundland (see Chapter 7) and elsewhere in Atlantic Canada, it is a relatively high value fishery overall. Like other large pelagic fisheries in the region, the fishery is focused primarily on the shelf break or in deeper waters to the south and east, and uses longline gear. Typically, swordfish longlines are set out for a day or less and then pulled back aboard the ship with its catch; the preferred "soak" time is at night when fish are most active. Most fishing effort for this species has been concentrated in the Maritimes Region, but some harvesters do follow the fish eastwards to areas off southern and eastern Newfoundland. DFO reported total landings of nearly 1,600 tonnes of swordfish worth $13 million in 2015, all by Maritimes-based enterprises (DFO 2017). Domestic swordfish harvesting levels have been relatively low in the Newfoundland and Labrador Region, as compared to landings from Georges Bank and the Scotian Shelf in the Maritimes Region. Typically, the movement from the Scotian Shelf to the Grand Bank occurs in mid- to late summer, depending on fishing conditions in the west, and some harvesters may continue fishing in the east until late fall.

Figure 12-3 illustrates the known distribution of domestic (landed in Canada) commercial fishing activity for swordfish for the period 2011-2015, based on the DFO commercial fisheries geospatial datasets described and used in Chapter 7. As illustrated, there has been no recorded fishing activity for swordfish within or near the LSA over this period (Figure 12-3), with recorded catches occurring in NAFO Unit Areas well south of the Project Area, in NAFO Division 3O. As such, there is limited potential for negative interactions between planned Project activities and fishing activity for swordfish by either Indigenous or non-Indigenous fishing enterprises. In the event that commercial swordfish harvesting is undertaken within the LSA over the duration of this Project, potential effects would be similar to those described in Chapter 13 for commercial fisheries in general. Although Project components and activities, including the associated safety zones, will temporarily reduce access for fishing and other activities in certain areas, any such disturbances will be localized, short term, and reversible once Project activity ceases at a location. The potential for interference will be further mitigated through good communication and cooperation between industries, with fishing gear damage compensation initiatives being implemented as required. This, along with the relatively localized and in most cases short-term duration of these disruptions, the limited amount of sword fishing activity in the region overall, and the amount of alternative fishing areas available, will mean that detectable effects on the overall nature, location, timing, or value of these activities are unlikely.

This VC assessment also considers potential indirect effects on such activities, including whether and how Project-related changes in and effects on the biophysical environment off Eastern Newfoundland (within the LSA) may affect resources that are used by Indigenous groups, including as a result of the known migration and movement patterns of marine-associated biota that are known to be used for these purposes. Swordfish have large-scale migration ranges that are ocean-wide in scale and occur primarily in a north-south pattern (Hoey et al. 1989; Trenkel et al. 2014). They are generally associated with thermal fronts, where there is large horizontal temperature gradients in the water column (Podesta et al. 1993, Dewar et al. 2011) that result in increased densities of swordfish prey items such as squid (Stilwell and Kohler 1985). The mixing of the cold Labrador Current and the North Atlantic Current creates these types of thermal fronts in some areas off Eastern Newfoundland, including the Newfoundland Seamounts and Flemish Cap (Carr et al. 2001), both of which are outside the LSA.

Therefore, while the LSA and RSA are located within the overall areas used by swordfish, their overall distribution and migration patterns include most of the North Atlantic Basin (Dewar et al. 2011; Trenkel et al. 2014). Swordfish numbers and their overall ranges and migration patterns therefore make it unlikely that individuals or populations would interact with and be negatively affected by planned Project activities, and especially, that this would translate into a decrease in the overall presence, abundance, distribution, or quality of this resource in any area, and thus, their overall availability for resource use activities by any Indigenous groups. No adverse effects oncurrent or potential commercial-communal harvesting of this species by Indigenous communities are therefore expected.

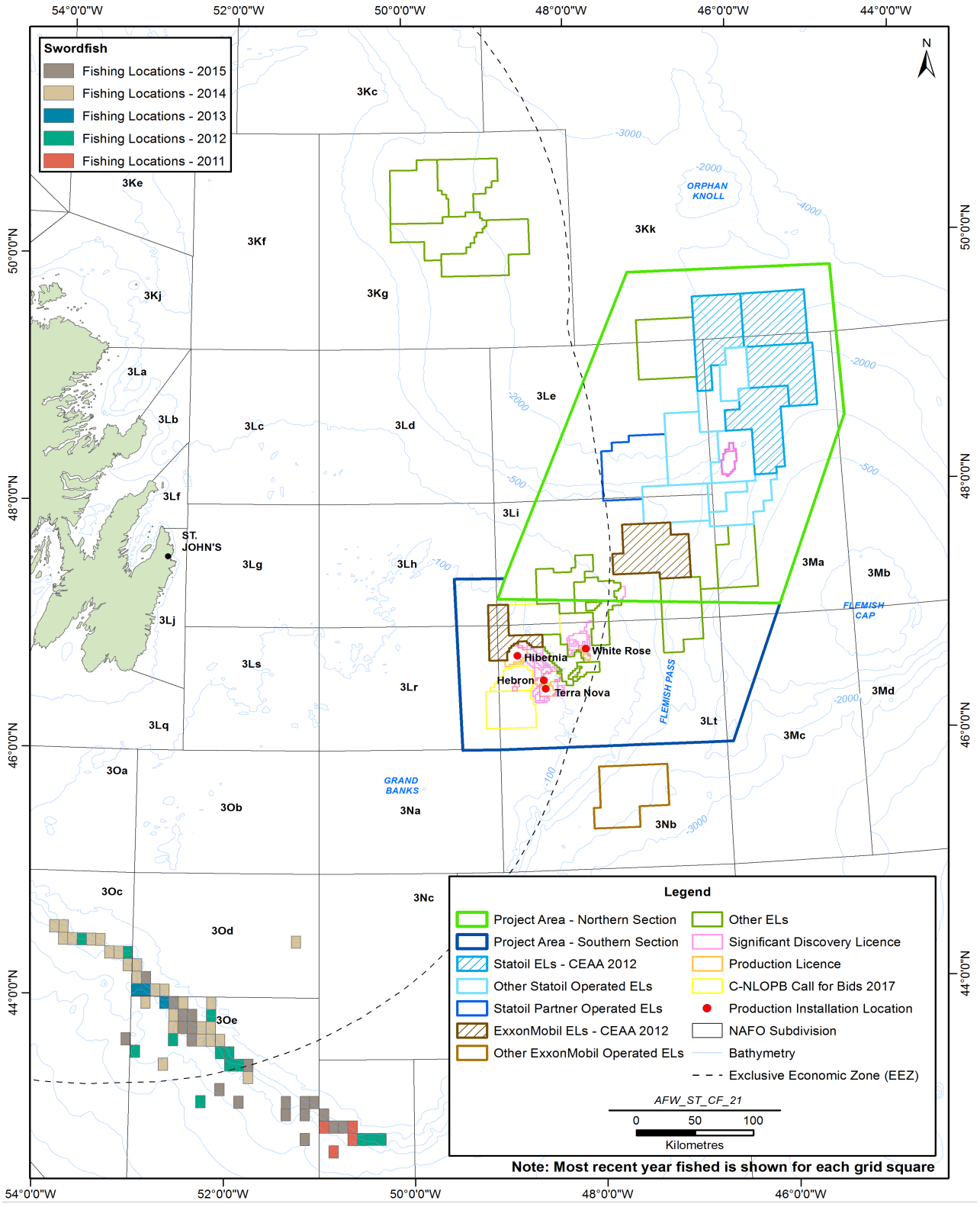


Figure 12-3 Domestic Commercial Harvesting Locations: Swordfish (2011-2015)

12.3.2.3 Physical and Cultural Heritage, Including Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance

The Project Area and LSA are not known to contain resources of historical, archaeological, paleontological, or architectural significance, and given its location far offshore Eastern Newfoundland, are not likely to contain such resources or materials that are relevant to and valued by Indigenous groups. As discussed above, based on the nature, location, extent and duration of planned Project activities and the associated emission and discharges, the Project will not interact with nor adversely affect physical and cultural sites, including structures, sites, or things of historical, archaeological, paleontological, or architectural significance.

12.4 Significance of Residual Environmental Effects

This section summarizes the predicted residual effects of the Project on Indigenous communities and their activities, and presents a determination of significance for the environmental effects assessment for this VC.

12.4.1 Residual Environmental Effects Summary

Table 12.4 summarizes the environmental effects assessment for the Project as a whole, including characterization of potential effects from potential Project interactions and applicable mitigation measures relating to Indigenous Communities and Activities. Tables 12.5 to 12.11 then provide individual environmental effects assessment summaries for planned Project activities on each of the ELs that comprise the Project being assessed under CEAA 2012. Given the nature, location and timing of the various Project activities and associated environmental interactions, it is not anticipated to have adverse effects on Indigenous communities and their activities (Table 12.4).

Most Project-related activities will take place in an offshore marine environment, hundreds of kilometers from land and away from any Indigenous community. Project-related emissions and discharges and environmental interactions will be localized and short-term in nature (Chapter 8 to 10), and are unlikely to extend to or affect the physical or social health and well-being or other socioeconomic conditions of an Indigenous community. Fishing enterprises associated with Indigenous groups undertake commercial fishing activities off Eastern Newfoundland. However, as determined through existing documentation and engagement with Indigenous groups, there are no food, social or ceremonial licences within or near the Project Area / LSA and groups do not otherwise undertake the current use of lands and resources for traditional purposes within or near this area. There are also no other known aspects of the physical and cultural heritage of these groups located in proximity to, or which may otherwise be affected by, the Project.

Table 12.4 Environmental Effects Assessment Summary: Indigenous Communities and Their Activities – Overall Project

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY	
Summary of Existing Conditions and Ecological and Social Context: Project Area / LSA • There are no communities or other aspects of the physical / cultural heritage and other socioeconomic components and activities of any Indigenous groups located within or near the Project Area / LSA • Other past and on-going projects and activities in Eastern Canada have, to varying degrees, interacted with and affected Indigenous communities and activities, depending on their location, nature, and scale in relation to the communities, activities and other components and interests of individual groups. • The description of the socioeconomic characteristics of these Indigenous communities provided in the EIS inherently reflects any such past and on-going activities and effects	**Summary of Key Mitigation** • Mitigation measures that are outlined elseswhere in this EIS will serve to avoid or reduce Project-related environmental emissions, disturbances and resulting environmental changes by reducing the nature, degree, extent and duration of these changes, and therefore reducing the potential for these to interact with and adversely affect the various components and activities that comprise this VC • A copy of the EA update will be sent to Indigenous groups and stakeholders identified in Chapter 3. The Operator will follow up with Indigenous groups and stakeholders on questions arising from the EA update • The Operator will continue to communicate with relevant Indigenous communities and representative organizations, through established and/or informal engagement processes, as required and requested. The specific nature, frequency, subject matter and format of such future engagement will be determined in discussion with the Indigenous organization and outlined in an Indigenous Communities Fisheries Communication Plan

Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors						
		Nature / Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty
Presence and Operation of Drilling Installation	• Possible direct interactions (interference or disturbances) with Indigenous communities and their activities Possible effects through associated changes to the biophysical environment (health, resource availability or quality)	N	-	-	-	-	-	H

Table 12.4 Environmental Effects Assessment Summary: Indigenous Communities and Their Activities – Overall Project

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Drilling and Associated Marine Discharges	• As above	N	-	-	-	-	-	H
Formation Flow Testing with Flaring	• As above	N	-	-	-	-	-	H
Wellhead Decommissioning	• As above	N	-	-	-	-	-	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• As above	N	-	-	-	-	-	H
Geological, Geotechnical and Environmental Surveys	• As above	N	-	-	-	-	-	H
Supply and Servicing	• As above	N	-	-	-	-	-	H

Evaluation of Significance

- As there are no Indigenous communities or other aspects of the physical / cultural heritage and other socioeconomic components and activities of these groups located within or near the Project Area / LSA, and because the environmental changes and effects of the Project will not otherwise extend to and affect lands and resources that are currently used by these groups for traditional purposes, the Project will not have adverse effects on this VC.
- The planned components and activities associated with the Project will therefore not likely have significant adverse effects upon Indigenous communities and their activities.

NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.

KEY

Nature / Direction:

P Positive
A Adverse
N Neutral (or No Effect)

Certainty in Predictions:

L Low level of confidence
M Moderate level of confidence
H High level of confidence

Table 12.5 Environmental Effects Assessment Summary: Indigenous Communities and Their Activities – EL 1135

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Summary of Existing Conditions and Ecological and Social Context: EL 1135 • There are no communities or other aspects of the physical / cultural heritage and other socioeconomic components and activities of any Indigenous groups located within or near this EL. • The description of the socioeconomic characteristics of Indigenous communities provided in the EIS inherently reflects the effects of any past and on-going activities and effects								**Summary of Key Mitigation** See Table 12.4
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature / Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of Drilling Installation	• Possible direct interactions (interference or disturbances) with Indigenous communities and their activities Possible effects through associated changes to the biophysical environment (health, resource availability or quality)	N	-	-	-	-	-	H
Drilling and Associated Marine Discharges	• As above	N	-	-	-	-	-	H
Formation Flow Testing with Flaring	• As above	N	-	-	-	-	-	H
Wellhead Decommissioning	• As above	N	-	-	-	-	-	H

Table 12.5 Environmental Effects Assessment Summary: Indigenous Communities and Their Activities – EL 1135

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• As above	N	-	-	-	-	-	H
Geological, Geotechnical and Environmental Surveys	• As above	N	-	-	-	-	-	H
Supply and Servicing	• As above	N	-	-	-	-	-	H

Evaluation of Significance

- As there are no Indigenous communities or other aspects of the physical / cultural heritage and other socioeconomic components and activities of these groups located within or near the Project Area / LSA, and because the environmental changes and effects of the Project will not otherwise extend to and affect lands and resources that are currently used by these groups for traditional purposes, the Project will not have adverse effects on this VC.
- The planned components and activities associated with the Project will therefore not likely have significant adverse effects upon Indigenous communities and their activities.

NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.

KEY: See Table 12.4

Table 12.6 Environmental Effects Assessment Summary: Indigenous Communities and Their Activities – EL 1137

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Summary of Existing Conditions and Ecological and Social Context: EL 1137 • There are no communities or other aspects of the physical / cultural heritage and other socioeconomic components and activities of any Indigenous groups located within or near this EL. • The description of the socioeconomic characteristics of Indigenous communities provided in the EIS inherently reflects the effects of any past and on-going activities and effects.								**Summary of Key Mitigation** See Table 12.4
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature / Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of Drilling Installation	• Possible direct interactions (interference or disturbances) with Indigenous communities and their activities Possible effects through associated changes to the biophysical environment (health, resource availability or quality)	N	-	-	-	-	-	H
Drilling and Associated Marine Discharges	• As above	N	-	-	-	-	-	H
Formation Flow Testing with Flaring	• As above	N	-	-	-	-	-	H
Wellhead Decommissioning	• As above	N	-	-	-	-	-	H

Table 12.6 Environmental Effects Assessment Summary: Indigenous Communities and Their Activities – EL 1137

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• As above	N	-	-	-	-	-	H
Geological, Geotechnical and Environmental Surveys	• As above	N	-	-	-	-	-	H
Supply and Servicing	• As above	N	-	-	-	-	-	H

Evaluation of Significance

- As there are no Indigenous communities or other aspects of the physical / cultural heritage and other socioeconomic components and activities of these groups located within or near the Project Area / LSA, and because the environmental changes and effects of the Project will not otherwise extend to and affect lands and resources that are currently used by these groups for traditional purposes, the Project will not have adverse effects on this VC.
- The planned components and activities associated with the Project will therefore not likely have significant adverse effects upon Indigenous communities and their activities.

NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.

KEY: See Table 12.4

Table 12.7 Environmental Effects Assessment Summary: Indigenous Communities and Their Activities – EL 1139

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Summary of Existing Conditions and Ecological and Social Context: EL 1139 • There are no communities or other aspects of the physical / cultural heritage and other socioeconomic components and activities of any Indigenous groups located within or near this EL. • The description of the socioeconomic characteristics of Indigenous communities provided in the EIS inherently reflects the effects of any past and on-going activities and effects								**Summary of Key Mitigation** See Table 12.4
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature / Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of Drilling Installation	• Possible direct interactions (interference or disturbances) with Indigenous communities and their activities Possible effects through associated changes to the biophysical environment (health, resource availability or quality)	N	-	-	-	-	-	H
Drilling and Associated Marine Discharges	• As above	N	-	-	-	-	-	H
Formation Flow Testing with Flaring	• As above	N	-	-	-	-	-	H
Wellhead Decommissioning	• As above	N	-	-	-	-	-	H

Table 12.7 Environmental Effects Assessment Summary: Indigenous Communities and Their Activities – EL 1139

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• As above	N	-	-	-	-	-	H
Geological, Geotechnical and Environmental Surveys	• As above	N	-	-	-	-	-	H
Supply and Servicing	• As above	N	-	-	-	-	-	H

Evaluation of Significance

- As there are no Indigenous communities or other aspects of the physical / cultural heritage and other socioeconomic components and activities of these groups located within or near the Project Area / LSA, and because the environmental changes and effects of the Project will not otherwise extend to and affect lands and resources that are currently used by these groups for traditional purposes, the Project will not have adverse effects on this VC.
- The planned components and activities associated with the Project will therefore not likely have significant adverse effects upon Indigenous communities and their activities.

NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.

KEY : See Table 12.4

Table 12.8 Environmental Effects Assessment Summary: Indigenous Communities and Their Activities – EL 1140

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Summary of Existing Conditions and Ecological and Social Context: EL 1140 • There are no communities or other aspects of the physical / cultural heritage and other socioeconomic components and activities of any Indigenous groups located within or near this EL. • The description of the socioeconomic characteristics of Indigenous communities provided in the EIS inherently reflects the effects of any past and on-going activities and effects								**Summary of Key Mitigation** See Table 12.4
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature / Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of Drilling Installation	• Possible direct interactions (interference or disturbances) with Indigenous communities and their activities Possible effects through associated changes to the biophysical environment (health, resource availability or quality)	N	-	-	-	-	-	H
Drilling and Associated Marine Discharges	• As above	N	-	-	-	-	-	H
Formation Flow Testing with Flaring	• As above	N	-	-	-	-	-	H
Wellhead Decommissioning	• As above	N	-	-	-	-	-	H

Table 12.8 Environmental Effects Assessment Summary: Indigenous Communities and Their Activities – EL 1140

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• As above	N	-	-	-	-	-	H
Geological, Geotechnical and Environmental Surveys	• As above	N	-	-	-	-	-	H
Supply and Servicing	• As above	N	-	-	-	-	-	H

Evaluation of Significance

- As there are no Indigenous communities or other aspects of the physical / cultural heritage and other socioeconomic components and activities of these groups located within or near the Project Area / LSA, and because the environmental changes and effects of the Project will not otherwise extend to and affect lands and resources that are currently used by these groups for traditional purposes, the Project will not have adverse effects on this VC.
- The planned components and activities associated with the Project will therefore not likely have significant adverse effects upon Indigenous communities and their activities.

NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.

KEY: See Table 12.4

Table 12.9 Environmental Effects Assessment Summary: Indigenous Communities and Their Activities – EL 1141

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Summary of Existing Conditions and Ecological and Social Context: EL 1141 • There are no communities or other aspects of the physical / cultural heritage and other socioeconomic components and activities of any Indigenous groups located within or near this EL. • The description of the socioeconomic characteristics of Indigenous communities provided in the EIS inherently reflects the effects of any past and on-going activities and effects								**Summary of Key Mitigation** See Table 12.4
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature / Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of Drilling Installation	• Possible direct interactions (interference or disturbances) with Indigenous communities and their activities Possible effects through associated changes to the biophysical environment (health, resource availability or quality)	N	-	-	-	-	-	H
Drilling and Associated Marine Discharges	• As above	N	-	-	-	-	-	H
Formation Flow Testing with Flaring	• As above	N	-	-	-	-	-	H
Wellhead Decommissioning	• As above	N	-	-	-	-	-	H

Table 12.9 Environmental Effects Assessment Summary: Indigenous Communities and Their Activities – EL 1141

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• As above	N	-	-	-	-	-	H
Geological, Geotechnical and Environmental Surveys	• As above	N	-	-	-	-	-	H
Supply and Servicing	• As above	N	-	-	-	-	-	H

Evaluation of Significance

- As there are no Indigenous communities or other aspects of the physical / cultural heritage and other socioeconomic components and activities of these groups located within or near the Project Area / LSA, and because the environmental changes and effects of the Project will not otherwise extend to and affect lands and resources that are currently used by these groups for traditional purposes, the Project will not have adverse effects on this VC.
- The planned components and activities associated with the Project will therefore not likely have significant adverse effects upon Indigenous communities and their activities.

NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.

KEY: See Table 12.4

Table 12.10 Environmental Effects Assessment Summary: Indigenous Communities and Their Activities – EL 1142

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Summary of Existing Conditions and Ecological and Social Context: EL 1142 • There are no communities or other aspects of the physical / cultural heritage and other socioeconomic components and activities of any Indigenous groups located within or near this EL. • The description of the socioeconomic characteristics of Indigenous communities provided in the EIS inherently reflects the effects of any past and on-going activities and effects								**Summary of Key Mitigation** See Table 12.4
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature / Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of Drilling Installation	• Possible direct interactions (interference or disturbances) with Indigenous communities and their activities Possible effects through associated changes to the biophysical environment (health, resource availability or quality)	N	-	-	-	-	-	H
Drilling and Associated Marine Discharges	• As above	N	-	-	-	-	-	H
Formation Flow Testing with Flaring	• As above	N	-	-	-	-	-	H
Wellhead Decommissioning	• As above	N	-	-	-	-	-	H

Table 12.10 Environmental Effects Assessment Summary: Indigenous Communities and Their Activities – EL 1142

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• As above	N	-	-	-	-	-	H
Geological, Geotechnical and Environmental Surveys	• As above	N	-	-	-	-	-	H
Supply and Servicing	• As above	N	-	-	-	-	-	H

Evaluation of Significance

- As there are no Indigenous communities or other aspects of the physical / cultural heritage and other socioeconomic components and activities of these groups located within or near the Project Area / LSA, and because the environmental changes and effects of the Project will not otherwise extend to and affect lands and resources that are currently used by these groups for traditional purposes, the Project will not have adverse effects on this VC.
- The planned components and activities associated with the Project will therefore not likely have significant adverse effects upon Indigenous communities and their activities.

NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.

KEY: See Table 12.4

The Operator is aware that a number of Indigenous communities hold treaty-based commercial communal swordfish licences for NAFO areas 3O, 3M and 3N - which overlap or are near the Project Area – and has engaged associated licence holders. To date, no Indigenous community has provided information that they actively fish in the Project Area at the current time. This does not mean that those Indigenous communities will not fish in those areas in the future. Given the nature of the drilling project, including its limited, localized and short-term environmental disturbances, and the associated small safety zone (500 m), it is not anticipated that there would be adverse effects to any such fishing activity, even if it did occur in the LSA over the course of the Project.

The environmental effects analysis also indicates there is limited potential for marine associated species that are known to be used by the identified Indigenous groups to occur within the Project Area / LSA prior to moving to any area of traditional use. The implementation of the mitigation measures outlined throughout this EIS will reduce direct or indirect potential effects on these resources. The Project will not have a significant adverse effect on the availability or quality of resources that are currently used for traditional purposes by Indigenous groups to a nature and to a degree that would alter the nature, location, timing, intensity or value of these activities or the health or heritage of Indigenous community.

12.4.2 Determination of Significance

As there are no Indigenous communities or other aspects of the physical / cultural heritage and other socioeconomic components and activities of these groups located within or near the Project Area / LSA, and because the environmental changes and effects of the Project will not otherwise extend to and affect lands and resources that are currently used by these groups for traditional purposes, the Project will not likely have adverse residual effects on this VC.

With the application of mitigation measures and adherence to published and/or industry standards and best management practices, there will be no residual Project effects on Indigenous communities and their activities, and therefore, no significant adverse effects.

12.5 Environmental Monitoring and Follow-up

The various environmental monitoring initiatives outlined earlier in relation to relevant components of the biophysical environment will also be indirectly applicable to this VC. Based on a current review of existing, publicly available information and engagement conducted with Indigenous groups to date, no additional and specific environmental monitoring or follow-up is considered necessary in relation to this VC, as no residual effects are anticipated. As noted in Chapter 3, numerous Indigenous groups indicated a desire to review the EIS before being able to provide further input regarding their interests and concerns. The Operators remain committed to ongoing engagement throughout the review process.

The Operator will, in accordance with its commitment to ongoing engagement with identified Indigenous groups, also continue to review these inputs and perspectives as the planning and eventual implementation of the Project progress, and will consider them in its Project-related planning and decision-making as applicable. Project implementation will also include on-going communication and cooperation mechanisms involving key organizations and Indigenous groups throughout its

operational life, as discussed in this EIS. These are intended to allow for continued discussion of Project related activities and issues as they may arise during its implementation, as well as to cooperatively and collaboratively plan and implement required (adaptive) management measures throughout the life of the Project.

The Operator will continue to communicate with relevant Indigenous communities and organizations, through established and/or informal engagement processes, as required and requested. The specific nature, frequency, subject matter and format of such future engagement will be determined in discussion with the Indigenous organizations and outlined in an Indigenous Communities Fisheries Communication Plan. Indigenous communities or community designated representative organizations will be invited to participate in the development of the Plan, which will be reflective of the nature of the Project. The plan would likely include:

- Communication objectives
- List of participants and key contacts
- Environmental Assessment Update process that provides specific information of planned offshore operational activities for that year and provides opportunity for feedback and further exchange of information on specific aspects of interest
- Expectations for communications during the unlikely event of a major spill (Note- accidental events effects assessment is provided in Chapter 15).

12.6 References

Addison, J. A., and M.W. Hart. 2004. Analysis of population genetic structure of the green sea urchin (*Strongylocentrotus droebachiensis*) using microsatellites. Marine Biology, 144(2): 243-251.

Ainley, David G., Daivd N. Nettleship, Harry R. Carter and Anne E. Storey. 2002. Common Murre (*Uria aalge*), The Birds of North America (P.G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna.org/Species-Account/bna/species/commur

Andersen, J.M., Wiersma, Y.F., Stenson, G., Hammill, M.O., and A. Rosing-Asvid. 2009. Movement patterns of hooded seals (*Cystophora cristata*) in the Northwest Atlantic during the post-moult and pre-breed seasons. Journal of Northwest Atlantic Fishery Science, 42: 1-11.

Anderson, Eric M., Rian D. Dickson, Erika K. Lok, Eric C. Palm, Jean-Pierre L. Savard, Daniel Bordage and Austin Reed. 2015. Surf Scoter (*Melanitta perspicillata*), The Birds of North America (P.G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna.org/Species-Account/bna/species/sursco

Ball, D. Fisheries and Oceans, Personal communication. 2017.

Barr, J.F., Eberl, C., and J.W. McIntyre. 2000. Red-throated Loon (*Gavia stellata*), The Birds of North America (P.G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna.org/Species-Account/bna/species/retloo

Beacham, T. D., Brattey, J., Miller, K. M., Le, K. D., and R.E. Withler. 2002. Multiple stock structure of Atlantic cod (*Gadus morhua*) off Newfoundland and Labrador determined from genetic variation. ICES Journal of Marine Science, 59(4), 650-665.

Beukema, J.J. and J. de Vlas. 1989. Tidal current transport of thread-drifting postlarval juveniles of the bivalve *Macoma balthica* from the Wadden Sea to the North Sea. Marine Ecological Progress Series, 52: 193-200.

Bordage, Daniel and Jean-Pierre L. Savard. 2011. Black Scoter (*Melanitta americana*), The Birds of North America (P.G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna.org/Species-Account/bna/species/blksco2

Bowering, W. R. (1984). Migrations of Greenland halibut, Reinhardtius hippoglossoides, in the Northwest Atlantic from tagging in the Labrador-Newfoundland region. Journal of Northwest Atlantic Fishery Science, 5(1), 85-91.

Bradbury, I.R., Gardiner, K., Snelgrove, P.V., Campana, S.E., Bentzen, P. and L. Guan. 2006. Larval transport, vertical distribution, and localized recruitment in anadromous rainbow smelt (*Osmerus mordax*). Canadian Journal of Fisheries and Aquatic Sciences, 63(12): 2822-2836.

Bradbury, I.R., Laurel, B.J., Robichaud, D.R., Rose, G.A., Snelgrove, P.V.R., Gregory, R.S., Cote, D., and D.J.S. Windle (2008). Discrete spatial dynamics in a marine broadcast spawner: reevaluating scales of connectivity and habitat associations in Atlantic cod (*Gadus morhua* L.) in coastal Newfoundland. Fisheries Research, 91: 299-309.

Brown, Patrick W. and Leigh H. Fredrickson. 1997. White-winged Scoter (*Melanitta fusca*), The Birds of North America (P.G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna.org/Species-Account/bna/species/whwsco

Butler, Ronald G. and Daniel E. Buckley. 2002. Black Guillemot (*Cepphus grylle*), The Birds of North America (P.G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna.org/Species-Account/bna/species/blkgui

Canadian Environmental Assessment Agency. 2015a. Technical Guidance for Assessing Physical and Cultural Heritage or any Structure, Site or Thing. Updated: March 2015

Canadian Environmental Assessment Agency. 2015b. Technical Guidance for Assessing the Current Use of Lands and Resources for Traditional Purposes under CEAA 2012. December 2015. Draft for public comment.

Caron, F. 1983. Migration vers l'Atlantique des post-saumoneaux (*Salmo salar*) du Golfe du Saint-Laurent. Le Naturaliste Canadien, 110: 223-227.

Carr, M.E. and Rossby, H.T., 2001. Pathways of the North Atlantic Current from surface drifters and subsurface floats. Journal of Geophysical Research: Oceans, 106(C3): 4405-4419.

Christian, J.R., Grant, C.G.J., Meade, J.D. and L.D. Noble. 2010. Habitat Requirements and Life History Characteristics of Selected Marine Invertebrates Species Occurring in the Newfoundland and Labrador Region. Canadian Manuscript Report of Fisheries and Aquatic Science, 2925.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2002. COSEWIC assessment and update status report on the Blue Whale Balaenoptera musculus in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. vi + 22 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2010. COSEWIC assessment and status report on the Atlantic Salmon *Salmo salar* (Nunavik population, Labrador population, Northeast Newfoundland population, South Newfoundland population, Southwest Newfoundland population, Northwest Newfoundland population, Quebec Eastern North Shore population, Lake Ontario population, Gaspe-Southern Gulf of St. Lawrence population, Eastern Cape Breton population, Nova Scotia Southern Upland population, Inner Bay of Fundy population, Outer Bay of Fundy population) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. xlvii+136 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2013. COSEWIC assessment and status report on the North Atlantic Right Whale Eubalaena glacialis in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. xi + 58 pp

COSEWIC (Committee on the Status of Wildlife in Canada). 2017. COSEWIC Species at Risk Public Registry. http://www.cosewic.gc.ca/default.asp?lang=en&n=3DFEE625-1

Craik, S., Pearce, J., and R.D. Titman. 2015. Red-breasted Merganser (*Mergus serrator*), The Birds of North America (P.G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America:https://birdsna.org/Species-Account/bna/species/rebmer

CSAS (Canadian Science Advisory Secretariat). 2012. Stock status of Atlantic salmon (*Salmo salar*) in DFO Gulf Region (Salmon Fishing Areas 15 to 18). Canadian Science Advisory Secretariat Science Response, 2012/040.

CSAS (Canadian Science Advisory Secretariat). 2013. Recovery potential assessment for the south Newfoundland Atlantic salmon (*Salmo salar*) Designatable Unit. Canadian Science Advisory Secretariat Science Response, 2012/007.

CSAS (Canadian Science Advisory Secretariat). 2015. Stock assessment of Newfoundland and Labrador salmon - 2013. Canadian Science Advisory Secretariat Science Response, 2014/023.

CSAS (Canadian Science Advisory Secretariat). 2016. Updated information on fishing bycatch of the Atlantic salmon, inner Bay of Fundy population, and its impact on the survival or recovery of this Atlantic salmon designatable unit (DU). Canadian Science Advisory Secretariat Science Response, 2016/023.

Delahanty, D.J. 2001. Grouse, Turkeys and Allies. In: The Sibley Guide to Bird Life & Behavior. C. Elphick, J.B. Dunning Jr. and D.A. Sibley, Eds. Alfred A. Knopf, New York.

Dewar, H., Prince, E.D., Musyl, M.K., Brill, R.W., Sepulveda, C., Luo, J., Foley, D., Orbesen, E.S., Domeier, M.L., Nasby-Lucas, N., Snodgrass, D., Laurs, R.M., Hoolihan, J.P., Block, B.A., and McNaughton, L.M. 2011. Movements and behaviors of swordfish in the Atlantic and Pacific Oceans examined using pop-up satellite archival tags. Fisheries Oceanography, 20(3): 219-241.

DFO (Fisheries and Oceans Canada). 2011. 2011-2015 Integrated Fisheries Management Plan for Atlantic Seals. Accessed on 07/20/2017 at: http://www.dfo-mpo.gc.ca/fm-gp/seal-phoque/reports-rapports/mgtplan-planges20112015/mgtplan-planges20112015-eng.htm.

DFO (Fisheries and Oceans Canada). 2012. Current Status of Northwest Atlantic Harp Seals, (Pagophilus groenlandicus). Can. Sci. Advis. Sec. Sci. Advis. Rep., 2011/070: 15 pp.

DFO (Fisheries and Oceans Canada). 2013. Important Marine and Estuarine Habitat of Inner Bay of Fundy Atlantic Salmon. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep., 2013/054.

DFO (Fisheries and Oceans Canada). 2014. Status of Northwest Atlantic harp seals, *Pagophilus groenlandicus*. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep., 2014/011.

DFO (Fisheries and Oceans Canada). 2015. Stock Assessment of Newfoundland and Labrador Atlantic Salmon – 2013. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep., 2014/023.

DFO (Fisheries and Oceans Canada). 2016. Ocean Data Inventory (ODI): database inventory of moored current meters, thermographs and tide gauges from the East Coast of Canada, 1960 to present. Department of Fisheries and Oceans, Canada. http://www.bio.gc.ca/science/data-donnees/base/data-donnees/odi-en.php

DFO (Fisheries and Oceans Canada). 2017. Landings. http://www.dfo-mpo.gc.ca.

Dutil, J.-D. and J.M. Coutu. 1988. Early marine life of Atlantic salmon, *Salmo salar*, postsmolts in the northern Gulf of St. Lawrence. Fishery Bulletin, 86: 197-212.

ECSAS (Eastern Canada Seabirds at Sea). 2016. Eastern Canada Seabirds at Sea sightings database. Environment and Climate Change Canada - Canadian Wildlife Service, Atlantic Canada. Information provided by CWS in response to data request.

Evers, D.C., Paruk, J.D., McIntyre, J.W. and J.F. Barr. 2010. Common Loon (*Gavia immer*), The Birds of North America (P.G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America:https://birdsna.org/Species-Account/bna/species/comloo

Gaston, Anthony J. and J. Mark Hipfner. 2000. Thick-billed Murre (*Uria lomvia*), The Birds of North America (P.G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna.org/Species-Account/bna/species/thbmur

Gjertz, I, Lydersen, C. and O. Wiig. 2001. Distribution and diving of harbour seals (*Phoca vitulina*) in Svalbard. Polar Biology. 24(3):209-214.

Good, Thomas P. 1998. Great Black-backed Gull (*Larus marinus*), The Birds of North America (P.G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna.org/Species-Account/bna/species/gbbgul

Gomes, M.C., Haedrich, R.L., and J.C. Rice. 1992. Biogeography of groundfish assemblages on the Grand Bank. Journal of Northwest Atlantic Fishery Science,. 14: 13-27.

Gosselin, J.F. and F. Boily. 1994. Unusual southern occurrence of a juvenile bearded seal, *Erignathus barbatus*, in the St. Lawrence Estuary, Canada. Marine Mammal Science, 10(4): 480-483.

Goudie, R.I., Robertson, G.J. and A. Reed. 2000. Common Eider (*Somateria mollissima*), The Birds of North America (P.G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America:https://birdsna.org/Species-Account/bna/species/comeid

Hammill, M.O., Bowen, W.D. and B. Sjare. 2010. Status of harbour seal (*Phoca vitulina*) in Atlantic Canada. NAMMCO Sci. Publ. 8:175-190.

Hammill, M.O, Stenson, G.B., Doniol-Valcroze, T., and A. Mosnier. 2015. Conservation of northwest Atlantic harp seals: Past success, future uncertainty? Biological Conservation, 192: 181-191.

Harvey, V., Côté, S.D. and M.O. Hammill. 2008. The ecology of 3-D space use in a sexually dimorphic mammal. Ecography, 31(3): 371-380.

Harvey, V., Hammill, M.O, Swain, D.P, Breed, G.A., Lydersen, C. and K.M. Kovacs. 2012. Winter foraging by a top predator, the grey seal *Halichoerus grypus*, in relation to the distribution of prey. Marine Ecology Progress Series, 462: 273-286.

Hatch, Jeremy J. 2002. Arctic Tern (*Sterna paradisaea*), The Birds of North America (P.G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna.org/Species-Account/bna/species/arcter

Hoey, J.J., Conser, R.J. and Bertolino, A.R., 1989. The western North Atlantic swordfish. Audubon Wildlife Report, 1989/1990: 457-477.

Jonsson, N., L.P. Hansen, and B. Jonsson. 1993. Migratory behaviour and growth of hatchery-reared post-smolt Atlantic salmon *Salmo salar*. Journal of Fish Biology, 42: 435-443.

Kenchington, E., Freeman, K. R., Vercaemer, B., and B. MacDonald. 2002. Comparative settlement depths of Mytilus edulis C. Linnaeus, 1758 and M. trossulus Gould, 1850: II. Field Observations. Journal of Shellfish Research, 21(1), 67-73.

Lawson. J.W., and Gosselin, J.-F. 2009. Distribution and preliminary abundance estimates for cetaceans seen during Canada's marine megafauna survey - A component of the 2007 TNASS. DFO Can. Sci. Advis. Sec. Res. Doc., 2009/031: vi + 28 pp.

Lefevre, M.A., M.J.W. Stokesbury, F.G. Whorskey, M.J. Dadswell. 2012. Atlantic salmon post-smolt migration routes in the Gulf of St. Lawrence. ICES Journal of Marine Science, 69(6): 981-990. Doi:10.1093/icesjms/fss092

Lesage, V., Hammill, M.O. and K.M. Kovacs. 2004. Long-distance movements of harbour seals (*Phoca vitulina*) from a seasonally ice-covered area, the St. Lawrence River Estuary, Canada. Canadian Journal of Zoology, 82: 1070-1081.

Lesage, V., Gavrilchuk, K., Andrews, R.D., and Sears, R. 2016. Wintering areas, fall movements and foraging sites of blue whales satellite-tracked in the Western North Atlantic. DFO Can. Sci. Advis. Sec. Res. Doc., 2016/078. v + 38 pp.

Longcore, J.R., McAuley, D.G., Hepp, G.R. and J.M. Rhymer. 2000. American Black Duck (*Anas rubripes*), The Birds of North America (P.G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America:https://birdsna.org/Species-Account/bna/species/ambduc

MacLaren Plansearch. 1994. Innu of Labrador: Profile and Harvesting Practices: Technical Report 12. Prepared for Department of National Defence for Environmental Impact Statement on Military Flying Activities in Labrador and Québec.

Montevecchi, William A. and Iain J. Stenhouse. 2002. Dovekie (*Alle alle*), The Birds of North America (P.G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna.org/Species-Account/bna/species/doveki

Mowbray, T.B., Ely, C.R., Sedinger, J.S., Trost, R.E., 2002. Canada goose (*Branta canadensis*). In: Poole, A. (Ed.), The Birds of North America Online. Ithaca: Cornell Laboratory of Ornithology. Retrieved from the Birds of North America Online: /http://bna.birds.cornell.edu/bna/species/682S

Nakashima, B. S. 1992. Patterns in coastal migration and stock structure of capelin (*Mallotus villosus*). Canadian Journal of Fisheries and Aquatic Sciences, 49(11), 2423-2429.

Nisbet, Ian C., D. V. Weseloh, Craig E. Hebert, Mark L. Mallory, Alan F. Poole, Julie C. Ellis, Peter Pyle and Michael A. Patten. 2017a. Herring Gull (*Larus argentatus*), The Birds of North America (P.G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna.org/Species-Account/bna/species/hergul

Nisbet, Ian C., Jennifer M. Arnold, Stephen A. Oswald, Peter Pyle and Michael A. Patten. 2017b. Common Tern (*Sterna hirundo*), The Birds of North America (P.G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna.org/Species-Account/bna/species/comter

Pearce, J., Mallory, M.L. and K. Metz. 2015. Common Merganser (*Mergus merganser*), The Birds of North America (P.G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America. Available at: https://birdsna.org/Species-Account/bna/species/commer

Perez, K.O., Carlson, R.L., Shulman, M.J. and J.C. Ellis. 2009. Why are intertidal snails rare in the subtidal? Predation, growth and the vertical distribution of *Littorina littorea* (L.) in the Gulf of Maine. Journal of Experimental Marine Biology and Ecology, 369(2), 79-86.

Puebla, O., Sévigny, J. M., Sainte-Marie, B., Brêthes, J. C., Burmeister, A., Dawe, E. G., and M. Moriyasu. 2008. Population genetic structure of the snow crab (*Chionoecetes opilio*) at the Northwest Atlantic scale. Canadian Journal of Fisheries and Aquatic Sciences, 65(3), 425-436.

Reddin, D.G. 2006. Perspectives on the marine ecology of Atlantic salmon (*Salmo salar*) in the Northwest Atlantic. Canadian Science Advisory Secretariat Research Document, 2006/018.

Reddin, D.G. and K.D. Friedland. 1993. Marine environmental factors influencing the movement and survival of Atlantic salmon. Pp. 79-103. in: D. Mills (ed.). Salmon in the Sea and New Enhancement Strategies. Atlantic Salmon Federation, Fishing New Books/Blackwell Publishing, ON.

Reddin, D.G., and W.M. Shearer. 1987. Sea-Surface Temperature and Distribution of Atlantic salmon in the Northwest Atlantic Ocean. American Fisheries Society Symposium, l: 262-275.

Reddin, D.G., R.J. Poole, G. Clarke, and N. Cochrane. 2010. Salmon rivers of Newfoundland and Labrador. DFO Can. Sci. Advis. Sec. Res. Doc., 2009/046. iv+24 pp.

Roques, S., Sévigny, J. M., and L. Bernatchez. 2002. Genetic structure of deep-water redfish, *Sebastes mentella*, populations across the North Atlantic. Marine Biology, 140(2), 297-307.

Scott, W.B., and M.G. Scott. 1988. Atlantic fishes of Canada. Canadian Bulletin of Fisheries and Aquatic Sciences, 219: 731 pp.

Sheehan, T.F., D.G. Reddin, G. Chaput, and M.D. Renkawitz. 2012. SALSEA North America: a pelagic exosystem survey targeting Atlantic salmon in the Northwest Atlantic. ICES Journal of Marine Science, 69(9): 1580-1588. D oi:10.1093/icesjms/fss052

Stenson, G.B. and B. Sjare. 1997. Seasonal distribution and diving behavior of harp seals, *Phocus groenlandica*, in the Northwest Atlantic. ICES CM, 1997/CC.

Stillwell, C.E. and Kohler, N.E., 1985. Food and feeding ecology of the swordfish *Xiphias gladius* in the western North Atlantic Ocean with estimates of daily ration. Marine Ecology Progress Series, 22(3): 239-247.

Strom, J.F., Thorstad, E.B., Chafe, G., Sørbye, S.H., Righton, D., Rikardsen, A.H. and Carr, J. 2017. Ocean migration of pop-up satellite archival tagged Atlantic salmon from the Miramichi River in Canada. ICES J. Mar. Sci., 74(5): 1356-1370.

Trenkel, V.M., Huse, G., MacKenzie, B.R., Alvarez, P., Arrizabalaga, H., Castonguay, M., Goñi, N., Grégoire, F., Hátún, H., Jansen, T. and Jacobsen, J.A., 2014. Comparative ecology of widely distributed pelagic fish species in the North Atlantic: Implications for modelling climate and fisheries impacts. Progress in Oceanography, 129: 219-243.

Valentin, A. E., Power, D., and J.M. Sévigny. 2016. Understanding recruitment patterns of historically strong juvenile year classes in redfish (*Sebastes* spp.): Yhe importance of species identity, population structure, and juvenile migration. Canadian Journal of Fisheries and Aquatic Sciences, 72(5), 774-784.

Vis, M. L., Carr, S. M., Bowering, W. R., & Davidson, W. S. (1997). Greenland halibut (Reinhardtius hippoglossoides) in the North Atlantic are genetically homogeneous. Canadian Journal of Fisheries and Aquatic Sciences, 54(8), 1813-1821.

Wang, C. H., and W.N. Tzeng. 1998. Interpretation of geographic variation in size of American eel *Anguilla rostrata* elvers on the Atlantic coast of North America using their life history and otolith ageing. Marine Ecology Progress Series, 35-43.

13.0 COMMERCIAL FISHERIES AND OTHER OCEAN USERS: ENVIRONMENTAL EFFECTS ASSESSMENT

Commercial Fisheries and Other Ocean Users have been identified and included as a VC for this EIS due to the economic and socio-cultural importance of commercial fishing and other marine activities to Newfoundland and Labrador and other jurisdictions that are known to undertake these activities off Eastern Newfoundland, and the associated potential for interactions between these ocean uses and Project-related components and activities during the temporal scope of the Project.

Commercial fishing is a key economic activity within Newfoundland and Labrador and elsewhere, and fisheries within the Eastern Newfoundland offshore area are extensive and diverse, involving a range of participants, species, gear types and other characteristics at various times of the year (see Section 7.1). This includes fishing activity by Canadian enterprises and vessels (primarily within Canada's 200-nautical mile EEZ) and by both Canadian and non-Canadian fishers outside of the EEZ. There are also various regulatory jurisdictions that pertain to marine fish and fisheries in the region, with the Government of Canada having jurisdiction over fish stocks and fishing activities within its EEZ and for benthic invertebrates (such as crab) across the entire continental shelf, while NAFO manages groundfish activities and other resources beyond the EEZ. The management and conduct of commercial fishing activities in this region is therefore the subject of various relevant legislation, regulations and other regulatory and policy instruments involving Canadian (federal) and international jurisdictions. A range of other anthropogenic components and human activities occur throughout the marine environment offshore Eastern Newfoundland. These activities have been defined in Section 6.1.9.2 of the EIS Guidelines and include: marine shipping, research, oil and gas activity, military operations, and ocean infrastructure such as subsea cables. The existing conditions of these other ocean uses have been discussed in Chapter 7, and are assessed in the sections below.

Commercial Fisheries and Other Ocean Users have been identified by government departments and agencies, Indigenous communities, and stakeholder organizations as being important and requiring consideration in the EIS due to their presence in the region and the potential effects of the Project on these activities (see Chapter 3). The assessment of potential effects on this VC is also required by, and is conducted in accordance with, the EIS Guidelines issued by the CEA Agency in December 2016. This VC considers any fisheries and other activities undertaken in the identified LSA and RSA (see below) for commercial or recreational purposes by both Indigenous and non-Indigenous persons and organizations. Any fisheries or other activities which are currently undertaken by Indigenous peoples for traditional purposes, or commercial harvesting activities that are undertaken on the basis of asserted and/or established Aboriginal or Treaty Rights, have been considered separately in Chapter 12.

13.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

A number of spatial assessment boundaries have been defined for the environmental effects assessment of this VC, which reflect the varying ways and scales in which the Project may influence commercial fishing activity and other ocean uses.

Three Study Areas have been identified and considered in conducting the environmental effects assessment for this VC (Figure 13-1), as follows:

Project Area: This represents the overall geographic areas offshore Eastern Newfoundland within which planned Project-related exploration activities will take place. While the Project Area is defined as an overall polygon that encompasses such activities over the course of the Project, the various components and activities associated with the drilling of each individual well and other planned components will occupy fairly small areas within this overall Project Area, as described in Chapter 2. The assessment also considers related supply and support vessel and aircraft traffic to and from this offshore Project Area.

Local Study Area (LSA): This encompasses the overall geographic area over which planned Project-related environmental interactions (including emissions and other disturbances) will occur. The LSA therefore represents the predicted environmental zone of influence of the Project's planned components and activities. Because most of the potential effects of the Project on Commercial Fisheries and Other Ocean Users would relate to the potential for direct disturbance and interference with established activities due to the presence of Project-related components and activities, these are likely to occur primarily if not exclusively within the Project Area itself. As described for the preceding Marine Fish and Fish Habitat VC (Chapter 8), a 10 km area around the Project Area has also been defined as the LSA for that VC, to account for Project activities that could conceivably occur on the edges of the Project Area boundary and associated interactions with other marine activities and their associated resources beyond the Project Area boundary. For this VC, the LSA is therefore also (conservatively) defined as the offshore Project Area and an appropriately 10 km area around it as well as the associated vessel and aircraft traffic routes to the ELs.

Regional Study Area (RSA): In addition to these Project- and disturbance-related factors, the environmental effects assessment for this VC also recognizes and considers the spatial distribution and overall geographic extent of fishing and other human activities within and adjacent to the Project Area / LSA, as well as the seasonality of activities within the LSA and for these marine sectors as a whole, including key times as outlined below. The RSA for this VC therefore generally captures the marine waters offshore Eastern Newfoundland, namely NAFO Divisions 3K, 3L, 3M, 3N and 3O.

The temporal boundaries, as described in Section 2.3, for the effects assessment encompass the likely timing and duration of Project-related (in-field) activities in the Project Area, as well as the likely duration of resulting environmental effects. In conducting the assessment, consideration is given to timing and seasonality of VC-related activity within the Project and Assessment Areas, including important or sensitive time periods. Chapter 7 provides details of commercial fisheries and other ocean users and their timing of occurrence within these areas, and indicates that while commercial fishing and other ocean uses occur year-round within the Project Area / LSA and RSA, the most active period is typically during the summer months.

It is within the above spatial and temporal boundaries that the potential environmental effects on this VC resulting from planned Project components and activities and their significance are assessed and evaluated.

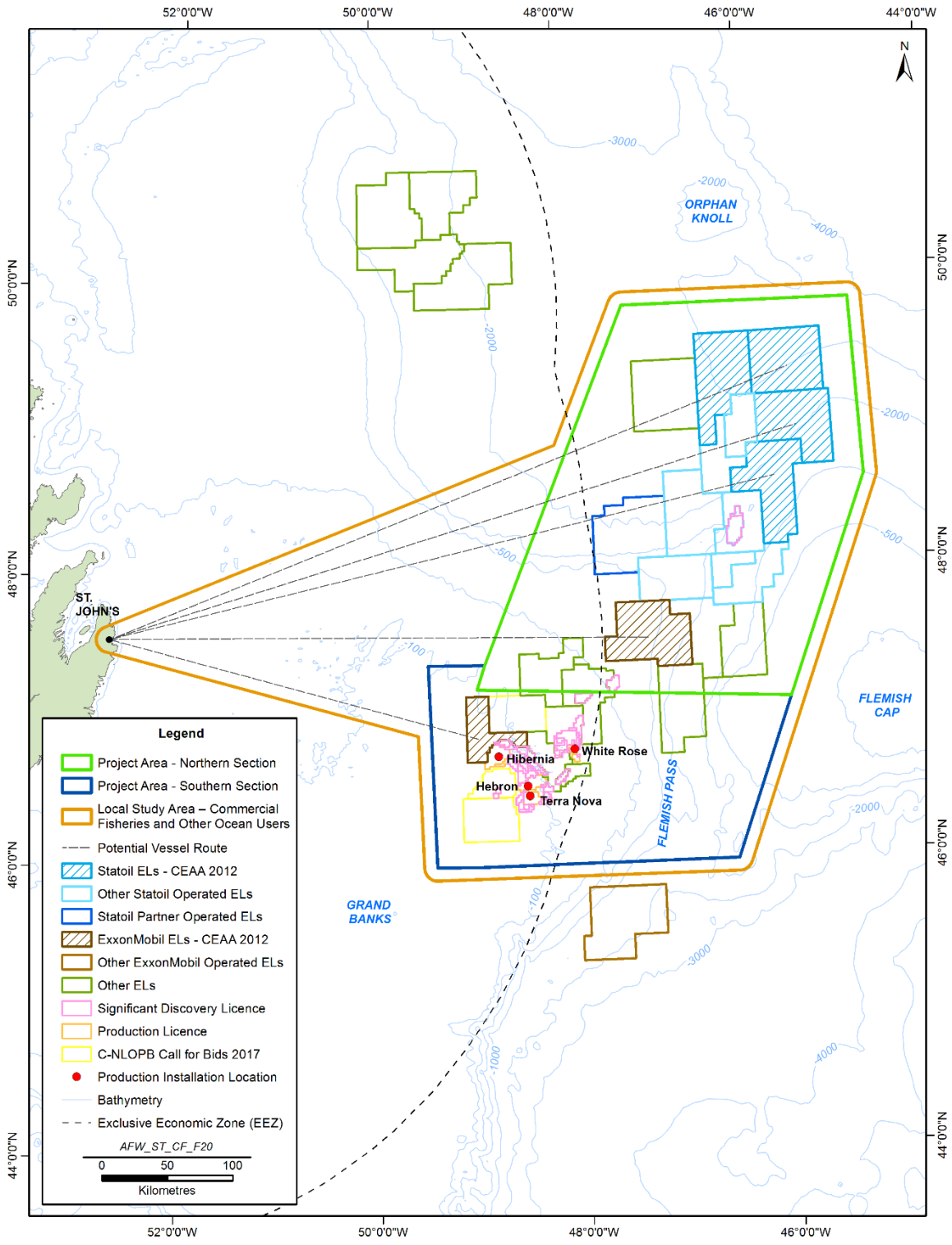


Figure 13-1 Environmental Assessment Study Areas: Commercial Fisheries and Other Ocean Users

Significant environmental effects are considered to be those that cause an adverse change in a VC that would alter its status or integrity beyond an acceptable and sustainable level. For the purposes of this EA, significant environmental effects on Commercial Fisheries and Other Ocean Users are defined as those that would cause one or more of the following outcomes:

- A detectable reduction in the overall economic returns generated from commercial fisheries or other ocean activities within the RSA over one or more years; and/or
- A detectable decrease in overall activity levels and/or the enjoyment or cultural value of recreational activities within the RSA for a community or region over multiple years

13.2 Potential Environmental Changes, Effects, and Associated Parameters

Potential interactions between offshore oil and gas exploration activities and Commercial Fisheries and Other Ocean Users can be direct or indirect in nature. Key potential interactions have been identified based on previous EAs conducted for similar projects and activities offshore Newfoundland and Labrador, including the Eastern Newfoundland SEA (Amec 2014), and include:

- Damage to fishing gear, vessels, equipment, or other components as a result of direct interactions between Project equipment or emissions and these other ocean users
- Loss of access to important and established fishing grounds or other areas of potential marine use as a result of Project activities, and associated decreases in value (economic or otherwise) of these activities
- Indirect effects on commercial fisheries and other ocean users due to biophysical effects on the presence, abundance, distribution or quality of marine fish species or other resources
- Interference with scheduled government / industry research activities, including direct disturbance and/or effects on research results and associated management decisions

The EIS Guidelines issued by the Canadian Environmental Assessment Agency in December 2016 also identify and specify a number of issues and potential effects on this VC which require consideration in the EIS (Section 6.3.8.2), including:

- Effects of changes to the environment on commercial fishing activities (e.g., effects on fished species affecting fisheries success, displacement from fishing areas (e.g., exclusion zones), gear loss or damage)
- How drilling activities correlate to key commercial fisheries windows, and potential effects resulting from overlapping periods
- Effects from subsea infrastructure that could be left in place (e.g., wellheads) following abandonment
- Changes to habitat of commercial fish species (e.g., noise, water, and sediment quality)
- Effects of changes to the environment on health and socioeconomic conditions, physical and cultural heritage and any site, structure, or thing that is of historical, archaeological, paleontological, or architectural value, including, but not limited to the following, as applicable

- Recreational activities
- Other ocean uses
- Socioeconomic conditions
- Human health
- Physical and cultural heritage (e.g., shipwrecks)
- Rural and urban settings that could be affected by routine activities and/or accidental events and malfunctions

As indicated in the existing socioeconomic environment chapter (Chapter 7), the Project is located over 300 km offshore and in an area that is not used for recreational purposes. Other than shipwrecks, there are no known sites related to physical or cultural heritage. Due to the distance of the Project Area from land, rural and urban settlements and human health will not interact with routine Project activities; therefore, a human health risk assessment was not required. The VC assessment therefore focuses on the potential effects to commercial fishing activities, and other ocean uses. Accidental events and malfunctions, and the potential effects on this VC are assessed in Chapter 15.

Questions and comments related to this VC were also noted during the Operators' Project-related engagement with government departments and agencies, stakeholder organizations, and Indigenous groups. This included questions and concerns regarding the locations and timing of key fishing activities in relation to the Project Area, and the potential for direct interference with fisheries and other marine activities due to the presence of the drilling installation and associated safety zones, as well as direct effects on fish resources due to Project-related noise and other emissions. Engagement outcomes also included perspectives about current fishing activity, as well as the requirement to also consider what the future fisheries might look like over the course of the Project, including th potential reestablishment of key fisheries such as those for cod and flounder (see Chapter 3 for further details).

The environmental effects assessment for this VC considers and focuses on a number of key potential environmental interactions and associated environmental changes that may lead to possible environmental effects on this VC. These are summarized in Table 13.1, along with the identification of associated parameters through which these Project-related changes and effects may be reflected.

Table 13.1 Potential Project-Related Environmental Changes and Potential Effects: Commercial Fisheries and Other Ocean Users

Potential Environmental Effects	Contributing Potential Environmental Changes Resulting from the Project	Associated Parameter(s)
Direct Interference, Resulting in a Change in the Distribution, Intensity and/or Function (Effectiveness / Efficiency) of Commercial Fishing and Other Ocean Uses	The presence of drilling installations and other exploration equipment and activities may result in a temporary loss of access to marine areas for commercial fishing or other ocean uses for safety reasons These interferences resulting from a loss of access to fishing grounds or other resources (including altering vessel routes to avoid safety zones) can affect the effectiveness and efficiency of these activities (i.e., resulting in lower catches / revenues, or lost time and additional operating costs)	• Marine areas used and available for fishing and other ocean users • Time and costs associated with carrying out these marine activities • Economic returns from fishing or other marine activities
Damage to Fishing Gear, Vessels, and Other Equipment and Components	Offshore exploration activities may result in damage to fishing gear, vessels, or other equipment if these come into direct contact with offshore drilling installations or other equipment, activities, and environmental emissions. This may, in turn, have associated economic implications for fishers and other ocean users both directly (through associated repair or replacement costs) and through lost time and revenues.	• Number of damage or loss claims / complaints from commercial fishers • Economic returns from fishing or other marine activities
Change in the Abundance, Distribution, and Quality of Marine Resources, Resulting in a Change in Distribution, Intensity and/or Function (Effectiveness / Efficiency) of Commercial Fishing and Other Ocean Uses	Biophysical changes resulting from Project-related disturbances / emissions and associated environmental effects on fish and fish habitat may have implications for the availability (abundance / distribution) and quality of fish and other marine resources A change in the abundance or distribution of commercial fish species or other marine resources has potential to affect the effectiveness and efficiency of these activities (such as by resulting in lower catches / revenues, or lost time and additional operating costs) In addition, any change in the (real or perceived) quality of marine resources has the potential to result in lower economic returns from commercial fish harvests and other activities	• Availability and quality of marine resources. • Time and costs associated with carrying out other marine activities • Economic returns from fishing or other marine activities

Table 13.2 outlines the key potential interactions between commercial fisheries and other ocean users and the various planned Project components and activities.

Table 13.2 Potential Project-VC Interactions: Commercial Fisheries and Other Ocean Users

Project Component / Activity	Potential Environmental Effects		
	Direct Interference, Resulting in a Change in the Distribution, Intensity and/or Function (Effectiveness / Efficiency) of Commercial Fishing and Other Ocean Uses	Damage to Fishing Gear, Vessels, and Other Equipment and Components	Change in the Abundance, Distribution and Quality of Marine Resources, Resulting in a Change in Distribution, Intensity and/or Function (Effectiveness / Efficiency) of Commercial Fishing and Other Ocean Uses
Presence and Operation of drilling installation (Including lights, noise, air emissions, anchoring)	•		•
Drilling and Associated Marine Discharges		•	•
Formation Flow Testing with Flaring			
Wellhead Decommissioning	•	•	
Geophysical, Geohazard, Wellsite and Seabed Surveys and VSP	•	•	•
Geological, Geotechnical and Environmental Surveys	•	•	•
Supply and Servicing	•	•	•

The environmental effects assessment for this VC is structured so as to focus primarily on those planned aspects of the Project that have the greatest potential to affect Commercial Fisheries and Other Ocean Users through direct interference (loss of access or possible damage) or indirectly (through possible biophysical changes affecting marine resource availability or quality). This includes the presence and operation of the drilling installation(s) and associated activities and environmental emissions, as well as associated supply vessel transits to and from the offshore Project Area. For the purposes of efficiency and brevity, and given the similarity in their potential interactions with and effects on this VC, other types of "Project-related surveys" (as listed in the Table 13.2) are addressed in a single subsection, with key differences highlighted as applicable. These surveys include:

- Vertical seismic profiling
- Geophysical / geohazard / wellsite and seabed surveys
- Geological surveys

- Geotechnical surveys
- Environmental surveys

13.3 Environmental Effects Assessment and Mitigation

The following sections provide an assessment and evaluation of the potential effects of the Project (planned components and activities) on Commercial Fisheries and Other Ocean Users. Mitigation measures to prevent or reduce adverse effects upon this VC are identified and considered integrally within and throughout the environmental effects analysis that follows, as applicable. The environmental effects assessment for accidental events for all VCs, including this one, is presented in Chapter 15.

13.3.1 Approach and Methods

The potential effects of the Project on this VC are assessed by first identifying the potential interactions between Project components and activities and the various aspects of this VC, including each of the key associated parameters listed in Table 13.1. These are identified and evaluated through a review and analysis of the existing and available information on the current nature, distribution and timing of commercial fisheries and other marine activities in the Project Area/LSA and RSA, as provided in Chapter 7 of this EIS, as well as relevant scientific literature on the effects of oil and gas exploration projects on the various aspects of this VC. Each planned component of the Project is considered in terms of its potential to result in environmental changes that may have associated environmental effects on the VC, with a focus on the various potential environmental interactions and changes identified in the previous section, and integrating mitigation measures throughout the effects analysis. Project-related residual effects are then characterized and evaluated for significance.

This VC also relates to, and overlaps with, other components of the environment, as potential effects to fishing activity, for example, may result from changes in the availability and quality of Marine Fish and Fish Habitat (Chapter 8). These potential inter-relationships are considered throughout the environmental effects assessment for this VC, with cross referencing as relevant.

13.3.2 Summary of Key Mitigation

Key mitigation measures that will be implemented in relation to the Project to help avoid or reduce potential environmental effects on Commercial Fisheries and Other Ocean Users include:

- Use of existing and common travel routes for vessels and helicopters will be used where possible and practicable
- Low-level aircraft operations will be avoided where it is not required per Transport Canada protocols
- Operational discharges will be treated prior to release in accordance with the OWTG and other applicable regulations and standards.
- The selection and screening of chemicals to be discharged, including drilling fluids, will be in accordance with the Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands

- During formation flow testing with flaring, produced hydrocarbons and produced water will be flared. If there is a large amount of produced water encountered, it will be treated in accordance with the relevant regulatory requirements prior to ocean discharge, or shipped to shore for appropriate disposal
- Appropriate handling, storage, transportation, and on-shore disposal of solid and hazardous waste
- Establishment of a safety zone around drilling installations in accordance with the Newfoundland Offshore Petroleum Drilling and Production Regulations SOR/2009-316
- Issuance of Notices to Shipping, Notice to Mariners (where appropriate) regarding planned Project activities
- Ongoing communication with commercial fishers through One Ocean, FFAW-Unifor and seafood producers regarding planned project activities, including timely communication of drilling locations, safety zone, and decommissioned wellheads. This information will also be communicated to Indigenous fishers in accordance with the Indigenous Communities Fisheries Communication Plan
- Ongoing communications with the NAFO Secretariat, through DFO as the Canadian representative, regarding planned Project activities, including timely communication of drilling locations, safety zone, and decommissioned wellsites
- In accordance with the One Ocean "Risk Management Matrix Guidelines," the need for a Fisheries Liaison Officer (FLO) and/or fisheries guide vessels during drilling installation movement from port to its offshore location will be determined in consideration of the guidelines. Use of a FLO during geophysical programs will also be determined in consideration of these guidelines
- A single point of contact (SPOC) will be established during Project activities to facilitate communications between fishers and the Operator regarding gear loss/damage and other compensation matters
- Develop and implement a compensation program for damages resulting from Project activities. This compensation program will be developed in consideration of C-NLOPB guidelines, including the Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activities (March 2002) and as revised. This program will outline compensation procedures for actual loss or damages to commercial fishers, including Commercial-communal fishers, attributable to the operator resulting from a spill or debris, or expenses incurred in taking remedial action. Actual loss or damage includes loss of income or future income; loss of hunting, fishing, or gathering opportunities; and costs and expenses incurred for action taken to remedy a situation involving a spill, including measure to control or clean a spill
- The communication of suspended and/or abandoned wellsite locations to the appropriate authorities for inclusion on nautical charts for use by commercial fishers and other mariners
- Contact DFO regarding timing and locations of planned DFO research surveys
- Contact DND regarding timing of planned offshore military exercises

These mitigation measures are considered in a fully integrated manner throughout the environmental effects analysis that follows. Measures to prevent or reduce potential adverse environmental effects on Marine Fish and Fish Habitat (Chapter 8) will also be indirectly relevant to this VC.

13.3.3 Presence and Operation of Drilling Installation (Including Drilling and Associated Marine Discharges)

The presence and operation of the drilling installation(s) within the Project Area has the potential to interact with Commercial Fisheries and Other Ocean Users through direct interference and lack of access to limited parts of the Project Area for specified periods, as well as potentially damaging fishing gear, vessels, and equipment in the unlikely event of a direct interaction. This interaction would most likely occur during transit of the drilling installation from one area to another. The presence and operation of the drilling installation may also lead to changes in the abundance, location and/or quality of marine resources due to indirect interactions (e.g., underwater noise, emissions and discharges, drill cuttings), which may in turn affect their use by fishers or other marine users.

During periods at which the drilling installation is stationed at a wellsite and involved in drilling a well, a safety zone will be established around it within which fishing and non-Project-related vessels and activities are excluded. This safety zone is required for the protection of Project personnel and equipment and those of other marine users, as well as in compliance with relevant regulations. The overall nature and spatial extent of the safety zone will be determined once a drilling installation has been contracted. Safety zones will range from an approximate area of 1 km² to 12 km², depending on type of drilling installation (DP vs anchor moorings). As there is the potential for multiple (two) drilling installations to be operating at any one time during the Project, this could increase the total size of the safety zone(s) within the Project Area to approximately 2 to 24 km². A safety zone will be in place between 30 to 65 days for each exploration well, depending on water and well depth.

The temporary restriction of access to fishing grounds has the potential to result in a decrease in the effectiveness and/or efficiency of fishing activities, because harvesters have to either wait for access or redirect their fishing effort (and possibly, their vessel routes) to other areas. This can translate into a loss of economic returns for fish harvesters. The potential effects of being restricted from certain fishing areas will be most likely during the summer months, when fishing activity is at its highest, and when key seasonal fisheries (e.g., snow crab) are occurring (see Section 7.1). In addition, the overall level of fishing activity and diversity is somewhat greater in the Project Area – Southern Section as compared to the Project Area – Northern Section, and therefore, potential effects on fishing activity resulting from the establishment of safety zones are likely to be more apparent in the Jeanne d'Arc Basin Project Area. At the same time, however, fishers in the latter region are increasingly familiar with the nature and presence of these safety zones, given the relatively high degree of past exploration activity in the area, and the presence of four producing projects in this area over the long term. In either case, however, the localized (several km^2) and short-term (65 days or less) nature of this access restriction will likely mean that there will be not be a detectable effect on the overall nature and intensity of, or economic returns from, fishing or other marine uses in the area. The early identification and timely communication of these safety zones as Project plans progress, along with on-going communication and cooperation with the fishing industry, will help to avoid adverse effects.

While conventional drilling activities would see the drilling installation positioned at a specific location for the length of time required to fully drill a well, the Project may undertake batch drilling. Batch drilling consists of completing the top-hole portion of a well for multiple wells consecutively, and then returning to complete the remaining components of each well's drilling activities at a later date. This approach results in an increase to the frequency of drilling installation movements compared to drilling a complete well before moving on to the next. However, it may reduce the overall drilling program duration. Even with the planned implementation of batch drilling, the top-hole portion of the wells will be drilled the same as if the entire well was drilled and the mitigation measures identified and committed to for this Project will likewise continue to be implemented, including Notices to Shipping. While the required number of drilling installation movements would increase with batch drilling approaches, any such activity will be short-term in duration and transient in nature, occurring at any one location for a short period of time.

Scheduled Project activities, including the planned location of the drilling installation and timing of planned activities at each wellsite, will be communicated in advance to commercial fishers and other ocean users. Although an unlikely and relatively infrequent occurrence, damage to gear, vessels or other marine assets would be managed through applicable compensation policies and procedures, as described in Section 13.3.2.

The presence and operation of the drilling installation(s) will result in a number of associated environmental interactions and disturbances, including underwater noise, lights, and drilling discharges. Project-related biophysical effects to fish or other marine resources could result in a subsequent change in the nature, quality and/or value of one or more of the marine activities that use or depend upon them. As assessed and described in some detail in Chapter 8 (Marine Fish and Fish Habitat VC), the Project is not predicted to result in significant adverse environmental effects upon marine biota or their habitats. Although the environmental disturbances, discharges and other potential interactions that will be associated with the Project have the potential to interact with marine biota, these activities will be undertaken in adherence to relevant standards and guidelines that pertain to drilling, vessel traffic, waste management, and other potential environmental discharges and emissions. This includes the use of mitigation measures that are typically required and implemented for such programs in the Canada-NL Offshore Area as conditions of regulatory approvals and which have been identified by the Operator in this EIS. Disturbances to fish or other marine biota will therefore be localized and of short-term duration at any one location. It is therefore unlikely that marine resources will be affected or disrupted due to drilling installation presence and associated drilling activities in a manner and to a degree that would then translate into effects on the overall availability or quality of a marine resource, and thus, on the overall nature, intensity, or value of other commercial activity.

The presence and operation of the drilling installation and the safety zone, may also interact with other ocean users (e.g., research vessels, shipping activities, military exercises), possibly requiring them to reroute, relocate or reschedule their activities. Given the short-term and localized nature of these planned Project activities, and in consideration of the implementation of communication protocols, such as Notices to Shipping, it is predicted there will be no measurable adverse effects on other ocean users resulting from the presence and operation of the drilling installation and associated drilling activities.

As described in Section 7.1, a number of marine subsea cables are present within the Project Area/LSA and RSA, the majority of which are inactive or abandoned. The Hibernia transatlantic cable and the Hebron fibre optic cable are the only active cables that cross through the Project Area (see Table 7.18 and Figure 7-34). The only known structures, sites, or things of historical, archaeological, paleontological, or architectural significance within or near the Project Area are shipwrecks. The potential for interaction between the drilling installation(s) and subsea cables and/or shipwrecks will be avoided through the conduct of geohazard wellsite surveys prior to placement of the drilling installation(s).

Based on the information summarized here, and with the implementation of appropriate mitigation measures as summarized in Section 13.3.2, effects on Commercial Fisheries and Other Ocean users from the presence and operation of the drilling installation are expected to be adverse, low in magnitude, localized, short-term in duration, occurring continously when drilling activities are schedule and reversible once drilling ceases. These effects have been predicted with a high level of confidence.

13.3.4 Formation Flow Testing with Flaring

Formation flow testing, including associated flaring activity, is not expected to have adverse interactions with or effects on Commercial Fisheries and Other Ocean Users. When well fluids are sent through the wellbore and to the drilling installation for testing, it is in a closed casing and does not interact with the surrounding marine environment. Formation flow testing with flaring is not anticipated to have an interaction with commercial fishing activity and other ocean users. Flaring would not have direct contact with nor interfere with commercial fishing activities or resources, nor interact with other ocean users.

13.3.5 Wellhead Decommissioning

Wellhead decommissioning will be undertaken as described in Section 2.5.2, in compliance with regulatory requirements. As described in Section 2.5.2, in water depths up to 500 m wellheads will be removed by cutting below the seafloor, whereas in depths between 500 m and 1,500 m wellheads will be cut, leaving a portion of the pipe above the seafloor (up to 0.85 m). At depths greater than 1,500 m, the wellhead will remain in place and will not be removed. Wells will be inspected in accordance with applicable regulatory requirements at the time of their decommissioning.

Planned wellhead removal in shallower areas, such as those found in the Project Area – Southern Section, using conventional wellhead removal methods will result in minimal environmental disturbance, given the localized and short-term nature of these activities. These activities may take place within the above described safety zone, after the periods at which the drilling installation will have been present for some time, and so no interactions with commercial fishing activity are expected. However, the wellhead removal may occur at a later date, and would result in a short-term (a few days) safety zone. Communication with commercial fishers and other users will reduce the potential for interaction, and will aid in Project planning for wellhead removal.

In deeper areas (500-1,500 m), such as those found in the Project Area – Northern Section, the long-term presence of wellhead infrastructure protruding above the seafloor has the potential to interact

with certain types of fishing gear that interact with the seabed, particularly mobile gear such as trawls, possibly resulting in damage. The primary fishery within this part of the Project Area is for deepwater species (e.g., Greenland halibut, redfish), which requires the use of trawls. Trawls have the potential to interact with the abandoned wellhead by hooking or snagging on the infrastructure, resulting in damage to the gear. The potential for gear damage is limited as the cut will be as close to the seafloor as possible (maximum height is 0.85 m) and the Operator will provide the locations for each decommissioned well to fishers and the Canadian Hydrographic Service, and issue a Notice to Mariners. These initiatives will allow mobile-gear and fixed-gear fishers to avoid these locations or plan activities around the abandoned wellhead.

At depths greater than 1,500 m, it is planned to leave the wellhead in place. The available information indicates that at those depths there is relatively little fishing activity being undertaken so there is a low probability of associated inference with fishing activity. The Operator will engage with commercial fish harvesters and DFO when it is planned to leave wellheads in place. As indicated above, the locations of wellheads will be sent to fishers and the Canadian Hydrographic Service.

The relatively small numbers and sizes of these wellhead areas means there will be little or no potential for adverse effects on fishing efficiency or associated economic returns. In addition, the Operator will implement gear compensation in accordance with the C-NLOPB gear damage compensation guidelines. With the implementation of these mitigation measures, the effects of the planned wellhead decommissioning strategy will be of low magnitude, limited extent, and of long-term duration.

As part of the 2016 Amendment to Environmental Assessment (Statoil 2016), submitted to the C-NLOPB for existing Exploration Licenses, Statoil consulted fishery stakeholders regarding this approach to wellhead decommissioning. This included meeting and/or correspondence with the FFAW-Unifor, OCI, ASP and One Ocean. Feedback indicated that as the maximum potential for height of pipe left on the seabed (0.85 m) trawl gear may be damaged although a “rock-hopper” on the the gear may clear that height. However, with the planned notifications and addition of wellheads to nautical charts, avoidance should not be an issue. In 2016, Statoil cut and removed four wellheads in the Project Area, the height of the pipe remaining after wellhead removal ranged from 0.05 m to 0.65 m.

Other ocean uses, such as offshore ocean research surveys that use fishing equipment also have the potential to encounter similar interactions with abandoned wellheads. As discussed in Chapter 7, the most recent geospatial data for DFO research surveys do not show transects occurring within the Flemish Pass Project Area and would not likely interact with wellheads in that region. With wellheads in the Project Area – Southern Section in relatively shallower water, and most likely being cut below the surface upon decommissioning, it is expected that there is a low potential for abandoned wells to interact with these research studies. The locations of abandoned wellheads will be communicated to DFO and other research institutions via Canadian Hydrographic Service maps of wellhead locations, and Notice to Mariners from the Operator, to inform them and allow them to plan research activities they may undertake.

Given the implementation of mitigation measures, the resulting residual environmental effects on Commercial Fisheries and Other Ocean Users is expected to be adverse, low in magnitude,

localized, long-term in duration, occurring continously, and reversible. The predictions have been made with a high level of confidence.

13.3.6 Project-Related Surveys

As noted in Table 13.2, Project-related surveys (geophysical / geohazard / wellsite and seabed surveys, geological surveys, geotechnical surveys, and environmental surveys) have the potential to interact with Commercial Fisheries and Other Ocean Users through direct interference, damage to fishing gear, vessels, and equipment, and a change in abundance, location, and quality of marine resources.

Some Project-related surveys that use geophysical sound, such as VSP and wellsite surveys, can result in direct interference with commercial fishing activity due to the towing of survey equipment, such as hydrophones and streamers. This equipment has the potential to interact with fishing gear (e.g., crab pots) that may already be set in an area where surveying is taking place. The entanglement of survey equipment with fishing gear has the potential to result in direct damage to the fishing equipment, which can translate into lost time or catch, and subsequent lower economic returns for the harvester. However, due to the transient and localized nature of project surveys, their short duration, and low levels of fishing activity on Operator ELs (Chapter 7), gear damage is not likely. Similarly, although there is a potential for interaction with research gear, and other vessels, the likelihood is low due to the nature of the Project activity. Ongoing coordination and communication between the Operator and the fishing industry (e.g., One Ocean, Notices to Shipping, indigenous Communities Fisheries Communication Plan), and a compensation program for damage to commercial fisheries will reduce the potential for effects between Project-related surveys and commercial fishers.

For other surveys that do not used towed gear, such as geotechnical and environmental surveys, there is limited potential for direct interactions with commercial fishing gear. The presence of the survey vessels may result in a temporary restriction in the area of the survey, however, as indicated above, it is not anticipated that the resulting effects will be measurable because these surveys are relatively non-intrusive, transient, short-term, infrequent, and localized. To further reduce potential effects to commercial fishers and other users, scheduled survey activities will be communicated through Notices to Shipping. Similarly, although there is a potential for interaction with research gear and other vessels, the likelihood is low due to the nature of the activity and the communication protocols that will be implemented.

The effects of underwater noise associated with Project-related surveys, such as noise from vessels or geophysical surveys, has the potential to indirectly affect commercial fishing activity through changes in fish behavior and avoidance of certain areas (Section 8.3.3). This avoidance could reduce catch rates of fish in some areas, therefore resulting in lower economic returns for fishers. The effects of underwater noise associated with Project-related surveys on marine fish species have been assessed in the Marine Fish and Fish Habitat VC (Chapter 8). It was concluded that there would not be a significant effect of marine fish species (including commercial fish species) from the presence of underwater noise from Project-related surveys. Therefore, underwater noise is likely to have only limited indirect effects on catch rates and associated economic value for commercial fishers. While operation of a source array could injure fish species if they are within proximity to the sound source,

it is likely that mobile fish will disperse from the source during ramp-up or vessel approach, and avoid harm. The more likely effect is that fish species, including commercial species, will move away from an area due to the presence of underwater noise. Skalski et al. (1992), for example, cite geophysical activity as a contributing factor for decreased fish abundance, and Lokkeborg (1991) observed reduced fish catches for days following 2D/3D seismic survey exposure as a result of changes in fish behaviour. Catches for some species / gear types (such as gillnet catches of orange rockfish and halibut) have actually increased during geophysical activity, whereas others (such as longline catches of haddock) have been observed to decrease (Løkkeborg et al. 2010). At larger scales, regions with geophysical survey activity had decreased catches for only a few species for certain gear types (e.g., saithe and haddock with gill nets; Vold et al. 2009). In other studies, the effects of geophysical survey exposure on cod catches off the coast of Norway found that catch rates decreased by at least 50% within the geophysical survey area, lasting for approximately 24 hours within a 10 km radius (Engås et al. 1996). The potential effects of geophysical survey activity on fish catch rates therefore appear to vary by species and gear type (Hirst and Rodhouse 2000; Lokkeborg et al. 2012; Worcester 2006; Vold et al. 2012).

The behaviour of invertebrate species such as snow crab, does not appear to be as affected as mobile species by underwater noise (Christian et al. 2004; Parry and Gason 2006). Catchability of pre- and post-geophysical survey noise exposure of snow crab was investigated by Christian et al. (2004) during a commercial fishing season; among the findings was the catch-per-unit-effort did not decrease after snow crabs were exposed to geophysical survey sound. Parry and Gason (2006) found no evidence of geophysical noise effects on catch rates of Australian rock lobster.

Overall, the behavioural response of fish to sound from geophysical surveys is expected to be less than that to traditional geophysical surveys due to the smaller source array, shorter survey period, and more localized nature than 3D seismic surveys. Indirect effects to Commercial Fisheries and Other Ocean Users is expected to be low due to the transient, localized, and short-term nature of the surveys. Mitigation measures to further reduce effects of underwater noise on marine fish are presented in Section 8.3.2.

In consideration of the limited temporal scope of many of these surveys, and the implementation of mitigation measures, the residual environmental effects of Project-related surveys are predicted to be adverse, low in magnitude, localized, short-term in duration, occurring sporadically, and reversible following Project completion. These predictions have been made with a high level of confidence.

13.3.7 Supply and Servicing

As noted in Table 13.2, supply and servicing has the potential to interact with Commercial Fisheries and Other Ocean Users through a change in availability or function of commercial fishing and other ocean uses, damage to fishing gear, vessels, and equipment, and a change in abundance, location, and quality of commercial fishing resources.

Supplies and servicing and transfer of personnel will be provided to the drilling installation by supply vessels helicopters. Due to the potential for spatial overlap, the discussion below focuses on the interaction between supply vessels and Commercial Fisheries and Other Ocean Users. There is not anticipated to be an interaction with aircraft traffic. As described in Chapter 2, the contribution of the

Project to existing supply vessel and aircraft traffic serving the offshore industry will be negligible, and will continue at approximately the same level as current traffic supporting the Operators' on-going exploration activities in the region. Supply vessel transit activities will employ long-established mitigation, including use of established traffic routes and communication protocols. The transient nature of their presence is consistent with existing shipping traffic.

Supply vessels traversing the Project Area have the potential to contact and damage fishing gear, as well as other vessels. Fixed fishing gear (i.e., crab pots) are most at risk from interaction with vessel traffic along the transportation corridor (Chapter 7). Based on historic evidence, damage to other vessels is highly unlikely; there have been no incidents reported regarding interaction between a supply vessel and a commercial fishing or other ocean user vessel (C-NLOPB 2017). The implementation of standard industry measures and operation of vessels will reduce the likelihood of this occurrence. In the unlikely event of an interaction between an supply vessel and fishing gear, a fisheries compensation program will be implemented as part of the Project to reduce potential effects.

Underwater sound levels associated with supply vessels are not expected to be incrementally increased because supply vessel traffic serving the Project will continue at approximately the same level as current traffic. As discussed in Marine Fish and Fish Habitat (Section 8.5), a detectable difference in behavior or distribution of commercial fish species is not likely, due to the transitory, short-term, and localized nature of supply vessel traffic. Discharges from supply vessels have the potential to affect commercial fishers by either a change in water quality that may have an effect on target fish species, or through other effects such as fouling of fishing gear. As presented in Section 8.3.4, the discharge wastes associated with supply vessels will be within limits established by MARPOL. Mitigation measures outlined in the assessment of Marine Fish and Fish Habitat (Section 8.3.2) will further reduce the potential effects of waste discharges on fish species, including commercial species.

In summary, residual environmental effects on Commercial Fisheries and Other Ocean Users associated with supply and servicing operations are predicted to be adverse, low in magnitude, localized, short-term in duration, occurring at regular intervals during project activities, and reversible following Project completion. These predictions have been made with a high level of confidence.

13.4 Significance of Residual Environmental Effects

This section summarizes the residual effects of the Project on Commercial Fisheries and Other Ocean Users and presents a definition and determination of significance for the environmental effects assessment for this VC.

13.4.1 Residual Environmental Effects Summary

Table 13.3 summarizes the environmental effects assessment for the Project as a whole, including characterization of potential effects from potential Project interactions and applicable mitigation measures relating to Commercial Fisheries and Other Ocean Users. Tables 13.4 to 13.9 then provide individual environmental effects assessment summaries for planned Project activities on each of the ELs that comprise the Project being assessed under CEAA 2012. As described above and summarized in Table 13.3, with the implementation of mitigation measures outlined in the preceding sections, the Project is likely to result in adverse, low magnitude, localized, and short-term residual environmental effects on Commercial Fisheries and Other Ocean Users.

The potential for the Project to interact with and affect Commercial Fisheries and of Ocean Users will depend upon the nature, location and timing of these activities, and the equipment or gear involved. With respect to spatial and temporal variation within the Project Area, there is greater potential that Project activities will affect fishing activities during the summer months when fishing activity is greatest, and within the Project Area – Southern Section where the intensity and diversity of fishing is greater than that in the Project Area – Northern Section. In all cases, mitigation measures such as communication protocols, Notice to Shippers and Notice to Mariners, and the presence of FLOs, where applicable, will reduce adverse effects to this VC.

13.4.2 Determination of Significance

With the implementation of mitigation measures to avoid or reduce adverse effects on Commercial Fisheries and Other Ocean Users, the Project is not likely to result in significant adverse effects. This prediction has been made with a high level of confidence based on a good understanding of commercial fisheries and other offshore activities that occur in the Project Area and RSAs, and the general effects that past oil and gas projects have had on commercial fisheries and other ocean uses. The primary mechanism of interaction that may have adverse effects on this VC is the presence of the drilling installation with its associated safety zone; although the safety zone is a mitigation measure to avoid collisions with other vessels and fishing gear, it also results in the loss of fishing and other ocean-use access to the drilling installation area. While this in turn may lead to a temporary decrease in the area available to be harvested or used, the effect is anticipated to be negligible to minor and spatially and temporally limited; therefore, it is not anticipated to result in a detectable reduction in the overall economic returns generated from commercial fisheries or other ocean activities, or to result in a decrease in overall activity levels and/or the enjoyment or cultural value of any recreational activities.

Table 13.3 Environmental Effects Assessment Summary: Commercial Fisheries and Other Ocean Users – Overall Project

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY	
Summary of Existing Conditions and Ecological and Social Context: Project Area / LSA • A variety of commercial fishing activity for multiple fish species takes place within the Project Area / LSA and RSA, with the summer months usually being the times when offshore Newfoundland and Labrador experiences the most ocean use / activity. • Important commercial fisheries include those for snow crab and northern shrimp. Other commercial fisheries that occur in the area include those for clams, cockles, capelin, Greenland and Atlantic halibut, yellowtail flounder, and pelagic species such as swordfish and various species of tuna. • Recent decades have seen important and widespread changes in the fishing industry due to natural (climate change) and human (other	**Summary of Key Mitigation** • Use of existing and common travel routes for vessels and helicopters will be used where possible and practicable • Low-level aircraft operations will be avoided where it is not required per Transport Canada protocols • Operational discharges will be treated prior to release in accordance with the OWTG and other applicable regulations and standards. • The selection and screening of chemicals to be discharged, including drilling fluids, will be in accordance with the Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands • During formation flow testing with flaring, produced hydrocarbons and produced water will be flared. If there is a large amount of produced water encountered, it will be treated in accordance with the relevant regulatory requirements prior to ocean discharge, or shipped to shore for appropriate disposal • Appropriate handling, storage, transportation, and on-shore disposal of solid and hazardous waste • Establishment of a safety zone around drilling installations in accordance with the Newfoundland Offshore Petroleum Drilling and Production Regulations SOR/2009-316 • Issuance of Notices to Shipping, Notice to Mariners (where appropriate) regarding planned Project activities • Ongoing communication with commercial fishers through One Ocean, FFAW-Unifor and seafood producers regarding planned project activities, including timely communication of drilling locations, safety zone, and decommissioned wellheads. This information will also be communicated to Indigenous fishers in accordance with the Indigenous Communities Fisheries Communication Plan • Ongoing communications with the NAFO Secretariat, through DFO as the Canadian representative, regarding planned Project activities, including timely communication of drilling locations, safety zone, and decommissioned wellsites • In accordance with the One Ocean "Risk Management Matrix Guidelines," the need for a Fisheries Liaison Officer (FLO) and/or fisheries guide vessels during drilling installation movement from port to its offshore location will be determined in consideration of the guidelines. Use of a FLO during geophysical programs will also be determined in consideration of these guidelines • A single point of contact (SPOC) will be established during Project activities to facilitate communications between fishers and the Operator regarding gear loss/damage and other compensation matters • Develop and implement a compensation program for damages resulting from Project activities. This compensation program will be developed in consideration of C-NLOPB guidelines, including the Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activities (March 2002) and as revised. This program will outline compensation procedures for actual loss or damages to commercial fishers, including Commercial-communal fishers, attributable to the operator resulting from a spill or debris, or expenses incurred

Table 13.3 Environmental Effects Assessment Summary: Commercial Fisheries and Other Ocean Users – Overall Project

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY	
anthropogenic activities), which have influenced the nature, intensity, distribution, and timing of fisheries into his region. • There are also possible future changes in the fisheries off Eastern Newfoundland, such as a possible resurgence of groundfish activities, which are relevant to the characteristics of the VC over the lifespan of this Project	in taking remedial action. Actual loss or damage includes loss of income or future income; loss of hunting, fishing, or gathering opportunities; and costs and expenses incurred for action taken to remedy a situation involving a spill, including measure to control or clean a spill • The communication of suspended and/or abandoned wellsite locations to the appropriate authorities for inclusion on nautical charts for use by commercial fishers and other mariners • Contact DFO regarding timing and locations of planned DFO research surveys • Contact DND regarding timing of planned offshore military exercises

Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors						
		Nature / Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty
Presence and Operation of Drilling Installation	• Direct interference • Change in resource abundance, location, quality	A	L	L	S	C	R	H
Drilling and Associated Marine Discharges	• Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	R	R	H
Formation Flow Testing with Flaring	• None expected	N	-	-	-	-		H
Wellhead Decommissioning	• Direct interference	A	L	L	L	C	R	H

Table 13.3 Environmental Effects Assessment Summary: Commercial Fisheries and Other Ocean Users – Overall Project

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
	• Damage to equipment							
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Direct interference • Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	S	R	H
Geological, Geotechnical and Environmental Surveys	• Direct interference • Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	S	R	H
Supply and Servicing	• Direct interference • Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	R	R	H

Evaluation of Significance

- The Project is not likely to result in significant adverse environmental effects on Commercial Fisheries and Other Ocean Users. The establishment of a safety zone around the Drilling Installation may temporarily displace commercial fishers and other activities from accessing certain localized areas, but is unlikely to have an overall and detectable economic effect on any industry within the RSA.
- The implementation of standard mitigation measures for Commercial Fisheries and Other Ocean Users, such as gear damage compensation, establishment of a safety zone around the drilling installation, presence and active advice of a FLO as required, Notice to Shippers and Notice to Mariners, and other communications are expected to further reduce the potential for interactions and effects.

NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.

Table 13.3 Environmental Effects Assessment Summary: Commercial Fisheries and Other Ocean Users – Overall Project

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY		
KEY		
Nature / Direction:	Frequency:	Certainty in Predictions:
P Positive	O Occurs once	L Low level of confidence
A Adverse	S Occurs sporadically	M Moderate level of confidence
N Neutral (or No Effect)	R Occurs on a regular basis	H High level of confidence
	C Occurs continuously	
Magnitude:		N/A Not Applicable
N Negligible	Duration:	
L Low	S Short term (For duration of the activity)	
M Medium	M Medium term (Beyond duration of the activity – weeks or months)	
H High	L – Long term (Beyond duration of the activity years)	
Geographic Extent:	P Permanent (Recovery unlikely)	
L Localized, In Immediate Vicinity of Activity	Reversibility:	
PA Within Project Area	R Reversible (Will recover to baseline)	
LSA Within LSA	I Irreversible (Permanent)	
RSA Within RSA or Beyond		

Table 13.4 Environmental Effects Assessment Summary: Commercial Fisheries and Other Ocean Users – EL 1135

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY	
Summary of Existing Conditions and Ecological and Social Context: EL 1135 • See Table 13.3 for an overview of the Project Area / LSA as a whole. • In this EL and surrounding area, there is a relatively high level of commercial fishing activity, as the licence is located on the continental shelf and overlaps with these fishing areas. • Commercial fishing activity has been recorded in this area between 2011 and 2015. • Fishing occurs primarily for snow crab and northern shrimp, and is most active from April to August. • Potential vessel transit routes to EL 1135 overlap with areas that are fished commercially.	**Summary of Key Mitigation** See Table 13.3

Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors						
		Nature / Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty
Presence and Operation of Drilling Installation	• Direct interference • Change in resource abundance, location, quality	A	L	L	S	C	R	H
Drilling and Associated Marine Discharges	• Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	R	R	H
Formation Flow Testing with Flaring	• None expected	N	-	-	-	-		H
Wellhead Decommissioning	• Direct interference • Damage to equipment	A	L	L	L	C	R	H

Table 13.4 Environmental Effects Assessment Summary: Commercial Fisheries and Other Ocean Users – EL 1135

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Direct interference • Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	S	R	H
Geological, Geotechnical and Environmental Surveys	• Direct interference • Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	S	R	H
Supply and Servicing	• Direct interference • Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	R	R	H

Evaluation of Significance

- The Project is not likely to result in significant adverse environmental effects on Commercial Fisheries and Other Ocean Users. The establishment of a safety zone around the Drilling Installation may temporarily displace commercial fishers and other activities from accessing certain localized areas, but is unlikely to have an overall and detectable economic effect on any industry within the RSA.
- The implementation of standard mitigation measures for Commercial Fisheries and Other Ocean Users, such as gear damage compensation, establishment of a safety zone around the drilling installation, presence and active advice of a FLO as required, Notice to Shippers and Notice to Mariners, and other communications are expected to further reduce the potential for interactions and effects.

NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.

KEY: See Table 13.3

Table 13.5 Environmental Effects Assessment Summary: Commercial Fisheries and Other Ocean Users – EL 1137

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Summary of Existing Conditions and Ecological and Social Context: EL 1137 • See Table 13.3 for an overview of the Project Area / LSA as a whole. • EL is in a location of the Jeanne d'Arc Basin that does not contain a large amount of fishing activity. • Commercial fishing activity has been recorded in this area between 2011 and 2015. • Fishing occurs primarily for snow crab and northern shrimp, and is most active from April to August. • Potential vessel transit routes to EL 1137 overlap with areas that are fished commercially. • Other ocean use, primarily oil and gas development, is established and known within this area.							**Summary of Key Mitigation** See Table 13.3	
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature / Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of Drilling Installation	• Direct interference • Change in resource abundance, location, quality	A	L	L	S	C	R	H
Drilling and Associated Marine Discharges	• Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	R	R	H
Formation Flow Testing with Flaring	• None expected	N	-	-	-	-		H
Wellhead Decommissioning	• Direct interference • Damage to equipment	A	L	L	L	C	R	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Direct interference • Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	S	R	H

Table 13.5 Environmental Effects Assessment Summary: Commercial Fisheries and Other Ocean Users – EL 1137

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Geological, Geotechnical and Environmental Surveys	• Direct interference • Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	S	R	H
Supply and Servicing	• Direct interference • Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	R	R	H

Evaluation of Significance

- The Project is not likely to result in significant adverse environmental effects on Commercial Fisheries and Other Ocean Users. The establishment of a safety zone around the Drilling Installation may temporarily displace commercial fishers and other activities from accessing certain localized areas, but is unlikely to have an overall and detectable economic effect on any industry within the RSA.
- The implementation of standard mitigation measures for Commercial Fisheries and Other Ocean Users, such as gear damage compensation, establishment of a safety zone around the drilling installation, presence and active advice of a FLO as required, Notice to Shippers and Notice to Mariners, and other communications are expected to further reduce the potential for interactions and effects.

NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.

KEY: See Table 13.3

Table 13.6 Environmental Effects Assessment Summary: Commercial Fisheries and Other Ocean Users – EL 1139

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY	
Summary of Existing Conditions and Ecological and Social Context: EL 1139 • See Table 13.3 for an overview of the Project Area / LSA as a whole. • In this EL and surrounding area, there is a relatively low level of commercial fishing activity. • No recorded commercial landings in EL 1139 between 2011 and 2015. • Commercial fishing in this area is primarily for deep-water fish, primarily Greenland halibut • Potential vessel transit routes to EL 1139 overlap with areas that are fished commercially.	**Summary of Key Mitigation** See Table 13.3

Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors						
		Nature / Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty
Presence and Operation of Drilling Installation	• Direct interference • Change in resource abundance, location, quality	A	L	L	S	C	R	H
Drilling and Associated Marine Discharges	• Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	R	R	H
Formation Flow Testing with Flaring	• None expected	N	-	-	-	-		H
Wellhead Decommissioning	• Direct interference • Damage to equipment	A	L	L	L	C	R	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Direct interference • Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	S	R	H

Table 13.6 Environmental Effects Assessment Summary: Commercial Fisheries and Other Ocean Users – EL 1139

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Geological, Geotechnical and Environmental Surveys	• Direct interference • Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	S	R	H
Supply and Servicing	• Direct interference • Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	R	R	H
Evaluation of Significance • The Project is not likely to result in significant adverse environmental effects on Commercial Fisheries and Other Ocean Users. The establishment of a safety zone around the Drilling Installation may temporarily displace commercial fishers and other activities from accessing certain localized areas, but is unlikely to have an overall and detectable economic effect on any industry within the RSA. • The implementation of standard mitigation measures for Commercial Fisheries and Other Ocean Users, such as gear damage compensation, establishment of a safety zone around the drilling installation, presence and active advice of a FLO as required, Notice to Shippers and Notice to Mariners, and other communications are expected to further reduce the potential for interactions and effects. NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.								
KEY: See Table 13.3								

Table 13.7 Environmental Effects Assessment Summary: Commercial Fisheries and Other Ocean Users – EL 1140

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY	
Summary of Existing Conditions and Ecological and Social Context: EL 1140 • See Table 13.3 for an overview of the Project Area / LSA as a whole. • In this EL and surrounding area, there is a relatively low level of commercial fishing activity. • No recorded commercial landings in EL 1140 between 2011 and 2015. • Commercial fishing in this area is for deep-water fish, primarily Greenland halibut. Potential vessel transit routes to EL 1140 overlap with areas that are fished commercially.	**Summary of Key Mitigation** See Table 13.3

Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors						
		Nature / Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty
Presence and Operation of Drilling Installation	• Direct interference • Change in resource abundance, location, quality	A	L	L	S	C	R	H
Drilling and Associated Marine Discharges	• Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	R	R	H
Formation Flow Testing with Flaring	• None expected	N	-	-	-	-		H
Wellhead Decommissioning	• Direct interference • Damage to equipment	A	L	L	L	C	R	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Direct interference • Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	S	R	H

Table 13.7 Environmental Effects Assessment Summary: Commercial Fisheries and Other Ocean Users – EL 1140

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Geological, Geotechnical and Environmental Surveys	• Direct interference • Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	S	R	H
Supply and Servicing	• Direct interference • Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	R	R	H
Evaluation of Significance • The Project is not likely to result in significant adverse environmental effects on Commercial Fisheries and Other Ocean Users. The establishment of a safety zone around the Drilling Installation may temporarily displace commercial fishers and other activities from accessing certain localized areas, but is unlikely to have an overall and detectable economic effect on any industry within the RSA. • The implementation of standard mitigation measures for Commercial Fisheries and Other Ocean Users, such as gear damage compensation, establishment of a safety zone around the drilling installation, presence and active advice of a FLO as required, Notice to Shippers and Notice to Mariners, and other communications are expected to further reduce the potential for interactions and effects. NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.								
KEY: See Table 13.3								

Table 13.8 Environmental Effects Assessment Summary: Commercial Fisheries and Other Ocean Users – EL 1141

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY	
Summary of Existing Conditions and Ecological and Social Context: EL 1141 • See Table 13.3 for an overview of the Project Area / LSA as a whole. • In this EL and surrounding area, there is a relatively low level of commercial fishing activity. • Low recorded harvest in EL 1141 in recent years. • Commercial fishing in this area is for deep-water fish, primarily Greenland halibut. • Potential vessel transit routes to EL 1141 overlap with areas that are fished commercially.	**Summary of Key Mitigation** See Table 13.3

Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors						
		Nature / Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty
Presence and Operation of Drilling Installation	• Direct interference • Change in resource abundance, location, quality	A	L	L	S	C	R	H
Drilling and Associated Marine Discharges	• Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	R	R	H
Formation Flow Testing with Flaring	• None expected	N	-	-	-	-		H
Wellhead Decommissioning	• Direct interference • Damage to equipment	A	L	L	L	C	R	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Direct interference • Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	S	R	H

Table 13.8 Environmental Effects Assessment Summary: Commercial Fisheries and Other Ocean Users – EL 1141

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Geological, Geotechnical and Environmental Surveys	• Direct interference • Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	S	R	H
Supply and Servicing	• Direct interference • Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	R	R	H
Evaluation of Significance • The Project is not likely to result in significant adverse environmental effects on Commercial Fisheries and Other Ocean Users. The establishment of a safety zone around the Drilling Installation may temporarily displace commercial fishers and other activities from accessing certain localized areas, but is unlikely to have an overall and detectable economic effect on any industry within the RSA. • The implementation of standard mitigation measures for Commercial Fisheries and Other Ocean Users, such as gear damage compensation, establishment of a safety zone around the drilling installation, presence and active advice of a FLO as required, Notice to Shippers and Notice to Mariners, and other communications are expected to further reduce the potential for interactions and effects. NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.								
KEY: See Table 13.3								

Table 13.9 Environmental Effects Assessment Summary: Commercial Fisheries and Other Ocean Users – EL 1142

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY	
Summary of Existing Conditions and Ecological and Social Context – EL 1142 • See Table 13.3 for an overview of the Project Area / LSA as a whole. • In this EL and surrounding area, there is a relatively low level of commercial fishing activity • Low recorded harvest in EL 1142 in recent years. • Commercial fishing in this area is for deep-water fish, primarily Greenland halibut. • Potential vessel transit routes to EL 1142 overlap with areas that are fished commercially.	**Summary of Key Mitigation** See Table 13.3

Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors						
		Nature / Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty
Presence and Operation of Drilling Installation	• Direct interference • Change in resource abundance, location, quality	A	L	L	S	C	R	H
Drilling and Associated Marine Discharges	• Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	R	R	H
Formation Flow Testing with Flaring	• None expected	N	-	-	-	-		H
Wellhead Decommissioning	• Direct interference • Damage to equipment	A	L	L	L	C	R	H
Geophysical, Geohazard, Wellsite Seabed and VSP Surveys	• Direct interference • Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	S	R	H

Table 13.9 Environmental Effects Assessment Summary: Commercial Fisheries and Other Ocean Users – EL 1142

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY								
Geological, Geotechnical and Environmental Surveys	• Direct interference • Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	S	R	H
Supply and Servicing	• Direct interference • Damage to equipment • Change in resource abundance, location, quality	A	L	L	S	R	R	H

Evaluation of Significance

- The Project is not likely to result in significant adverse environmental effects on Commercial Fisheries and Other Ocean Users. The establishment of a safety zone around the Drilling Installation may temporarily displace commercial fishers and other activities from accessing certain localized areas, but is unlikely to have an overall and detectable economic effect on any industry within the RSA.
- The implementation of standard mitigation measures for Commercial Fisheries and Other Ocean Users, such as gear damage compensation, establishment of a safety zone around the drilling installation, presence and active advice of a FLO as required, Notice to Shippers and Notice to Mariners, and other communications are expected to further reduce the potential for interactions and effects.

NOTE: The environmental effects assessment for accidental events is presented separately, in Chapter 15.

KEY: See Table 13.3

13.5 Environmental Monitoring and Follow-up

As documented previously in this Chapter, the Operator has committed to a number of measures and on-going processes to avoid or reduce the potential for adverse interactions with, and effects upon, fisheries and other marine activities and users. These include on-going communication and cooperation mechanisms throughout the operational life of the Project (Section 13.3.2). These are intended to allow an on-going discussion of Project-related activities and issues as they may arise during Project implementation, and cooperative and collaborative planning and implementation of required management measures throughout the life of the Project.

Given the high level of confidence regarding the prediction of not significant adverse environmental effects on commercial fisheries or other ocean uses in the Project Area/LSA or RSAs, and the implementation of mitigation, no follow-up is proposed to be implemented for routine Project activities.

13.6 References

Amec Environment and Infrastructure. 2014. Eastern Newfoundland Strategic Environmental Assessment. Final Report, 2014. Available at: http://www.cnlopb.ca/sea/eastern.php. Accessed March 16, 2016.

Christian, J.R., A. Mathieu, D.H. Thomson, D. White and R.A. Buchanan. 2004. Effect of seismic energy on snow crab (*Chionoecetes opilio*). Environmental Studies Research Funds Report, 144: 106 pp.

C-NLOPB (Canada-Newfoundland and Labrador Offshore Petroleum Board). 2016. Incident Disclosures: Available at: http://www.cnlopb.ca/incidents/

Engås, A., Løkkeborg, S., Ona, E., and A.V. Soldal. 1996. Effects of seismic shooting on local abundance and catch rates of cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*). Canadian Journal of Fisheries and Aquatic Sciences, 53(10): 2238-2249.

Hirst, A. G., and P.G. Rodhouse. 2000. Impacts of geophysical seismic surveying on fishing success. Reviews in Fish Biology and Fisheries, 10(1), 113-118.

Løkkeborg, S. 1991. Effects of geophysical survey on catching success in longline fishing. Paper presented at the International Council for the Exploration of the Sea (ICES) Annual Science Conference. ICES. 40: 1-9.

Løkkeborg, S., Ona, E., Vold, A., Pena, H., Salthaug, A., Totland, B., Øvredale, J.T., Dalen, J., and N.O. Handegard. 2010. Effects of seismic surveys on fish distribution and catch rate of gillnets and longlines in Vesterålen in summer 2009. Havforskningsinstituttet Prosjekrapport Fisken og Havet, 2-2010: 74 pp.

Løkkeborg, S., Ona, E., Vold, A., and A. Salthaug. 2012. Sounds from seismic air guns: gear-and species-specific effects on catch rates and fish distribution. Canadian Journal of Fisheries and Aquatic Sciences, 69(8), 1278-1291.

Parry, G.D. and A. Gason. 2006. The effect of seismic surveys on catch rates of rock lobsters in western Victoria, Australia. Fisheries Research, 79: 272

Skalski, J.R., Pearson, W.H. and C.I. Malme. 1992. Effects of sounds from a geophysical survey device on catch-per-unit-effort in a hook-and-line fishery for rockfish (*Sebastes* spp). Canadian Journal of Fisheries and Aquatic Sciences, 49:1357-1365.

Vold, A., Løkkeborg, S., and M.M. Tenningen. 2012. Using catch statistics to investigate effects of seismic activity on fish catch rates. Pp. 411-413. In The Effects of Noise on Aquatic Life, Springer New York.

Vold, A., Løkkeborg, S., and Tenningen, M., and J. Saltskar. 2009. Analysis of commercial catch data to study the effects of seismic surveys on fisheries of Lofoten and Vesteralen summer of 2008. Fiske nog Havet 5/2009, Havforskningsinstituttet, Bergen. (summary in English).

Worcester, T. 2006. Effects of seismic energy on fish: A literature review. Fisheries and Oceans Canada, Science Advisory Secretariat Research Document, 2006/092.:66 pp.

14.0 CUMULATIVE ENVIRONMENTAL EFFECTS

As required under Section 19(1) of CEAA 2012, the EIS assesses and evaluates cumulative environmental effects that are likely to result from the Project in combination with other physical activities that have been or will be carried out, as well as the significance of these potential effects. The cumulative effects assessments for all VCs are reported in separate subsections within this chapter, and were completed in accordance with the approach and methods described below.

14.1 Approach and Methods

As noted in the EIS Guidelines (Section 6.6.3), cumulative effects "*are defined as changes to the environment due to the project combined with the existence of other past, present and reasonably foreseeable physical activities. Cumulative effects may result if:*

- The implementation of the project may cause direct residual adverse effects on the VC, taking into account the application of technically and economically feasible mitigation measures
- The same VC may be affected by other past, present and future physical activities"

As also specified in the EIS Guidelines, the approach and methods used in undertaking the cumulative effects assessment are based on the guidance provided in the following Canadian Environmental Assessment Agency (2014, 2015) documents:

- Operational Policy Statement Assessing Cumulative Environmental Effects under the Canadian Environmental Assessment Act, 2012 and
- Technical Guidance for Assessing Cumulative Environmental Effects under the Canadian Environmental Assessment Act, 2012

The cumulative environmental effects assessment considers the overall total effect on the VCs as a result of the Project's predicted residual environmental effects (as described in the preceding chapters) and those of other relevant projects and activities.

14.1.1 Identification of Valued Components

The EIS Guidelines (Section 6.6.3) also state that the cumulative effects assessment will "*identify and provide a rationale for the VCs that will constitute the focus of the cumulative effects assessment, focusing the cumulative effects assessment on the VCs most likely to be affected by the project and other project and activities*", while also noting that "*VCs that would not be affected by the project or would be affected positively by the project can, therefore, be omitted from the cumulative effects assessment*."

The cumulative effects assessment reported herein focusses upon the same set of VCs as those which were considered in the Project-specific effects assessment, as these represent the components of the environment that may interact with and be adversely affected by the Project, and thus, upon which the Project and its effects may contribute to cumulative effects within the spatial and temporal boundaries under consideration (EIS Section 14.1.2).

Table 14.1 lists the various environmental components specified in the EIS Guidelines as requiring consideration in planning and completing the cumulative effects assessment, and provides an indication of whether and how each of these are included and are being addressed.

Table 14.1 Environmental Components Considered and Included in the Cumulative Effects Assessment

Components	Consideration / Inclusion in the Environmental Effects Assessment		
	Project Effects Assessment	Cumulative Effects Assessment	Overview / Rationale
Fish and Fish Habitat	•	•	• Potential for residual (but not significant) environmental effects as a result of the Project, which may contribute to cumulative effects.
Migratory Birds	•	•	• Potential for residual (but not significant) environmental effects as a result of the Project, which may contribute to cumulative effects.
Marine Mammals and Marine Turtles	•	•	• Potential for residual (but not significant) environmental effects as a result of the Project, which may contribute to cumulative effects.
Species at Risk	•	•	• Potential for residual (but not significant) environmental effects as a result of the Project, which may contribute to cumulative effects. • Included in an integrated manner within each of the above listed biological components
Marine Plants			• The Marine Fish and Fish Habitat VC includes relevant fish species as well as plankton, algae, benthos and relevant components of their habitats (such as water and sediment), as well as marine plants given the clear interrelationships between these environmental components. • The consideration of Marine Plants within this VC is in keeping with current and standard EA practice, and provides for a more comprehensive, holistic approach while at the same time reducing unnecessary repetition. • Although as described in Chapter 8, the Project has little potential to adversely affect marine plants, this component is retained as part of the overall Marine Fish and Fish Habitat VC for completeness and as outlined above.
Special Areas	•	•	• Potential for residual (but not significant) environmental effects as a result of the Project, which may contribute to cumulative effects.
Commercial Fisheries	•	•	• Potential for residual (but not significant) environmental effects as a result of the Project, which may contribute to cumulative effects. This includes effects to fishers who may be operating under a commercial-communal licence on behalf of Indigenous communities.

Table 14.1 Environmental Components Considered and Included in the Cumulative Effects Assessment

Components	Consideration / Inclusion in the Environmental Effects Assessment		
	Project Effects Assessment	Cumulative Effects Assessment	Overview / Rationale
Indigenous Communities and Activities	•	•	• Although as described in Chapter 12, the Project has little potential to adversely affect Indigenous Communities and Activities, this component is considered in the cumulative effects to assessment to systematically examine whether there is potential for it to contribute to cumulative effects. • This is considered appropriate and prudent given the overall number and diversity of Indigenous communities, activities, and interests that the EIS Guidelines require be considered in the EIS, and the wide geographic distribution of these throughout Eastern Canada.
Air Quality and Greenhouse Gases			• Not a separate VC for the Project-specific environmental effects assessment or the cumulative effects assessment. • These aspects of the atmospheric environment are addressed as part of the overall discussion of potential Project-related environmental emissions in the Project Description (Section 2.9). • This includes a description of the anticipated types and levels of Project-related air emissions and their contribution to regional ambient air quality and GHG levels. • By considering their accumulation with other emissions sources, the analysis of Project-specific air emissions is therefore inherently an analysis of potential cumulative effects. • This analysis has shown that the Project will make a negligible contribution to same, and therefore will not result in or contribute to detectable effects on the atmospheric environment. • The Project-related emissions calculations, as presented previously in Chapter 2, do have the potential to cumulatively interact with the emissions from other marine vessel traffic in the area and the operation of existing and planned offshore operations in the Jeanne d'Arc Basin. However, due to the distances of these sources with respect to the Project, an interaction with the potential to result in a detectable effect is very unlikely. • This is supported by results presented in the 2013 ESRF Air Emissions Study – Effects of Offshore Oil and Gas Production on Air Quality in Canada's East Coast Offshore Areas (Stantec 2013), which concluded that air emission concentrations (in this case NOx) generally

Table 14.1 Environmental Components Considered and Included in the Cumulative Effects Assessment

Components	Consideration / Inclusion in the Environmental Effects Assessment		
	Project Effects Assessment	Cumulative Effects Assessment	Overview / Rationale
			meet onshore ambient air quality regulations within 500 m of the emitting platform.
Human Environment			• Not a separate VC for the Project-specific environmental effects assessment or the cumulative effects assessment. • Relevant aspects of the human environment that have the potential to be affected by the Project (such as commercial fisheries and other marine users) and/or which are required to be considered in the EIS under relevant provisions of CEAA 2012 (such as, for Indigenous Communities and Activities, those factors required under Section 5(1)(c) of the Act) are part of the other socioeconomic VCs identified above.

No other components of the biophysical or socioeconomic environments have been identified as having the potential to be directly and adversely affected by the Project which would necessitate or justify their inclusion in the cumulative effects assessment presented in this EIS.

14.1.2 Spatial and Temporal Boundaries

The EIS Guidelines (Section 6.6.3) state that the EIS will "*identify and justify the spatial and temporal boundaries for the cumulative effect assessment for each VC selected*". The Guidelines also state that "*the boundaries for the cumulative effects assessments will generally be different for each VC considered*", noting that "*these cumulative effects boundaries will also generally be larger than the boundaries for the corresponding project effects*."

For all VCs, the spatial and temporal boundaries used for the cumulative effects assessment are consistent with those established and used for the Project-specific effects assessment (see earlier RSA definitions, Section 4.3 and Chapters 8 to 13). This is the case because these boundaries were defined to incorporate:

- The likely geographic and temporal zones of influence of the Project and its environmental effects
- The overall geographic extents and distribution patterns of the various biota and human activities that comprise the VCs under consideration and which may therefore be affected by the Project and its environmental effects
- The other projects and activities and associated environmental effects that may affect the same individuals or populations as those affected by the Project (whether these occur within or outside the RSA itself)

As described in Section 4.3 (EA Approach and Methods), the RSAs defined for the VCs have also been established to be larger than the likely and predicted extent of Project-related effects, in order to account for the larger movements and distributions of the various biological and socioeconomic components that may be affected by the Project. The RSAs therefore also consider and incorporate the overall distributions and movements, as applicable, of potentially affected individuals and populations during the time period which they may be affected by the Project, and thus, for which they may be affected cumulatively as a result of other projects and activities and effects occurring within these areas and ranges.

The effects assessment therefore includes an "environment-focused" approach to determining and defining spatial and temporal boundaries for the analysis, focusing on and considering the overall nature and geographic and temporal dimensions of the affected environmental components, while also considering the nature and location of the other projects and activities that may potentially contribute to the cumulative effects on the VC within these spatial (ecological or socioeconomic) boundaries (see Section 14.1.2).

14.1.3 Sources of Potential Cumulative Effects

The EIS Guidelines (Section 6.6.3) state that the cumulative effects assessment should "*specify other projects or activities that have been or that are likely to be carried out that could cause effects on each selected VC within the boundaries defined, and whose effects would act in combination with the residual effects of the project*".

A general list of the other physical activities that are considered in the cumulative effects assessment is provided in Table 14.2, which includes various on-going and future projects and activities off Eastern Newfoundland and elsewhere. Where the particular locations and/or geographic extents of these other projects and activities at present and/or within the temporal duration of the Project are defined and known, this information is summarized on Figures 14-1 and 14-2 including overall distances from the centre of the Project Area – Northern Section (Figure 14-1) and its Southern Section (Figure 14-2). This includes, for example, the locations of the four offshore production projects (which are also shown on all EIS base maps), commercial fishing activity (see also more detailed Figures in Section 7.1), and other human components and activities (see Section 7.2).

Table 14.2 Other Projects and Activities Considered in the Cumulative Effects Assessment

Project / Activity	Overview
Hibernia Oilfield	• Discovered in 1979, the Hibernia Oilfield is operated by the Hibernia Management and Development Company Ltd. (HMDC), and is located approximately 315 km east-southeast of St. John's, NL. • The development phase of that project commenced in late 1990 and continued until the mating of the Gravity Based Structure (GBS) and its topsides at Bull Arm NL in 1997, after which the platform was towed to and installed at its site on the Grand Banks in June of that year. • With estimated recoverable reserves of approximately 1.4 billion barrels, commercial production from the Hibernia field commenced in November 1997 and is on-going. • In recent years, the project has been further expanded to include the Hibernia South Extension, from which production commenced in 2011. • This on-going project is located approximately 51 km from the closest edge of the Project Area - Northern Section, and is within the Project Area - Southern Section. • It is located approximately 8 km from the closest Project EL in the Project Area's Southern Section (EL 1137, ExxonMobil operated), and 110 km from EL 1135 (ExxonMobil operated) and 260 km from EL 1142 (Statoil operated) in the Project Area's Northern Section. • Production activities at this oilfield are planned to extend throughout the temporal duration of this Project.
Terra Nova Oilfield	• Discovered in 1984 and declared a significant discovery in 1985, this oilfield has reserve estimates of approximately 500 million barrels of recoverable oil. • The Terra Nova Project is currently in operation by Suncor Energy Inc. using a floating production, storage, and offloading (FPSO) facility, and is located approximately 350 km southeast of St. John's and 35 km southeast of Hibernia. • Production from the FPSO began in January 2002. • This on-going project is located approximately 80 km from the closest edge of the Project Area - Northern Section, and is within the Project Area - Southern Section. • It is also located approximately 38 km from the closest Project EL in the Project Area's Southern Section (EL 1137, ExxonMobil operated), and 118 km from EL 1135 (ExxonMobil operated) and 263 km from EL 1142 (Statoil operated) in the Project Area's Northern Section. • Production activities at this oilfield are planned to extend throughout the temporal duration of this Project.

Table 14.2 Other Projects and Activities Considered in the Cumulative Effects Assessment

Project / Activity	Overview
White Rose Oilfield and Extension Project	• Discovered in 1984, a significant discovery licence for the field was issued in January 2004. • It is located approximately 350 km east-southeast of St. John's, and approximately 50 km from the Hibernia and Terra Nova fields. • The White Rose oilfield and its satellite extensions are operated by Husky Energy Inc. using an FPSO, and first oil was produced in November 2005 followed by the North Amethyst expansion in May 2010. • This on-going project is located approximately 44 km from the closest edge of the Project Area - Northern Section, and is within the Project Area - Southern Section. • It is also located approximately 37 km from the closest Project EL in the Project Area's Southern Section (EL 1137, ExxonMobil operated), and 71 km from EL 1135 (ExxonMobil operated) and 213 km from EL 1142 (Statoil operated) in the Project Area's Northern Section. • Production activities at this oilfield are planned to extend throughout the temporal duration of this Project.
Hebron Oilfield	• First discovered in 1980, this oilfield is estimated to contain more than 700 million barrels of recoverable resources. • The Hebron Platform was towed to field in June 2017. The Project is designed for an oil production rate of 150,000 barrels of oil per day. • First oil from the Hebron Project is expected by the end of 2017. • This project is located approximately 73 km from the closest edge of the Project Area - Northern Section, and is within the Project Area - Southern Section. • It is also located approximately 30 km from the closest Project EL in the Project Area's Southern Section (EL 1137, ExxonMobil operated), and 112 km from EL 1135 (ExxonMobil operated) and 259 km from EL 1142 (Statoil operated) in the Project Area's Northern Section. • Production activities at this oilfield are planned to extend throughout the temporal duration of this Project.
Offshore Petroleum Exploration - Drilling	• The Eastern Newfoundland offshore area is also subject to on-going and planned offshore exploration drilling programs which were in progress or being subject to EA review or recently approved as of the time of writing (see *http://www.cnlopb.ca/assessments*). • As of May 31, 2017, a total of 440 wells had been drilled in the Canada-NL Offshore Area, including 168 exploration wells, 56 delineation wells, and 216 development wells. • The type and amount of offshore exploration activity can vary considerably from year to year throughout the Eastern Newfoundland offshore. • Over the period January 1, 2014 to May 31, 2017, nearly 80 wells were drilled (or re-entered) in the Eastern Newfoundland and Jeanne d'Arc Basin areas, including approximately 15 exploration wells (C-NLOPB 2017b)

Table 14.2 Other Projects and Activities Considered in the Cumulative Effects Assessment

Project / Activity	Overview
Offshore Petroleum Exploration – Geophysical and Other Exploration Activities	• Offshore geophysical survey programs are often planned and conducted to get an overall understanding of regional geology and hydrocarbon potential, and to help identify sites or zones that may warrant further investigation, such as through eventual exploration drilling activities (see below). • These may include two-dimensional (2D), three-dimensional (3D) and possibly four dimensional (4D) geophysical data acquisition, as well as associated geochemical, environmental, and geotechnical survey activities. • While exploration projects and activities are typically proposed and approved through the EA process as multi-year programs that can cover quite large offshore areas, the type and level of activity conducted each year can also vary and is usually a fraction of the overall scope assessed. • For general illustration, over the period 2014 to 2016 an average of approximately 390,000 km of geophysical survey data (2D, 3D and other) was collected annually in the Eastern Newfoundland offshore region, with an average of approximately 35,000 undertaken annually in the Jeanne d'Arc Basin area (C-NLOPB 2017a). • There are a number of offshore geophysical programs off the Eastern Newfoundland offshore area that were in progress, being subject to EA review or recently approved as of the time of EIS writing (see *http://www.cnlopb.ca/assessments*).
Fishing Activity	• Commercial fisheries within and around the Project are extensive and diverse, as described in detail (including associated mapping) in Chapter 7 of this EIS.
Other Marine Vessel Traffic	• This includes tanker traffic and supply vessels associated with the existing offshore oil developments, as well as cargo ships and fishing vessel transits (see Chapter 7).
Hunting Activity	• Wildlife (especially seabird) populations off Newfoundland and Labrador are subject to hunting activity. • Although little or no hunting activity is expected to occur in the far offshore locations that comprise the Project Area, these activities do affect the bird and seal populations that occur in, and move to and through, the region.

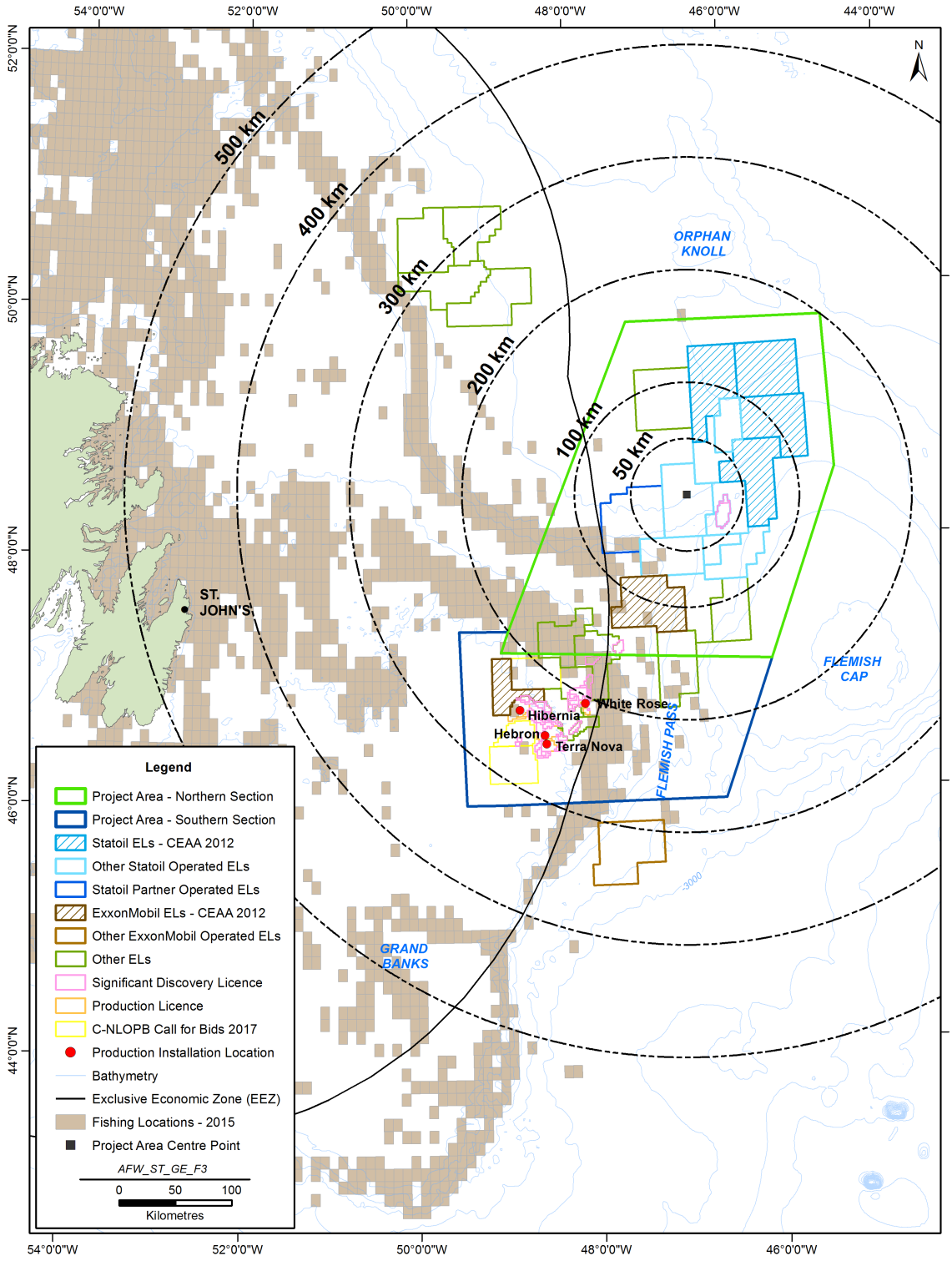


Figure 14-1 Other Projects and Activities Considered in the Cumulative Effects Assessment (Including Distances from Project Area – Northern Section)

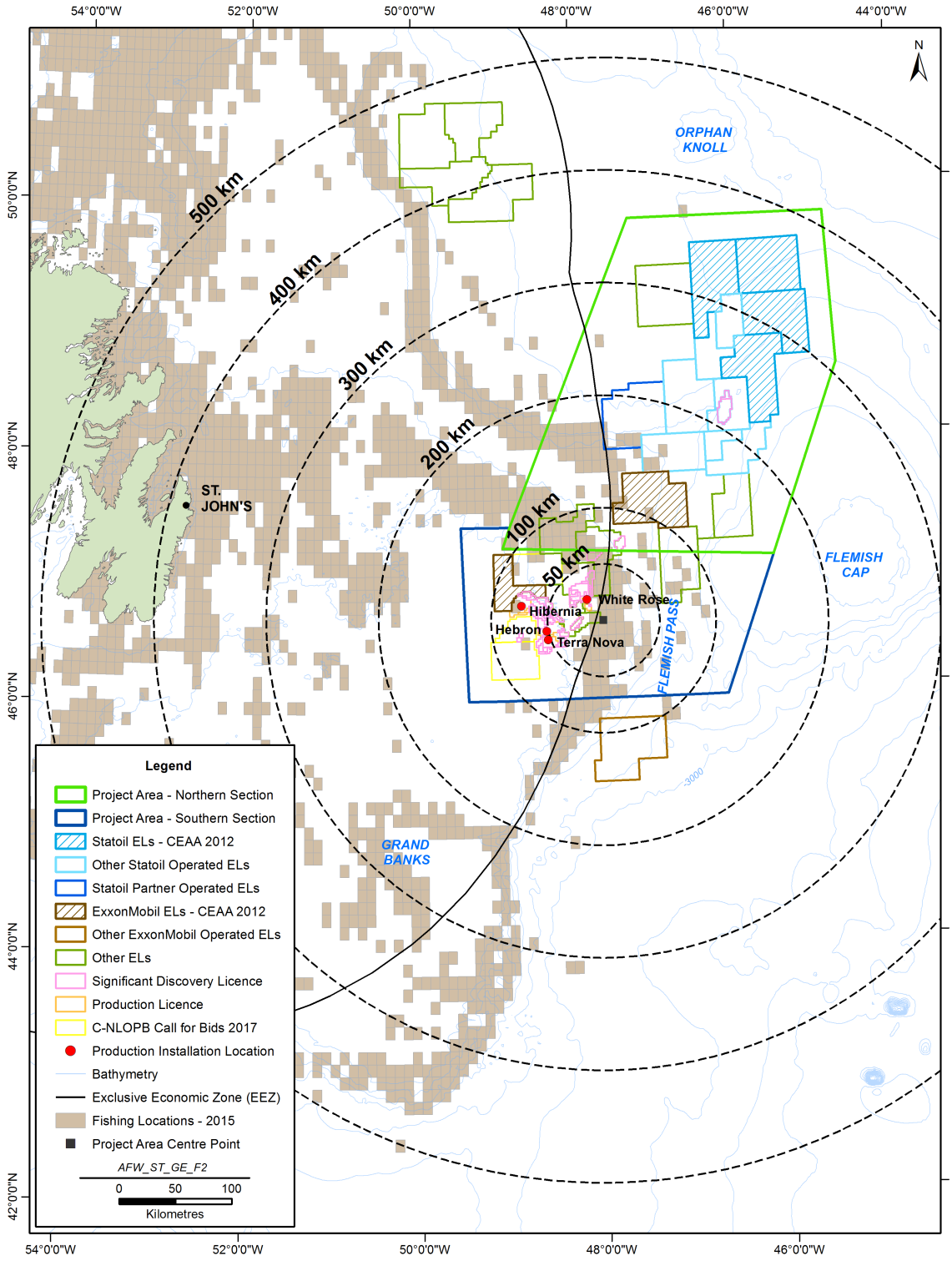


Figure 14-2 Other Projects and Activities Considered in the Cumulative Effects Assessment (Including Distances from Project Area – Southern Section)

Other relevant projects and activities are identified and considered on a VC-specific basis, as required and applicable. This includes other past, present, and reasonably foreseeable projects and activities whose environmental effects will potentially affect the same VCs (individuals and populations) as those which will be affected by the Project.

This includes other projects and activities that are within or in proximity to the defined RSA for the assessment for each VC. In cases where components of the VC may be located outside of the Eastern Newfoundland offshore area (e.g., the Indigenous Communities and Activities VC), the cumulative effects assessment generally considers projects and activities in other areas and jurisdictions as applicable, where these have or may contribute to overall, cumulative effects upon the VC.

14.1.4 Assessing Cumulative Effects on Each VC

The cumulative effects assessment considers the predicted residual environmental effects of the Project and their potential accumulation and interaction in space and time with those of other past, on-going, and future projects and activities. Section 6.6.3 of the EIS Guidelines specify that the EIS will "*assess the cumulative effects on each VC selected by comparing the future scenario with the project and without the project. Effects of past activities (activities that have been carried out) will be used to contextualize the current state of the VC*."

Past and on-going projects and activities and their environmental effects are reflected in the existing baseline environmental conditions for each VC, as described in Chapters 6-7 of this EIS. The current condition of the VC as a result of natural and anthropogenic factors, and its overall sensitivity or resiliency to further disturbance or change, has been considered in a fully integrated manner throughout the environmental effects assessments. This includes predicting the likely nature and degree of the potential effects of this Project on the VC, as well as potential effects resulting from other, multiple sources of future disturbance, as described below.

The cumulative effects assessment summarizes and considers whether and how this existing, pre-Project environmental condition may be changed by the introduction of the Project and its potential residual (with mitigation) environmental effect, as determined and described in the preceding Project-specific environmental effects assessment (Chapters 8 to 13).

Other future projects and activities that are relevant to the VC and its cumulative effects assessment are then considered (Table 14.3). These comprise certain or reasonably foreseeable future physical activities that will affect the same VCs as the Project, and whose effects on the VC would likely overlap in space and time with those of the Project and/or would affect the same individuals, populations, or communities as the Project. The cumulative effects assessment therefore focusses on determining and considering the likely nature and spatial and temporal characteristics of the residual environmental effects of the Project, of the affected environmental components and systems, and the environmental effects of other relevant projects and activities within these areas and time periods.

Table 14.3 Potential Interactions with Other Projects and Activities Considered in the Cumulative Effects Assessment

Project / Activity	VCs Potentially Affected					
	Marine Fish and Fish Habitat	Marine and Migratory Birds	Marine Mammals and Sea Turtles	Special Areas	Indigenous Communities and Activities	Commercial Fisheries and Other Ocean users
Hibernia Oilfield	●	●	●	●	●	●
Terra Nova Oilfield	●	●	●	●	●	●
White Rose Oilfield and Extension Project	●	●	●	●	●	●
Hebron Oilfield	●	●	●	●	●	●
Offshore Petroleum Exploration –Geophysical and Other Exploration Activities	●	●	●	●	●	●
Offshore Petroleum Exploration - Drilling	●	●	●	●	●	●
Fishing Activity	●	●	●	●	●	
Other Marine Vessel Traffic	●	●	●	●	●	●
Hunting Activity		●	●		●	

In cases where the predicted residual environmental effects of the Project on the VC will likely accumulate or interact with those of one or more other such projects and activities, the potential cumulative effects of the Project in combination with these other activities are assessed and evaluated This includes considering the potential implications for the VC resulting from multiple sources and types of environmental change, including the likely future condition of the environment both with and without the Project. Analytical methods and assumptions used in the VC specific cumulative effects assessments are defined and described. Where available and applicable, the assessment uses relevant scientific, engineering, community, stakeholder, and Indigenous knowledge and perspectives.

14.1.5 Mitigation

The cumulative effects assessment includes the identification and consideration of technically and economically feasible mitigation measures that the Operator will implement to avoid or reduce potential environmental (including cumulative) effects.

The mitigation measures are intended to avoid or reduce the potential effects of the Project (as identified and considered in Chapters 8 to 13), and thus the Project's contribution to cumulative environmental effects. Where relevant, however, the assessment also identifies and considers additional mitigation that may be required and applicable to cumulative effects only, as well as other relevant mitigation that may be the responsibility of parties other than the Operator or its contractors, as applicable and as required in the EIS Guidelines.

Information on other projects and activities and their known or likely environmental effects and planned mitigation measures has been obtained through existing and publicly available information sources. The cumulative effects assessment considers the nature, location and timing of these other projects and their environmental effects in relation to the Project, as well as environmental protection measures which are known and/or required to be implemented in relation to them, including those required under applicable legislation, regulations, and other requirements. The assessments of cumulative effects presented here are therefore not based on information or assumptions regarding mitigation measures by other proponents that would require discussions with, and confirmation by, other parties.

14.1.6 Determination of Significance

The significance of predicted residual cumulative environmental effect is evaluated, using the same VC-specific significance definitions as those used in the Project-specific effects assessments (see Chapters 8 to 13).

14.1.7 Follow-up

The cumulative effects assessment concludes with the identification and discussion of environmental follow-up programs that may be required "*to verify the accuracy of the assessment or to dispel any uncertainty concerning the effectiveness of mitigation measures for certain cumulative effects*" (EIS Guidelines, Section 6.6.3). This includes considering whether follow-up specific to cumulative effects may be necessary or appropriate, as well as the relevance of follow-up identified as part of the Project-specific environmental effects assessment (Section 14.8) to cumulative environmental effects.

14.2 Marine Fish and Fish Habitat (including Species at Risk)

14.2.1 Past and On-going Effects (Baseline)

Marine fish and their habitats in the Project Area, RSA and in the larger Northwest Atlantic have been and are being affected by a variety of natural and anthropogenic factors and processes. These include past and on-going fishing activity, offshore petroleum exploration and production, general vessel and aircraft traffic and other human activities (both planned and routine, as well as illegal activities and accidental events), as well as the effects of climate change and other natural and anthropogenic processes (Amec 2014; Cordes et al. 2016). These have collectively, and to varying degrees, influenced the presence, distribution and abundance of fish and invertebrate species in areas, depths, and times, as well as the overall size and health of fish populations.

As described in Section 6.1 and Chapter 8, the Marine Fish and Fish Habitat VC includes fish and invertebrate species and the habitats upon which they depend. These include commercially and/or ecologically important species that are considered secure, as well as those listed as species at risk. Overfishing and extreme climate conditions have collectively contributed to the collapse of the Atlantic cod and other groundfish stocks in the North Atlantic in the early 1990s (Kulka 2011; Christensen et al. 2014; Nogueira et al. 2017), which coincided with an increase in prey species, including snow crab and shrimp, on the Grand Bank and Flemish Cap. Recently, these prey species

have, in turn, declined in response to the recovering groundfish stocks and other factors (Nogueira et al. 2015, 2017). Commercial fishing efforts continue to influence commercial and non-commercial (as bycatch and through trophic interactions) species populations in the Northwest Atlantic (Edinger et al. 2007; Clark et al. 2016; Nogueira et al. 2017). Such activities have also affected corals and sponges which are sensitive, habitat forming species that are distributed primarily on the slopes of the Grand Banks and Flemish Cap (Edinger et al. 2007; Clark et al. 2016; Guijarro et al. 2016; Ragnarsson et al. 2017). On the Flemish Cap, for example, species density has been declining across depth assemblages since the mid to late 2000s (Nogueira et al. 2017) as a result of modifications in fishing pressure and the effects of climate change. Oceanographic variability through the Atlantic multidecadal oscillation also has implications for trophic levels, resulting in increased plankton and fish productivity during warm periods and the reverse in cold conditions (Drinkwater et al. 2014).

The effects of previous activities and natural environmental influences are reflected in the existing baseline environmental conditions for this VC, as described in Section 4.4. This includes considering the current condition (e.g., health or quality) of potentially affected fish and invertebrate populations and their habitats, and their potential resiliency or sensitivity to further environmental change as a result of the Project and other on-going and future projects and activities that may affect the same VC.

14.2.2 Potential Project-Related Contributions to Cumulative Effects

As described in Chapter 8, offshore exploration drilling and associated activities may affect Marine Fish and Fish Habitat, including possible injury, mortality, or behavioral effects due to noise or other disturbances in the marine environment, effects to benthic communities through the alteration of marine habitats and change in habitat quality from discharges or accidental events.

The Project will interact with fish and their habitats within and adjacent to the Project Area, although as described in Chapter 8 it will entail a relatively minor, localized and short-term environmental disturbance at any one location. Marine discharges will be treated prior to release in accordance with regulatory requirements, reducing associated effects on the environment. Modelling of released drilling muds and cuttings has also indicated that they would be highly dispersed into the environment, causing low sedimentation reducing smothering effects on benthic species. To further reduce the potential for effects on sensitive benthic habitats (coral and sponge beds), pre-drill coral surveys will be conducted and appropriate setbacks applied where these species are observed within the immediate vicinity of a planned well site. Acoustic noise from VSP will largely be directed into the well, resulting in reduced area of potential effect over a short period. Furthermore, employed mitigation measures, including gradual ramp-up of air-guns, promote temporary avoidance of the area by mobile species while operations are ongoing and will help to reduce exposure to species. Other planned Project activities likewise represent localized and short-term activities and associated environmental disturbances, which are addressed through standard mitigation measures and which are not anticipated to adversely affect this VC. With the implementation of the various mitigation measures outlined in this EA, the Project will itself not result in significant adverse effects to Marine Fish and Fish Habitat.

The planned activities associated with this Project (and thus, associated environmental disturbances) will occur for a short period of time in any one location, resulting in a short-term disturbance within a relatively limited zone of influence. This will reduce the potential for individuals and populations to be affected through multiple interactions with this Project and other activities in the marine environment, and for species to be affected simultaneously and repeatedly by multiple projects and activities, as described in the following sections.

14.2.3 Future Projects and Activities and Their Effects

In terms of other on-going and future projects and activities which may affect Marine Fish and Fish Habitat within the Project Area and larger RSA (Table 14.4), the commercial fishing industry will continue to be a key influence, resulting in fish catches (mortality) and habitat disturbance through current and future fishing activities, practices, and management processes. The spatially and temporally extensive (and rather dynamic) nature of fishing activity throughout the region (in terms of fishing locations, seasons, gear types and key species) makes it difficult to predict specific areas and times from year to year for both domestic and foreign fleets, and thus, the potential for interactions between activities and their effects. However, it is considered likely that there will be some degree of overlap between fishing activities and the environmental zone of influence of this Project over its duration.

Table 14.4 Marine Fish and Fish Habitat: Other Projects and Activities and their Potential Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
Hibernia Oilfield	• Change in habitat availability and quality. • Change in fish mortality / injury risk and fish health. • Change in fish presence and abundance.	• Components on the Hibernia oilfield includes the Hibernia Platform and the Hibernia Southern Extension excavated drill centre. • EEM has shown barium levels from drill cuttings not different from baseline up to 1 km from platform. • EEM sediment toxicity tests showed Microtox responses west of platform up to 6 km away and toxic responses in amphipods up to 3 km from the platform. • Fish health and body burden measures were similar between American plaice sampled within 1 km of platform and fish in the reference area 60 km away (Stantec 2012) • EEM programs have therefore indicated that environmental changes attributed to the project are limited with regard to the spatial extent and magnitude of chemical contaminants, and similarity, of fish health parameters between the platform area and the reference area 50 km away (Stantec 2012).
Terra Nova Oilfield	• Change in habitat availability and quality.	• Components on the Terra Nova oilfield includes an FPSO and a semi-submersible drilling installation.

Table 14.4 Marine Fish and Fish Habitat: Other Projects and Activities and their Potential Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
	• Change in fish mortality / injury risk and fish health. • Change in fish presence and abundance.	• The EEM program has shown that barium levels in sediment decreased to background within 1 km of drill centres (Terra Nova 2013). • Increased abundance of benthic invertebrates within 1-2 km of drill centres associated with higher barium and hydrocarbon concentrations were observed during the EEM (Whiteway et al. 2014). • The EEM program has indicated no change in fish health indices in relation to produced water discharge (Mathieu et al. 2011).
White Rose Oilfield and Extension Project	• Change in habitat availability and quality. • Change in fish mortality / injury risk and fish health. • Change in fish presence and abundance.	• Components on the White Rose Oilfield include a FPSO and five excavated drill centres. • EEM has indicated that hydrocarbon concentration was correlated with distance up to 5.8 km from the drill centre. • The EEM indicated that the distance over which barium concentration was correlated with distance to drill centres was approximately 1 km. • Fish health indices were not different from reference area for American plaice and snow crab collected within 4 km of drill centres (Husky Energy 2017).
Hebron Oilfield	• Change in habitat availability and quality. • Change in fish mortality / injury risk and fish health. • Change in fish presence and abundance.	• Components for the Hebron oilfield include a drilling and production platform. • It is estimated that WBM based drill cuttings deposition would be 12.8 km^2 total around the Platform and Drilling installations being used (Stantec 2011). • Disposal of SBM drill cuttings will be by reinjection into wells with some disposal of treated SBM drill cuttings into the environment (Appendix G).
Offshore Petroleum Exploration – Geophysical and Other Exploration Activities	• Change in habitat availability and quality. • Change in fish mortality / injury risk and fish health. • Change in fish presence and abundance.	• These types of offshore exploration activities have been widely carried out off Eastern Newfoundland and elsewhere, typically use relatively standard equipment and techniques, and are subject to general environmental protection requirements and mitigation measures that are based in regulation and other guidelines. • Project-specific EAs for these projects in the Canada-NL Offshore Area therefore typically conclude that with the implementation of these mitigation measures, they are not likely to result in significant adverse environmental effects (see *http://www.cnlopb.ca/assessments*).

Table 14.4 Marine Fish and Fish Habitat: Other Projects and Activities and their Potential Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
		• Although the often extensive survey areas covered by some types of offshore geophysical surveys can increase the potential for spatial interactions between their potential effects and those of other activities in the marine environment, most geophysical survey activities operate for a short period of time in any one location, resulting in a short-term disturbance within a relatively limited zone of influence.
Offshore Petroleum Exploration - Drilling	• Change in habitat availability and quality. • Change in fish mortality / injury risk and fish health. • Change in fish presence and abundance.	• As noted above, these types of offshore exploration activities have been widely carried out off Eastern Newfoundland and elsewhere, typically use relatively standard equipment and techniques, and are subject to general environmental protection requirements and mitigation measures that are based in regulation and other guidelines. • Project-specific EAs for these projects in the Canada-NL Offshore Area therefore typically conclude that with the implementation of these mitigation measures, they are not likely to result in significant adverse environmental effects (see *http://www.cnlopb.ca/assessments*). • Drilling and other types of exploration activities are typically relatively short-term and localized activities. This can reduce the potential for individuals and populations to be affected simultaneously and repeatedly by multiple projects and activities
Fishing Activity	• Change in habitat availability and quality. • Change in fish mortality / injury risk and fish health. • Change in fish presence and abundance.	• Commercial fishing activity in the region is extensive and diverse, involving a variety of participants, species, gear types, and occurring year-round. • Commercial fishing effort is primarily concentrated in the Project Area's southern section and in the southwest corner of the northern section of the Project Area, (See Commercial Fisheries Section 7.1).
Other Marine Vessel Traffic	• Change in fish mortality / injury risk and fish health. • Change in fish presence and abundance.	• Vessels are highly transitory, minimizing potential effects in any location and time.
Hunting Activity	• n/a	• n/a

The Eastern Newfoundland offshore area is also subject to on-going and planned offshore oil and gas exploration and production activities within and outside the Project Area. There are four operational oil producing facilities (Hibernia, Hebron, Terra Nova, White Rose) with the most recent facility, Hebron, starting offshore operations in 2017. While each of these production projects represents a relatively large scale and long-term operations in this offshore area, and have associated environmental emissions and interactions related to this VC, these projects and their environmental zones of influence are for the most part, quite far removed from those which may be associated with this Project (see Table 14.4). Project activities for the southern section of the Project Area are closer to existing oil production facilities than activities in the northern section. Environmental effects monitoring (EEM) programs for three of the operational production facilities (Hibernia, Terra Nova, White Rose, and associated expansions) have found project-induced environmental changes to sediment or benthic organisms to be limited to the area immediately surrounding the developments, with no indication of significant adverse environmental effects (Stantec 2012; Terra Nova 2013, Husky Energy 2017). Details on EEM study designs, methods and results to date are available on the C-NLOPB website.

The Eastern Newfoundland offshore area is also subject to other on-going and planned offshore geophysical programs, exploration drilling projects and associated survey activities that are in progress, approved or are subject to regulatory review as of the time of EIS preparation (Table 14.4). Offshore petroleum exploration and development activities also have associated vessel traffic, and there are vessel movements associated with fishing vessels, cargo transport, and other marine activities that will continue to occur throughout the region (Section 7.2.3).

14.2.4 Potential Cumulative Environmental Effects

The Project will have the potential to interact with fish and their habitats within and adjacent to the Project Area. As described, the planned activities will be short-term, localized and with limited Project induced changes at any one location and time throughout the duration of the Project.

The presence and operation of the drilling installation(s) and associated drilling, ancillary and supply and service activities, for example, will result in the introduction of a number of disturbances into the marine environment, including underwater noise and vibrations, light emissions, drill muds / cuttings and other discharges, as well as resulting in direct interactions with the benthic environment. As discussed in Chapter 8, however, in all cases these Project-related environmental disturbances will be short-term and localized in nature, and are not expected to have overall (population level) adverse effects on fish in the LSA or RSA. Potential effects on coral and sponge aggregations will be avoided through the completion of pre-drill coral surveys, with appropriate mitigation, defined based on the outcomes of the surveys (see Chapter 3), and associated discharges from the drilling installation will be managed in accordance with applicable regulations and guidelines. Drilling fluids themselves are essentially non-toxic, and these and other chemicals used during the Project will be selected and used in accordance with applicable guidelines and Operator procedures. The marine disposal and deposition of drill cuttings (and residual muds) may accumulate on the seabed. Drill cuttings modelling carried out for the EIS (Appendix G) indicates that there will be limited accumulation of a cuttings pile in this relatively deep and dynamic offshore environment. In only limited areas will the cuttings pile thicknesses exceed the established thresholds for creation of anoxic areas and

smothering of benthic species. The small and localized areas of benthic disturbance associated with the Project will mean that these effects will not likely accumulate or interact with other such projects and activities in the region. The eventual recolonization of cuttings accumulations on the seabed means that significant adverse environmental effects to fish and fish habitat are not anticipated.

While there is therefore little potential for the direct "footprint" or environmental zones of influence of Project-related disturbances or effects to accumulate with those of other projects and activities, it is recognized that the widespread and often migratory nature of some fish species increases the potential for individuals and populations to be affected by multiple perturbations, and therefore, for cumulative environmental effects to occur. In addition, the often extensive areas and times covered by some types of marine activities (e.g., offshore geophysical surveys) can further increase the potential for spatial interactions between their effects and those of other projects and activities in the marine environment. Many benthic invertebrate species are relatively immobile or sessile, which limits the potential for interactions with multiple projects and disturbances. Mobile fish and invertebrate species that have higher potential to interact with multiple projects also have higher capability for avoidance of potential effects. The typical movement patterns and ranges of most marine fish species, coupled with the availability of alternative habitats during short periods of Project-related disturbance, limits the potential for cumulative effects to occur.

14.2.4.1 Project Area – Northern Section

Within the Project Area's Northern Section, commercial fishing and other petroleum exploration activities and their effects have the potential to interact in space and time with those of planned Project activities. Fixed fishing gear, including crab pots, is used primarily in the southwestern corner of the Project Area. Commercial fisheries using mobile fishing gear may have seafloor interactions that have a higher potential for environmental effects; but the existing and available geospatial data on these fisheries (Section 7.1) shows that they are currently concentrated primarily in several parts of the overall Project Area in deeper waters. The short term and localized nature of Project-related effects and the planned and required implementation of safety zones around the planned activities will reduce the potential for direct interactions between activities and their effects, and thus, cumulative effects on fish and fish habitat from the Project in combination with commercial fisheries.

Other petroleum exploration activities in this region, such as offshore geophysical and other surveys and associated vessel traffic, will also contribute to cumulative effects on this VC, and there are various on-going and planned exploration programs in the Flemish Pass region. The environmental effects of these activities are, however, localized and short-term, including those resulting from offshore geophysical surveys, which result in a temporary environmental disturbance at a given location and time. In the same way, exploration drilling activity may only take place in accordance with an approved EL issued by the C-NLOPB, which gives the operator the exclusive right to conduct exploration drilling within that geographic area for the defined time period. This, along with the relatively limited geographic zone of influence associated with the environmental disturbances that result from offshore drilling (Section 8.3), including the areas covered by drill cuttings accumulations around these wellsites, means that there is little or no potential for overlap and interaction between disturbances and eventual effects. These factors will reduce any spatial and temporal interactions between the effects of this Project and geophysical and exploratory drilling activities that may be

taking place simultaneously in the area. Marine vessel traffic from fisheries, research surveys and other activities is also common in these offshore areas, although inherently transient in nature and required to remain specified distances from active offshore exploration drilling and geophysical programs in the region.

14.2.4.2 Project Area – Southern Section

Planned Project activities in the Southern Section of the Project Area have the potential to result in cumulative effects in combination with commercial fisheries and other petroleum exploration activities as those described above for the Project Area-Northern Section. Fixed fishing gear is primarily used on the slope of the Grand Banks and occurs throughout this portion of the Project Area. The available data shows low mobile gear use in the Southern Portion of the Project Area in general, and particularly within EL 1137 within which exploration drilling may occur as part of this Project. This is likely due to both environmental (depths and species presence) considerations, as well as in part to the long-term presence of several operational oil production projects in this region.

Unlike the Northern Section of the Project Area, there are several existing and imminent petroleum production projects in this region (Hibernia, White Rose, Terra Nova, Hebron), each of which have and will contribute somewhat to environmental effects on fish and fish habitat. The on-going EEM programs for these projects have, however, generally demonstrated a localized (less than 10 km) geographic extent for the project-induced changes on fish habitat. It is also expected the Hebron Project that will be located near the Terra Nova development will have a similar zone of influence (see Table 14.2). This suggests a limited potential for cumulative effects to occur between the Project and these ongoing petroleum production projects.

14.2.5 Species at Risk

As described in the existing environment description for fish and fish habitat (Section 6.1), there are some 19 species with conservation designations that do or may occur in the Project Area and surrounding marine environments. These include several wolffish species, Atlantic cod, cusk, American eel, Atlantic salmon, American plaice, bluefin tuna, and a number of species of grenadier, redfish, sharks, and skates. As with secure fish species, species at risk may potentially interact with Project activities based on occupation of various habitats at different life history stages (Table 8.11) and the same planned mitigation measures will be used to avoid or reduce such adverse interactions.

For Atlantic cod, cusk, grenadier species, redfish species, wolffish species, spiny dogfish and thorny skate, fishing effort has been identified as the main factor affecting species abundance (COSEWIC 2007a, 2008, 2010a, 2010b, 2012a; Nogueira et al. 2015). Population trends for these species vary depending on level of fishing effort and area. The Flemish Pass restricts passage of many groundfish species between the Grand Banks and the Flemish Cap. Studies from the Grand Bank shelf (NAFO area 3LNO) indicate that Atlantic cod and American plaice have had a positive population growth rate from 2002-2013, but they have not reached historic population levels (Nogueira et al. 2015). Similarly, Nogueira et al. (2015) indicated that redfish species populations were increasing and have even increased their depth range to shallower waters. Over the same time period, sampled roughhead grenadiers have had an overall increase in mean length, suggesting there has been a decreasing impact of fishing over time (Nogueira et al. 2015). Cusk on the Grand Banks have had a

continuous decline since the 1970s, but populations have stabilized at relatively low levels since 1999 (COSEWIC 2012a). Spiny dogfish on the Grand Bank have had highly variable abundance between 1972-2005 and have been increasing or showing no trends in previous years. Thorny skate declined from 1974-1995 but increased on the Grand Banks from 1996-2010.

On the Flemish Cap, populations of Atlantic cod and American plaice increased in the late 2000s, but have declined in recent years. Redfish species increased in the early 2000s, but have declined since the mid to late 2000s (Nogueira et al. 2017). Wolffish abundance has declined since the 1980s but there has been an upward trend in abundance since the mid-1990s. Northern wolffish have shown the least recovery of the three species (COSEWIC 2012b, 2012c, 2012d). As grenadiers, wolffish and redfish are slow growing and long-lived species, there is higher potential for cumulative effects over their lifetime. The main threats to American eels are habitat loss and migration barriers in freshwaters (COSEWIC 2006a). Their marine growth phase is also mainly limited to shallow coastal waters (COSEWIC 2006a). Threats to Atlantic salmon include climate change, habitat loss, fishing and barriers to migration in freshwaters (COSEWIC 2010c). There have been broad-scale declines in marine survival, however main drivers for this trend remain uncertain. Salmon originating from the coast of North American are unlikely to remain in the Project Area as it is generally below preferred ocean temperatures. The low potential for interaction, in combination with their capacity for avoidance, suggests that effects on this species are unlikely.

Pelagic species including basking shark, porbeagle, shortfin mako, white sharks and blue fin tuna are seasonal migrants in Canadian waters. Bycatch mortality is one of the main threats to these pelagic species. These species migrate into North Atlantic waters for foraging opportunities or reproduction purposes. High mobility in these pelagic species indicates that they may interact with multiple projects, increasing their potential for cumulative effects. However, their highly transitory nature also suggests that they will likely be able to avoid areas of disturbance, reducing potential for project activity interactions and thereby reducing potential for cumulative effects.

All of these species are highly mobile in their adult stages, and given the highly localized and short-term nature of planned Project activities and their likely environmental effects (along with the planned implementation of mitigation measures outlined previously), the Project will not have adverse effects upon these species. Identified critical habitat for such species or the residences of other key habitats of individuals or populations will also not be affected. Any potential for effects from the Project would be negligible in comparison to effects on these species resulting from commercial fisheries and climate change. Therefore, the Project will not make a perceptible contribution to potential cumulative effects on species at risk.

14.2.6 Cumulative Effects Summary and Evaluation

The Project activities will operate for a short period of time in any one location, resulting in a short-term disturbance within a relatively limited zone of influence. This will reduce the potential for individuals and populations to be affected through multiple interactions with this Project and other activities in the marine environment, and for species to be affected simultaneously and repeatedly by multiple projects and activities. As part of the planning and implementation of its activities over the course of this Project, the Operator will continue to communicate with relevant marine users and other stakeholders, including other oil and gas exploration companies and other marine users

operating in the area, to make a reasonable effort to provide appropriate spatial and temporal separation that is maintained as required for operational, regulatory and safety reasons. This, along with the other planned Project-related mitigation measures that will be implemented, will reduce the potential for and degree of associated cumulative effects on fish and fish habitat.

Table 14.5 summarizes the results of the cumulative effects assessment for this VC. As illustrated, the Project will not result in significant adverse cumulative environmental effects on Marine Fish and Fish Habitat (including any species at risk) in combination with other projects and activities that have been or will be carried out.

14.3 Marine and Migratory Birds (including Species at Risk)

14.3.1 Past and On-going Effects (Baseline)

As described in Section 6.2, the waters off eastern and southern Newfoundland and Labrador provide important feeding areas for many marine-associated bird species, some of which breed along the province's coastline. Although they do not regularly occur in the offshore environment, landbirds and shorebirds may pass through the area on a transient basis during spring and fall migration. The distribution, abundance and health of marine and migratory birds and their populations are often influenced by both natural phenomena such as weather, food availability and oceanographic variation, as well as human activities and their associated disturbances including hunting, fishing activity, vessel traffic, offshore structures, and pollution. Vessel movements associated with fishing activity and general marine traffic throughout the region, as well as previous offshore exploration and production activities may also have affected marine bird populations in the region. Fisheries bycatch and hunting activity (both legal and illegal) also puts pressure on some bird populations. In addition to these local disturbances, migratory bird species may also be affected by a variety of activities and associated effects within their often extensive ranges, including hunting, pesticides, and other pollution.

In general, the populations of most marine-associated bird species occurring off Eastern Newfoundland are considered stable overall (Section 6.2), although the Leach's Storm-petrel, for example, has declined in recent years (Wilhelm et al. 2015). That species is thought to be particularly vulnerable to the potential effects of offshore activities through attraction to artificial light sources resulting in collision and strandings. In addition, because they may forage hundreds of kilometres from the nest site during the breeding season (Pollet et al. 2014) there may be risk of exposure of adults and eggs to oil from spills and routine discharges (Morandin and O'Hara 2016).

The effects of previous and on-going projects and activities within the Project Area, LSA and RSA (and elsewhere) are reflected in, and considered as part of, the existing (baseline) environmental conditions for this VC, as described in Section 6.2.

Table 14.5 Summary of Potential Cumulative Environmental Effects: Marine Fish and Fish Habitat

Summary of Potential Cumulative Environmental Effects		
VC Existing Condition (Past and On-Going Activities)	• The Project Area encompasses the northeast region of the Grand Bank and extends over the slope regions between the Grand Bank and Flemish Cap and part of the Orphan Basin. • Within this marine environment, habitats transition from relatively shallow shelf zones, through the continental slope to deep abyssal regions. • These habitats are used by fish and invertebrate species of commercial, cultural, ecological and/or conservation importance, and support regionally important areas of biodiversity and marine productivity. • Fish presence and abundance for secure species and species at risk affected by directed commercial fisheries and bycatch, as well as oceanographic conditions. • Fishing pressures along with oceanographic conditions continue to influence fish distribution and abundance in the Project Area and overall region. Overall, due to warming conditions, groundfish have been recovering on the Grand Bank with a decline in groundfish prey species.	
Residual Environmental Effects of the Project	• The Project will not result in significant effects on Marine Fish and Fish Habitat. • Based on the short-term nature of most Project-related activities, confidence is high that while residual effects may adversely affect a small number of individuals in a localized area they will be short term and reversible. Effects are unlikely to alter the overall and long-term viability of local or regional populations.	
Other Projects / Activities	**Potential for Interaction with Effects of Project: Project Area – Northern Section**	**Potential for Interaction with Effects of Project: Project Area – Southern Section**
Hibernia Oilfield	N – Operations are located well outside of the Project Area and LSA, with highly localized environmental effects as determined from on-going EEM programs.	Y – Some potential for interaction as operations are located within the Project Area, and adjacent to the ELs where exploration activity may occur. EEM programs indicate localized environmental effects suggesting low potential for interaction.
Terra Nova Oilfield	N – Operations are located well outside of the Project Area and LSA, with highly localized environmental effects as determined from on-going EEM programs.	Y – Some potential for interaction as operations are located within the Project Area, but are distant from the ELs where exploration activity may occur. EEM programs indicate localized environmental effects suggesting low potential for interaction.
White Rose Oilfield and Extension Project	N – Operations are located well outside of the Project Area and LSA, with highly localized environmental effects as determined from on-going EEM programs.	Y – Some potential for interaction as operations are located within the Project Area, but are distant from the ELs where exploration activity may occur. EEM programs indicate localized environmental effects suggesting low potential for interaction.
Hebron Oilfield	N - The imminent Hebron Project is located well outside of the Project Area and LSA. Based on its	Y – Some potential for interaction as operations are located within the Project Area, but are distant from the ELs where exploration

Table 14.5 Summary of Potential Cumulative Environmental Effects: Marine Fish and Fish Habitat

Summary of Potential Cumulative Environmental Effects		
	Comprehensive Study Report and other existing EEM programs, the project will have localized environmental effects suggesting there is no potential for interaction.	activity may occur. EEM programs indicate localized environmental effects suggesting low potential for interaction.
Offshore Petroleum Exploration – Geophysical and Other Exploration Activities	Y – Some potential for interaction, although localized and short term nature of these activities and their effects, along with planned and required separation measures and other mitigation measures, will reduce potential for interaction.	Y – Some potential for interaction, although localized and short term nature of these activities and their effects, along with planned and required separation measures and other mitigation measures, will reduce potential for interaction.
Offshore Petroleum Exploration - Drilling	Y – Some potential for interaction, although localized and short term nature of these activities and their effects, along with planned and required separation measures and other mitigation measures, will reduce potential for interaction.	Y – Some potential for interaction, although localized and short term nature of these activities and their effects, along with planned and required separation measures and other mitigation measures, will reduce potential for interaction.
Fishing Activity	Y – Some potential for interaction, although these activities occur primarily in select parts of the Project Area only, mostly outside of the ELs. Safety zones around Project activities will limit the potential for overlapping and concurrent environmental effects, and thus, for cumulative effects on this VC.	Y – Some potential for interaction, although these activities occur primarily in select parts of the Project Area only, mostly outside of the ELs. Safety zones around Project activities will limit the potential for overlapping and concurrent environmental effects, and thus, for cumulative effects on this VC.
Other Marine Vessel Traffic	Y – Some potential for interaction, although these activities and their effects are highly localized and transient. Safety zones around Project activities measures will limit the potential for overlapping and concurrent environmental effects, and thus, for cumulative effects on this VC	Y – Some potential for interaction, although these activities and their effects are highly localized and transient. Safety zones around Project activities will limit the potential for overlapping and concurrent environmental effects, and thus, for cumulative effects on this VC.
Hunting Activity	N – Not applicable.	N – Not applicable.
Cumulative Effects Summary	The Project components and activities in the Project Area – Northern Section are not likely to result in significant adverse cumulative environmental effects on fish and fish habitat in combination with other projects and activities that have been or will be carried out.	The Project components and activities in the Project Area – Southern Section are not likely to result in significant adverse cumulative environmental effects on fish and fish habitat in combination with other projects and activities that have been or will be carried out.

14.3.2 Potential Project-Related Contributions to Cumulative Effects

Potential interactions with, and effects on, marine and migratory birds as a result of the Project relate primarily to possible attraction and/or disorientation of the birds around the drilling installation and/or vessels due to artificial light sources. There may also be disturbance of individuals from lights, noise and possible waste discharges and other related vessel and aircraft traffic. These potential interactions will be mitigated by adhering to relevant standards and regulations for acceptable discharges and emissions from Project activities, and other planning and mitigation measures as described in Section 9.3.2. Spill prevention plans and response procedures will be in place throughout the life of the Project.

As described in the Project-specific environmental effects assessment for this VC (Chapter 9), the planned activities associated with this Project will operate for a short period of time in any one location, resulting in a short-term disturbance within a relatively limited zone of influence. With the implementation of the various mitigation measures outlined in Section 9.3.2, the Project will not result in significant adverse environmental effects on marine and migratory birds and their habitats. Platform attraction associated with lighting and increased foraging opportunities may lead to some increased potential for mortality or injury, particularly in the spring and fall migration periods and during specific meteorological conditions such as fog or inclement weather; however, these conditions and potential effects will be short-term in duration. Discharges from offshore platforms and vessels, may interact with birds both directly and indirectly, particularly in the winter months when thermoregulatory stress is highest. These discharges are managed through adherence to relevant regulations. These interactions may be of concern for the Leach's Storm-petrel, a species that is, for example, especially vulnerable to attraction due to lighting and is the species most frequently found stranded on drilling installations and vessels (Section 9.3). Vessel and aircraft traffic in nearshore environments may also have potential interactions due to disturbance effects, but they will be reduced through adherence to common traffic routes and avoidance of known bird colonies. Because such effects are anticipated to minor and spatially and temporally limited, and given the typically wide variation in marine bird presence and distribution in space and time throughout this large offshore area, the number of individuals affected by the Project is not expected to have population-level effects.

14.3.3 Future Projects and Activities and Their Effects

Offshore activities such as oil and gas exploration and production activities and general marine vessel traffic (commercial and fishing) off Eastern Newfoundland also have the potential to affect marine-associated avifauna. The widespread and migratory nature of many marine bird species can also increase the potential for avifauna to be affected by multiple perturbations, and therefore, for cumulative environmental effects to occur.

Table 14.6 provides an overview of other projects and activities that have or may affect marine and migratory birds, and thus, contribute to cumulative environmental effects on this VC within the RSA. As indicated, the environmental zone of influence of each project and activity in the region is typically localized (especially with regards to the effects of lights and other such disturbances), and small compared with the total amount of habitat available in the region.

Table 14.6 Marine and Migratory Birds: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
Hibernia Oilfield	• Change in mortality / injury levels and health of individuals or populations • Change in avifauna presence and abundance • Change in habitat availability and quality • Change in food availability and quality	• Current or potential effects are similar to those that could be associated with this Project, and are primarily associated with possible implications for mortality / injury levels and habitat availability / quality due to attraction of night-flying birds to artificial lighting (including flares) and exposure/attraction to emissions and discharges from platforms and vessels (Ellis et al. 2013). • Unlike the Project, however, production platforms and their associated effects are confined to a fixed location but are relatively longer-term in nature. There are also potential disturbance effects from vessel and aircraft traffic. • Non-routine discharges may contribute to a change in mortality/injury levels, but these are not anticipated; routine discharges are expected to comply with regulation and are unlikely to cause measurable change in mortality / injury. There may be a change in food availability due to discharges of organic waste. • Interactions with the VC are anticipated to be confined to within approximately 5 km of the source for lighting attraction effects (Poot et al. 2008). • Operational discharges and effects of vessel and aircraft traffic are more localized (Rojek et al. 2007; Hoang 2013). • The majority of strandings reported by operator occur in September and October, corresponding with the departure of Leach's storm-petrel fledglings from the breeding colonies, and with fall landbird migration (LGL 2017). • Inclement weather conditions (fog, drizzle) are also associated with greater numbers of strandings.
Terra Nova Oilfield	• Change in mortality / injury levels and health of individuals or populations • Change in avifauna presence and abundance • Change in habitat availability and quality • Change in food availability and quality	
White Rose Oilfield and Extension Project	• Change in mortality / injury levels and health of individuals or populations • Change in avifauna presence and abundance • Change in habitat availability and quality • Change in food availability and quality	
Hebron Oilfield	• Change in mortality / injury levels and health of individuals or populations • Change in avifauna presence and abundance • Change in habitat availability and quality • Change in food availability and quality	
Offshore Petroleum Exploration –	• Change in mortality / injury levels and health of individuals or populations	• Effects from other exploration drilling and other survey programs are anticipated to be similar in nature and scale to predicted

Table 14.6 Marine and Migratory Birds: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
Geophysical and Other Exploration Activities and Drilling	• Change in avifauna presence and abundance • Change in habitat availability and quality • Change in food availability and quality	Project effects (see Chapter 9), and are primarily associated with attraction to artificial lighting (including flares) and operational discharges from drilling installations and vessels (Ellis et al. 2013). • Although the large survey areas covered by some types of offshore geophysical surveys can increase the potential for spatial interactions between their effects and those of other projects and activities in the marine environment, most survey activities operate for a short period of time in any one location, resulting in a short-term disturbance within a relatively limited zone of influence. • Available research suggests these effects are therefore minor and short-term in duration for marine and migratory birds and their habitats (e.g. Davis et al. 1998; MMS 2004; Dooling and Popper 2007). • There are potential disturbance effects from vessel and aircraft traffic. • Interactions with the VC are anticipated to be confined to within approximately 5 km of the source for lighting attraction effects (Poot et al. 2008); operational discharges and effects of vessel and aircraft traffic are more localized (Rojek et al. 2007; Hoang 2013).
Fishing Activity	• Change in mortality / injury levels and health of individuals or populations • Change in avifauna presence and abundance • Change in habitat availability and quality • Change in food availability and quality	• Entanglement in fishing gear, particularly gillnets and, to a lesser extent, longlines and bottom trawls, can cause changes in mortality and injury levels to seabirds (accidental bycatch). • In Newfoundland and Labrador, murres and shearwaters are the most commonly captured (Ellis et al. 2013). • The southwest slope of the Grand Bank has seasonally high bycatch rates that are potentially of concern (Ellis et al. 2013), although Common Murre populations in southeastern Newfoundland have not shown signs of decrease (Robertson et al. 2004). • Vessel lighting, disturbance and emissions/discharges from fishing vessels

Table 14.6 Marine and Migratory Birds: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
		may cause a change in habitat quality; this change is again quite short-term and transient at any given location. • Bait and offal from fishing vessels cause change in food availability for marine birds, and this in turn may result in localized changes in presence and abundance of avifauna.
Other Marine Vessel Traffic	• Change in mortality / injury levels and health of individuals or populations • Change in avifauna presence and abundance • Change in food availability and quality	• Vessel and aircraft traffic may affect seabirds through lighting, discharges, and displacement/disturbance. • Vessels are highly transitory, reducing effects in a given location and time • Interactions with the VC are anticipated to be confined to within approximately 5 km of the source (Poot et al. 2008). • Vessel and aircraft traffic in proximity to coastal breeding colonies and IBAs has the greatest potential for negative effects on the VC.
Hunting Activity	• Change in mortality / injury levels and health of individuals or populations	• Some types of marine birds (specifically, murres and waterfowl) can experience change in mortality / injury levels due to hunting. • Although hunting is restricted to nearshore areas, some birds are highly mobile and individuals that occur in the RSA may also be at risk of mortality due to hunting.

14.3.4 Potential Cumulative Environmental Effects

Potential interactions with, and effects on, marine and migratory birds as a result of the Project and other projects and activities in the region relate primarily to possible attraction effects associated with Project lighting, and to disturbances from lights, noise and possible waste materials that are often associated with these offshore activities, where these may affect the same individuals or populations. Potential interactions with marine birds as a result of the Project will, however, entail a localized and short-term disturbance at any one location and time, which reduces the potential for individuals and populations to be affected repeatedly through multiple interactions with this Project, as well as the potential for, and degree and duration of, overlap between the effects of this Project and other activities in the marine environment.

14.3.4.1 Project Area – Northern Section

The potential for cumulative effects to occur within the Northern Section of the Project Area would result from spatial and temporal interaction between the Project, other offshore exploration activities, other marine traffic and commercial fishing activity which may occur throughout the region. Hunting pressure on birds that frequent the Project area also has potential to contribute to cumulative effects, particularly in the case of murres. Waterfowl are more commonly found in coastal habitats and less prone to interaction with the Project.

The current production projects (Hibernia, Terra Nova, White Rose, and Hebron) are located 40 km or more outside the Project Area - Northern Section, and with the possible exception of associated vessel transits, environmental disturbances that are relevant to this VC resulting from Project activities (including light emissions that may attract and/or disorient night-flying birds) in this area will not overlap with those of the current production projects. The environmental effects of on-going or planned exploration activities in the region will also be localized and short-term in nature, including those resulting from offshore geophysical surveys, which result in a temporary and short-term environmental disturbance (including lights and other emissions) at a given location and time. Exploration drilling activity may only take place in accordance with an approved EL issued by the C-NLOPB, which gives the operator the exclusive right to conduct exploration drilling within that geographic area for a defined time period. This, along with the relatively limited geographic zone of influence associated with the environmental disturbances (including lights) that result from offshore drilling (Section 9.3), means that there is little or no potential for overlap and interaction between disturbances, and for effects on the same individuals.

14.3.4.2 Project Area – Southern Section

In the Southern Section of the Project Area, there is potential for cumulative effects to result from the combined effects of the Project and other offshore exploration and production activities, marine traffic, and commercial fishing activity. The Hibernia, Terra Nova, White Rose, and Hebron Oilfields are located within this section of the Project Area. Although these are long-term operations with similarly long term environmental disturbances, the localized nature of these effects, and the short-term and localized environmental disturbances that may result from adjacent activities associated with this Project, will reduce the potential for cumulative effects to occur.

14.3.5 Species at Risk

The Project is not anticipated to result in adverse effects on marine-associated avian species at risk, and therefore, to contribute to cumulative effects on these species. There is no identified and designated critical habitat for avian species at risk within the Project Area / LSA or RSA, and Ivory Gull and Red-necked Phalarope are the only such species that have the potential to be found in the area on a regular basis. The Ivory Gull is generally associated with pack ice, and as such, it is more likely to occur in the northern regions of the Project Area - Northern Section. During fall migration, there is some potential for Peregrine Falcons and nocturnally migrating landbird species at risk to pass through, but the risk of interactions with this and other projects in the area is low.

14.3.6 Cumulative Effects Summary and Evaluation

Table 14.7 summarizes the results of the cumulative effects assessment for this VC. As illustrated, the Project is not likely to result in significant adverse cumulative environmental effects on marine and migratory birds (including any species at risk) in combination with other projects and activities that have been or will be carried out. The relative contribution of this Project and its potential effects to overall effects on this VC within the overall RSA will be low, and will not likely be perceptible.

14.4 Marine Mammals and Sea Turtles (including Species at Risk)

14.4.1 Past and On-going Effects (Baseline)

The potential environmental effects of human activities on marine mammals and sea turtles include possible hearing impairment or permanent injury or mortality from exposure to loud underwater noise, as well as behavioural effects (avoidance) due to noise emissions or other disturbances, which may alter the presence, abundance and overall distribution of these species and their health, movements, communications, feeding and other activities. Marine mammals and sea turtles may also be affected by other marine environmental discharges and disturbances, including through physical exposure, ingestion, effects on prey and habitats and other changes.

Marine activities off Eastern Newfoundland, including commercial fishing, general marine traffic and oil and gas exploration and development, have resulted in portions of the region's underwater environment having elevated sound levels at particular times, relative to naturally occurring oceanographic sounds. Naturally occurring oceanographic sound levels vary spatially and temporally based on differences in abiotic and biotic conditions. For example, as described in Section 5.6, results from underwater acoustic recorders deployed by JASCO Applied Sciences in 2015/2016 indicate that ambient sound levels in the Eastern Newfoundland offshore area are slightly higher in the winter due to the effects of higher winds and sea states, and the presence of singing fin whales (Appendix C). Underwater noise from the existing oil and gas platforms (Hibernia, Terra Nova, and White Rose) was found to increase the average received sound levels at recording stations located within 35 km from the platforms. Noise from geophysical survey sources over 100 km from the recorders were still a dominant noise source (Appendix C). In addition to noise-related interactions, marine mammals and sea turtles may also be affected by other anthropogenic disturbances. These include potential for interactions with general vessel traffic and commercial or recreational fishing activity, which may result in effects due to entrapment and entanglement in fishing gear, or collisions with marine vessels.

The widespread and migratory nature of marine mammals and sea turtles and their overall sensitivity to certain types of disturbance increases the potential for individuals and populations to be affected by multiple environmental disturbances, and thus, for cumulative effects to occur. This is reflected in the fact that many species of marine mammals and sea turtles that may be found off Eastern Newfoundland have been designated as species at risk or are otherwise of conservation concern.

Table 14.7 Summary of Potential Cumulative Environmental Effects: Marine and Migratory Birds

Summary of Potential Cumulative Environmental Effects		
VC Existing Condition (Past and On-Going Activities)	• Offshore Newfoundland provides important habitat for tens of millions of marine and migratory birds. Several major seabird colonies are also found along the Newfoundland coastline, and species that do not breed in the area are drawn to the productive Grand Banks for foraging throughout the year. • In general, the populations of most marine-associated bird species occurring off Eastern Newfoundland are considered stable overall, although one species, the Leach's Storm-petrel, has seen declines in recent years.	
Residual Environmental Effects of the Project	• Platform attraction associated with lighting and increased foraging opportunities may increase potential for mortality or injury; however, this is anticipated to be localized and short-term, and will not have adverse effects to populations. • Discharges from offshore platforms and vessels may interact with birds both directly and indirectly. The Leach's Storm-petrel is considered especially vulnerable. • Vessel and aircraft traffic in nearshore environments may interact with birds, but will be reduced through adherence to common traffic routes where possible, and avoidance of known seabird colonies • These interactions may lead to increased potential for mortality or injury of individuals, but such effects are anticipated to be minor and spatially and temporally limited. Project activities are not anticipated to have population-level effects. • The Project is not likely to result in significant effects on marine and migratory birds.	
Other Projects / Activities	**Potential for Interaction with Effects of Project: Project Area – Northern Section**	**Potential for Interaction with Effects of Project: Project Area – Southern Section**
Hibernia Oilfield	N – Operations are located well outside of the Project Area, with highly localized environmental effects.	Y - Some potential for interaction as operations are located within the Project Area, and adjacent to an EL where Project-related exploration activity may occur. However, localized environmental effects, and short-term nature of this Project, suggests low potential for interaction.
Terra Nova Oilfield	N – Operations are located well outside of the Project Area, with highly localized environmental effects.	Y - Some potential for interaction as operations are located within the Project Area, and in proximity to an EL where Project-related exploration activity may occur. However, localized environmental effects, and short-term nature of this Project, suggests low potential for interaction.
White Rose Oilfield and Extension Project	N – Operations are located well outside of the Project Area, with highly localized environmental effects.	Y - Some potential for interaction as operations are located within the Project Area, and in proximity to an EL where Project-related exploration activity may occur. However, localized environmental effects, and short-term nature of this Project, suggests low potential for interaction.

Table 14.7 Summary of Potential Cumulative Environmental Effects: Marine and Migratory Birds

Summary of Potential Cumulative Environmental Effects		
Hebron Oilfield	N - The imminent Hebron Project is located well outside of the Project Area. Based on its EA results, the project will have localized environmental effects suggesting there is no potential for interaction.	Y - Some potential for interaction as operations are located within the Project Area, and in proximity to an EL where Project-related exploration activity may occur. However, localized environmental effects, and short-term nature of this Project, suggests low potential for interaction. Therefore, interactions are anticipated to be minor and primarily associated with vessel and aircraft traffic.
Offshore Petroleum Exploration – Geophysical and Other Exploration Activities and Drilling	Y – Some potential for interaction, although localized and short term nature of these activities and their effects, along with required separation measures and other mitigation measures, will reduce potential for interaction.	Y – Some potential for interaction, although localized and short term nature of these activities and their effects, along with required separation measures will reduce potential for interaction.
Fishing Activity	Y - Some potential for interaction, although these transient activities occur in select parts of the Project Area only, primarily outside of the ELs. Fisheries bycatch could potentially result in cumulative changes in mortality/injury. Vessel and aircraft traffic and associated emissions (including offal) could have cumulative effects on habitat quality and food availability, although these would be minor due to the spatially and temporally limited nature of these effects.	Y - Some potential for interaction, although these transient activities occur in select parts of the Project Area only, primarily outside of the ELs. Fisheries bycatch could potentially result in cumulative changes in mortality/injury. Vessel and aircraft traffic and associated emissions (including offal) could have cumulative effects on habitat quality and food availability, although these would be minor due to the spatially and temporally limited nature of these effects
Other Marine Vessel Traffic	Y – Some potential for interaction, although these activities and their effects are highly localized and transient. Vessel and aircraft traffic and associated emissions could have cumulative effects on habitat quality and food availability, but these would be minor due to the spatially and temporally limited nature of these effects.	Y – Some potential for interaction, although these activities and their effects are highly localized and transient. Vessel and aircraft traffic and associated emissions could have cumulative effects on habitat quality and food availability, but these would be minor due to the spatially and temporally limited nature of these effects.
Hunting Activity	Y - Hunting pressure could potentially result in cumulative changes in mortality/injury to murres and, to a lesser extent, waterfowl.	Y - Hunting pressure could potentially result in cumulative changes in mortality/injury to murres and, to a lesser extent, waterfowl.

Table 14.7 Summary of Potential Cumulative Environmental Effects: Marine and Migratory Birds

Summary of Potential Cumulative Environmental Effects		
Cumulative Effects Summary	The Project components and activities in the Project Area – Northern Section are not likely to result in significant adverse cumulative environmental effects on this VC in combination with other projects and activities that have been or will be carried out.	The Project components and activities in the Project Area – Southern Section are not likely to result in significant adverse cumulative environmental effects on this VC in combination with other projects and activities that have been or will be carried out.

The effects of past and on-going projects and activities and other such influences are reflected in the existing (baseline) environmental conditions for this VC, as described in Section 6.3. This includes considering the current condition (health or quality) of potentially affected populations and their habitats, and thus, their potential resiliency or sensitivity to further environmental change as a result of the Project and/or other projects and activities within the RSA and likely beyond the RSA.

14.4.2 Potential Project-Related Contributions to Cumulative Effects

As discussed in Chapter 10, potential interactions with, and effects on, marine mammals and sea turtles as a result of the Project relate to possible injury or disturbance from the movement, noise, lights, and possible waste materials associated with the drilling installations and other related vessel and aircraft traffic. The primary pathways for potential residual effects on marine mammals are those associated with increases in underwater noise and vessel traffic that may result in change in mortality or injury or change in habitat quality or use (behavioural effects). Other potential pathways include change in food availability or quality (effects on prey) or change in health (contaminants). Mitigation measures that will be applied across a number of Project components and activities and that are designed to prevent or reduce potential interactions with and effects on marine mammals and sea turtles are described in Section 10.3.2.

With the application of these mitigation measures, potential for Project-VC interactions is thus likely to be highly transient and temporary for individual marine mammals or sea turtles, especially in consideration of anticipated large-scale daily and seasonal fluctuations in presence within the assessment areas and the alternate habitats available throughout the RSA. The Project will therefore not result in significant adverse effects to this VC.

14.4.3 Future Projects and Activities and Their Effects

On-going and potential projects and activities which may affect marine mammals and sea turtles within the RSA include fisheries, general vessel traffic, and other on-going and planned offshore oil and gas exploration and production activities, as listed in Table 14.8.

Table 14.8 Marine Mammals and Sea Turtles: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
Hibernia Oilfield	• Change in mortality or injury (underwater noise) • Change in mortality or injury (vessel strikes) • Change in habitat quality or use (behavioural effects) • Change in food availability or quality • Change in health (contaminants)	• The Hibernia Platform is located within the Project Area - Southern Section. • A Safety Zone (where no other activities can occur) of 6 km^2 has been established around the development. • The Hibernia Southern Extension is located 6 km from the Hibernia Platform and is connected back to the existing Hibernia GBS. A safety zone of 53 km^2 is established, plus zones for each future flowline. • Production at the Hibernia Platform and associated supply vessel traffic occur year-round and are a continuous source of underwater sound contributing to elevated background sound levels.
Terra Nova Oilfield	• Change in mortality or injury (underwater noise) • Change in mortality or injury (vessel strikes) • Change in habitat quality or use (behavioural effects) • Change in food availability or quality • Change in health (contaminants)	• The Terra Nova Project is located within the Project Area - Southern Section. • The Terra Nova Field Safety Zone (where no other activities can occur) extends 9.26 km (5 nautical miles) from the FPSO. • Production at the Terra Nova FPSO and associated supply vessel traffic occur year-round and are a continuous source of underwater sound contributing to elevated background sound levels.
White Rose Oilfield and Extension Project	• Change in mortality or injury (underwater noise) • Change in mortality or injury (vessel strikes) • Change in habitat quality or use (behavioural effects) • Change in food availability or quality • Change in health (contaminants)	• The White Rose Oilfield and Extension Project is located within the Project Area - Southern Section. • The White Rose Safety Zone is approximately 95 km^2. The safety zone associated with the South White Rose Extension drill center is approximately 9 km^2. • Production at the White Rose Oilfield and Extension Project and associated supply vessel traffic occur year-round and are a continuous source of underwater sound contributing to elevated background sound levels.

Table 14.8 Marine Mammals and Sea Turtles: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
Hebron Oilfield	• Change in mortality or injury (underwater noise) • Change in mortality or injury (vessel strikes) • Change in habitat quality or use (behavioural effects) • Change in food availability or quality • Change in health (contaminants)	• The Hebron Project is located within the Project Area - Southern Section. • A Safety Zone of 6 km^2 is established around the GBS and offloading system. • Production at the Hebron Platform and associated supply vessel traffic will occur year-round and will be a source of underwater sound contributing to elevated background sound levels.
Offshore Petroleum Exploration – Geophysical and Other Exploration Activities	• Change in mortality or injury (underwater noise) • Change in mortality or injury (vessel strikes) • Change in habitat quality or use (behavioural effects) • Change in food availability or quality • Change in health (contaminants)	• The primary environmental issues related to offshore geophysical activities and their effects on marine mammals and sea turtles are related to underwater noise and its potential direct and indirect effects on these species. • This can include temporary hearing impairment or permanent injury or mortality from exposure to loud underwater noise after coming into close contact with a geophysical sound source, as well as possible behavioural effects (avoidance) due to sound emissions or other disturbances, altering the presence, abundance and overall distribution of marine mammal and sea turtles and their movements, feeding and other activity. • Although the large survey areas covered by some 2D/3D offshore geophysical surveys and the known propagation of noise in the marine environment can increase the potential for spatial interactions between their effects and those of other projects and activities in the marine environment, most survey activities operate for a short period of time in any one location. • Underwater noise recordings within the RSA have, however, found that geophysical surveys were detected over 100 km from the recorders and were still a dominant sound source (Appendix C).

Table 14.8 Marine Mammals and Sea Turtles: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
Offshore Petroleum Exploration - Drilling	• Change in mortality or injury (underwater noise) • Change in mortality or injury (vessel strikes) • Change in habitat quality or use (behavioural effects) • Change in food availability or quality • Change in health (contaminants)	• The underwater noise and other environmental emissions and interactions associated with offshore drilling can have effects on marine mammals and sea turtles. • Drilling programs are typically relatively short-term and localized activities, which can reduce the potential for individuals and populations to be affected simultaneously and repeatedly by multiple projects and activities
Fishing Activity	• Change in mortality or injury (underwater noise) • Change in mortality or injury (vessel strikes) • Change in habitat quality or use (behavioural effects) • Change in food availability or quality • Change in health (contaminants)	• Commercial fishing activity in the region is extensive and diverse, involving a variety of participants, species, gear types, and occurs year-round. • Commercial fishing effort is mainly located in portions of the Project Area's southern section and in the southwest corner of the northern section of the Project Area (See Commercial Fisheries Section 7.1).
Other Marine Vessel Traffic	• Change in mortality or injury (underwater noise) • Change in mortality or injury (vessel strikes) • Change in habitat quality or use (behavioural effects) • Change in health (contaminants)	• Other marine vessel traffic in the Project Area and RSA include naval vessels (Department of National Defence) and DFO research survey vessels. • Other marine transportation activities taking place along the Atlantic coast, including cargo ships, supply vessels, cruise ships and other commercial and recreational vessels. • Vessels are highly transitory, leading to limited potential for overlap of effects at a given location and time
Hunting Activity	• Change in mortality / injury levels and health of individuals or populations (seals)	• Some types of marine mammals (seals) can experience change in mortality / injury levels due to hunting. • Although such hunting is restricted to nearshore areas (outside the RSA), some species are mobile and individuals that occur in the RSA may also be at risk of mortality due to hunting.

14.4.4 Potential Cumulative Environmental Effects

Other on-going and future offshore oil exploration and production projects are expected to adhere to regulated and/or industry standards and applicable best management practices to reduce their

effects (and contributions to cumulative effects) on marine mammals and sea turtles. There remains, however, the potential for Project residual effects to act cumulatively with those of other projects and activities in affecting marine mammals and sea turtles within the RSA, depending on the specific nature, location, and timing of these activities.

Offshore oil and gas production fields and exploration drilling installations have established safety zones, where other activities are excluded. These zones are permanent for existing oil and gas production platforms, and temporary for exploratory drilling operations, and as a result, no physical activities from the different projects can occur in the same area at the same time. These required distances will help reduce the degree to which the potential environmental zones of influence resulting from associated noise emissions may overlap and interact in space and time. There is, however, the potential that underwater noise produced from these activities may extend beyond these established safety zones and interact spatially with those of other projects and activities. Individual marine mammals and sea turtles may also be exposed to multiple sources of underwater noise while in the RSA due to their widespread, mobile, and migratory nature, which could increase the risk of mortality or physical injury and may result in behavioural changes in individuals exposed to multiple noise sources.

Source levels generated by operating drilling installations range from approximately 130 to 190 dB re 1 µPa at 1 m (peak frequency range: 10 – 10,000 Hz) (Richardson et al. 1995, Hildebrand 2005, OSPAR 2009). Recent noise measurements within the RSA showed that oil and gas production platforms (Hibernia, Terra Nova, White Rose) and their associated support vessels increase the sound pressure levels (SPL) in the approximately 40-225 Hz frequency band by 15-20 dB at ranges of 35 km from platforms in shallow water (Appendix C). Sound levels were recorded to be 110-120 dB re 1 µPa at this same distance, due to the continuous noise generated by platforms and support vessels from the Hibernia and Hebron oil developments (the two closest developments to where the noise measurements were taken) (Appendix C).

The production platforms are located in the Project Area - Southern Section at distances ranging from 44-80 km to the closest edge of the Project Area - Northern Section. Production and associated vessel traffic at these developments occurs year-round, and results in a continuous noise source that causes permanent elevations in the background sound levels above the US regulatory behavioural disturbance threshold for marine mammals and sea turtles (120 dB re 1 µPa RMS SPL; NOAA n.d.) at varying distances from the sound source. Overall source levels from these activities are below those expected to cause auditory injury (Zykov 2016).

Whereas the sounds generated by production platforms are continuous and occur year-round, sounds generated by exploratory drilling and geophysical surveys are temporary and relatively short-term in nature. Geophysical surveys generate higher SPLs that potentially exceed the thresholds for auditory injury, while also contributing to noise levels that result in behavioural changes. In recent noise recordings for the Eastern Newfoundland offshore area, geophysical surveys were detected over 100 km from recorders and were a dominant sound source (Appendix C). Other projects are anticipated to require standard mitigation measures (e.g., geophysical survey best practices), reducing the potential for individual marine mammals and sea turtles to be temporarily exposed to high SPLs. Moreover, the mobility of these species, coupled with the availability of alternative

habitats during short periods of Project-related disturbance, limits the potential for cumulative effects to occur.

The various components and activities associated with this Project along with other on-going and future projects and activities in the region also have the potential to contribute to and result in cumulative effects on health (contaminants) for marine mammals and sea turtles, as a result of routine discharges of drilling wastes and other materials. With the implementation of standard mitigation measures, which are anticipated to be in place for other projects as well, these discharges are not expected to result in a measurable change in health for marine mammals and sea turtles, either individually or cumulatively.

Project vessel traffic within the RSA and vessel traffic associated with other projects and activities pose a risk of mortality or physical injury to marine mammals and sea turtles due to the increased potential for vessel strikes. Project-related vessel traffic is short-term and transient in nature, however, which limits the opportunity for vessel strikes. Project-related vessels will maintain a steady course and safe vessel speed and avoid concentrations of marine mammals and sea turtles whenever possible to reduce the risk of a vessel strike. Along with vessel strikes, marine mammals are also at increased risk of mortality or physical injury due to entanglement in fishing gear or in equipment used for geophysical surveys.

14.4.4.1 Project Area – Northern Section

Within the Project Area's Northern Section, commercial fishing and other petroleum exploration activities and their effects have the potential to interact in space and time with those resulting from the Project. Commercial fishing activity is currently concentrated in several specific parts of the overall Project Area. With the exception of EL1135, which is within a known fishing area, most commercial fishing activity occurs well outside the boundaries (and deeper waters) of most of the ELs for which exploration drilling may occur as part of this Project. The short-term and localized nature of Project-related activities and the planned and required implementation of safety zones around the planned activities will limit the potential for activities and their disturbances to overlap in space and time, and thus, for cumulative effects on marine mammals and sea turtles, including through indirect effects on fish (prey) and fish habitat.

Other planned petroleum exploration activities in this region, such as offshore geophysical surveys and associated vessel traffic, will also contribute to cumulative effects on this VC. The Project activities will operate for a short period of time in any one location, resulting in a short-term and relatively localized disturbance. Other on-going or planned exploration activities in the region, including geophysical surveys, likewise result in a temporary and short-term environmental disturbance at a given location and time. Exploration drilling activity may only take place in accordance with an approved EL issued by the C-NLOPB, which gives the operator the exclusive right to conduct exploration drilling within that geographic area for a defined time period. This, along with the relatively limited geographic zone of influence associated with the environmental disturbances (including underwater sound) that result from offshore drilling (Section 10.3), means that there is little or no potential for overlap and interaction between effects. Marine vessel traffic from fisheries, surveys, and other activities, is also common in these offshore areas, although inherently transient in nature.

14.4.4.2 Project Area – Southern Section

Planned Project activities in the Southern Section of the Project Area have a similar potential to result in cumulative effects in combination with commercial fisheries and other petroleum exploration activities as those described above. As described in Section 7.1, fixed gear fishing activity is focused on the slope of the Grand Banks and occurs throughout this portion of the Project Area, while the available data shows little current mobile gear use in the Southern Portion of the Project Area in general, and particularly, within the EL for which exploration drilling may occur as part of this Project.

Unlike the Northern Section of the Project Area, however, there are several petroleum production projects in this region (Hibernia, White Rose, Terra Nova, Hebron), each of which are potentially contributing to cumulative environmental effects on this VC within their respective zones of influence. Marine vessel traffic is also common in these offshore areas, although inherently transient in nature. The localized nature of these projects and their effects will also reduce spatial and temporal interactions between the effects of this Project and other activities in the area. The overall mobility of marine mammal and sea turtle species, along with the availability of alternative habitats during short periods of Project-related disturbance, also helps limit the potential for cumulative effects to occur.

14.4.5 Species at Risk

Within the RSA there are some 23 species of cetaceans likely to be present, of which seven are mysticetes (baleen whales), and 16 are odontocetes (toothed whales), along with four species of phocids (seals) and four species of sea turtle. While some of these species are migratory, others may be present in the Project Area and/or RSA year-round. Eleven of these species are listed under Schedule 1 of SARA, or have been identified as species of conservation concern by COSEWIC. Detailed descriptions of species sightings in the Project Area (Northern and Southern Sections) and RSA and their ecology are found in Section 6.3.

Four listed mysticetes species have the potential to occur in the Project Area (Northern and Southern Sections) and RSA, namely blue, bowhead, fin, and North Atlantic right whales. The Atlantic population of blue whale is listed as Endangered under Schedule 1 of SARA, there may be fewer than 250 adult individuals, and recruitment appears to be low (COSEWIC 2002). Blue whales may be sensitive to large-scale climatic shifts that could alter prey abundance, in addition to localized threats such as vessel strikes, pollution, and interaction with fishing and whale-watching activities (COSEWIC 2002). The Eastern Canada – West Greenland population of bowhead whale remains listed as Special Concern with COSEWIC, despite a recent rise in numbers to an estimated 6,000 individuals from post-commercial whaling lows (COSEWIC 2009a). The continued listing of this bowhead whale population reflects uncertainty surrounding how the whales will respond to climate-associated changes in habitat, in addition to the increased industrial activity that such changes could facilitate in their habitat (COSEWIC 2009a). The Atlantic population of fin whale is listed as Special Concern under Schedule 1 of SARA. Trends in population abundance are uncertain as is how anthropogenic threats may affect this population (COSEWIC 2005). However, vessel strikes and interaction with fishing activities present possible threats (COSEWIC 2005). The North Atlantic right whale population is listed as Endangered under Schedule 1 of SARA because of the relatively small size of the population and the prevalence of threats (COSEWIC 2013). The North Atlantic right whale

population has increased to an estimated 468 individuals following the cessation of commercial whaling, though at a slower rate than would be expected naturally (COSEWIC 2013). This is likely due to increased interaction with fishing equipment and the growing incidence of ships striking individuals, particularly females of reproductive age (COSEWIC 2013).

Five listed odontocete species have the potential to occur in the Project Area and RSA, namely: beluga whale, harbour porpoise, killer whale, northern bottlenose whale and Sowerby's beaked whale. The St. Lawrence Estuary population of beluga whale is listed as Endangered under Schedule 1 of SARA. The relatively recent (1979) cessation of commercial whaling has resulted in a severely depleted population and recovery may be hampered by pollutants in their habitat as contaminant levels are high in the tissue of belugas from this area (COSEWIC 2014). The prevalence of threats such as pollution, industrial activity, noise, and disease, coupled with decreased juvenile survival mean that the risk to this population continues to increase (COSEWIC 2014). The Northwest Atlantic population of harbour porpoise is listed as Special Concern by COSEWIC. Range-wide estimates for the abundance of harbour porpoise in eastern Canada do not exist, however, this population is considered to be abundant in the region (COSEWIC 2006b). The most important recent and current threat to this population is the susceptibility of harbour porpoises to bycatch in fishing gear. The relatively secure status of this population is due, in large part, to measures taken to restore groundfish stocks rather than to conserve harbour porpoises, and it is likely that bycatch will increase significantly if groundfish stocks recover in the region (COSEWIC 2006b). The Northwest Atlantic – Eastern Arctic population of killer whale is listed as Special Concern by COSEWIC. The number of individuals in this population is unknown, though it believed there are fewer than 1,000 mature individuals, and likely less than 250 (COSEWIC 2009b). Despite this population's small size, the number of killer whale sightings in eastern Canada have been more frequent over the past decade (NOAA 2015). Threats to this population include hunting in Greenland, acoustic and physical disturbance, and contaminants (COSEWIC 2009b). The Scotian Shelf population of northern bottlenose whale is listed as Endangered by both SARA (Schedule 1) and COSEWIC, and the Davis Strait-Baffin Bay-Labrador Sea population is listed as Special Concern by COSEWIC. The Scotian Shelf population is estimated to have 164 individuals, but there are no estimates for the size of the Davis Strait-Baffin Bay-Labrador Sea population or for the total number of individuals in the Northwest Atlantic (COSEWIC 2011). Threats to northern bottlenose whale include entanglement in fishing gear, acoustic disturbance from oil and gas activities (including geophysical surveys), and exposure to contaminants (COSEWIC 2011; DFO 2016a). The Atlantic population of Sowerby's beaked whale is listed as Special Concern by both SARA (Schedule 1) and COSEWIC. There are currently no estimates for the size of this population in Atlantic Canada (COSEWIC 2007b; DFO 2016b). Threats to this population include acoustic disturbance, entanglement in fishing gear, vessel strikes, and exposure to contaminants (COSEWIC 2007b; DFO 2016b).

Two listed species of sea turtles have the potential to occur in the Project Area and/or RSA: leatherback and loggerhead. The Atlantic population of leatherback sea turtle is listed as Endangered by both SARA (Schedule 1) and COSEWIC. Sightings data suggests that the population in Atlantic Canadian waters numbers in the thousands, and although current data are insufficient to determine fluctuations and trends in this population, most major Northwestern Atlantic nesting populations are thought to be stable or increasing slightly (COSEWIC 2012e). The main threat facing this population is bycatch in fisheries, though globally, the species is threatened by ship strikes, marine debris, oil

and gas exploration, the poaching of eggs, and the effects of climate change on nesting beaches and marine habitat (COSEWIC 2012e). The Atlantic population of loggerhead sea turtle is listed as Endangered by both SARA (Schedule 1) and COSEWIC. Based on bycatch records, it has been determined that this species has a substantive presence in Atlantic Canadian waters, though the size of this population is not known (COSEWIC 2010d). This population is threatened by commercial fishing, particularly as bycatch in the pelagic longline fleet, and by loss and degradation of nesting beaches in the southeastern USA and the Caribbean (COSEWIC 2010d). Globally, loggerhead sea turtles face threats due to poaching, construction and development on nesting beaches, pollution, and climate change (COSEWIC 2010d).

The RSA is, in general, a productive area for marine mammals and sea turtles and there are a number of Ecologically and Biologically Significant Areas (EBSAs) which intersect the area, some of which represent important foraging habitat and migratory routes for these species. No critical habitat for marine mammals or sea turtles has, however, been designated in the Project Area or in the RSA.

The main potential environmental interactions between the Project, other projects and species at risk are the same as those for the marine mammals and sea turtles' VC as a whole. These species are highly mobile, and many have broad ranges and show large movements across annual migration routes. Large seasonal and even daily fluctuations in presence and abundance within the Project Area and RSA are therefore likely. Although the widespread and often migratory nature of some species increases the potential for individuals and populations to be affected by multiple perturbations, these mobile species likewise have capability for avoidance. While there is some potential for overlap and interaction between the Project and other projects and activities (particularly with respect to underwater noise), effects are likely to be transient and temporary in nature without significant adverse cumulative effects on individuals or populations.

14.4.6 Cumulative Effects Summary and Evaluation

Table 14.9 summarizes the results of the cumulative effects assessment for this VC. As illustrated, the Project is not likely to result in significant adverse cumulative environmental effects on marine mammals and sea turtles (including any species at risk) in combination with other projects and activities that have been or will be carried out. The Project is expected to make a negligible contribution to cumulative effects on this VC on a regional scale, beyond currently existing conditions.

14.5 Special Areas

Special Areas of various types are located within and offshore Eastern Newfoundland. These include coastal and marine areas that have been designated as protected through regulatory processes or formally identified through relevant initiatives as being special or sensitive areas, as described in detail in the Section 6.4 of this EIS.

Table 14.9 Summary of Potential Cumulative Environmental Effects: Marine Mammals and Sea Turtles

Summary of Potential Cumulative Environmental Effects		
VC Existing Condition (Past and On-Going Activities)	• Species that occur in the RSA that may interact with the Project include: 23 species of cetaceans, of which 7 are mysticetes (baleen whales), 16 are odontocetes (toothed whales); four species of phocids (seals); and 4 species of sea turtle. • While some of these species are migratory, others may be present in the Project Area and adjacent areas year-round. • Eleven of these species are listed under Schedule 1 of SARA, or have been identified as species of conservation concern by COSEWIC. • A number of EBSAs, some of which represent important foraging habitat and migratory routes for marine mammals and sea turtles, intersect the RSA. • There is no overlap with designated critical habitat for marine mammals or sea turtles in the Project Area or RSA.	
Residual Environmental Effects of the Project	• The Project is not likely to result in significant effects on Marine Mammals and Sea Turtles. • Based on the distribution and habitat use of marine mammals and sea turtles in the Project Area and RSA and the short-term nature of most Project-related activities, confidence is high that while residual effects may adversely affect a small number of individual marine mammals or sea turtles, such effects are unlikely to alter the long-term viability of local or regional populations. • Project activities will occur in an area where no critical habitat for SAR has been designated, and where marine mammal and sea turtle presence is likely to be transient, with daily and seasonal fluctuations in the individuals potentially exposed.	
Other Projects / Activities	**Potential for Interaction with Effects of Project: Project Area – Northern Section**	**Potential for Interaction with Effects of Project: Project Area – Southern Section**
Hibernia Oilfield	Y - Continuous noise and other environmental disturbances are generated by the production platform and temporary noise is generated by associated shuttle tankers and supply vessels. However, it is unlikely there will be more than minor interaction with the effects of the Project due to the separation distances between the two projects and associated activities.	Y - Continuous noise and other environmental disturbances are generated by the production platform and temporary noise is generated by associated shuttle tankers and supply vessels. Some potential for interaction as operations are located within the Project Area, and in proximity to an EL where exploration activity may occur. However, localized environmental effects, and short-term nature of this Project, suggests low potential for interaction. Therefore, interactions are anticipated to be minor and primarily associated with vessel traffic.
Terra Nova Oilfield	Y - Continuous noise and other environmental disturbances are generated by the production platform and temporary noise is generated by associated shuttle tankers and supply vessels. However, it is unlikely there	Y - Continuous noise and other environmental disturbances are generated by the FPSO and temporary noise is generated by associated shuttle tankers and supply vessels. Some potential for interaction as operations are located within the

Table 14.9 Summary of Potential Cumulative Environmental Effects: Marine Mammals and Sea Turtles

Summary of Potential Cumulative Environmental Effects		
	will be more than minor interaction with the effects of the Project due to the separation distances between the two projects and associated activities.	Project Area, and in proximity to an EL where exploration activity may occur. However, localized environmental effects, and short-term nature of this Project, suggests low potential for interaction. Therefore, interactions are anticipated to be minor and primarily associated with vessel traffic.
White Rose Oilfield and Extension Project	Y - Continuous noise and other environmental disturbances are generated by the production platform and temporary noise is generated by associated shuttle tankers and supply vessels. However, it is unlikely there will be more than minor interaction with the effects of the Project due to the separation distances between the two projects and associated activities.	Y- Continuous noise and other environmental disturbances are generated by the FPSO and temporary noise is generated by associated shuttle tankers and supply vessels. Some potential for interaction as operations are located within the Project Area, and in proximity to an EL where exploration activity may occur. However, localized environmental effects, and short-term nature of this Project, suggests low potential for interaction. Therefore, interactions are anticipated to be minor and primarily associated with vessel traffic
Hebron Oilfield	Y - Continuous noise and other environmental disturbances are generated by the production platform and temporary noise is generated by associated shuttle tankers and supply vessels. However, it is unlikely there will be more than minor interaction with the effects of the Project due to the separation distances between the two projects and associated activities.	Y - Continuous noise and other environmental disturbances will be generated by the production platform and temporary noise is generated by associated shuttle tankers and supply vessels. Some potential for interaction as operations are located within the Project Area, and in proximity to an EL where exploration activity may occur. However, localized environmental effects, and short-term nature of this Project, suggests low potential for interaction. Therefore, interactions are anticipated to be minor and primarily associated with vessel traffic
Offshore Petroleum Exploration - Geophysical and Other Exploration Activities	Y –Underwater noise generated by geophysical surveys. Some potential for interaction, although localized and short-term nature of these activities and their effects, along with planned and required separation measures will reduce potential for interaction.	Y – Underwater noise generated by geophysical surveys. Some potential for interaction, although localized and short term nature of these activities and their effects, along with planned and required separation measures will reduce potential for interaction.
Offshore Petroleum Exploration - Drilling	Y – Underwater noise generated by exploratory drilling. Some potential for interaction, although localized and short-term nature of these activities and their effects,	Y – Underwater noise generated by exploratory drilling. Some potential for interaction, although localized and short term nature of these activities and their effects, along with planned

Table 14.9 Summary of Potential Cumulative Environmental Effects: Marine Mammals and Sea Turtles

Summary of Potential Cumulative Environmental Effects		
	along with planned and required separation measures will reduce potential for interaction.	and required separation measures will reduce potential for interaction.
Fishing Activity	Y - Marine mammals and sea turtles may be affected by commercial fishing activities through entanglement in fishing gear, increased competition for prey species, and the alteration of habitat via underwater noise created by fishing vessels. Some potential for interaction, although these activities occur in select parts of the Project Area only, primarily outside of the ELs. Safety zones around Project activities will limit potential for overlap, and thus, cumulative effects on this VC.	Y - Marine mammals and sea turtles may be affected by commercial fishing activities through entanglement in fishing gear, increased competition for prey species, and the alteration of habitat via underwater noise created by fishing vessels Some potential for interaction, although these activities occur in select parts of the Project Area only, primarily outside of the ELs. Safety zones around Project activities will limit potential for overlap, and thus, cumulative effects on this VC.
Other Marine Vessel Traffic	Y – Underwater noise generated that may result in changes in behaviour and increased risk of vessel strikes Some potential for interaction, although these activities and their effects are highly localized and transient. Safety zones around Project activities will limit potential for overlap, and thus, cumulative effects on this VC.	Y – Underwater noise generated that may result in changes in behaviour and increased risk of vessel strikes Some potential for interaction, although these activities and their effects are highly localized and transient. Safety zones around Project activities will limit potential for overlap, and thus, cumulative effects on this VC.
Hunting Activity	Y - Hunting pressure could potentially result in cumulative changes in mortality/injury to harvested seal species.	Y - Hunting pressure could potentially result in cumulative changes in mortality/injury to harvested seal species.
Cumulative Effects Summary	The Project components and activities in the Project Area – Northern Section are not likely to result in significant adverse cumulative environmental effects on this VC in combination with other projects and activities that have been or will be carried out.	The Project components and activities in the Project Area – Southern Section are not likely to result in significant adverse cumulative environmental effects on this VC in combination with other projects and activities that have been or will be carried out.

14.5.1 Past and On-going Effects (Baseline)

Environmental interactions between human activities and special areas may be both direct and indirect in nature and cause (Amec 2014). In terms of direct effects, conducting an activity within or near such a marine area may, for example, have adverse implications through the presence of rigs and vessels, other equipment and personnel and associated noise and other emissions and resulting environmental disturbances. An associated decrease in the real or perceived integrity of these sites in the short or long term may, in turn, affect their ecological and/or socio-cultural importance, value and, where applicable, the use and enjoyment of these areas. Biophysical effects resulting from offshore oil and gas or other human activities either within or outside of these areas may also indirectly affect them by affecting the marine fish, birds, mammals or other environmental components and systems that are relevant to their identification and their key and relevant characteristics and importance.

The current environmental conditions within the existing, identified Special Areas off Eastern Newfoundland reflect the occurrence and environmental consequences of past and ongoing anthropogenic activities and natural processes within and beyond their boundaries, as well as those that may have affected the larger natural and socioeconomic features and processes that characterize and influence them. Special areas are identified and designated in order to recognize their importance and/or protect particularly important or sensitive environmental components. In certain cases, this is based on the objective of conserving the presently pristine nature of these areas, while in other cases their designation is intended to help prevent further damage to already affected and sensitive environmental features and components.

14.5.2 Potential Project-Related Contributions to Cumulative Effects

Many of the identified special areas in Eastern Newfoundland are in nearshore and onshore areas and thus would not have direct contact with the Project-related activities. These include provincial (ecological reserves, parks and protected areas and historic sites), national (MPAs, fisheries closures within the EEZ, MBSs, parks and historic sites) and international (IBAs and WHSs) designations, none of which will be directly affected by the Project.

Several of the special areas off Eastern Newfoundland or portions of them overlap with the Project Area (Northern and/or Southern Sections) and potential vessel and aircraft traffic routes including several EBSAs, VMEs and NAFO FCAs (See Figures 6-95 and 6-96 in Section 6.4). Four of the ELs that may be drilled as part of this Project overlap with portions of these types of Special Areas, and there are no prohibitions of the types of activities being planned as part of this Project. Given the overall nature of the planned Project activities, the overall and defining physical, biological, and socioeconomic environments within these areas will not be adversely affected by the Project. Many of the offshore activities and associated disturbances that will occur as a result of this Project will be relatively localized and of a short-term nature at a given location, and the implementation of the various environmental protection measures and procedures outlined throughout this EIS will serve to further address direct (or indirect) potential effects on the existing environmental characteristics and conditions of these Special Areas.

14.5.3 Future Projects and Activities and Their Effects

On-going and other future projects and activities that may affect Special Areas include fisheries, general vessel traffic, and other current and planned offshore oil and gas production and exploration activities, as listed in Table 14.10.

Table 14.10 Special Areas: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
Hibernia Oilfield	• Project-related environmental disturbances and interactions may affect the existing natural or human environments in the area. • This in turn may affect the key environmental characteristics and processes that define and distinguish these areas, and thus, affect their overall and underlying characteristics, integrity, and value.	• The Hibernia Oilfield has a small and well-defined footprint, which does not overlap with existing Special Areas. • Hibernia has been producing oil year-round since 1997 and is expected to be in production until at least 2040.
Terra Nova Oilfield		• The Terra Nova Oilfield has a small and well-defined footprint, which does not overlap with existing Special Areas. • Terra Nova, which operates year-round, began producing oil in 2002 with an estimated production life of 25 years.
White Rose Oilfield and Extension Project		• The White Rose Project has a small and well-defined footprint, which does not overlap with existing Special Areas. • White Rose, which operates year-round, achieved first oil in 2005 and is expected to produce oil until at least 2020.
Hebron Oilfield		• The Hebron Oilfield will have a small and well-defined footprint, which does not overlap with existing Special Areas. • Hebron is anticipated to begin production in 2017 with an estimated life of 30 years.
Offshore Petroleum Exploration – Geophysical and Other Exploration Activities		• Although the large survey areas covered by some types of offshore geophysical surveys can increase the potential for spatial interactions between their effects and those of other projects and activities in the marine environment, most survey activities operate for a short period of time in any one location, resulting in a short-term disturbance within a relatively limited zone of influence overall.
Offshore Petroleum Exploration – Drilling		• Drilling and other types of exploration activities are typically relatively short-term and localized activities. • This can reduce the potential for environmental features and areas to be affected simultaneously and repeatedly by multiple projects and activities

Table 14.10 Special Areas: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
Fishing Activity	• Project-related environmental disturbances and interactions may affect the existing natural or human environments in the area. • This in turn may affect the key environmental characteristics and processes that define and distinguish these areas, and thus, affect their overall and underlying characteristics, integrity, and value.	• Commercial fishing activity in the region is extensive and diverse, involving a variety of participants, species, gear types, and occurs year-round. • Fishing activity takes place with Special Areas (such as EBSAs) unless otherwise prohibited (e.g., bottom fishing activities within Fisheries Closure Areas, see below) • Commercial fishing effort is mainly located in the Project Area's southern section and in the southwest corner of the northern section of the Project Area, (See Commercial Fisheries, Section 7.1). • Fishing activity is most intense in the summer months (May-August). • Bottom contact fishing is prohibited within NAFO FCAs and mainly limited to a small portion of the Project Area - Northern Section.
Other Marine Vessel Traffic		• Marine vessel traffic occurs in the offshore year-round but some sectors, such as the cruise ship industry, may be more active from spring to fall. • Vessels are highly transitory, minimizing effects in a given location and time
Hunting Activity		• Some types of marine birds and (specifically, murres and waterfowl) and mammals (seals) can experience change in mortality / injury levels due to hunting.

14.5.4 Potential Cumulative Environmental Effects

The special areas that overlap with the Project Area (Northern and Southern Sections) include: one EBSA; five VME areas and eight NAFO FCAs, which are special areas identified for their high sponge and coral concentrations (Table 14.11). Several of the ELs that may be drilled as part of this Project overlap with the Northeast Shelf and Slope EBSA and several others overlap with the Sackville Spur and Northern Flemish Cap VMEs and the Sackville Spur FCA.

Table 14.11 Special Areas Overlapping with Project Area

Special Area		Project Area	
Type	**Name**	**Northern**	**Southern**
EBSA	Northeast Shelf and Slope	Overlaps	Overlaps
VME	Northeast Shelf and Slope (within Canadian EEZ)	Overlaps	-
	Sackville Spur	Overlaps	-
	Northern Flemish Cap	Overlaps	

Table 14.11 Special Areas Overlapping with Project Area

Special Area		Project Area	
Type	**Name**	**Northern**	**Southern**
	Southern Flemish Pass to Eastern Canyons	-	Overlaps
	Beothuk Knoll	-	Overlaps
NAFO FCA	Northwest Flemish Cap (10)	Overlaps	-
	Northwest Flemish Cap (11)	Overlaps	-
	Northwest Flemish Cap (12)	Overlaps	-
	Flemish Pass / Eastern Canyon (2)	Overlaps	Overlaps
	Sackville Spur (6)	Overlaps	-
	Northern Flemish Cap (7)	Overlaps	-
	Northern Flemish Cap (8)	Overlaps	-
	Northern Flemish Cap (9)	Overlaps	-

These special areas do not overlap with the operating and planned oil and gas production projects (Hibernia, Terra Nova, White Rose, or Hebron) in the Southern Section of the Project Area. They do or may, however, interact spatially with planned or potential oil and gas exploration activities in the region, including offshore geophysical surveys and drilling. In terms of the latter, for example, several other existing and active ELs in this region overlap with portions of these or other special areas. Although the specific location and timing of other offshore oil and gas exploration activities in the region over the 10-year duration of this Project is not and cannot be known and defined, most such survey activities result in a short-term disturbance within a relatively limited zone of influence with applicable mitigation measures implemented avoid or reduce their environmental consequences. This reduces the potential for areas and their environmental characteristics to be affected simultaneously and repeatedly by multiple projects and activities, resulting in the accumulation of environmental effects over time. In addition, while other general marine traffic occurs throughout the Newfoundland offshore and is likely to intersect with EBSAs and VMEs that overlap the Project Area, vessel traffic is intermittent and transient at any one location and time, with negligible contributions to cumulative effects on an area.

Although commercial fishing activity in the region is extensive and diverse, it is focused in certain parts of the Project Area. While commercial fishing results in direct loss (mortality) of fish and introduces other disturbances into the marine environment, such as artificial lights, its occurrence at a given location and time is likewise limited, and these activities have relatively small footprints and are of short duration. Overall, fishing activity is subject to applicable management processes and regulations, and is not prohibited overall within any of the special areas that overlap with this Project. It is therefore not likely to affect the overall environmental integrity and viability of these special areas. Bottom contact fishing is prohibited within NAFO FCAs, and so these special areas will not be directly affected by such fishing activity in combination with Project activities. Given the minor, localized and short-term nature of Project-related disturbances within these areas, and the determination that the Project will not have a significant effect on these special areas, cumulative effects are not anticipated. In addition, bird hunting activity likely does not occur within these offshore areas, and does not target many of the species that are relevant to the identification of these special areas (see Section 6.2).

14.5.4.1 Project Area – Northern Section

Twelve special areas overlap with the Project Area - Northern Section and four with the Project Area - Southern Section as shown in Table 14.11. Specifically, two of the ELs that may be drilled as part of this Project overlap with the Northeast Shelf and Slope EBSA and another two overlap with the Sackville Spur and Northern Flemish Cap VMEs as well as the Sackville Spur FCA.

The existing oil production projects off Eastern Newfoundland do not overlap with, and are a large distance from, existing special areas, including those within this part of the Project Area. While activities associated with this Project and other ongoing or planned exploration activities could potentially occur in the Sackville Spur VME and the Sackville Spur FCA, these are again localized and short term activities and their environmental effects are not likely to overlap in time or space. Bottom contact fishing activities may also take place in EBSAs and VMEs but not occur within the NAFO FCAs. A portion of the Sackville Spur VME is also an FCA, which precludes bottom contact fishing. Generally, such fishing is limited to the southwest portion of the Project Area - Northern Section including a portion of the Northeast Shelf and Slope EBSA and Northeast Shelf and Slope (within Canadian EEZ) VMEs but mainly uses fixed gear, which is not likely to adversely affect benthic habitats. Various planning and mitigation measures such as pre-drill coral surveys will be used to identify sensitive areas and mitigations as relevant (see Chapter 8). Other activities such as general marine vessel traffic also occur throughout the area, resulting in noise, light, emissions, and effluents, and these are relatively short term and localized disturbances with low environmental effects.

14.5.4.2 Project Area – Southern Section

Special areas overlap with the Project Area - Southern Section (Table 14.11). This part of the Project Area also intersects with an EBSA, two VMEs and a NAFO FCA, which is closed to bottom contact fishing because of high coral and sponge concentrations. None of the ELs that may be drilled as part of this Project overlap with special areas in the Southern Section. None of these Special Areas overlap with the existing oil and gas production projects in the region, and their potential to be affected cumulatively by the Project and other oil and gas exploration, commercial fishing and other activities in the region would be like, similarly avoided or reduced by. the factors described in the preceding section.

14.5.5 Cumulative Effects Summary and Evaluation

Table 14.12 summarizes the results of the cumulative effects assessment for special areas. As illustrated, the Project is not likely to result in significant adverse cumulative environmental effects on special areas in combination with other projects and activities that have been or will be carried out. Moreover, the relative contribution of this Project and its potential effects to overall effects on this VC will be low, and will not likely be perceptible.

Potential cumulative effects on biological / ecological aspects and human use related to special areas have also been addressed in the other VCs considered in this Chapter. Implementation of the various environmental mitigation procedures outlined throughout this EIS, including those which are designed to avoid or reduce Project-related discharges and / or disturbances and their associated

environmental effects, will also serve to help address potential Project-related contributions to cumulative effects on special areas.

14.6 Indigenous Communities and Activities

This EIS has described Indigenous communities and their activities in Newfoundland and Labrador, the Maritime Provinces (NS, NB, PEI) and Quebec (Section 7.3) and assessed and evaluated the potential effects of the Project on these communities and activities (Chapter 12). The environmental effects assessment for this VC focuses on and addresses each of the associated factors specified in and required under CEAA 2012, including: 1) the current use of lands and resources for traditional purposes, 2) human health, 3) socioeconomic conditions, 4) physical and cultural heritage, and 5) structures, sites, or things of historical, archaeological, paleontological, or architectural significance to groups, as well as other factors as relevant.

14.6.1 Past and On-going Effects (Baseline)

Other past and on-going projects and activities in Eastern Canada have, to varying degrees, interacted with and affected Indigenous communities and activities, depending on their location, nature and scale in relation to the communities, activities and other components and interests of individual Indigenous groups. While it is not practical in this EIS to attempt to identify and describe past and ongoing development projects and other processes and activities that have influenced and otherwise affected these Indigenous peoples, an overview of current socioeconomic characteristics and condition of these Indigenous communities, which reflects past and on-going effects, was presented in Section 7.3. This has included, where possible and applicable, an identification of where and how certain socioeconomic components, such as traditional land use patterns for example, may have been influenced by previous and on-gong development activities and other factors.

Table 14.12 Summary of Potential Cumulative Environmental Effects: Special Areas

Summary of Potential Cumulative Environmental Effects		
VC Existing Condition (Past and On-Going Activities)	• Various types of Special Areas are located within the RSA, including coastal and marine areas protected through legislation or formally identified as being special or sensitive. • Many of these Special Areas in the RSA are in nearshore and onshore areas. These include: provincial ecological reserves, parks and protected areas and historic sites, national MPAs, fisheries closures within the EEZ, MBSs, parks and historic sites, as well as international designations such as IBAs and WHSs. • Several types of Special Areas are in the LSA within the offshore environment. These include EBSAs, VMEs, NAFO FCAs and preliminary RMAs. No RMAs overlap with the Project Area.	
Residual Environmental Effects of the Project	• Project components and activities may have direct effects where they involve drilling and surveys that collect samples of bottom habitats if they occur within Special Areas. These activities have small footprints and occur for relatively short periods of time within any location.	
Other Projects / Activities	**Potential for Interaction with Effects of Project: Project Area – Northern Section**	**Potential for Interaction with Effects of Project: Project Area – Southern Section**
Hibernia Oilfield	N – There are no Special Areas that overlap with this project.	N – There are no Special Areas that overlap with this project, which is far removed from Project activities within this part of the Project Area.
Terra Nova Oilfield	N – There are no Special Areas that overlap with this project.	N – There are no Special Areas that overlap with this project, which is far removed from Project activities within this part of the Project Area.
White Rose Oilfield and Extension Project	N – There are no Special Areas that overlap with this project.	N – There are no Special Areas that overlap with this project, which is far removed from Project activities within this part of the Project Area.
Hebron Oilfield	N – There are no Special Areas that overlap with this project.	N – There are no Special Areas that overlap with this project, which is far removed from Project activities within this part of the Project Area.
Offshore Petroleum Exploration - Geophysical and Other Exploration Activities	Y –Some potential for interaction, although localized and short term nature of these activities and their effects, along with planned and required separation measures will reduce potential for interaction.	Y –Some potential for interaction, although localized and short term nature of these activities and their effects, along with planned and required separation measures will reduce potential for interaction.

Table 14.12 Summary of Potential Cumulative Environmental Effects: Special Areas

Summary of Potential Cumulative Environmental Effects		
Offshore Petroleum Exploration - Drilling	Y –Some potential for interaction, although localized and short term nature of these activities and their effects, along with planned and required separation measures will reduce potential for interaction.	Y –Some potential for interaction, although localized and short term nature of these activities and their effects, along with planned and required separation measures will reduce potential for interaction.
Fishing Activity	Y - Fishing activity occurs throughout the offshore area. Fishing activity and ELs that may be drilled as part of this Project both overlap with portions of the Northeast Shelf and Slope EBSA.	Y - Fishing activity occurs throughout the offshore area.
Other Marine Vessel Traffic	Y - Some potential for interaction, although these activities and their effects are highly localized and transient. Safety zones around Project activities will limit interactions and thus cumulative effects on this VC.	Y - Some potential for interaction, although these activities and their effects are highly localized and transient. Safety zones around Project activities will limit interactions and thus cumulative effects on this VC.
Hunting Activity	N - No hunting activity within Special Areas offshore, nor targeting key species relevant to their designations.	N - No hunting activity within Special Areas offshore, nor targeting key species relevant to their designations
Cumulative Effects Summary	The Project components and activities in the Project Area – Northern Section are not likely to result in significant adverse cumulative environmental effects on this VC in combination with other projects and activities that have been or will be carried out.	The Project components and activities in the Project Area – Southern Section are not likely to result in significant adverse cumulative environmental effects on this VC in combination with other projects and activities that have been or will be carried out.

14.6.2 Potential Project-Related Contributions to Cumulative Effects

Given the nature, location and timing of the various marine activities and associated Project induced changes to the environment likely to occur as a result of this Project, it is not expected to have adverse effects on Indigenous Communities and Activities. As most Project-related activities will take place in the offshore marine environment, hundreds of kilometers from land and thus from any community (Indigenous or otherwise) and because associated environmental emissions and other disturbances are expected to be quite localized and short-term in nature (Chapter 8 to 10), they are unlikely to extend to or in any way affect the health (physical or social) and well-being or other socioeconomic conditions of Indigenous peoples.

There are no documented food, social or ceremonial licenses within the Project Area/LSA and groups do not otherwise undertake the current use of lands and resources for traditional purposes within or near this area. There are also no other known aspects of the physical and cultural heritage of these groups located in proximity to, or which may otherwise be affected by, the Project.

The Operator is aware that a number of Indigenous communities hold commercial communal swordfish licences for NAFO areas 3O, 3M and 3N - which overlap or are near the Project area. Additionally, other fishing enterprises associated with Indigenous groups undertake commercial fishing activities off Eastern Newfoundland. The Operator has engaged associated licence holders. To date, no Indigenous community has specifically provided information that they actively fish in the Project Area at the current time. However, this does not mean that those Indigenous communities will not exercise their right to fish in those areas in the future. However, at the current time there appears to be no potential for interaction with commercial communal fishery licence holders.

The environmental effects analysis also indicates that few of the marine associated resources (species) that are known to be used by these Indigenous groups migrate through the Project Area / LSA and are thus likely to be affected by Project activities and disturbances, and the implementation of the various environmental mitigation measures and procedures outlined throughout this EIS will serve to further address direct or indirect potential effects on these resources. There is therefore almost no potential for the availability or quality of resources that are currently used for traditional purposes by Indigenous groups to be reduced or negatively affected in other ways as a result of the Project, especially to a nature and to a degree that would alter the nature, location, timing, intensity or value of these activities or the health or heritage of Indigenous peoples.

No residual effects (direct nor indirect) on the current use of lands and resources for traditional purposes by any group are therefore anticipated as a result of this Project

14.6.3 Cumulative Effects Summary and Evaluation

As a result of the above, the Project will therefore not result in residual environmental effects on Indigenous Communities and Activities, and will therefore not result in or contribute to cumulative effects to this VC (Table 14.13).

Table 14.13 Summary of Potential Cumulative Environmental Effects: Indigenous Communities and Activities

Summary of Potential Cumulative Environmental Effects		
VC Existing Condition (Past and On-Going Activities)	• Indigenous groups reside in Newfoundland and Labrador, Nova Scotia, New Brunswick, PEI, and Quebec • Other past and on-going projects and activities have, to varying degrees, interacted with and affected Indigenous Communities and Activities.	
Residual Environmental Effects of the Project	• The Project will not result in residual environmental effects on Indigenous Communities and Activities, and will therefore not result in or contribute to cumulative effects to this VC.	
Other Projects / Activities	**Potential for Interaction with Effects of Project: Project Area – Northern Section**	**Potential for Interaction with Effects of Project: Project Area – Southern Section**
Hibernia Oilfield	N - The Project will not directly affect Indigenous Communities and Activities.	N - The Project will not directly affect Indigenous Communities and Activities.
Terra Nova Oilfield	N - The Project will not directly affect Indigenous Communities and Activities.	N - The Project will not directly affect Indigenous Communities and Activities.
White Rose Oilfield and Extension Project	N - The Project will not directly affect Indigenous Communities and Activities.	N - The Project will not directly affect Indigenous Communities and Activities.
Hebron Oilfield	N - The Project will not directly affect Indigenous Communities and Activities.	N - The Project will not directly affect Indigenous Communities and Activities.
Offshore Petroleum Exploration - Geophysical and Other Exploration Activities and Drilling	N - The Project will not directly affect Indigenous Communities and Activities.	N - The Project will not directly affect Indigenous Communities and Activities.
Fishing Activity	N - The Project will not directly affect Indigenous Communities and Activities.	N - The Project will not directly affect Indigenous Communities and Activities.
Other Marine Vessel Traffic	N - The Project will not directly affect Indigenous Communities and Activities.	N - The Project will not directly affect Indigenous Communities and Activities.
Hunting Activity	N - The Project will not directly affect Indigenous Communities and Activities.	N - The Project will not directly affect Indigenous Communities and Activities.

Table 14.13 Summary of Potential Cumulative Environmental Effects: Indigenous Communities and Activities

Summary of Potential Cumulative Environmental Effects		
Cumulative Effects Summary	The Project components and activities in the Project Area – Northern Section are not likely to result in significant adverse cumulative environmental effects on this VC in combination with other projects and activities that have been or will be carried out.	The Project components and activities in the Project Area – Southern Section are not likely to result in significant adverse cumulative environmental effects on this VC in combination with other projects and activities that have been or will be carried out.

14.7 Commercial Fisheries and Other Ocean Users

14.7.1 Past and On-going Effects (Baseline)

There are a variety of marine activities that occur in the Eastern Newfoundland offshore area, including commercial fishing activity. Based on the existing and available information provided in Section 7.1, the primary fishing areas off the east coast of Newfoundland and Labrador in recent years appear to be concentrated along the continental shelf of the Grand Banks, and in inshore waters off the coast of the Island of Newfoundland. The main species harvested in the region are northern shrimp and snow crab, which have represented the largest component of commercial harvests since the collapse of groundfish stocks in the 1990s. Other shellfish, groundfish and pelagic species are also harvested in offshore Newfoundland and Labrador, including in areas of deeper water such as the Flemish Pass, but at a lower scale compared to shrimp and crab. It has been noted in Section 7.1 that in recent years, stocks for northern shrimp and snow crab have been in decline, resulting in fisheries closures in some offshore areas. Recent trends in groundfish landings (2012-2015) indicate a stabilization of harvesting levels for these species.

While commercial fishing activity is carried during all months of the year, the most active time for harvesting is from April to August. This coincides with key seasonal fisheries such as snow crab, which is harvested from April to July (or August), with a decrease in activity in October through to March (see Section 7.1). Commercial fishing in the region uses a combination of fixed and mobile gear, depending primarily on the species harvested. Northern shrimp is primarily harvested using mobile gear (shrimp trawls), while snow crab is harvested using fixed gear (crab pots). Other mobile gear (longlines, seines, dragnets) and fixed gear (such as gillnets) are used for species of groundfish, shellfish, and pelagic species.

As described in Section 7.1, commercial fisheries off Eastern Newfoundland and elsewhere have seen important changes over the past decades, with the collapse in groundfish stocks and associated moratoria in the early 1990s and consequential shift in fishing towards new species, such as crab and shrimp. Recent engagement related to Newfoundland and Labrador fisheries have also noted that continuing changes within the marine environment are affecting the availability and distribution of commercial fish species (Amec 2014); a recent example of these changes is the closure of the Northern shrimp fishery in Divisions 3L and 3M. As the marine environment continues to warm, fishers expect that they will be able to fish more for groundfish, as in pre-moratorium times, and many have kept their groundfish licences in anticipation of this trend in the future (Amec 2014).

Recent ongoing and potential future changes to offshore commercial fisheries that may occur during the temporal scope of the Project include the transition from a predominantly shellfish-based commercial fishery towards an increased re-focus on groundfish. While the latest stock assessment for Atlantic cod in NAFO Divisions 2J3KL found that the stock has increased considerably over the last decade, the species still remains below pre-moratoria levels, and is still within the critical recovery zone (DFO 2016c). Industry representatives are also cautious about the potential return of a commercial fishery for Atlantic cod, indicating that while the stock has increased, the species still needs further recovery before consideration can be given to a commercial fishery (CBC 2016). As the temporal scope for this Project spans a number of years, it is difficult to state with certainty

whether these potential future changes will occur. Outside factors that are not known during the time of writing the EIS may also have a direct or indirect influence on changes in commercial fishing activities in the future. These could include additional quota changes, new fishing technologies, climate change, new or increased marine activities in the region.

In addition to commercial fishing activity, other ocean user also occurs in the Canada-NL Offshore Area. This includes research activities undertaken by DFO annually, and by industries and other academic institutions. Military training exercises also occur offshore, along with marine shipping, subsea fibre optic cables and infrastructure, and other oil and gas activities related to exploration and development.

14.7.2 Potential Project-Related Contributions to Cumulative Effects

The Project-specific environmental effects assessment for commercial fisheries and other ocean users (Chapter 13), identified and assessed a number of potential Project-induced changes resulting from the Project on this VC, including:

- Possible interference resulting in a change in the distribution, intensity, and/or effectiveness / efficiency of commercial fishing and other ocean uses
- Possible damage to fishing gear, vessel, and other equipment and components
- Changes in the abundance, distribution, and quality of marine resources, resulting in a change in the intensity, and/or efficiency/effectiveness of commercial fishing and other ocean uses

These Project-induced changes relate to possible interactions between Project activities and commercial fishing and other ocean users, and may result from a loss of access due to the presence of a temporary safety zone around Project infrastructure during exploration activities, potential interference between Project components and fishing equipment, and biophysical changes on fish and fish habitat from Project activities that may affect the quality and availability of commercial fish resources. These interactions and potential effects may result in lost time, reduced catch volumes, lower economic returns on catches, and increased operational costs for fishers and other ocean users in the area.

While there were potential interactions identified between the Project and commercial fishing and other ocean users, due to the localized nature and short-term duration of Project activities, and the implementation of standard mitigation measures, it was predicted that there would be no significant adverse environmental effects on this VC (Chapter 13). Although the presence of the drilling installation and its safety zone and other planned Project activities will temporarily reduce access for fishing and other activities in certain areas, such interactions will be localized, short term, and reversible once Project activity ceases at a well or survey site. To mitigate the potential of fishing gear damage, Notice to Shippers, Notice to Mariners, and other communication protocols will be implemented. In the unlikely event of fishing gear damage, the Operator will be implementing a fishing gear damage compensation program, consistent with previous oil and gas exploration drilling programs.

14.7.3 Future Projects and Activities and Their Effects

Fisheries and other human activities in the marine environment may be affected both individually and collectively by offshore oil and gas exploration and production activities, general marine traffic, and other activities and associated disturbances. Each of these may result in direct disturbance to such activity, damage to equipment, and effects on marine resources and/or other disturbances, which effects may accumulate or interact over time on a regional scale resulting in cumulative environmental effects. The dynamic nature of fishing and other marine based activity throughout the region (in terms of locations, seasons, gear types, and key species) makes it difficult to predict specific areas and times from year-to-year for both domestic and foreign fleets, and thus, the potential for interactions between separate projects, activities and their effects. This includes projects and activities related to oil and gas production, exploration, and marine vessel traffic, as summarized in Table 14.14.

Table 14.14 Commercial Fisheries and Other Ocean Users: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
Hibernia Oilfield	• Direct interference, resulting in a change in the distribution, intensity, and/or effectiveness / efficiency of commercial fishing and other ocean uses. • Damage to fishing gear, vessels, and other equipment and components.	• The Hibernia field is located within the Project Area - Southern Section. • Production at Hibernia is year-round for the life of the project. • Collective safety zone of 53 km^2 around the Hibernia GBS, offloading system, and Hibernia Southern Extension, with additional zones for each flowline.
Terra Nova Oilfield	• Direct interference, resulting in a change in the distribution, intensity, and/or effectiveness / efficiency of commercial fishing and other ocean uses. • Damage to fishing gear, vessels, and other equipment and components.	• The Terra Nova field is located within the Project Area - Southern Section. • Terra Nova safety zone extends approximately 9.26 km (5 nautical mile) from FPSO. • Terra Nova Fisheries Exclusion Zone is approximately 14 km^2.
White Rose Oilfield and Extension Project	• Direct interference, resulting in a change in the distribution, intensity, and/or effectiveness / efficiency of commercial fishing and other ocean uses. • Damage to fishing gear, vessels, and other equipment and components.	• The White Rose field is located in the Jeanne d'Arc Basin. • Production at White Rose is year-round for the life of the project. • White Rose safety zone is approximately 95 km^2. • Safety zone associated with the South White. Rose Extension is approximately 9 km^2.
Hebron Oilfield	• Direct interference, resulting in a change in the distribution, intensity, and/or effectiveness / efficiency of commercial fishing and other ocean uses.	• The Hebron field is located within the Project Area - Southern Section. • Production at the Hebron field will be year-round for the life of the project.

Table 14.14 Commercial Fisheries and Other Ocean Users: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
	• Damage to fishing gear, vessels, and other equipment and components.	• Safety zone around Hebron is expected to be approximately 6 km^2 around the GBS and offloading system (similar to Hibernia).
Offshore Petroleum Exploration - Geophysical and Other Exploration Activitiesl	• Direct interference, resulting in a change in the distribution, intensity, and/or effectiveness / efficiency of commercial fishing and other ocean uses. • Damage to fishing gear, vessels, and other equipment and components.	• Geophysical activities can cover large overall areas, but activity (and associated interferences) at any one location localized, short-term and transient in nature. • Standard communication and coordination procedures between the offshore oil and gas industry and the fishers help to limit the potential for adverse interactions.
Offshore Petroleum Exploration - Drilling	• Direct interference, resulting in a change in the distribution, intensity, and/or effectiveness / efficiency of commercial fishing and other ocean uses. • Damage to fishing gear, vessels, and other equipment and components.	• Exploration drilling programs occur in localized areas and are short-term in nature.
Fishing Activity	• n/a	• n/a.
Other Marine Vessel Traffic	• Direct interference, resulting in a change in the distribution, intensity, and/or effectiveness / efficiency of commercial fishing and other ocean uses. • Damage to fishing gear, vessels, and other equipment and components.	• Oil and gas related supply vessels follow established routes to production fields and drilling installations. • DFO research vessel schedules are released annually. • Vessel activity is higher during summer months.
Hunting Activity	• None	• N/A

14.7.4 Potential Cumulative Environmental Effects

The following paragraphs provide an assessment of the potential cumulative environmental effects of the Project in combination with other projects and activities that are currently on-going or planned for the Eastern Newfoundland offshore area. This discussion is structured to deal in turn with each of these types of activities and their effects, followed by an overall assessment of their potential for cumulative interactions with the effects of this Project.

Oil and gas production projects in the region include the three current producing fields (Hibernia, Terra Nova, White Rose), and the newest field, Hebron, which is scheduled to begin production in 2017. Both Hibernia and Hebron operate using a gravity-based structure (GBS), while Terra Nova and White Rose use a floating production, storage, and offloading (FPSO) platform system. These

operations also involve the use of drilling equipment, supply vessels, and safety zones, which restrict access to certain areas for commercial fishers and other ocean users. The duration of these projects is longer than for exploration drilling activity, as production drilling (including associated safety zones) is continuous for the life of each development. While the temporal scope provides more potential for interactions with commercial fishers and other ocean users, some of these projects have been operating from as early as 1997, and are an established and known part of the seascape in offshore Newfoundland and Labrador. Safety zones from these fields occupy a relatively small footprint in comparison to available fishing ground. Supply vessel activity for producing fields is also more frequent, as these are continuous operations with multiple supply vessels and shuttle tankers servicing producing fields. However, operators of these fields have established communication protocols to mitigate interactions with other ocean users, including commercial fish harvesters, and supply vessels use established vessel routes to move between production platforms and the supply base. These measures help reduce the potential for interactions between commercial fishers and other ocean users.

The Eastern Newfoundland offshore area is also subject to ongoing and planned oil and gas exploration activities. This includes both exploration drilling and geophysical survey activities that have either been approved, or which may be approved and implemented within the timeframe of the Project. Drilling installations establish safety zones during project activities, which have the potential to restrict access to areas for commercial fishing activity and other ocean uses. The potential exists for multiple exploration operations to occur within the Project Area or RSA at a given time during the life of the Project. The implementation of multiple safety zones, depending on proximity to one another, could result in a (cumulatively) larger area restricted to commercial fishers and other ocean users. However, due to the short-term and localized nature of these activities, and the implementation of mitigation measures such as ongoing communication with the fishing industry and Notice to Shippers, it is not anticipated that these exploration projects would result in adverse environmental effects on other ocean activities. In addition, as an EL gives the licence holder the exclusive right to drill within its boundaries over its term, the regulatory process helps to plan exploration drilling programs by multiple operators so that they are separated in space and time.

In terms of offshore geophysical surveys, the often spatially extensive nature of these activities increases the potential for fishing enterprises and other pursuits to be affected by multiple projects and activities in a region. As part of the planning and implementation of such survey activities, however, operators typically communicate and coordinate with relevant marine users and other stakeholders, including other oil and gas exploration companies operating in the area, to plan and coordinate activities in an effort to make a reasonable effort to provide spatial and temporal separation that is maintained for technical (data quality), safety and environmental reasons.

The presence of supply vessels, domestic and foreign fishing vessels, and marine traffic associated with other industries (shipping, military, research) are also sources of potential interactions with fishing vessels and activities within the Project Area and RSA. The volume of marine traffic associated with ongoing offshore activities, if increased over time, could potentially cause adverse effects on commercial fish harvesting activity and other ocean use. These supply vessel routes have been established over time. Supply vessel traffic represents a small component of total marine traffic in the region, is expected to occupy a low proportion of the total available fishing area, and is

inherently short-term and transitory in nature. Similarly, for other vessel traffic such as that for military exercises and research activities, timely communication between industry and research institutes, such as DFO and Department of National Defense (DND), will help to reduce the potential overlap of marine traffic occurring in the offshore area at a given time.

In consideration of the various activities that have been, are being, and will be carried out in the area, the Project is (as described in Section 14.7.2) expected to contribute to overall environmental effects on commercial fisheries and other ocean users, particularly as compared to a future scenario without the Project. The implementation of a safety zone around the drilling installation during exploration drilling activities and other Project-related activities will add incrementally to the overall areas of restricted or reduced access for fishing and other activities, while at the same time helping to avoid direct damage to fishing gear and equipment. Due to the relatively small areas that are restricted in the region (both individually and cumulatively), especially as compared to the overall size of the region and available fishing grounds and the short-term duration of the safety zone being in place for most projects, the Project is not anticipated to result in significant adverse cumulative environmental effects.

The Project Area and LSA do not contain known or unique fishing grounds, or concentrated fishing effort that occurs exclusively within these areas, nor is it likely to represent a substantial portion of the overall fishing grounds typically accessed by commercial fishers. The early and on-gong communication of these access restrictions and continued engagement and cooperation with the fishing industry will help to reduce effects that Project operations will have on commercial fish harvesting operations. The potential for temporary loss of access to fishing grounds because of the Project and other projects and activities is therefore anticipated to be negligible and is unlikely to have a measurable effect on the overall distribution, intensity, efficiency or value of fishing activities and other marine activities in the region. Although an unlikely and relatively infrequent occurrence, damage to gear, vessels or other marine assets would also be managed through applicable compensation policies and procedures.

The movement of supply vessels back and forth from the drilling installation(s) to the supply base will result in a small increase in total marine traffic travelling through the RSA and the Project Area. The potential for interference by offshore oil and gas vessels as well as general marine traffic can be mitigated through good communication and cooperation between industries, and the various mitigation measures outlined above and detailed in Chapter 13. Overall, marine vessel traffic and their effects are highly localized and transient in nature, with limited potential for spatial and temporal overlap with the effects of other projects and activities.

14.7.4.1 Project Area - Northern Section

Within the Project Area - Northern Section, the most likely potential for cumulative effects throughout the life of the Project is with other oil and gas exploration activities that may occur in this area. The closest Project-related EL (EL 1135) in this part of the Project Area is at least 70 km from the producing fields and their (longer-term) access restrictions for fishing activity, and so cumulative effects are unlikely.

The Flemish Pass area has been an area of increased exploration interest offshore Newfoundland and Labrador and multiple other exploration programs (geophysical, drilling) have been ongoing or are planned for this area. Potential environmental effects to this VC resulting from these projects and activities would be similar to the Project induced changes identified (interference / loss of access, possible damage to fishing gear, vessel, and equipment), and so this Project could contribute to cumulative effects on the VC on a regional scale. The establishment of safety zones for these exploration projects are relatively short-term and/or localized, and with a relatively small footprint of restricted access relative to the size of an EL. There would be additional fishing areas available throughout the larger region to access during exploration operations such as drilling. The regulatory nature of the exploration process only allows for the licence holder to drill within the boundaries of their respective EL. This provides a large amount of spatial separation between other exploration activities that may be occurring at the same time as the Project. The loss of access to fishing ground from these projects, combined with the Project, is therefore expected to be localized and short-term (temporary). This is also relevant to supply vessels that may be supporting these activities. There would be limited marine traffic occurring in the Project Area – Northern Section than in the Project Area – Southern Section, Given the distances between other exploration projects and the Project, it is not likely that there would be a cumulative effect created from supply vessel traffic to and from the drilling installation. Potential for damage to fishing gear is considered low.

Overall, there is a relatively lower amount of commercial fishing activity within the Project Area - Northern Section than in other areas within the RSA (see Chapter 7). The potential damage to fishing gear, equipment, and vessels due to direct contact with Project components (drilling installation and supply vessels) may be reduced with ongoing communication between industry and other ocean users and gear compensation programs.

14.7.4.2 Project Area - Southern Section

There is relatively more existing and planned marine-based activity occurring within the Project Area - Southern Section than in other areas of the RSA. In terms of oil and gas development, producing fields (Hibernia, Terra Nova, White Rose, Hebron) are located in the Jeanne d'Arc Basin. Hibernia is the closest producing facility to the Project-related ELs, at nearly 10 km away. While these producing fields may have their own effects on commercial fishing activity, such as the creation of safety zones around productions platforms, and supply vessel traffic, it is not anticipated that effects on commercial fishing activity and other marine users from those producing fields will interact cumulatively with potential environmental effects of the Project.

The Project Area – Southern Section has higher levels of marine traffic than other areas of offshore Newfoundland and Labrador, mostly due to the presence of established oil and gas production fields, and higher volumes of marine research, commercial fishing, and shipping activities (See Section 7.2). This has the potential to result in cumulative effects due to the increase in supply vessel traffic related to the Project. However, Project-related supply vessel traffic will only contribute a small increase to the marine traffic that already occurs within the Project Area - Southern Section. Due to the short-term nature of Project activities and transient nature of supply vessel operations, and established traffic routes and communications protocols that have been in operation for years, it is not anticipated that this Project will result in or contribute to detectable, adverse cumulative effects

on Commercial Fisheries and Other Ocean Users. The implementation of mitigation measures outlined in Section 13.3.2 for the assessment of Commercial Fisheries and Other Ocean Users will help to further reduce the potential for the Project to contribute to cumulative effects.

14.7.5 Cumulative Effects Summary and Evaluation

Table 14.15 summarizes the results of the cumulative effects assessment. As illustrated, the Project is not likely to result in significant adverse cumulative environmental effects on this VC in combination with other projects and activities that have been or will be carried out. Moreover, the relative contribution of this Project and its potential effects to overall effects on this VC within the overall RSA will be low, and will not likely be measurable.

14.8 Monitoring and Follow-up

Monitoring or follow-up programs that have been identified and described for VCs as part of the Project-specific environmental effects assessment (Chapters 8 to 13) would be relevant to cumulative effects, in that they are relevant to the Project's potential contribution to cumulative effects in the region. No additional or revised monitoring or follow-up is required or proposed related specifically to potential cumulative environmental effects.

Table 14.15 Summary of Potential Cumulative Environmental Effects: Commercial Fisheries and Other Human Activities

Summary of Potential Cumulative Environmental Effects		
VC Existing Condition (Past and On-Going Activities)	• Commercial fishing and other ocean activity occurs throughout the Project Area and elsewhere off Eastern Newfoundland. • The main species harvested in the region are northern shrimp and snow crab • Other shellfish, groundfish and pelagic species are also harvested in offshore Newfoundland and Labrador, including the deeper waters of the Flemish Pass. • April to August are the most active for commercial fishing activity • Recent years have seen significant changes in overall nature of commercial fishing activities off Eastern Newfoundland and elsewhere, shifts to other key species and recent indications of renewed interest in groundfish. • Other ocean activity (research, shipping, military exercises) also occur throughout the Project Area and LSA.	
Residual Environmental Effects of the Project	• Potential effects include interference resulting in a change in the effectiveness / efficiency of commercial fishing and other ocean activity; damage to fishing gear, vessels, and other equipment; and a change in abundance, distribution, and quality of marine resources resulting in a change in effectiveness / efficiency of commercial fishing and other ocean activity • Interactions from Project activities (safety zones, increased vessel traffic) are localized to a small area, short-term in nature, and transient. • With implementation of standard mitigation measures, no significant residual environmental effects on this VC are anticipated.	
Other Projects / Activities	**Potential for Interaction with Effects of Project:** **Project Area – Northern Section**	**Potential for Interaction with Effects of Project:** **Project Area – Southern Section**

Table 14.15 Summary of Potential Cumulative Environmental Effects: Commercial Fisheries and Other Human Activities

Summary of Potential Cumulative Environmental Effects		
Hibernia Oilfield	N – Operations are located well outside of the Project Area, with localized environmental effects.	Y - Some potential for interaction as operations are located within the Project Area, although localized environmental effects suggests low potential for interaction. The ELs associated with this Project are outside the local zone of influence of the oilfield for this VC overall. Therefore, interactions are anticipated to be minor and primarily associated with vessel traffic and safety zones.
Terra Nova Oilfield	N – Operations are located well outside of the Project Area, with localized environmental effects	Y - Some potential for interaction as operations are located within the Project Area, although localized environmental effects suggests low potential for interaction. The ELs associated with this Project are outside the local zone of influence of the oilfield for this VC overall. Therefore, interactions are anticipated to be minor and primarily associated with vessel traffic and safety zones.
White Rose Oilfield and Extension Project	N – Operations are located well outside of the Project Area, with localized environmental effects.	Y - Some potential for interaction as operations are located within the Project Area, although localized environmental effects suggests low potential for interaction. The ELs associated with this Project are outside the local zone of influence of the oilfield for this VC overall. Therefore, interactions are anticipated to be minor and primarily associated with vessel traffic and safety zones.
Hebron Oilfield	N - The Hebron Project is located well outside of the Project Area. with localized environmental effects.	Y - Some potential for interaction as imminent operations are located within the Project Area, although localized environmental effects suggests low potential for interaction. The ELs associated with this Project are outside the local zone of influence of the oilfield for this VC overall. Therefore, interactions are anticipated to be minor and primarily associated with vessel traffic and safety zones.
Offshore Petroleum Exploration - Geophysical and Other Exploration Activities	Y - Offshore oil and gas exploration activity (geophysical) is increasing within the Project Area - Northern Section and surrounding regions. There is a potential for cumulative interactions between the Project and other exploration activities within the Project Area - Northern Section through loss of access and increased marine traffic. Although some potential for interaction, localized and short term nature of these	Y - Offshore oil and gas exploration activity (geophysical) does exist within the Project Area - Southern Section and surrounding regions. There is a potential for cumulative interactions between the Project and other exploration activities within the Project Area - Southern Section through loss of access and increased marine traffic. Although some potential for interaction, localized and short term nature of these activities and their effects,

Table 14.15 Summary of Potential Cumulative Environmental Effects: Commercial Fisheries and Other Human Activities

Summary of Potential Cumulative Environmental Effects		
	activities and their effects, along with planned and required separation measures will reduce potential for interaction.	along with planned and required separation measures will reduce potential for interaction.
Offshore Petroleum Exploration - Drilling	Y - Offshore oil and gas exploration activity (drilling) is increasing within the Project Area - Northern Section and surrounding regions. There is a potential for cumulative interactions between the Project and other exploration activities within the Project Area - Northern Section through loss of access and increased marine traffic. Although some potential for interaction, localized and short term nature of these activities and their effects, along with planned and required separation measures will reduce potential for interaction.	Y - Offshore oil and gas exploration activity (drilling) is increasing within the Project Area - Southern Section and surrounding regions. There is a potential for cumulative interactions between the Project and other exploration activities within the Project Area - Southern Section through loss of access and increased marine traffic. Although some potential for interaction, localized and short term nature of these activities and their effects, along with planned and required separation measures will reduce potential for interaction.
Fishing Activity	n/a	n/a
Other Marine Vessel Traffic	Y - Marine vessel traffic from various industries could increase in the Project Area - Northern Section over the temporal scope of the Project. Increase in marine traffic may result in increased risk of damage to fishing gear and equipment. Some potential for interaction, although these activities and their effects are highly localized and transient.	Y - Marine vessel traffic from various industries could increase in the Project Area - Southern Section over the temporal scope of the Project. Increase in marine traffic may result in increased risk of damage to fishing gear and equipment. Some potential for interaction, although these activities and their effects are highly localized and transient.
Hunting Activity	n/a	n/a
Cumulative Effects Summary	The Project components and activities in the Project Area – Northern Section are not likely to result in significant adverse cumulative environmental effects on this VC in combination with other projects and activities that have been or will be carried out.	The Project components and activities in the Project Area – Southern Section are not likely to result in significant adverse cumulative environmental effects on this VC in combination with other projects and activities that have been or will be carried out.

14.9 References

Amec Environment and Infrastructure. 2014. Eastern Newfoundland and Labrador Offshore Area Strategic Environmental Assessment. Submitted to Canada-Newfoundland and Labrador Offshore Petroleum Board, St. John's, NL.

Canadian Environmental Assessment Agency. 2014. Technical Guidance for Assessing Cumulative Environmental Effects under the *Canadian Environmental Assessment Act, 2012*. Draft.

Canadian Environmental Assessment Agency. 2015. Operational Policy Statement Assessing Cumulative Environmental Effects under the *Canadian Environmental Assessment Act, 2012*.

CBC (Canadian Broadcasting Company). 2016. Cod returning, but long way to go for Successful Fishery, Plant CEO Says. Available at: http://www.cbc.ca/news/canada/newfoundland-labrador/cod-returning-but-long-way-to-go-for-successful-fishery-plant-ceos-say-1.3765913. Accessed December 11, 2016.

Christensen, V., Coll, M., Piroddi, C., Steenbeek, J., Buszowski, J., & Pauly, D. 2014. A century of fish biomass decline in the ocean. Marine Ecology Progress Series, 512: 155-166.

Clark, M.R., Althaus, F., Schlacher, T.A., Williams, A., Bowden, D.A. and A.A. Rowden. 2016. The impacts of deep-sea fisheries on benthic communities: A review. ICES Journal of Marine Science, 73 (Supplement 1): 151-169.

C-NLOPB (Canada-Newfoundland and Labrador Offshore Petroleum Board). 2017a. Cumulative Survey Data Acquired Per Year Since 2014. Available at: http://www.cnlopb.ca/information/statistics.php#exploration

C-NLOPB (Canada-Newfoundland and Labrador Offshore Petroleum Board). 2017b. Schedule of Wells Summary – Updated May 2017. http://www.cnlopb.ca/wells/

Cordes, E.E., Jones, D.O., Schlacher, T.A., Amon, D.J., Bernardino, A.F., Brooke, S., Carney, R., DeLeo, D.M., Dunlop, K.M., Escobar-Briones, E.G., Gates, A.R., Génio, L., Gobin, J., Henry, L.A., Herrera, S., Hoyt, S., Joye, N., Kark, S., Mestre, N.C., Metaxas, A., Pfeifer, S., Sink, K., Sweetman, A.K. and U. Witte. 2016. Environmental impacts of the deep-water oil and gas industry: A review to guide management strategies. Frontiers in Environmental Science.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2002. COSEWIC assessment and update status report on the Blue Whale *Balaenoptera musculus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. vi + 22 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2005. COSEWIC assessment and update status report on the fin whale *Balaenoptera physalus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. ix + 37 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada) 2006a. COSEWIC assessment and status report on the American eel *Anguilla rostrata* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. x + 71 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2006b. COSEWIC assessment and update status report on the harbour porpoise *Phocoena phocoena* (Northwest Atlantic population) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. vii + 32 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2007a. COSEWIC assessment and status report on the Roughhead Grenadier *Macrourus berglax* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. vii + 40 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2007b. COSEWIC Assessment and Update Status Report on the Sowerby's Beaked Whale *Mesoplodon bidens* in Canada. Committee on the Status of Endangered Wildlife in Canada, ON. Ottawa vi + 20 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2008. COSEWIC assessment and status report on the Roundnose Grenadier *Coryphaenoides rupestris* in Canada. Committee on the Status of Endangered Wildlife in Canada, ON. Ottawa. vii + 42 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2009a. COSEWIC assessment and update status report on the Bowhead Whale *Balaena mysticetus*, Bering-Chukchi-Beaufort Population and Eastern Canada-West Greenland population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. viii + 51 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2009b. COSEWIC Assessment and Update Status Report on the Killer Whale *Orcinus orca* Southern Resident population, Northern Resident population, West Coast Transient population, Offshore population and Northwest Atlantic / Eastern Arctic population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. viii + 65 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2010a. COSEWIC assessment and status report on the Atlantic Cod *Gadus morhua* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. xiii + 105 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2010b. COSEWIC assessment and status report on the Deepwater Redfish/Acadian Redfish complex *Sebastes mentella* and *Sebastes fasciatus*, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. x + 80 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2010c. COSEWIC assessment and status report on the Atlantic Salmon *Salmo salar* (Nunavik population, Labrador population, Northeast Newfoundland population, South Newfoundland population, Southwest Newfoundland population, Northwest Newfoundland population, Quebec Eastern North Shore population, Quebec Western North Shore population, Anticosti Island population, Inner St. Lawrence population, Lake Ontario population, Gaspé-Southern Gulf of St. Lawrence population, Eastern Cape Breton population, Nova Scotia Southern Upland population, Inner Bay of Fundy population, Outer Bay of Fundy population) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. xlvii + 136 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2010d. COSEWIC assessment and status report on the Loggerhead Sea Turtle *Caretta caretta* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. viii + 75 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2011. COSEWIC Assessment and Status Report on the Northern Bottlenose Whale *Hyperoodon ampullatus* in Canada. Committee on the Status of Endangered Wildlife in Canada, ON. Ottawa xii + 31 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2012a. COSEWIC assessment and status report on the Cusk *Brosme brosme* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. x + 85 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2012b. COSEWIC assessment and status report on the Atlantic Wolffish *Anarhichas lupus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. ix + 56 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2012c. COSEWIC assessment and status report on the Spotted Wolffish *Anarhichas minor* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. x + 44 pp.

COSEWIC (Committee on the status of Endangered Wildlife in Canada). 2012d. COSEWIC assessment and status report on the Northern Wolffish *Anarhichas denticulatus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2012e. COSEWIC assessment and status report on the leatherback sea turtle *Dermochelys coriacea* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. xv + 58 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2013. COSEWIC assessment and status report on the North Atlantic Right Whale *Eubalaena glacialis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. xi + 58 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2014. COSEWIC assessment and status report on the Beluga Whale *Delphinapterus leucas*, St. Lawrence Estuary population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. xii + 64 pp.

Davis, R.A., Thomson, D. H., and C.I. Malme. 1998. Environmental Assessment of Seismic Exploration on the Scotian Shelf. Prepared for Mobil Oil Canada Properties Ltd., Shell Canada Ltd. and Imperial Oil Ltd. Submitted to the Canada - Nova Scotia Offshore Petroleum Board, Halifax, NS.

DFO (Fisheries and Oceans Canada). 2016a. Recovery Strategy for the Northern Bottlenose Whale, (*Hyperoodan ampullatus*), Scotian Shelf population, in Atlantic Canadian Waters [Final]. *Species at Risk Act* Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa, ON. vii + 70 pp.

DFO (Fisheries and Oceans Canada). 2016b. Management Plan for the Sowerby's Beaked Whale (*Mesoplodon bidens*) in Canada [Proposed]. *Species at Risk Act* Management Plan Series. Fisheries and Oceans Canada, Ottawa, ON. iv + 48 pp.

DFO (Fisheries and Oceans Canada. 2016c. Stock assessment of northern cod (NAFO Divs. 2J3KL) in 2016. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep., 2016/026: v +17 pp.

Dooling, R.J. and A.N. Popper. 2007. The Effects of Highway Noise on Birds. Report prepared for the California Department of Transportation Division of Environmental Analysis.

Drinkwater, K. F., Miles, M., Medhaug, I., Otterå, O. H., Kristiansen, T., Sundby, S., & Gao, Y. 2014. The Atlantic Multidecadal Oscillation: Its manifestations and impacts with special emphasis on the Atlantic region north of 60 N. Journal of Marine Systems, 133, 117-130.

Edinger, E., Baker, K., Devillers, R., and V. Wareham. 2007. Coldwater Corals off Newfoundland and Labrador: Distribution and Fisheries Impacts. World Wildlife Canada Report. v +31 pp.

Ellis, J.I., Wilhelm, S.I., Hedd, A., Fraser, G.S., Robertson, G.J., Rail, J.F., Fowler, M., and K.H. Morgan. 2013. Mortality of migratory birds from marine commercial fisheries and offshore oil and gas production in Canada. Avian Conserv. Ecol. 8.

Guijarro, J., Beazley, L., Lirette, C., Kenchington, E., Wareham, V., Gilkinson, K., Koen-Alonso, M., and Murillo, F.J. 2016. Species distribution modelling of corals and sponges from research vessel survey data in the Newfoundland and Labrador region for use in the identification of significant benthic areas. Canadian technical Report for Fisheries and Aquatic Sciences, 3171: vi + 126p.

Hildebrand, J.A. 2005. Impacts of anthropogenic sound. Pp. 101-124. In: J.E. Reynolds, W.F. Perrin, R.R. Reeves, S. Montgomery and T.J. Ragen (eds.). Marine Mammal Research: Conservation Beyond Crisis. John Hopkins University Press, Baltimore, MD.

Hoang, T. 2013. A Literature Review of the Effects of Aircraft Disturbances on Seabirds, Shorebirds and Marine Mammals. Report Presented to NOAA, Greater Farallones National Marine Sanctuary and The Seabird Protection Network, August 2013.

Husky Energy. 2017. White Rose Environmental Effect Monitoring Program 2014; Volume 1 of 2. Document No. WR-HSE-RP-4392. xv + 236 pp.

Kulka D. 2011. Part B: Regional Reviews: B1. Northwest Atlantic, FAO Statistical Area 21. In: D. Milton and J. Plummer (eds.). Review of the state of world marine fisheries resources. 569.

LGL Limited. 2017. Study of Seabird Attraction to the Hebron Production Platform; A Proposed Approach. Report prepared for Hebron Project ExxonMobil Canada Properties, St. John's, NL.

Mathieu, A., Hanlon, J., Myers, M., Melvin, W., French, B., DeBlois, E. M., King, T., Lee, K., Williams, U.P., Wight, F.M. and G. Janes. 2011. Studies on Fish Health Around the Terra Nova Oil Development Site on the Grand Banks Before and After Discharge of Produced Water. In Produced Water (pp. 375-399). Springer New York.

MMS (Minerals Management Service). 2004. Geological and Geophysical Exploration for Mineral Resources on the Gulf of Mexico Outer Continental Shelf: Final Programmatic Environmental Assessment. United States Department of the Interior, Gulf of Mexico Outer Continental Shelf Region.

Morandin, L.A., and P.D. O'Hara. 2016. Offshore oil and gas, and operational sheen occurrence: is there potential harm to marine birds? Environmental Reviews, 24(3): 285-318.

NOAA (National Oceanic and Atmospheric Administration). 2015. Killer Whale (*Orcinus orca*): Western North Atlantic Stock. Available from: http://nefsc.noaa.gov/publications/tm/tm231/71_killerwhale_F2014July.pdf. Accessed: April 2017.

NOAA (National Oceanic and Atmospheric Administration). No Date. Marine Mammals: Interim Sound Threshold Guidance (webpage). National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/threshold_guidance.html.

Nogueira, A., Paz, X., & González-Troncoso, D. 2015. Changes in the exploited demersal fish assemblages in the Southern Grand Banks (NAFO Divisions 3NO): 2002–2013. ICES Journal of Marine Science, 72(3), 753-770.

Nogueira, A., Paz, X., and D. González-Troncoso. 2017. Demersal groundfish assemblages and depth-related trends on Flemish Cap (NAFO division 3M): 2004-2013. Fisheries Research, 186, 192-204.

OSPAR Commission (OSPAR). 2009. Overview of the Impacts of Anthropogenic Underwater Sound in the Marine Environment. Publication number 441/2009. 134pp. Available from: http://qsr2010.ospar.org/media/assessments/p00441_Noise_background_document.pdf.

Pollet, I. L., Ronconi, R. A., Jonsen, I D., Leonard, M. L., Taylor, P. D. and D. Shutler. 2014. Foraging movements of Leach's storm-petrels *Oceanodroma leucorhoa* during incubation. Journal of Avian Biology, 45: 305-314. doi: 10.1111/jav.00361P. 894

Poot, H., Ens, B., de Vries, H., Donners, M., Wernand, M., and J. Marquenie. 2008. Green light for nocturnally migrating birds. Ecology and Society, 13(2).

Ragnarsson, S.Á., Burgos, J.M., Kutti, T., van den Beld, I., Egilsdóttir, H., Arnaud-Haond, S. and A. Grehan. 2017. The Impact of Anthropogenic Activity on Cold-Water Corals. Marine Animal Forests: The Ecology of Benthic Biodiversity Hotspots, 1-35.

Richardson, W.J., Greene, Jr., C.R., Malme, C.I., and Thomson, D.H. 1995. Marine Mammals and Noise. Academic Press, San Diego, CA. 576 pp.

Robertson, G.J., Wilhelm, S.I. and P.A. Taylor. 2004. Population Size and Trends of Seabirds Breeding on Gull and Great Islands, Witless Bay Islands Ecological Reserve, Newfoundland, Up to 2003. Canadian Wildlife Service Technical Report Series, Atlantic Region, No. 418. Mount Pearl, NL, Canada.

Rojek, N.A, Parker, M.W., Carter, H.R. and G.J. McChesney. 2007. Aircraft and vessel disturbances to Common Murres *Uria aalge* at breeding colonies in Central California, 1997 1999. Marine Ornithology, 35:61-69.

Stantec Consulting Ltd. 2011. Hebron Project: Comprehensive Study Report. Report prepared for ExxonMobil Canada Properties, St. John's, NL.

Stantec Consulting Limited. 2012. Hibernia Production Phase Environmental Effects Monitoring Program – Year Eight (2011) Volume I – Interpretation. Prepared for Hibernia Management and Development Company Limited. File No. 121510634 / 121510831. i + 179 pp.

Stantec Consulting Ltd. 2013. ESRF Air Emissions Project, Effects of Offshore Oil and Gas Production on Air Quality in Canada's East Coast Offshore Areas.

Terra Nova. 2013. Terra Nova 2012 Environmental Effects Monitoring Program Year 8 (Volume 1). Project No.: 121510970. xiv + 246 pp.

Whiteway, S.A., Paine, M.D., Wells, T.A., DeBlois, E.M. Kilgour, B.W., Tracy, E.J., Crowley, R.D. and G.G. Janes. 2014. Toxicity assessment in marine sediments for the Terra Nova Environmental Effects Monitoring Program (1997-2010). Deep-Sea Res. II., 110: 26-37

Wilhelm, S.I., Mailhiot, J., Arany, J., Chardine, J.W., Robertson, G.J. and Ryan, P.C. 2015. Update and trends of three important seabird populations in the western North Atlantic using a geographic information system approach. Marine Ornithology, 43: 211-222.

Zykov, M.M. 2016. Modelling Underwater Sound Associated with Scotian Basin Exploration Drilling Project: Acoustic Modelling Report. JASCO Document 01112, Version 2.0. Technical report by JASCO Applied Sciences for Stantec Consulting Ltd.

15.0 ACCIDENTAL EVENTS

Accidental events could occur as a result of equipment malfunctions, human error, or exceptional natural events (e.g., earthquake, hurricane, submarine landslide). This section of the EIS addresses accidental spills to the marine environment that could occur as a result of accidental events. Operator commitments and procedures for spill prevention and response are presented to provide context for the spill risk and probability analysis as well as the fate and behavior analysis that are used to inform the assessment of environmental effects of accidental spills on VCs.

Accidental events associated with local conditions and natural hazards such as extreme weather conditions and external events (e.g., seismic events, icebergs, hurricane, submarine landslide potential) are addressed in Chapter 16 (Effects of the Environment on the Project). However, to the extent that these accidental events may result in a spill to the marine environment, the spill response measures and effects analysis presented herein remains relevant.

The regulation of spills at offshore drilling and production operations are the responsibility of the C-NLOPB, under the Accord Acts.

The C-NLOPB requires an Environmental Protection Plan that follows the Environmental Protection Plan Guidelines (National Energy Board et al. 2011), and must include the identification of potential environmental emergencies and hazards, including spills, and reference to spill response plans and general emergency response plans and procedures that will be used in the case of an environmental emergency.

During drilling, operational discharges are managed in accordance with Statoil's Environmental Protection and Compliance Monitoring Plan (EPCMP). Discharges not identified in the EPCMP are not permitted to be discharged, and are considered a spill if released into the marine environment. Response and management of spill events is outlined in the Operator's Project and site-specific Oil Spill Response Plan.

Under the *Canada Shipping Act, 2001,* the vessel or facility operator will be the Responsible Party in the case where the source of the spill is a supply vessel or, a shore-based facility.

The *Canada Shipping Act, 2001* requires that these vessel and facility operators have response plans in place, personnel trained in oil spill response, and a contractual arrangement with a Transport Canada-certified Response Organization. The Eastern Canada Response Corporation (ECRC) is the Response Organization retained by Statoil and supply vessels in every applicable case.

While the *Canada Shipping Act, 2001* regulations do not directly apply to Statoil's drilling or production activities, Statoil's spill response capabilities meet or exceed *Canada Shipping Act, 2001* standards.

15.1 Spill Prevention and Response

Statoil maintains a strong commitment to safe, secure and sustainable operations. Central to this commitment is a corporate Safety and Sustainability management system. Statoil developed a management system to capitalize on the collective knowledge and best practice gained over many

years. The Management System contains the information needed to set on the right path when performing work. It is also how safe, secure and sustainable activities are ensured and risks are effectively managed. Statoil's emergency response philosophy is to reduce the impact of an emergency on people, environment, and the integrity of Statoil, contractor, and third party assets.

15.1.1 Spill Prevention and Well Control

15.1.1.1 Spill Prevention

Statoil recognizes that prevention is the most effective way to avoid environmental effects from accidental spills.

Facilities, processes and management system procedures are intended and designed to reduce or eliminate the chance of a spill, even in the case of equipment failure, during all potential hydrocarbon handling operations. Routine maintenance and testing schedules will be established for all aspects of the drilling program, with particular attention paid to well control, product storage and handling and fuel transfer systems. Prior to exploration, practices and limits for operating in poor weather, high sea state, or sea ice or iceberg conditions will be established. Good communications and sound marine practices for all vessels will also improve the ability to prevent spills.

Proper environmental operating practices will be assured through regular inspections and audits of the drilling installation. The general awareness of offshore workers will be increased through training, workshops and safety meetings, including specific training in oil spill prevention, reporting and response requirements and procedures. Personnel will be responsible and actively encouraged to report potential problems and 'near miss' incidents in an attempt to avoid a re-occurrence that could result in a loss of containment or unauthorized release of petroleum or other hydrocarbons.

Oil spill prevention is a key focus of the Operator's plans and activities. Oil spill prevention, response and overall preparedness approaches for the Project will be further developed and defined as the various regulatory review and approval processes move forward. The Operator will develop and implement a Project and site-specific Oil Spill Response Plan (OSRP), which will be submitted to the C-NLOPB as part of the OA application process described in Chapter 1.

15.1.1.2 Well Control and Blowout Prevention

There are a number of control measures that are implemented during drilling to maintain well control and reduce risk of a well blowout. These control measures include mechanical controls and barriers that are implemented as part of well design (e.g., steel casing, blowout preventer), and drilling and monitoring procedures.

As noted in Section 2.5.2.2, a steel casing is cemented in place after the initial well sections are drilled to prevent the wall of the wellbore from caving in and to prevent the seepage of muds and other fluids. The riser and blowout preventer (BOP) are then installed onto the wellhead. The riser acts as a conduit connecting the rig to the wellhead through the water column, and the wellhead provides structural integrity to house the BOP and pressure integrity for drilling operations. During drilling, the formation pressure is monitored continuously and the density of drilling fluid is controlled

to maintain an adequate pressure against the formation to keep the wellbore stable. In the event that this primary barrier fails, secondary barriers such as the BOP system can be used to regain well control. A BOP is a critical piece of safety equipment which houses a system of high pressure valves that prevent water or hydrocarbons from escaping into the environment in the event of an emergency or equipment failure. The BOP is comprised of multiple rams capable of shearing the drill pipe and sealing the well. It is capable of being activated various location on the drilling installation, as well as from a lifeboat or a standby vessel by using various redundant control systems. BOP intervention is performed immediately upon indication that a well kick is occurring. The BOP and other pressure control equipment are tested regularly in accordance with the Drilling and Production Guidelines (C-NLOPB and CNSOPB 2017).

15.1.2 Contingency Planning and Emergency Response

Statoil's emergency response philosophy is to reduce the impact of an emergency on people, environment, and the corporation. Statoil is committed to ensuring the safety of all people associated with its operations onshore and offshore. During an emergency, maintaining the safety of those initially unaffected; ensuring the safety of those responding to the incident; and rescuing those who may have been injured are the prime responsibilities of responders and those in command.

The following sections provide an overview of Operator's contingency planning and emergency response including well capping and containment and spill response.

15.1.2.1 Contingency Planning

Prior to commencement of drilling operations, Statoil will develop contingency plans that will serve as the guidelines for the company's response to an emergency. Contingency plans will be developed to address emergencies that will be identified in operations-specific hazard and risk analyses. The plans will outline the necessary procedures, personnel, equipment, and logistics support required to respond to an emergency incident in a safe, prompt, coordinated manner. The plans will be distributed to designated personnel who will be responsible for emergency response actions. The content of the plans will contain sufficient detail to enable personnel to respond in a coordinated and effective manner. Statoil's careful planning will help protect sensitive coastal resources and local fishing activities in the unlikely event of a release. The OSRP/Emergency Response Plan will identify key contacts that require notification in the event of a release including regulatory agencies, spill contractors, and fishing authorities. These stakeholders will be made aware of the drilling location and schedule prior to the start of the drilling program and will help establish a reliable means of communication in the event of an emergency.

An emergency is defined by the Operator as any unexpected occurrence resulting in or having the potential to result in:

- Death or serious injury / illness requiring hospitalization
- Environmental impact
- Major or significant damage to Operator or contractor property
- Concern for the integrity of Statoil operations in the eyes of the public or regulatory agencies

- Several types of emergencies will be covered by the Operators contingency plans. The response to any the following incidents (which are not all inclusive) will require immediate action:
- Accidental injury
- Explosion or fire
- Loss of well control
- Hydrocarbon or chemical spills
- Unintentional discharge of any material at levels above those in permits
- Loss of or damage to drilling installation or supply vessel
- Equipment damage due to equipment failure or operator error
- Imminent threat to operations posed by weather, sea ice, or icebergs
- Collision or threat of collision with an ocean-going vessel

The following contingency plans will therefore be developed for the Project to address these emergencies:

- **Offshore Emergency Response Plan** – provides very specific role descriptions for personal for a number of potential emergencies and provides a link between offshore operations and onshore responders
- **Collision Avoidance Plan** – identifies potential collision situations involving the drilling installation, describes communications with the threatening vessel and lists actions to be taken on the drilling installation in the event the threatening vessel does not respond.
- **Ice Management Plan** – defines how personnel will monitor the movement of icebergs and pack ice approaching the Project Area and describes procedures for responding to threats including countermeasures such as iceberg deflection. Refer to Section 16 for more information on ice management
- **OSRP** – defines procedures for first response to spills originating at the drilling installation and includes consideration of various spill response tactics within the context of a Spill Impact Mitigation Assessment (refer to Section 15.1.3.3 for more information on spill response); includes a Wildlife Response Plan
- **Well Containment Plan** – describes the procedures and operations associated with subsea source control and containment and includes a Well Capping Plan and a Relief Well Contingency Plan (refer to Section 15.1.3.2 for more information on well containment)

Depending on the magnitude of the offshore spill event, as part of Statoil's Incident Management System processes, Incident Action Plans will be developed that may include the following response strategies.

- Response with vessel-based dispersant application to quickly treat the oil before it has the opportunity to spread;
- Response with aerially applied dispersants, which can be quickly deployed and treat large surface areas rapidly and efficiently;
- Implement subsea dispersant injection application as soon as possible, if warranted, to treat most oil spilled at the source before it encounters surface water resources;
- Deploy in situ burning equipment to burn thick oil near the source;

- Continue to use aerially applied dispersant as a primary response tool for oil further from the source where mechanical recovery/in situ burn operations are less effective;
- Use aerial dispersant application during calm seas on emulsified oil;
- Outfit vessels of opportunity (VOO) with appropriate oil spill response tools to provide a fleet of vessels that can be a line of defense against surface oil approaching shorelines.
- In the extremely unlikely event of shoreline impact, sensitive shorelines will receive prioritization for protective booming.
- Depending on the volume and metocean conditions, mechanical recovery at sea is possible.

Emergency preparedness also requires directed training and response exercises. Designated Operator personnel, including contractors, will receive emergency training. All personnel will undergo an orientation to elements of emergency response planning. Offshore personnel will receive a general overview of evacuation alarms and procedures and response organization. Offshore emergency teams and crews of dedicated standby vessels will receive specialized training with emphasis on hands on experience. The operator has a global team of emergency response personnel and specialists that are available to support local emergency operations, if required.

A regular program of response exercises will be conducted to confirm readiness of all personnel. These exercises will train personnel in emergency procedures, test preparedness of personnel, and provide a means of developing continued improvement to emergency procedures.

15.1.2.2 Well Capping and Containment Plan

The Operator's well control philosophy is focused on prevention using safety/risk management systems, management of change procedures and global standards.

In the event of a blowout, the Operator's primary objective would be to stop the flow as quickly as possible. This would involve shutting in at the wellhead and killing the well through the wellhead.

In the event that well control measures fail to control the well, a capping stack may be required. A capping stack is a specialized piece of equipment used to "cap" (i.e., stop or divert) well flow while work is being undertaken to permanently kill the well (e.g., through relief well drilling). Capping stacks are designed to withstand the maximum anticipated wellhead pressure to stop the spill and/or divert the flow to surface vessels for management and recovery of the hydrocarbons. A description of well capping and containment is provided in Appendix H. Statoil will prepare a Well Capping and Containment Plan which will describe the initiation, mobilization, and deployment of a capping stack and other containment equipment to the wellsite. Capping stack equipment would be sourced through Statoil's membership with OSRL.

The OSRL Capping Stack Systems (CSS) are located at 4 strategic locations around the world. It is anticipated that a capping stack would be sourced from Norway and/or Brazil and that the capping stack could be mobilized and deployed within 36 days of the incident occurring. Capping of a well is estimated to take between 18 and 36 days. The lower end of the time range is the scenario that includes mobilization of a capping stack from Norway in the summer, with optimal weather for rapid transit and installation, and transport direct to the wellsite (no port call) for installation. The 36 days

scenario assumes mobilization of the secondary capping stack from Brazil in the winter, reduced transit speeds due to ice and weather, inclusion of a port call for testing and commissioning prior to mobilizing to the wellsite and a longer installation time due to technical or weather delays. The precise duration for cap installation and closure would be highly dependent on a number of factors including sea states and local conditions specific to the incident. The Operator would mobilize and install the capping stack as rapidly as safely possible. In the event of a blowout, Statoil's emergency response processes require the initiation of mobilization of both capping stacks in Norway and Brazil, although the capping stack in Norway is considered the primary stack as it is closest with the shortest transit time. For the purposes of the spill trajectory modelling, the longest capping duration (36 days) was assumed to be conservative.

Due to lack of the specialized local infrastructure including:

1) Proper maintenance and storage facilities
2) Transport and installation vessels with the capabilities required
3) Appropriate yard space, it is not feasible to maintain a capping stack locally in St. John's

Statoil maintains an international vessel of opportunity database that identifies vessels currently under contract that have the capabilities for transport and installation of the capping stack. The preferred way of mobilization of the CSS is by sea, but the CSS can also be transported by air by breaking down and containerizing the equipment. Air transport is not advisable, however, since the tear down and rebuilding of the CSS introduces additional risk. The increased logistics associated with air travel and road transport also increases the overall complexity of the logistical operation and any time savings realized are not significant, and in some cases may actually increase overall mobilization time. Therefore, it is assumed that mobilization of the CSS would be by sea.

Relief well drilling, and the subsequent dynamic kill, is considered a back-up strategy in the event that shut-in and/or killing the well through the wellhead is not possible or is unsuccessful. Whereas a capping stack is a temporary measure, relief well drilling is used to permanently shut-in flow to the well. It is estimated that a relief well can be executed in approximately 100 to 113 days. This includes securing a Drilling Installation and required equipment, mobilizing to the Project Area and drilling the relief well. The actual duration for relief well execution may be higher or lower than these estimated ranges. The precise duration would be highly dependent on the local operating conditions, well design and subsurface location. Further Operator specific emergency response information related well capping and containment is provided in Appendix H.

15.1.2.3 Spill Response

Spill response will develop in phases based on the level of planning that is required. An OSRP will be developed which will outline a tiered response to oil spills.

For response planning purposes, the severity of potential hydrocarbon spills has been divided into three levels, or Tiers. This classification allows for an appropriate initial response to each level of spill, and provides for the escalation of the response should the potential impact of the spill increase. Each Tier will require a successively higher level of operational effort and management.

The parameters to be considered in selecting the appropriate level of response include:

- Size and nature of the spill
- Environmental and operational conditions at the time of the spill
- Vessel and equipment availability
- Numbers and qualifications of personnel available at site
- On-site waste hydrocarbon storage
- Corporate exposure to risk and liability as a result of the hydrocarbon spill

The three levels are defined as follows:

- A Tier 1 spill poses the least threat of impact, and can be managed using resources available at site, with limited onshore support
- A Tier 2 spill response requires local shore-based management support and resources in addition to those already at site, and mutual aid agreements may be activated. Response contractors may be required. The Operator's global response team may be activated.
- A Tier 3 hydrocarbon spill has the potential to affect Statoil business operations and may require considerable corporate and contract resources drawn from local, regional, and international sources, and mutual aid agreements may be activated. The Operator's global response team will be activated.

Statoil has established a Global Incident Management Assist Team (GIMAT) that can support the local Incident Management Teams in all locations. The GIMAT is built upon an Incident Management System (IMS) oil spill response model and is comprised of personnel from Statoil who are trained to lead Sections, Branches and Units in the IMS organization, as well as Deputy Incident Commanders and the Command Staff. The GIMAT has response competence relevant to the respective functions.

The GIMAT can be deployed as, depending on scale of the incident such as:

- Tier 3 level oil spill incident when a full IMS structure and operational planning cycle is required
- Tier 2 level oil spill incident which could be long lasting and resource intensive
- At incidents of a magnitude larger than the local incident management team is able to handle

The GIMAT will muster if the Incident Management Team asks for such assistance. The Incident Commander together with the Crisis Manager (line 3), are the ones that initiate the mobilization of these extra resources.

The Operator is committed to implementing spill response measures for as long as is required to remediate spilled oil, including remediation of shoreline areas where oil has made contact. The types of long-term remediation measures are depedent on the size of the spill and the area and resources affected and would be developed in consultation with the C-NLOPB and the National Environmental Emergencies Centre (NEEC).

15.1.2.3.1 Incident Command System

Statoil will adopt the Incident Command System organizational structure for emergency response management. The Incident Command System structure has been widely adopted by major Operators

and emergency response agencies. It provides a systematic approach to incident management and emergency response, providing clear roles and responsibilities as well as lines of communication between different functional groups involved in the response, including coordination of internal and external responders.

15.1.2.3.2 Response Contractors and Agencies

Statoil will draw on external resources as necessary for Tier 2 and 3 spill response. This may include use of response organizations such as Eastern Canada Response Corporation (ECRC) and, in particular, for Tier 3 spills, Oil Spill Response Limited (OSRL). Assistance can also be provided through mutual aid agreements with other operators.

ECRC is a certified response organization under the *Canada Shipping Act, 2001* that is privately owned through membership agreements with individual operators including Statoil. ECRC provides marine oil spill response services acting under the direction of an On-Scene Commander of the "responsible party", providing a plan of action, equipment, resources and operational management in the clean-up effort. ECRC maintains oil spill response equipment in six Eastern Canada Response Centres including one in St. John's, Newfoundland and Labrador.

OSRL is an international industry-funded spill response organization that provides its members with global access to oil spill response personnel and equipment. As a shareholding member of OSRL, Statoil has access to specialized equipment and experts, which includes resources associated with their subsea division - Subsea Well Intervention Services (SWIS). SWIS provides OSRL members access to subsea intervention capabilities including aerial dispersant application, subsea dispersant injection application, and capping and containment equipment. OSRL's expertise and resources are located across the world to facilitate effective and efficient response to oil spill incidents, including command, control and communications equipment, and shoreline cleanup equipment.

Additionally, in the event of a spill, the Canadian Coast Guard may be engaged, through a Memorandum of Understanding with the C-NLOPB, to provide response advice and field monitoring of the response. In the event of an offshore spill, the C-NLOPB may call upon the National Environmental Emergencies Centre (NEEC) to provide expert advice. The NEEC is Environment Canada's focal point for the provision of scientific advice, such as weather forecast, contaminant dispersion and trajectory modelling, fate and behaviour of hazardous substances, the establishment of clean-up priorities and techniques, as well as the protection of sensitive ecosystems and wildlife such as migratory birds and fish. The NEEC can avail of the services and expertise of centres within Environment Canada, such as the Emergencies Science and Technology Section (ESTS), the Meteorological Service of Canada (MSC) and the Canadian Wildlife Service, to provide scientific support in the event of a spill.

Depending on the size and nature of the spill (i.e., Tier 1, 2 or 3), the OSRP will include the type and quantity of response equipment required (including equipment and expertise that will be available within local, regional and global response organizations and/or through mutual aid agreements with other operators).

Tier 1 equipment will be available immediately onsite. Tier 2 equipment is maintained onshore and consists of industry and ECRC equipment (located in St. John's, Newfoundland and Labrador). In addition, and if required, the Canadian Coast Guard also has an inventory of oil spill response equipment which may be suitable for offshore use. Tier 2 and Tier 3 equipment and expertise may also be sourced from outside of Newfoundland and Labrador including OSRL-SWIS equipment for subsea dispersant application, or capping and containment equipment (e.g., capping stacks).

15.1.2.3.3 Spill Response Tactics and Spill Impact Mitigation Assessment

The OSRP will consider a range of offshore spill response tactics as described in Table 15.1 and may also involve tracking of the spilled oil. Surveillance and tracking is undertaken using a variety of methods (aerial reconnaissance, vessel tracking; satellites) in combination with mechanical tracking devices. The surveillance information is used to assist in real-time trajectory modelling, maximize efficacy of response measures, and assist with the development of strategic response options.

A Spill Impact Mitigation Assessment (SIMA) (previously referred to as a Net Environmental Benefit Analysis [NEBA]) will be undertaken by Statoil as part of the OSRP during the OA approval process with the C-NLOPB. The SIMA for this Project will build on the initial SIMA that was developed for Statoil's OSRP for their 2017 exploration drilling program in the Flemish Pass and is on file with C-NLOPB (Coelho et al. 2017).

Table 15.1 Spill Response Tactics

Option	Comments	Environmental Effects Considerations
Natural Attenuation/ Degradation	• Represents the "no-response option" or unmitigated spill option • Weathered hydrocarbon breaks into small droplets by wave action • Droplets are naturally metabolized by micro-organisms • Effectiveness improves as wind and sea state increase • Monitoring would likely involve remote sensing and aerial observations; monitoring effort is affected by poor visibility (e.g., fog and daylight)	• No action scenario represented in predictive spill trajectory modelling • Surface oil can persist longer, increasing risk of interaction with migratory birds, marine mammals and sea turtles at surface, sensitive areas and shorelines • Effects on commercial and Indigenous fisheries due to fisheries closures based on surface oil sheen

Table 15.1 Spill Response Tactics

Option	Comments	Environmental Effects Considerations
Mechanical Containment and Recovery	• Containment and recovery of surface oil through absorbent booms, Single Vessel Side Sweep and ocean-rated skimmers and booms is currently world-class • Can be effective but limited by sea state and visibility, encounter rate of boom system and need for high logistics support • Low recovery rates as slick spreads • Sorbent boom will be on supply vessels • Tier 2/3 containment and recovery equipment will be available through a contracted Response Organization • Monitoring would likely involve remote sensing and aerial observations; monitoring effort is affected by poor visibility (e.g., fog and daylight)	• Provides environmental benefit over natural attenuation/degradation
In Situ Burning	• Authorization required from the C-NLOPB before implementation • Requires mechanical recovery with fire resistant booms • Used to quickly reduce the volume of surface oil that would otherwise reach shorelines or sensitive areas • Effective but limited by meteorological conditions (calm seas and light winds) • Monitoring would likely involve remote sensing and aerial observations; monitoring effort is affected by poor visibility (e.g., fog and daylight)	• Reduces amount of oil in water but increases oil particulate matter resulting in localized air quality effects. However, unlikely to require air quality monitoring given distance from human receptors.

Table 15.1 Spill Response Tactics

Option	Comments	Environmental Effects Considerations
Chemical Dispersion (Surface Dispersant Application, Subsea Dispersant Injection)	• Authorization required from C-NLOPB before application • Only two spill treating agent Corexit® EC9500A and Corexit® EC9580A have received regulatory approval for use in Canada (the intended use of Corexit® EC9580A is to treat substrate) • Increases distribution area of oil by breaking it up into smaller droplets, enhancing natural dispersion and biodegradation processes • Dispersants can be applied at surface (aerially or from vessels) or through subsea dispersant injection (SSDI); requires mobilization of specialized equipment and dispersants • Meteorological conditions are key factors determining effectiveness and method of application • SSDI is less sensitive to weather conditions and allows for continuous (24 hour) response (not hampered by visibility) • Reduces surface exposure and resulting health and safety risk to response workers • Monitoring to determine effectiveness is usually conducted using internationally recognized “Special Monitoring of Applied Response Technologies” protocols	• Reduces surface oil and volatile organic compounds at water surface and therefore reduces risk of adverse effects on human responders, migratory birds, and marine mammals and sea turtles at surface as well as for workers • Increases exposure to dispersed oil in water column for fish, marine mammals and sea turtles although concentrations of dispersed oil dilutes rapidly to below lethal thresholds • Will increase short-term exposure of dispersed oil to fish but decrease in surface oil could result in reduced duration of fisheries closure • Public perception of toxicity of dispersants can indirectly affect commercial and Indigenous fisheries after fisheries closure has been lifted • Reduces risk of nearshore and shoreline interaction
Sources: EMCP 2011; Coelho et al. 2017		

The SIMA will evaluate benefits and drawbacks of different response tactics considering feasibility and effectiveness of implementation in different spill scenarios and prevailing conditions. A major component of this exercise involves considering the environmental effects of each response tactic against a base case of no tactical response (i.e., natural attenuation/degradation). The SIMA considers the physical environment of the Project Area (e.g., wind and wave conditions, currents, ice conditions, air and seawater temperature, visibility) as well as potential resources of concern (i.e., VCs) and involves a risk assessment of response options (see Table 15.1) for summer and winter conditions. The outcome of the SIMA is impact mitigation scores indicating the potential for reducing or increasing risk relative to the baseline condition of “natural attenuation” for each response method which can then be used to help select the best response tactics for any given spill scenario. The SIMA process is an important part of contingency planning, and can be used to support exercises, drills and training. In the event of an actual spill, the SIMA process provides direction on response strategy and can be adjusted as necessary to manage specific response actions and end points (Coelho et al. 2017).

15.1.2.3.4 Chemical Dispersion

Dispersant are products used in oil spill response to enhance natural microbial degradation, a naturally occurring process where microorganisms remove oil from the environment. Chemical dispersion, whether by surface application or subsea dispersant injection (SSDI), is generally the most effective means of removing significant quantities of oil from the surface quickly, thereby producing higher levels of environmental protection than other response strategies (Coelho et al. 2017). By promoting dissipation of oil in the water column, dispersant-use reduces the potential for surface oil to reach ecologically sensitive areas (e.g., EBSAs, shoreline environments), but also temporarily results in elevated exposure of organisms to in-water concentrations of oil in the immediate area of treatment. However, research and monitoring has shown that these exposures are rapidly mitigated by effects of dilution and microbial degradation of the dispersed oil (Coelho et al. 2017). When used properly, dispersants can rapidly reduce the volume of oil on the sea surface and accelerate the natural bioremediation process.

Dispersant application can also reduce volatile organic compounds at surface, improving the safety of the working environment for responders.

Coelho et al. (2017) notes that the toxicity of dispersed oil in the water column is related to three factors:

1) Whether the concentration exceeds known acute or chronic toxicity thresholds for the oil type that was spilled
2) The length of time that the concentrations persist above toxic thresholds
3) The toxicological sensitivity of the species exposed to oil above the acute or chronic toxicity thresholds

The overall toxicity of dispersed oil is determined primarily by the toxicity of the oil, although through increased dissolution, dispersants make the oil more available to organisms in the water column. Exposure time and sensitivity of aquatic organisms (which can vary amongst life stages) also affect toxicity and effects (Coelho et al. 2017). Dispersed oil rapidly dilutes (Cormack and Nichols 1977; McAuliffe et al. 1980; Daling and Indrebo 1996; French McCay and Payne 2001; French McCay et al. 2006), and concentrations above known toxicity thresholds do not persist for more than a few hours after effective dispersant application. Thus, the potential for acute impacts to the environment from dispersed oil is limited in duration and space. In contrast, a surface slick has the potential to impact marine mammals and birds for many days and strand on sensitive shorelines.

Following surface application under typical conditions, concentrations of dispersed oil in the water column may approach 30-50 ppm in the upper 10 m of the water column, with concentrations diminishing to below 10 ppm within the first hour and to less than 1 ppm within a few hours. Thus, for surface dispersant application, exposures to organisms are relatively short-lived, and occur only in the upper few metres of the water column (Coelho et al. 2017). SSDI increases dispersed oil concentrations in deeper regions of the water column, potentially increasing interaction of benthic species with dispersed oil. However, in both surface application and SSDI, dispersion of oil results in accelerated microbial degradation of spilled oil (Lee et al. 2013; Coelho et al. 2017).

In general, dispersant use has a net environmental benefit for migratory birds that could encounter surface oil. However, dispersant use in close proximity to various species may reduce surface tension at the feather-water interface thereby reducing the capacity of insulation provided by feathers (refer to Section 15.5.2 for a discussion of effects of oil on thermoregulation). The magnitude of these effects depends on the proximity of wildlife during dispersant application as well as the effectiveness of the dispersant on the surface oil (National Research Council 2005).

Statoil will not use dispersants without prior regulatory approval. If dispersant use is advisable in the event of a spill (as informed by a SIMA process), Statoil will seek approval from the C-NLOPB Chief Conservation Officer. With the amendments made to the *Canada-Newfoundland and Labrador Atlantic Accord Implementation Act* through the implementation of the *Energy Safety and Security Act*, the C-NLOPB will be able to conditionally approve the use of one or more of the spill treating agent (STA) products listed in the *Regulations Establishing a List of Spill-treating Agents* (*Canada Oil and Gas Operations Act*) to respond to an oil spill.

Corexit® 9500A, the primary STA used during the DWH incident spill response effort, along with Corexit® EC9580A, are currently the only STAs approved for use in Canada. The intended use for Corexit® EC9580A is to treat substrates.

Prior to approval of these STAs, Environment Canada conducted scientific testing focusing on assessing toxicity and effectiveness. Both Corexit® 9500A and Corexit® EC9580A were found to be highly effectives STAs and determined to have low toxicity in aquatic toxicity tests (Environment Canada 2016). In recognition that there is a potential for increased exposure to components of oil by aquatic organisms following the use of dispersants, Environment Canada stressed the need for consideration of net environmental benefits when making a determination for approval of dispersant use during a spill (Environment Canada 2016). The SIMA will therefore play a key role in advising dispersant use and approval conditions, taking into account site specific and incident specific considerations.

15.1.2.3.5 Shoreline Protection and Clean Up

In the event oil is predicted to make contact with shoreline areas, measures to protect these areas can be implemented. Barriers (boom and berms) can be used to deflect and protect sensitive coastal environments from surface oil. Deflection booming is used to divert oil to a suitable collection point at shore or at sea. Protection booming can also be used to hold or prevent oil from reaching shore. Additionally, sand, sand bags and earthen barriers can be used to prevent oil entering specific areas. Selection of equipment and strategies is dependent on local conditions, access to areas, and results of real-time spill trajectory modelling.

In the event that oil is predicted to reach shoreline, or makes contact with shore, a shoreline response program will be initiated. Shoreline clean-up assessment technique (SCAT) teams will be mobilized to perform systematic surveys to document the location, degree and type of shoreline oiling. This information will be used establish shoreline treatment recommendations appropriate for each area. Treatment measures can include a range of options including, but not limited to, low-pressure flushing, mechanical collection, manual cleaning, plowing, soil washing, and natural attenuation. SCAT teams will also be used to monitor and evaluate the effectiveness of the clean-up operations.

Engagement with local stakeholders in affected areas is necessary to be build consensus on objective and goals for the response effort.

15.1.2.3.6 Oiled Wildlife Response

Oiled wildlife response may be required for fauna encountered at sea and on the shorelines of Newfoundland. The Operator will draw upon the expertise and equipment of specialist contractors to support the oiled wildlife response effort. There are two licensed bird handling and rehabilitation centres for treatment and rehabilitation in Newfoundland and Labrador – Suncor Environment Centre (St. John's), and Newfoundland Environment Centre (Ship Cove). For the Suncor Environment Centre in St. John's, prior to commencing any offshore operations Statoil partners with Suncor to cooperate in maintaining the centre and sharing access to it. The Suncor Environment Centre would be the primary destination for oiled or injured seabirds for veterinarian controlled triage, stabilization and treatment. In addition, during operations Statoil maintains an agreement with an on-call veterinarian for the bird handling centre.

Oiled wildlife response typically is based on a three tier approach:

1) Primary response: surveillance to determine the location and extent of wildlife injuries and death; and deflecting oil away from areas of high sensitivity where practicable
2) Secondary response: deterring fauna from affected or potentially affected areas; and pre-emptive capture and exclusion activities
3) Tertiary response: capture and stabilization of oiled wildlife (using boats, or on the shoreline); transport to treatment facilities and treatment of affected fauna

15.1.2.3.7 Remediation

Remediation measures are dependent on the size of the spill and the area and resources affected. The Operator would use their internal specialists and external remediation expertise and contractors (e.g. OSRL, ECRC) to develop and implement long term remediation strategies and plans. These would be developed in consultation with the C-NLOPB and the National Environmental Emergencies Centre (NEEC) and other government agencies as necessary.

15.1.2.3.8 Financial

In addition to the spill response measures, an Operator must demonstrate that they have the financial resources to meet a liability obligation of $1 billion in order to obtain an authorization to drill offshore exploration wells in the Newfoundland and Labrador Offshore Area. The objective of the financial requirement is to prove that the Operator has the ability to: 1) respond to a serious incident such as a major spill; and 2) pay for all actual losses or damages incurred by any person as a result of the incident. Losses and damages includes loss of income, future loss of income and, with respect to any Indigenous peoples of Canada, loss of hunting, fishing, and gathering opportunities.

In addition, an Operator must provide minimum of $100 million in "financial responsibility". This financial responsibility must be available to the C-NLOPB, to be accessed by the C-NLOPB, if

needed, in response to an incident involving the release of debris and/or a spill, or an authorized discharge, emission or escape of oil or gas. This is effectively a financial "deposit" and is required in order to ensure that the C-NLOPB has unfettered access to funds for clean-up and remediation, should the C-NLOPB deem that an Operator has not taken appropriate action in response to an incident.

15.2 Potential Accidental Event Scenarios

Section 6.6.1 of the EIS Guidelines states:

> *The failure of certain works caused by equipment malfunctions, human error or exceptional natural events (e.g. earthquake, hurricane, submarine landslide) could cause major environmental effects. The proponent will therefore conduct an analysis of the risks of accidents and malfunctions, determine their effects, and present preliminary emergency response measures.*

In particular,

> *The effects of accidental spills and blowouts will therefore require assessment in the EIS, including fate and behaviour modelling, and hydrologic trajectory modelling for worst-case large-scale spill scenarios that may occur, including any assumptions, limitations, and formulated hypotheses, accompanied by supporting documentation of methodologies and the cumulative results of the modelling.*

A number of potential accidental event scenarios that could occur during drilling activity have been identified based on historic industry trends / incidents and the proposed Project. A summary of these events and the associated preventative and response barriers is presented below. It is possible that additional accidental event scenarios other than those presented below could occur. Further information about accidental event scenarios are described in the Safety Plan, which is submitted to the C-NLOPB as part of the OA regulatory approval process.

15.2.1 Local Conditions and Natural Hazards

Accidental events associated with local conditions and natural hazards such as extreme weather conditions and external events (e.g., seismic events, icebergs, hurricane, submarine landslide potential) are addressed in Section 16.2. However, to the extent that these accidental events may result in a spill to the marine environment, the potential environmental effects presented herein remains relevant.

15.2.2 Vessel Collision

15.2.2.1 Transit to and from Project Area

The Project will include supply and support vessel and aircraft traffic between a yet to be determined existing port facility in Eastern Newfoundland and the offshore Project Area as required throughout the duration of the Project. As described in Section 2.5.2, it is anticipated that with a single operating drilling unit installation there will be eight to ten return transits per month by the supply vessel during

the course of the Project. Supporting vessels that are involved in Project activities will travel in an essentially straight line between a drilling installation operating within an EL in the Project Area and an established port facility in Eastern Newfoundland, a practice which is common in the oil and gas industry that has been active in this region for several decades. This component of the Project will therefore involve standard and relatively routine vessel traffic to and through a portion of the Eastern Newfoundland offshore area, and as described in Section 2.5.2, this will make a small contribution to overall traffic levels in this region.

The environmental consequences of a vessel collision in transit or incident while supplying and off-loading vessels could include loss of primary containment of hydrocarbons, which could result in adverse effects to the receiving environment. While there is some potential for an accidental event to occur during any such activity, the possibly of, and potential environmental effects that may be associated with, any such incident are very low. The supplying and off-loading of Project-related vessels will occur within an existing industrial port facility, which handles supply vessel activity associated with multiple offshore operations and which operates in compliance with relevant legislation and regulations around materials handling, marine transits, and required spill prevention and response. Similarly, vessel traffic to and from these facilities in the nearshore environment will likewise be subject to applicable regulatory requirements, including requirements for vessel pilotage as required.

As detailed in Section 2.5.2, there have been no near-shore supply vessel groundings or spills over the greater than 30-year history of oil and gas exploration in the Newfoundland offshore area. Other analysis of potential hydrocarbon spills in the nearshore environment off St. John's have indicated that such a spill event would see oil moving to the east and not contacting the shoreline (RMRI nd).

The measures to be put in place to prepare, prevent, and respond to such a scenario are the same as those for offshore incidents, presented in Section 15.1. Likewise, the existing mechanisms and arrangements with response organizations for emergency response are the same as those for offshore incidents presented in Section 15.1.

15.2.2.2 Within the Project Area

It is possible that there could be a collision between the drilling installation and one of the vessels encountered in the Project Area *(i.e.,* one of the Project support vessels or one of the other domestic or international vessels passing through the Project Area). A collision could also arise if the drilling installation moves from its designated position or in the event of extreme weather, such as an intense storm, which may cause either a vessel or the drilling installation to lose position.

A 500-m safety zone is maintained at all times around the drilling installation. The safety zone is established for the protection of the drilling installation as well as other ocean users, and to prevent collisions between the drilling installation and other vessels. The safety zone will be monitored by the drilling installation standby vessel. The boundaries of the safety zone will be communicated to mariners through a Notice to Shipping.

Additionally, robust positioning systems and certified watch-keepers on the drilling installation and support vessels, navigation aids, weather radars and alarms will be used to keep the rig and vessels

on position and to highlight the presence of other vessels and changing weather conditions. Vessel and drilling installation operator procedures will be used, defining a process for collision assessment, communication protocols and procedures for the use of navigation equipment and alarms, which will be used by competent personnel.

The Project will use weather and natural hazard preparedness processes to monitor for and respond to extreme weather events. These processes will identify conditions when precautionary riser unlatching or rig evacuations are required.

Consequences of a marine collision could include a loss of primary containment of hydrocarbons, or it could cause other accidental events such as a loss of stability or loss of well control. Response barriers are in place to reduce the possibility of these consequences arising, such as fire and explosion suppression and protection systems, evacuation and escape protocols, and emergency unlatching protocols.

The measures to be put in place to prepare, prevent, and respond to such a scenario are presented in Section 15.1. Mechanisms and arrangements with response organizations for emergency response are also presented in Section 15.1.

15.2.3 Dropped Objects

Dropped objects refers to items accidentally falling either onboard the drilling installation structure, (e.g., from a crane on to the decking below) or subsea (i.e., from a support vessel or drilling installation on to the seafloor or subsea infrastructure). Subsea infrastructure includes project equipment, such as the BOP and the lower part of the riser which connects to the BOP, often referred to as the lower marine riser package (LMRP). Large objects dropped from height pose a health and safety risk as personnel could be injured or killed, and there is also potential for dropped objects to damage the drilling installation. Damage to the drilling installation could result in the loss of primary containment and the release of hydrocarbons into marine waters.

The risk of dropped objects is managed through the use of tested and certified lifting equipment and ropes, clear specifications for equipment limits, and the use of agreed and controlled lifting plans. An object could fall from the drilling installation during extreme weather events. Potential meteorological conditions are considered during the drilling installation selection process to confirm that the drilling installation is capable of operating safely. The Project will use weather forecasting to monitor and prepare for a response to extreme weather.

In March of 2016, Shell Canada Limited reported an incident to the CNSOPB where the riser and lower marine riser package were accidentally released to fall to the seabed during high waves and heave conditions, while operating in Nova Scotia. Typically, the riser is not attached to the drilling installation when in transit, moving to or away from site; it is stored on the rig deck. The riser is installed with the BOP stack (see Section 2.5.2). After drilling is completed and the well safely suspended or abandoned, the riser is retrieved and stored on the rig deck before moving offsite. Before the riser is retrieved, all fluids are removed and replaced by seawater; therefore, there is no potential for fluid loss to the environment. In certain circumstances, the riser and BOP remains attached when transiting between well sites. Under these circumstances, the riser is filled only with

seawater and supported by the top drive and/or rotary table to prevent loss of riser or BOP. The C-NLOPB must be informed of these events and requires certain measures to be implemented to prevent incidents from occurring, including undertaking a riser transit analysis, weather forecasting, limiting speed of the drilling installation, attaching a beacon to the BOP to track its offset below the drilling installation, and having an ROV transit ahead of the drilling installation to look for potential obstacles in the path of the transit. Therefore, with all these mitigations in place, there is a very low probability of a loss of riser incident, and if such an incident were to occur, there would be no significant environmental effect.

15.2.4 Loss of Drilling Installation Stability or Structural Integrity

The Project is likely to use a semi-submersible drilling rig or a drillship as the drilling installation for the Project. Stability is managed by controlling the distribution of weight both across the drilling installation, as well as below and above the waterline. One way in which this is managed is by using ballast. A loss of stability or structural integrity could cause the drilling installation to list, capsize, or even sink.

A loss of stability or structural integrity could be caused by a design or operation error, specifically its ballast system, or by an extreme weather event. Other accidental events could also result in the loss of the drilling installation stability or integrity, (e.g., a vessel collision, or a fire or explosion during a loss of well control event).

A loss of stability could also result in a loss of primary containment on the drilling installation, which could result in adverse environmental consequences. There is also a possibility that a loss of drilling installation stability could cause a loss of well control.

Some of the key barriers that are in place to prevent a loss of stability or structural integrity include the use of positioning and control systems, alarms, and operator interventions to ensure that the drilling installation is operated correctly, including careful control of variable deck load by competent personnel. Robust drilling installation design, including the use of inherently safe design systems, is verified through the Operators rig intake process and the third-party verification through the Certificate of Fitness. Maintenance and inspection processes are designed to test and regularly check equipment to confirm that it is still operating. Appropriately trained and competent personnel will be used in operations. As stated previously, the Project will use weather and natural hazard preparedness processes, such as weather forecasting tools. If the drilling installation loses position, an emergency disconnect protocol is in place that will allow the well to be shut in and the drilling installation to move off location.

15.2.5 Loss of Well Control

Primary well control is the use of wellbore fluid density to provide sufficient hydrostatic pressure to prevent the influx of formation fluid into the wellbore. Loss of primary well control will, if a permeable formation is exposed, allow formation fluid to flow into the wellbore and is referred to as a “kick”. The severity of the kick depends on the reaction time of the drill crew, the porosity and the permeability of the formation, and the difference between the formation pressure and the hydrostatic pressure of the drilling fluid.

There are five major causes for the loss of primary well control; failure to keep the hole filled while tripping, swabbing, lost circulation, insufficient mud density, and loss of riser drilling fluid column.

- Failure to keep the hole properly filled while tripping: As the drillstring is pulled out of the hole, the mud level will drop due to the volume of steel being removed. If the volume of steel removed from the well is not compensated for by filling the hole with mud, the mud level will drop and the hydrostatic pressure may be reduced enough to lose primary well control. This situation will be prevented by using a calibrated trip tank, which is monitored and filled frequently during tripping operations.
- Swabbing: When pipe or other tools are pulled out of the hole, the pulling speed and mud properties (viscosity) cause a "plunger effect" which reduces the bottom hole pressure. The risk of "swabbing in" a kick will be prevented by controlling pulling speed, evaluating the mud density prior to tripping (allow a mud weight "trip margin"), or by pumping while pulling out of the hole.
- Lost circulation: Loss circulation is the loss of drilling mud due to formation fractures, high mud overbalance (i.e. depleted/sub-normal pressured formations), or mechanical failures such as a hole in casing. If losses cause the fluid level in the well to drop, there could be a loss of primary well control. Causes of lost circulation may be natural or induced by drilling practices. Loss circulation will be prevented through fluid density evaluation (reduce weight while still maintaining overbalance), minimizing surge pressures while tripping (reduce tripping speed and mud viscosity), planning the drillstring and well design to reduce friction effects, or by pumping lost circulation materials.
- Insufficient fluid density: When the hydrostatic pressure of the drilling fluid is less than the formation pressure of a permeable zone, formation fluids will enter the wellbore. This may be caused by drilling into an abnormal pressured or higher than prognosed pressure zone, dilution of the drilling fluid due to treatment or contamination with gas/water, settling of weighted material (barite), or poor fluid displacement practices. Insufficient fluid density will be prevented by continuous monitoring of mud properties, monitoring of background/connection gas, flow checks while drilling and on connections, and high case pore pressure prediction and follow-up. Fluid density will be increased if there are any indications that the mud is too light and the wellbore is at risk of taking at kick.
- Loss of riser drilling column: For floating rigs, the loss of the drilling fluid column in the riser will reduce the hydrostatic pressure in the wellbore and may cause loss of overbalance and primary well control. This may be caused by riser damage, emergency disconnect due to rig drive-off / drift-off (weather), or poor planning/control of riser margin during operations. Where applicable, this will be prevented by drilling with a fluid density that maintains overbalance with riser removed (referred to as "riser margin"). Riser margin is not always available for deep water operations, so further prevention measures include pressure testing of riser lines during installation and at routine intervals, volume control of riser fluid, monitoring of weather forecasts, and preparation of procedures to ensure two well barriers are in place prior to riser disconnect.

There are several indicators that will be used to detect a kick. While drilling, drilling breaks (sudden changes in rate of penetration), increases in flow rate or pit volumes, variations in pump speed or

pressures, or changes in fluid properties will all be assessed for potential kicks. While tripping, a kick may also be detected if the hole is not taking/displacing the correct volume or fluid or by flow checks.

In the event that primary well control measures fail and a kick occurs, the drilling installation will be equipped with secondary well control equipment (BOP, choke manifold) which will allow the well to be shut in, the influx to be safely circulated out of the wellbore, and hydrostatic overbalance re-established. The BOP shall be installed prior to drilling out of the surface casing and will be equipped with an emergency shut-down system and a secondary closing function should the primary control system for operating the BOP rams fail. The BOP equipment used will comply with API and NORSOK standards and tested regularly per regulatory requirements. Secondary well control equipment is tested and verified as part of the rig intake process to ensure the equipment is fit for purpose and satisfies Statoil, drilling contractor, and regulatory standards.

For top hole operations before the BOP is installed, the location is screened for hazards such as shallow gas through the assessment of seismic data. If a risk of shallow gas is observed, a pilot hole may be drilled and/or the well location may be moved to avoid drilling a large diameter hole through a shallow gas zone. For wells with no shallow gas prognosed, riserless well control precautions such as tabletop drills with crew and kill mud are still prepared.

In additional to physical well control barriers, drilling contractor and operator personnel undergo frequent competency training and assessment for well control. Key personnel are required to hold industry-accredited well control training certification. Well control drills and tabletop exercises are performed as per Statoil and/or drilling contractor's management system to verify crew understanding of choke manifold/BOP line up, shut-in procedures, and well kill methods. For deep-water operations, additional focus is placed on early kick detection, handling of gas expansion and risks of gas in the riser, prevention of hydrates, use of choke line friction in well control procedures, and differences between surface and downhole mud properties. Should a well control event occur, the drilling crew offshore are supported by the onshore operations team, Statoil corporate well integrity experts in Norway, and the Statoil emergency response organization.

In summary, well control will be maintained by planning and executing the operation in a way that:

- Gives overbalance against pore pressure during drilling
- Includes a trip margin (safety margin) during tripping to prevent influx caused by swabbing or drop in fluid level
- Includes a riser margin (when suitable) to allow hydrostatic overbalance if the riser is disconnected. If no riser margin is available, a plan for establishing a primary barrier other than drilling fluid will be implemented before riser disconnect
- Allows a given kick size to be handled and circulated out of the well in a safe way
- Ensures all information which is needed in a kick situation is prepared beforehand
- Ensures continuous monitoring of the well and early diagnosis of pore pressure increase and overbalance decrease
- Ensures training and competency of onshore and offshore personnel

In the extremely unlikely event that both primary and secondary well control measures fail, an uncontrolled release from the well consisting of drilling mud, brine, water, gas, or oil may occur

referred to as a blowout. Mitigating measures for a blowout scenario including capping, relief well drilling / killing, and spill response are covered in Section 15.1.1.

15.2.6 Potential Spill Scenarios

Some of the potential accidental risk events described above could result in a release of hydrocarbons, chemicals, synthetic based drill cuttings or emissions, resulting in adverse environmental effects. Additionally, there are some potential operational spill events that could occur from anywhere that hydrocarbons or chemicals are stored or transferred on the drilling installation or support vessels.

There is potential for a spill to occur as a result of many accidental event scenarios. Two accidental spill scenarios were selected for detailed spill fate and behaviour modelling based on consideration of Project activities and potential environmental risk. These spill scenarios are considered representative of credible worst case spill scenarios that could result from an accidental event and include:

- Subsurface blowout
- Batch diesel spill

15.2.6.1 Subsurface Blowout

A loss of well control resulting in a subsurface blowout with a continuous release of oil represents the worst-case scenario for an accidental spill event. The estimated volumes of hydrocarbons released in the subsurface blowout scenarios are conservative (i.e., high) based on the current knowledge of subsurface properties and potential blowout scenarios. The duration of flowrate was determined in consideration of spill response measures to stop the flow of oil, such as installation of a capping stack (36 days) and / or drilling a relief well (113 days). Uncontrolled well discharge analysis was undertaken to assess the potential worst-case credible discharge that could occur as a result of an unmitigated blowout incident at two potential locations. The flowrates analysis was determined in consideration of reservoir properties based on previous drilling experience in the Project Area. Therefore, for effects assessment purposes, to assess potential impacts from the potential loss of well control events, two scenarios representing a range of flow rates and flow durations, were modelled: 1) a 4,980 m³/day event with a flow duration of 36-days, and 2) a 15,000 m³/day event with a flow duration of 113 days. As described in Section 15.1, The Operator has various mechanisms in place to prevent a loss of well control therefore the risk of a subsea blowout occurring is extremely low (refer to Section 15.3.4). However, in the extremely unlikely event of a subsea blowout, hydrocarbons such as crude oil and gas condensate could be released into marine waters. The duration of a blowout, and therefore the resulting volume spilled and geographic extent affected will be limited due to the implementation of emergency response measures as outlined in Section 15.1.2. The subsurface blowout scenarios have been modelled in terms of probability of occurrence, as well as for fate and effects; these are described in Section 15.4.1. The probability of a subsea blowout occurring over the life of the Project is presented in Section 15.3. The fate and behaviour of oil associated with a subsea blowout is discussed in Section 15.4. Potential environmental effects of a subsea blowout on the VCs is presented in Section 15.5.

15.2.6.2 Operational Batch Diesel Spill

Spills attributed to causes other than blowouts account for the vast majority of spills related to offshore exploration and production. These spills are also more likely to be smaller, with an average volume of less than 200 bbl (ERC 2017). Batch spills, which can occur from a drilling installation or supply vessel, are generally instantaneous or short-duration discharges that can involve the release of different types of hydrocarbons including diesel, hydraulic fluid, aviation fuel, or drilling fluids. These spills can occur accidentally during handling or transfer of cargo and during operations and maintenance activities. They can occur as a result of human error and/or equipment malfunction or failure.

The severity of an operational spill depends on the volume and type of spilled material. Potential environmental effects of a spill of drilling mud (SBM or WBM) is discussed in Section 15.5.1.2 and is similar in terms of extent and duration to the effects of drill mud cuttings during normal operations. For the purpose of this assessment, operational spill scenarios of a batch diesel spill (100 L and 1,000 L) have been considered to represent a credible worst case scenario.

Batch spill scenarios have been modelled in terms of probability of occurrence, as well as for fate and effects; these are described in Section 15.4.1. The probability of a batch diesel spill occurring over the life of the Project is presented in Section 15.3. The fate and behaviour of oil associated with a batch diesel spill is discussed in Section 15.4. Potential environmental effects of a batch spill on the VCs is presented in Section 15.5

15.3 Spill Risk and Probabilities

The following was prepared to provide a probability analysis of offshore spills and blowouts to support the Project. The report considers the probability of both continuous longer-term, larger scale blowouts, as well as smaller scale, shorter-term spill scenarios (batch spills) in association with the Project.

There are three important aspects to determining the “spill risk” associated with offshore exploratory well operations:

- Determining the likelihood or probability that a well blowout or other well release will occur
- Determining the distribution of potential oil spillage volumes that might occur and the probabilities that the spill will be a large-scale spill
- Determining the potential impacts of hypothetical spills

The results of the analyses show that the probability of a well blowout or other release is very low–i.e., blowouts and other spills from offshore exploratory wells are quite rare. The analyses also show that if a blowout or other spill were to occur, the chances are great that it would be a small volume of spillage rather than a very large event with high consequences. This report reviews the available data and findings based on historical research on offshore spills to determine the probabilities for spills and the potential spill volumes that might be involved.

In addition, this report complements the modelling and assessment of potential spill scenarios conducted as part of the Environmental Impact Statement (EIS) for the Project by providing a perspective on the probability of occurrence of the various scenarios (blowouts and batch spills) as well as the probability distributions of spill volumes. These modelled scenarios of hypothetical spills are shown in Table 15.2.

Table 15.2 Modelled Hypothetical Spill Scenarios for Project

Scenario	Location	Release Rate		Days	Total Release	
		m³/day	bbl/day		m³	bbl
Subsurface Blowout NPA	49.22882322, -45.41807056	4,980	31,323	36	179,280	1,127,637
Subsurface Blowout EPA	48.31274, - 45.8218	15,000	94,347	113	1,695,000	10,661,211
Batch Spill 100L-NPA	49.22882322, -45.41807056	0.1	0.63	1	0.1	0.63
Batch Spill 100L-EPA	48.31274, - 45.8218	0.1	0.63	1	0.1	0.63
Batch Spill 1000L-NPA	49.22882322, -45.41807056	1.0	6.3	1	1.0	6.3
Batch Spill 1000L-EPA	48.31274, - 45.8218	1.0	6.3	1	1.0	6.3

The probabilities of the hypothetical subsurface blowout scenarios at the two locations are based on the drilling of up to 30 exploratory wells over a time period of up to 10 years.

Each of the exploratory wells would be drilled over the course of 35 to 65 days followed by suspension or well decommissioning. While there are no specific drilling timelines, as wells have yet to be planned, the analysis assumes that drilling could occur at any time of the year, with the first well drilled in 2018. Similarly, the batch spill scenarios would be based on operations at wells at some point over the course of up to 10 years. Probabilities of incidents are provided per-well based on 35-day and 65-day exploratory drilling durations. The probability of a release would increase with the exposure, which would mean an increase in the number of wells, would increase the probability of an incident.

15.3.1 Historical Spill Data - Canada-NL Offshore Area

15.3.1.1 Sources of Oil Inputs in Newfoundland and Labrador Offshore

During the 1990s, total inputs of oil from anthropogenic sources in coastal areas of Eastern Canada have averaged 9,000 barrels (bbl) annually, and in offshore areas, 2,700 bbl annually, for a total of 11,700 bbl. Spill volumes off Eastern Canada have decreased significantly in the last decade to approximately 600 bbl. Occasional tanker spills have provided the greatest threat to the region in the past.

In addition to anthropogenic inputs from spills, urban runoff, and vessel and facility operations, natural seepage may also contribute to overall hydrocarbon inputs in the region. Several natural seeps have been identified in the region, though there are no quantifications of annual inputs from this source.

15.3.1.2 Canada-Newfoundland and Labrador Offshore Spill Data

Based on statistics from the C-NLOPB, offshore exploration and production facilities have spilled a total of 3099 bbl of oil (hydrocarbons[2] and synthetic-based drilling fluids) in 517 incidents during 1997 and 2015 in the Canada-NL Offshore Area. As shown in Table 15.3, of the 517 incidents, 41 (7.9 percent) occurred during exploration and 476 (92.1 percent) occurred during development and production.

Of the oil spilled in exploration drilling during 1997 through 2015, 95.5 percent of the total volume spilled was synthetic oils and fluids. Only 2.1 percent of the spilled oil was crude oil. The most frequent incidents were of crude oil (and condensate), followed by hydraulic and lubricating oils. The percentages of volumes and incident numbers are summarized in Table 15.4.

Most spills are relatively small with only infrequent larger spills. The spill volumes by size category based on the C-NLOPB data are in Table 15.5 and Table 15.6, with the addition of data on spills of 1 litre or less that were provided by C-NLOPB that were not classified with regard to oil type.

[2] The “Other Hydrocarbon” category (Table 15.3) incorporates crude, diesel/jet fuels, hydraulic / lube oils, and “other types”. In C-NLOPB data presentations, the term “other hydrocarbons” is used instead of what is termed “other types” in this section. A distinction is made herein to avoid confusion

Table 15.3 Newfoundland and Labrador Offshore Exploration and Production Oil Spills (1997-2015)

Year	Exploration						Development & Production						Total					
	Spill Number			Bbl			Spill Number			Bbl			Spill Number			Bbl		
	HC	SBM	All	HC	SBM	All	HC	SBM	All	HC	SBM	All	HC	SBM	All	HC	SBM	All
1997	1	0	1	0.25	0.00	0.25	10	0	10	10.64	0.00	10.64	11	0	11	10.89	0.00	10.89
1998	4	0	4	20.10	0.00	20.10	22	2	24	3.70	12.63	16.33	26	2	28	23.80	12.63	36.43
1999	11	0	11	10.74	0.00	10.74	28	8	36	7.29	46.37	53.66	39	8	47	18.03	46.37	64.40
2000	1	0	1	1.01	0.00	1.01	4	5	9	0.40	29.56	29.96	5	5	10	1.40	29.56	30.97
2001	0	0	0	0.00	0.00	0.00	15	2	17	0.82	35.22	36.04	15	2	17	0.82	35.22	36.04
2002	0	0	0	0.00	0.00	0.00	24	2	26	0.19	77.05	77.24	24	2	26	0.19	77.05	77.24
2003	1	1	2	0.63	27.68	28.30	19	4	23	1.81	167.48	169.29	20	5	25	2.44	195.15	197.60
2004	0	0	0	0.00	0.00	0.00	50	5	55	1,043.49	679.95	1,723.44	50	5	55	1,043.49	679.95	1,723.44
2005	0	0	0	0.00	0.00	0.00	40	1	41	1.21	25.35	26.56	40	1	41	1.21	25.35	26.56
2006	3	1	4	0.10	3.77	3.87	31	3	34	3.88	19.06	22.93	34	4	38	3.98	22.83	26.81
2007	0	1	1	0.00	465.45	465.45	37	1	38	0.61	6.85	7.46	37	2	39	0.61	472.30	472.91
2008	0	0	0	0.00	0.00	0.00	35	1	36	30.25	0.63	30.88	35	1	36	30.25	0.63	30.88
2009	4	0	4	0.06	0.01	0.07	37	0	37	1.80	0.00	1.80	41	0	41	1.86	0.01	1.87
2010	3	0	3	0.02	0.00	0.02	16	0	16	1.16	0.00	1.16	19	0	19	1.19	0.00	1.19
2011	2	5	7	0.28	180.78	181.06	36	2	38	3.51	28.94	32.45	38	7	45	3.78	209.72	213.50
2012	0	0	0	0.00	0.00	0.00	7	0	7	0.07	0.00	0.07	7	0	7	0.07	0.00	0.07
2013	0	0	0	0.00	0.00	0.00	11	2	13	39.33	1.40	40.73	11	2	13	39.33	1.40	40.73
2014	0	1	1	0.00	5.41	5.41	11	3	14	1.44	6.94	8.38	11	4	15	1.44	12.35	13.79
2015	1	1	2	0.00	92.93	92.93	1	1	2	0.02	0.90	0.92	2	2	4	0.02	93.83	93.85
Total	**31**	**10**	**41**	**33.18**	**776.02**	**809.21**	**434**	**42**	**476**	**1,151.63**	**1,138.32**	**2,289.95**	**465**	**52**	**517**	**1,184.81**	**1,914.35**	**3,099.16**
Avg	**2**	**1**	**2**	**1.75**	**40.84**	**42.59**	**23**	**2**	**25**	**60.61**	**59.91**	**120.52**	**24**	**3**	**27**	**62.36**	**100.76**	**163.11**

Data extracted from C-NLOPB spill statistics [http://www.cnlopb.ca/information/statistics.php#environment]
HC = Hydrocarbon
SBM = Synthetic-based [drilling] mud

Table 15.4 Oil Types in Spills in Offshore Newfoundland-Labrador

Oil Type[3]	Exploration		Development & Production	
	% Incidents	% Total Volume	% Incidents	% Total Volume
Synthetic Oils/Fluids	19.0%	95.5%	n/a	49.63%
Crude Oil/Condensate	37.9%	2.1%	n/a	49.33%
Hydraulic/Lubricating Oil	22.4%	0.1%	n/a	0.76%
Diesel and Jet Fuel	10.4%	2.1%	n/a	0.18%
Other Types (Oil)	10.3%	0.1%	n/a	0.09%

Table 15.5 Spill Volumes for Exploration in Newfoundland-Labrador

Volume Category (bbl)	% Total Spills >1 Litre					% Total All Spills (w/<1 Litre)
	Crude Oil/ Condensate	Diesel/Jet Fuel	Hydraulic/ Lube Oil	Synthetic Oils/Fluids	Other Types (Oil)	
0.0001-0.0009	-	-	-	-	-	**5.1%**
0.001-0.009	-	-	-	-	-	**2.6%**
0.01-0.09	40.0%	10.0%	85.7%	20.0%	50.0%	**33.3%**
0.1-0.9	0.0%	30.0%	14.3%	0.0%	50.0%	**15.4%**
1-9	60.0%	50.0%	0.0%	30.0%	0.0%	**28.2%**
10-99	0.0%	10.0%	0.0%	30.0%	0.0%	**10.3%**
100-999	0.0%	0.0%	0.0%	20.0%	0.0%	**5.1%**

Table 15.6 Spill Volumes for Development / Production in Newfoundland-Labrador

Volume Category (bbl)	% Total Spills (>1 litre)					% Total All Spills (w/<1 Litre)
	Crude Oil/ Condensate	Diesel/Jet Fuel	Hydraulic/ Lube Oil	Synthetic Oils/Fluids	Other Types (Oil)	
0.00001-0.00009	-	-	-	-	-	**4.4%**
0.0001-0.0009	-	-	-	-	-	**14.5%**
0.001-0.009	-	-	-	-	-	**35.4%**
0.01-0.09	3.2%	0.0%	0.0%	0.0%	4.5%	**0.6%**
0.1-0.9	59.7%	73.7%	5.5%	23.8%	77.3%	**17.2%**
1-9	24.2%	15.8%	64.4%	16.7%	18.2%	**15.9%**
10-99	8.1%	10.5%	21.9%	26.2%	0.0%	**7.1%**
100-999	3.2%	0.0%	8.2%	28.6%	0.0%	**4.2%**
1,000-9,999	0.0%	0.0%	0.0%	4.8%	0.0%	**0.4%**

[3] The "Other Hydrocarbon" category (Tables 15.4, 15.5 and 15.6) incorporates crude, diesel / jet fuels, hydraulic / lube oils, and "other types". In C-NLOPB data presentation, the term "other hydrocarbons" is used instead of what is termed "other types" in this report. A distinction is made herin to avoid confusion.

15.3.2 Probabilities of Spills from the Project

15.3.2.1 Probability of Batch Spills

Operational or batch spills may potentially occur, including spills of diesel from supply vessels and drilling installations. These spills would be expected to be smaller than large blowouts due to the much more limited quantities of oil. The spillage would be limited to the fuel stored on the vessels. For the proposed exploratory drilling project, the estimated frequencies of smaller batch spills of diesel of varying volumes were estimated to be as shown in Table 15.2. The two modelled scenarios of 100 litres and 1,000 litres are included. The probability analysis assumes that there are up 30 wells that may be in existence in the Project area. In actuality, there may be considerably fewer than 30 wells in existence at any one time. Both the number of wells and the duration of the exploration time period affect the probability of an incident. The more time spent in the exploratory drilling operations and the greater the number of wells, the greater the spill risk exposure.

The frequency of a spill of any volume – from very small to the largest probable batch diesel spill volume of 126 bbl, is 0.045 per well for a 35-day drilling period and 0.084 per well for a 65-day drilling period, as shown in Table 15.7. Since the release probability is time-dependent, the longer the duration of the drilling operation, the greater the probability of a spill. These data were divided into volume categories (Small, Small/Moderate, and Moderate/Large) for one well and 30 wells as shown in Table 15.8.

Table 15.7 Probability of Batch Spills for Project Based on Exploratory Drilling Time

Spill Volume			Each Well During Drilling Operations		Expected Number for 30 Wells During Drilling Operations	
Modelled Scenario	**Litres**	**Bbl**	**35-Day Exploration Duration**	**65-Day Exploration Duration**	**35-Day Exploration Duration**	**65-Day Exploration Duration**
Any volume			0.045	0.084	1.4	2.5
-	≤ 1	≤ 0.0063	0.018	0.034	0.55	1.0
-	10	0.063	0.0067	0.012	0.20	0.37
BS-100L	100	0.63	**0.012**	**0.023**	**0.37**	**0.69**
BS-1000L	1,000	6.30	**0.0046**	**0.0085**	**0.14**	**0.26**
-	10,000	63.00	0.0023	0.0043	0.069	0.13
-	20,000	126.00	0.000045	0.000084	0.0014	0.0025

Table 15.8 Probabilities of Project Drilling Installation Batch Spillage by Volume Category

Volume Category	Probability (Frequency in Exploration Period)			
	35-Day Exploration Duration/Well		65-Day Exploration Duration/Well	
	1 well	30 Wells	1 well	30 Wells
Small (< 1 bbl; <159 litres)	0.037	1.1	0.069	2.1
Small/Moderate (1-10 bbl; 159-1,590 litres)	0.0046	0.14	0.0085	0.26
Moderate/Large (100-1,000 bbl; 15.9-159 m^3)	0.0023	0.070	0.0044	0.13
Modelled Scenario (100 litres)	**0.012**	**0.37**	**0.023**	**0.69**
Modelled Scenario (1,000 litres)	**0.0046**	**0.14**	**0.0085**	**0.26**

In addition to diesel spills from drilling installations and supply vessels, other operational spills may occur, especially of synthetic drilling fluids and muds (SBM). For the Project, the estimated frequencies of SBM spills of varying sizes were estimated to be as shown in Table 15.9. The frequency of a spill of any volume – from very small to the largest likely SBM spill volume of 126 bbl, is 0.025 per well for a 35-day drilling period and 0.046 per well for a 65-day drilling period. The probabilities for larger spills are lower than for smaller spills. The probabilities for the spills of varying volumes add up to the total probability of any spill (0.025 for 35-day wells, and 0.046 for 65-day wells). In addition, the probability of SBM spills over the course of the Project varies by the number of wells. The more wells that are drilled, the more likely a release will occur. The expected spill number is shown for up to 30 wells. If fewer wells are drilled or the drilling period is reduced, the expected spill number is reduced.

Table 15.9 Probability of SBM Spills for Project Based on Exploratory Drilling Time

Spill Volume		Each Well During Drilling Operations		Expected Spill Number for 30 Wells During Drilling Operations	
Litres	Bbl	35-Day Exploration Duration	65-Day Exploration Duration	35-Day Exploration Duration	65-Day Exploration Duration
Any volume		0.025	0.046	0.7479	1.4
≤ 1	≤ 0.0063	0.011	0.020	0.3164	0.59
10	0.063	0.0038	0.0071	0.1151	0.21
100	0.63	**0.0070**	**0.013**	**0.2100**	**0.39**
1,000	6.30	**0.0026**	**0.0048**	**0.0777**	**0.14**
10,000	63.00	0.00075	0.0014	0.0224	0.042
20,000	126.00	0.00053	0.00098	0.0158	0.029

15.3.2.2 Probability of Blowouts

Large-scale exploratory well blowouts are very rare events. The primary concern about blowout scenarios is for the potential volume that may be released into the environment. This concern has become particularly heightened after the 2010 Macondo MC252 blowout in the US Gulf of Mexico (herein called the Deepwater Horizon or DWH spill). While this blowout released a large amount of oil, blowouts, in general, are infrequent and are also statistically shown to generally involve much smaller quantities of oil.

For this analysis, a blowout is defined as "a loss of well control or uncontrolled flow of formation or other fluids, including flow to an exposed formation (an underground blowout) or at the surface of the seabed (a surface blowout), flow through a diverter, or uncontrolled flow resulting from a failure of surface equipment or procedures"[4]. This definition is consistent based on that applied by the US Bureau of Safety and Environmental Enforcement (https://www.bsee.gov/stats-facts/offshore-incident-statistics/loss-of-well-control) [30 CFR Chapter II §250.187]. It is generally consistent with the definitions as applied in other contexts, such as the research analyses conducted (Holand 2006; Holand 2013; Holand 2016). This definition encompasses incidents in which fluids other than oil are released. Only 41 percent of blowouts involve the release of any oil, as opposed to brine, water, or gas. The majority of surface blowouts from exploratory wells last less than five days.

Worldwide, there have been about 50,000 exploratory wells drilled with two large blowouts–the 1979 *Ixtoc I* well blowout, and the DWH spill (2010 Macondo MC252 well blowout). The probability of a well blowout occurring depends on a large number of factors related to the location, well characteristics, operating conditions. For locations for which there are few, if any, offshore oil exploration and production wells, the only benchmarks are historical data from other regions. Estimates of the probability of well blowouts, measured as the frequency or rate per well, have varied by region, time period, and other factors.

Analyses of international and national historical spill data, well blowouts and other well-related spills from offshore drilling activities verify that large blowouts can be considered relatively rare events (Scandpower 2006; OGP 2010; Holand 2013). Estimates for the probability of a particular exploratory well having a blowout over its productive lifespan vary from 0.0011 to 0.005 per well depending on factors such as depth, well pressure, location, and blowout cause. The mean blowout probability for exploratory wells is 0.025 per well. Analyses of international data indicated that if a blowout does occur, there is a 56 percent chance of it only lasting two days or less (i.e., bridging naturally), and only a 15 percent chance of it lasting more than two weeks (Holand 2006).

The probability is also dependent on the number of exploration wells that are actually drilled, with the probability increasing directly with the well number, which could be up to 30 and the total duration of the exploratory drilling. The calculated subsurface release probabilities results are summarized in Table 15.10.

[4] This definition is consistent based on that applied by the US Bureau of Safety and Environmental Enforcement (https://www.bsee.gov/stats-facts/offshore-incident-statistics/loss-of-well-control) [30 CFR Chapter II §250.187]. It is generally consistent with the definitions as applied in other contexts.

Table 15.10 Mean Probabilities of Subsurface Releases for the Project

Spill Types	Mean Probabilities			
	1 well		30 wells	
	35 days	65 days	35 days	65 days
Blowouts	0.0000069	0.000013	0.00021	0.00039
Other Well Releases	0.000010	0.000019	0.00030	0.00057
Total Well Spills	0.000017	0.000032	0.00051	0.00096

These probabilities do not indicate the release volume or imply the release would be a worst-case discharge, only that there would be a release of any size. The probabilities of blowouts by volume category, exploratory drilling duration, and well number are in Table 15.11. Probabilities are differentiated by the length of time required to drill each exploratory well, which ranges from 35 to 65 days.

Table 15.11 Probabilities of Project Well Blowouts by Volume Category

Volume Category	Probability During Exploration Period			
	Per Well		For 30 Wells	
	35-Day	65-Day	35-Day	65-Day
Large (1,000–10,000 bbl or 159-1,590 m³)	0.00010	0.00019	0.0031	0.0057
Very Large (10,000–150,000 bbl or 1,590-23,848 m³)	0.000017	0.000032	0.00052	0.00096
Extremely Large (>150,000 bbl or >23,848 m³)	0.0000086	0.000016	0.00026	0.00048
Modelled Scenarios (3,396,492 bbl or 540,000 m³ (max. volume released))	0.0000018	0.000003	0.000054	0.00010

15.3.3 Summary

The estimated probabilities of the specific spill volumes associated with the modelled scenarios are shown in Table 15.12. The probabilities increase with the number of wells. Overall, the probabilities of spillage are very low and if spillage does occur, the spill volumes are likely to be relatively small.

Table 15.12 Probabilities of Project Scenario Spillage

Scenario[5]	Spill Type	Total Volume Spilled		Probabilities of Spills			
				1 Well		30 Wells	
		bbl	Metric	35-day	65-day	35-day	65-day
BS-100L	Batch spill	0.63	100 L	0.012	0.023	0.37	0.69
BS-1000L	Batch spill	6.3	1,000 L	0.0046	0.0085	0.14	0.26
SSB-NPA 4980 m³/day	Subsurface release	1,127,637	179,280 m³	0.0000018	0.000003	0.000054	0.00010
SSB-EPA 15,000 m³/day	Subsurface release	10,661,211	1,695,000 m³	0.0000018	0.000003	0.000054	0.00010

BS = Batch Spill
SSB – Subsurface Blowout
NPA = Northern Flemish Pass site
EPA = Eastern Flemish Pass site

Note that there is no difference in probabilities of spillage between the NPA and EPA locations per se. However, if there are differing numbers of wells in the two sites the probabilities would be proportional to the number of wells and the total exploratory drilling time.

15.4 Fate and Behaviour of Potential Spills

RPS conducted trajectory and fate modelling for unmitigated subsurface blowouts and batch spills of marine diesel to support the evaluation of environmental effects of accidental events (refer to Appendix E).

Three-dimensional oil spill trajectory and fate modelling and analyses were performed to support evaluation of the potential effects that releases of oil may have in the Atlantic Ocean near Newfoundland. RPS's nearfield OILMAPDeep blowout model and the farfield Spill Impact Model Application Package (SIMAP) trajectory, fate, and effects models were used.

[5] Note that there is no difference in probabilities of spillage between the Northern Flemish Pass site and Eastern Flemish Pass site locations, per se, although if there are differing numbers of wells in the two sites the probabilities would be proportional to the number of wells and the total exploratory drilling time

15.4.1 Study Area and Scenarios

As noted in Section 15.3, the following event scenarios were modelled. Figures 1-1 and 11-2 illustrate the location of the hypothetical modelling sites in relation to the exploration licences.

- Subsurface Blowout (Northern Flemish Pass release site (NPA)): a hypothetical release of 4,980 m³/day (31,323 bbl/day) of crude oil for 36 days for a total of 179,280 m³ (1,127,637 bbl) released from Site NPA (49.22882322, -45.41807056)
- Subsurface Blowout (Eastern Flemish Pass release site (EPA)): a hypothetical release of 15,000 m³/day (94,347 bbl/day) of crude oil for 113 days for a total of 1,695,000 m³ (10,661,229 bbl) released from Site EPA (48.31274, -45.8218)
- Batch Spill (BS)-100L-EPA: a hypothetical release of 100 litres (0.63 bbl) of marine diesel fuel from a drilling installation or supply vessel at the EPA release site (48.31274, -45.8218)
- Batch Spill BS-100L-NPA: a hypothetical release of 100 litres (0.63 bbl) of marine diesel fuel from a drilling installation or supply vessel at the NPA release site (49.22882322, -45.41807056).
- Batch Spill BS-1000L-EPA: a hypothetical release of 1,000 litres (6.3 bbl) of marine diesel fuel from a drilling installation at the EPA release site (48.31274, -45.8218)
- Batch Spill BS-1000L-NPA: a hypothetical release of 1,000 litres (6.3 bbl) of marine diesel fuel from a drilling installation or supply vessel at the NPA release site (49.22882322, -45.41807056)

The hypothetical releases modelled in this study may be considered representative of other potential releases in the Northern Project Area. As described earlier, drilling locations have yet to be determined. The depth of release of the EPA and NPA sites (1,100 m and 2,700 m, respectively) are within the range of areas present within the Northern Project Area. The hypothetical spill locations were chosen to represent the range in water depths over the exploration licences where drilling may occur, and proximity to sensitive areas. In the unlikely event of an actual oil spill, the trajectory, fate, and effects will be strongly determined by the specific environmental conditions, the precise locations and types of species present, and a myriad of details related to the event and specific timeframe. Modelled results are a function of the scenarios simulated and the input data used. The goal of this study was not to forecast every detail that could potentially occur, but to describe a range of possible consequences and effects of oil spills under various representative scenarios, located in different water depths and at varying distances to sensitive receptors within and around the ELs.

15.4.2 Overall Modelling Approach

15.4.2.1 Stochastic Approach

This modelling study employed a stochastic approach to determine the range of potential trajectories and fates of hypothetical hydrocarbon releases based upon the variable forcing conditions (e.g. wind and currents). Stochastic modelling provides a probabilistic view of the likelihood that a given region might experience effects from released hydrocarbons over many possible environmental conditions occurring within and across multiple years.

Hypothetical release scenarios were simulated using the OILMAPDeep and SIMAP modelling packages, two three-dimensional trajectory and fate models developed by RPS. OILMAPDeep was used to define the near-field dynamics of the subsurface blowout plume which was then used as the initial conditions for the far-field modelling conducted in SIMAP. These near-field plume dynamics include the location and size of the subsurface plume at the termination (i.e., trap) height and the characterization of the oil droplet size distribution. Typically, the near-field model is on the timescale of seconds and length scale of hundreds of metres, whereas the far-field model is on the scales of hours/days and many kilometres. These models are described in Appendix E.

A stochastic approach was used in SIMAP to determine the potential footprint of areas that may be affected by a release of oil based upon variability in meteorological and hydrodynamic conditions. A stochastic scenario is a statistical analysis of tens to hundreds of individual trajectories resulting from the same release event, with each trajectory starting at a randomized time from a relatively long-term window. The stochastic approach analyzes the same type of release under varying environmental conditions to provide the anticipated variability in probable movement and behaviour of the release. In order to reproduce the natural variability of winds and currents, the model requires both spatially- and temporally-varying datasets (e.g. hourly to daily time scales) spanning at least five years. A sufficient number of model runs will adequately sample the variability in wind and current speed and direction in the region of interest, and will result in a prediction of the many possible oil pathways for a release at the prescribed location.

In a stochastic analysis, multiple model runs (tens to hundreds of releases) are laid upon one another to create a cumulative footprint of releases. Further analyses provide two types of information for specific thresholds of interest including: 1) the probability that a given area may experience contamination, and 2) the shortest amount of time required for oil to reach any point within the predicted area. To analyze the probability or likelihood of potential effects, specific thresholds for surface oil thickness and shoreline oiling are used (Table 15.13). Figures and further analyses in this study include the lower socioeconomic thresholds of concern calculated from stochastic results.

It is important to note that although large footprints of oil contamination are depicted for stochastic analyses, they are not the expected distribution of oil from any single release. These maps do not provide any specific information on the quantity of oil in a given area. They simply denote the probability of oil exceeding the given threshold passing through each grid cell location in the model domain over the entire model duration (45 or 160 days), based on the entire ensemble of runs (119 individual releases for both locations). Only probabilities of ≥1 percent were included in the map output, as lesser probabilities represent random noise in each set of 119 trajectories. Stochastic maps of water column contamination of dissolved hydrocarbons depict the likelihood that concentrations will exceed the identified threshold at any depth within the water column, but do not specify the depth at which this occurs and do not imply that the entire water column (i.e., from surface to bottom) will experience a concentration above the threshold.

Stochastic results are useful in planning for oil spill response, as they characterize the probability that regions may experience contamination above specified thresholds, taking into account the wind and wave variability that is expected from many potentially-different release scenarios over time.

Table 15.13 Thresholds Used to Define Areas and Volumes Exposed Above Levels of Concern

Threshold Type	Cutoff Threshold	Rationale/Comments (Socioeconomic, Response, Ecological)	Visual Appearance	References
Oil Floating on Water Surface	0.04 g/m²	Socioeconomic: A conservative threshold used in several risk assessments to determine effects on socioeconomic resources (e.g., fishing may be prohibited when sheens are visible on the sea surface). Socioeconomic resources and uses that would be affected by floating oil include commercial, recreational and subsistence fishing; aquaculture; recreational boating, port concerns such as shipping, recreation, transportation, and military uses; energy production (e.g., power plant intakes, wind farms, offshore oil and gas); water supply intakes; and aesthetics.	Fresh oil at this minimum thickness corresponds to a slick being barely visible or scattered sheen (colorless or silvery/grey), scattered tarballs, or widely scattered patches of thicker oil.	French McCay et al., 2011; French McCay et al., 2012; French McCay, 2016; Lewis, 2007, Bonn Agreement
	10 g/m²	Ecological: Mortality of birds on water has been observed at and above this threshold. Sublethal effects on marine mammals, sea turtles, and floating Sargassum communities are of concern.	Fresh oil at this thickness corresponds to a slick being a dark brown or metallic sheen.	French et al., 1996; French McCay, 2009 (based on review of Engelhardt, 1983, Clark, 1984, Geraci and St. Aubin 1988, and Jenssen 1994 on oil effects on aquatic birds and marine mammals); French McCay et al., 2011; French McCay et al., 2012; French McCay, 2016

Table 15.13 Thresholds Used to Define Areas and Volumes Exposed Above Levels of Concern

Threshold Type	Cutoff Threshold	Rationale/Comments (Socioeconomic, Response, Ecological)	Visual Appearance	References
Shoreline Oil	1.0 g/m²	Socioeconomic/Response: A conservative threshold used in several risk assessments. This is a threshold for potential effects on socioeconomic resource uses, as this amount of oil may trigger the need for shoreline cleanup on amenity beaches, and affect shoreline recreation and tourism. Socioeconomic resources and uses that would be affected by shoreline oil include recreational beach and shore use, wildlife viewing, nearshore recreational boating, tribal lands and subsistence uses, public parks and protected areas, tourism, coastal dependent businesses, and aesthetics.	May appear as a coat, patches or scattered tar balls, stain	French-McCay et al., 2011; French McCay et al., 2012; French McCay, 2016
	100 g/m²	Ecological: This is a screening threshold for potential ecological effects on shoreline flora and fauna, based upon a synthesis of the literature showing that shoreline life has been affected by this degree of oiling. Sublethal effects on epifaunal intertidal invertebrates on hard substrates and on sediments have been observed where oiling exceeds this threshold. Assumed lethal effects threshold for birds on the shoreline.	May appear as black opaque oil.	French et al., 1996; French McCay, 2009; French McCay et al., 2011; French McCay et al., 2012; French McCay, 2016

Table 15.13 Thresholds Used to Define Areas and Volumes Exposed Above Levels of Concern

Threshold Type	Cutoff Threshold	Rationale/Comments (Socioeconomic, Response, Ecological)	Visual Appearance	References
In Water Concentration	1.0 ppb (µg/L) of dissolved PAHs; corresponds to approximately 100 ppb (µg/L) of whole oil (THC) in the water column (soluble PAHs are approximately 1% of the total mass of fresh oil)	Water column effects for both ecological and socioeconomic (e.g., seafood) resources may occur at concentrations exceeding 1 ppb dissolved PAH or 100 ppb whole oil; this threshold is typically used as a screening threshold for potential effects on sensitive organisms.	N/A	Trudel et al. 1989; French-McCay 2004; French McCay 2002; French McCay et al. 2012
*Thresholds used in supporting stochastic results figures. For comparison, a bacterium is 1-10 µm in size, a strand of spider web silk is 3-8 µm, and paper is 70-80 µm thick. Oil averaging 1 g/m² is approximately equivalent to 1 µm				

15.4.2.2 Deterministic Approach

Individual trajectories of interest were identified and selected from the stochastic ensemble of results for the deterministic analysis. The deterministic trajectory and fate simulations provided an estimate of the oil's transport through the environment as well as its physical and chemical behavior for a specific set of environmental conditions. While the stochastic analysis provides insight into the probable behavior of oil releases given historic wind and current data for the Project Area, the deterministic analysis provides individual trajectory, oil weathering information, expected concentrations or thicknesses of oil contamination, mass balance, or other information related to a single release at a given location and time.

Representative deterministic scenarios (i.e., single trajectory) were identified from each set of stochastic subsurface blowout results. Individual scenarios were selected based upon the size of the surface oil footprint, the mass of oil on shorelines, and the concentration of dissolved hydrocarbons in the water column, based upon a set of highly conservative socioeconomic thresholds:

- Surface oil average thickness >0.04 µm
- Shore oil average concentration >1.0 g/m²
- Subsurface (within the water column) dissolved hydrocarbon concentrations >1.0 µg/L

The selected scenarios included the identified 95th percentile runs for surface oil footprint, shoreline oil length, and water column contamination identified for each release location. Because there was limited predicted contact with shorelines, the 98th percentile shoreline oil length scenario was used. In addition to these six deterministic scenarios, four surface releases of marine diesel were modelled as batch spills, including two release volumes (100 L and 1,000 L) at both release locations.

15.4.3 Model Input Data

Geographical data including habitat mapping and shoreline identification and classification were obtained from multiple data sources. ECCC shoreline and habitat data was used for Newfoundland and Labrador areas. Additional site-specific data from the New Brunswick Department of Natural Resources and Nova Scotia Department of Natural Resources were used. For the US shoreline, the US National Oceanic and Atmospheric Administration's (NOAA) Environmental Sensitivity Index and Maine Department of Environmental Protection's Environmental Vulnerability Index were used. Bathymetry was characterized using databases provided by NOAA National Geophysical Data Center and General Bathymetric Chart of the Oceans (see Section 3 of Appendix E for details).

Currents for the North Atlantic region were acquired from the US Navy Global HYCOM (HYbrid Coordinate Ocean Model) circulation model. For this study, daily current data were obtained for the period January 2006 through December 2010 for the North Atlantic region. HYCOM is a primitive-equation ocean general circulation model that evolved from the Miami Isopycnic-Coordinate Ocean Model (MICOM). MICOM has become one of the premier ocean circulation models, having been subjected to several validation studies. As with any hydrodynamic model, there is the potential that local currents may deviate from predictions based upon grid resolution and small scale variability in ocean circulation dynamics. However, it is believed that the data that was used is sufficient for this type of modelling.

Wind data for this study were obtained from the US National Centers for Environmental Prediction Climate Forecast System Reanalysis (CFSR) model. All data were acquired for the period between 2006 and 2010 (see Section 3 of Appendix E for details).

Two hydrocarbon products and release sites were modelled for this study including:

1) Bay du Nord (BdN) crude oil at Statoil's NPA and EPA sites
2) Marine diesel in the surface vessel transfer batch-release deterministic scenarios

The physical and chemical data used to characterize these oils was provided by Statoil, with additional assays and measurements by S.L. Ross Environmental Research Ltd. (2016) and Intertek (2016).

BdN is a light crude oil with low viscosity and a high aromatic content (Tables 15.14 and 15.15). The marine diesel modelled is a standard diesel that also has a low viscosity and high content of soluble hydrocarbons. The low viscosity and high soluble content of these oil products provides conservative approximations of anticipated concentrations in the water following a release, as a relatively large proportion of constituents have the potential to dissolve into the water column, when compared to oils with lower soluble content. The physical and chemical parameters of BdN are similar to those of Hibernia crude oil, which was used in previous studies (SL Ross 2016; Environmental Science and Technology Center 2001). These oils would likely behave similarly in the event of a release, with marine diesel being least persistent.

Table 15.14 Physical Properties for the Two Oil Products Used in Modelling

Physical Property	BdN Crude Oil	Marine Diesel
Density (g/cm³)	0.84553 @16°C 0.85800 @0°C	0.83100 @25°C 0.83089 @16°C
Viscosity (cP)	5.0 @20°C 53.0 @0°C	2.76 @25°C 2.76 @15°C
API Gravity	35.85	38.8
Pour Point (°C)	-9	-50
Interface Tension (dyne/cm)	15.5	27.5
Emulsion Maximum Water Content (%)	72	0

Table 15.15 Fraction of the Whole Oil Comprised of Different Distillation Cuts for the Two Oil Products

Distillation Cut[6]	Boiling Point (°C)	Description	BdN Crude Oil	Marine Diesel
AR1	<180	highly volatile and soluble monoaromatic hydrocarbons (BTEX[7] and MAHs C_6-C_9)	0.023739	0.019333
AR2	180 - 264	semi-volatile and soluble 2-ring aromatics (MAHs and PAHs C_{10}-C_{12})	0.004166	0.011410
AR3	265 - 380	low volatility and solubility 3-ring aromatics (PAHs C_{13}-C_{18})	0.066998	0.015605
AL1	<180	highly volatile aliphatics (C_4-C_8)	0.206261	0.144667
AL2	180 - 280	semi-volatile aliphatics (C_9-C_{16})	0.160834	0.478690
AL3	280 - 380	low volatility aliphatics (C_{17}-C_{23})	0.168002	0.303295
THC1	<180	total hydrocarbon fraction 1 (sum of AR1 and AL1)	0.230000	0.164000
THC2	180 - 280	total hydrocarbon fraction 2 (sum of AR2 and AL2)	0.165000	0.490100
THC3	280 - 380	total hydrocarbon fraction 3 (sum of AR3 and AL3)	0.235000	0.318900
Residuals	>380	aromatics ≥ 4 rings and aliphatics > C20 that are neither volatile nor soluble	0.37000	0.02700
Note that the total hydrocarbon concentration (THC) is the sum of the aromatic (AR) and aliphatic (AL) groups. Numbers of carbons in the included compounds are listed.				

15.4.4 Model Results

The results from both the subsurface blowouts and topside releases presented below illustrate the spatial extent of the water surface and shoreline oil contamination. Stochastic results include:

- The probability footprints for surface oil in excess of 0.04 µm;
- The corresponding minimum time for surface oil to exceed a threshold of 0.04 µm;
- The probability footprints of shoreline oil in excess of 1 g/m²; and
- The corresponding minimum time for surface oil to exceed a threshold of 1 g/m².

[6] Note that the terms “aromatic” and “aliphatic” are used in a modelling context. “Aromatic” refers to all soluble and volatile hydrocarbons and may include actual aliphatic compounds in the chemical sense that are soluble. In the modelling context, “aliphatic” refers to insoluble and volatile hydrocarbons.
[7] BTEX (benzene, toluene, ethylbenzene, xylene), MAHs (monocylic aromatic hydrocarbons), and PAHs (polycyclic aromatic hydrocarbons) are the more soluble, bioavailable, and potentially toxic components in oil.

The probabilities of oiling were based on a statistical analysis of the ensemble of individual trajectories modelled for each release scenario. Stochastic figures do not imply that the entire contoured area would be covered with oil in the event of a release, nor do they provide any specific information on the quantity of oil in a given area. Rather, these figures denote the probability of oil exceeding socioeconomic effects thresholds over all stochastic runs (119 individual releases for the annual scenario), at all modelled time steps (over 160 days), and for each point within the modelled domain. Note that only probabilities of ≥1 percent were included in the map output.

15.4.4.1 Stochastic Results

The minimum time footprints correspond with the associated probability of oiling map. Each figure illustrates the shortest amount of time required (from the initial release) for each point within the footprint to exceed the defined threshold. The time reported is the minimum value for each point from the entire ensemble of trajectories. Together, probability and minimum time figures can be interpreted together to read: “There is X percent probability that oil will exceed the identified threshold at a specific location, and this exceedance can occur in as little as Y days”. The Exclusive Economic Zone (EEZ) for Canada and the U.S., as well as the international border, are depicted on each map to provide context in regard to the spatial extent.

Stochastic footprints for potential surface oil exceeding a thickness of 0.04 µm were between 2,235,000 and 2,751,000 km². These footprints depict areas with the highest predicted likelihood of potential oil on the surface to the east of the release sites, with a much lower probability (1-10 percent and 10-25 percent) for oil to be transported to the west towards Canadian waters. While these areas are quite large, most of this footprint represents a relatively low probability (<10 percent) of surface oil thickness >0.04 µm. Footprints depicting higher probability contours (90 percent) yield only a fraction of the total footprint, ranging from 81,630 to 586,600 km² depending on the scenario.

The highest predicted potential (1-2 percent) for oil to make contact with shorelines exceeding 1 g/m² occurred in winter scenarios, with summer conditions typically resulting in substantially less, if any contact with shorelines after 160 days. For releases at EPA, oil was predicted to reach Sable Island with a low probability (1-2 percent) during the summer season. During the winter season, oil was predicted to reach the southeastern and northern coasts of Newfoundland. The oil that was predicted to make it to shorelines is expected to be highly weathered, patchy, and discontinuous, as minimum time estimates for first shoreline oil exposure occurs after 78 days. There was no predicted shoreline contact from the releases at the NPA site. Modelled oil from these subsurface releases had a higher potential to be transported to the west and southwest prior to surfacing, where surface currents and winds typically carried releases further offshore.

All figures depict data where probability of a region exceeding the threshold is >1 percent. When comparing annual to seasonal results, the predicted percent exceedance depends on the total number of releases investigated in each subset of releases. Therefore, while only one scenario might be required to exceed the 1 percent threshold for visualization in seasonal results (64 or 55 modelled simulations), two scenarios would be required to exceed the same threshold in the annual analysis (119 modelled simulations), due to the greater number of modelled releases in the annual set of runs being analyzed.

Figures depicting stochastic results are provided for surface oil thickness >0.04 µm, dissolved hydrocarbon contamination >1 µg/L, and shoreline contact >1g/m² for annual, summer, and winter scenarios for EPA (Figures 15-1 to 15-9) and NPA (Figures 15-10 to 15-18). Predicted areas, volumes, and lengths exceeding the identified thresholds for surface oil thickness, water column concentration, and mass per unit area on shorelines for each of the NPA and EPA sites are provided in Table 15.16. The probability of shoreline contamination and minimum time for predicted oil exposure exceeding 1 g/m² are listed in Table 15.17.

Table 15.16 Predicted Areas, Volumes, and Lengths Exceeding the Identified Thresholds for Surface Oil Thickness, Water Column Concentration, and Mass per Unit Area on Shorelines for the Northern Flemish Pass site and the Eastern Flemish Pass Sites

Stochastic Scenario Parameters			Area, Volume, or Length Exceeding Threshold		
Component and Threshold	**Site**	**Probability Contour or Bin**	**Annual Results**	**Winter (ice cover)**	**Summer (ice-free)**
Area (km²) of Surface Oil > 0.04 µm, on average	EPA	1%	2,792,000	2,751,000	2,507,000
		10%	2,119,000	2,111,000	2,026,000
		90%	586,600	485,800	744,100
	NPA	1%	2,441,000	2,526,000	2,235,000
		10%	1,498,000	1,514,000	1,428,000
		90%	130,600	81,630	178,600
Volume (km³) of Water Column Dissolved Hydrocarbons > 1 µg/L at some depth within the water column	EPA	1%	2,888,000	2,951,000	2,807,000
		10%	2,437,000	2,532,000	2,374,000
		90%	1,294,000	1,243,000	1,491,000
	NPA	1%	2,516,000	2,522,000	2,479,000
		10%	2,000,000	2,111,000	2,077,000
		90%	705,200	818,700	727,400
Length (km) of Shoreline Oil > 1 g/m², on average	EPA	1 - 5%	-	8.3	5
		5 - 15%	-	-	-
		15 - 35%	-	-	-
	NPA	1 - 5%	-	-	-
		5 - 15%	-	-	-
		15 - 35%	-	-	-
EPA = Eastern Flemish Pass site NPA = Northern Flemish Pass site					

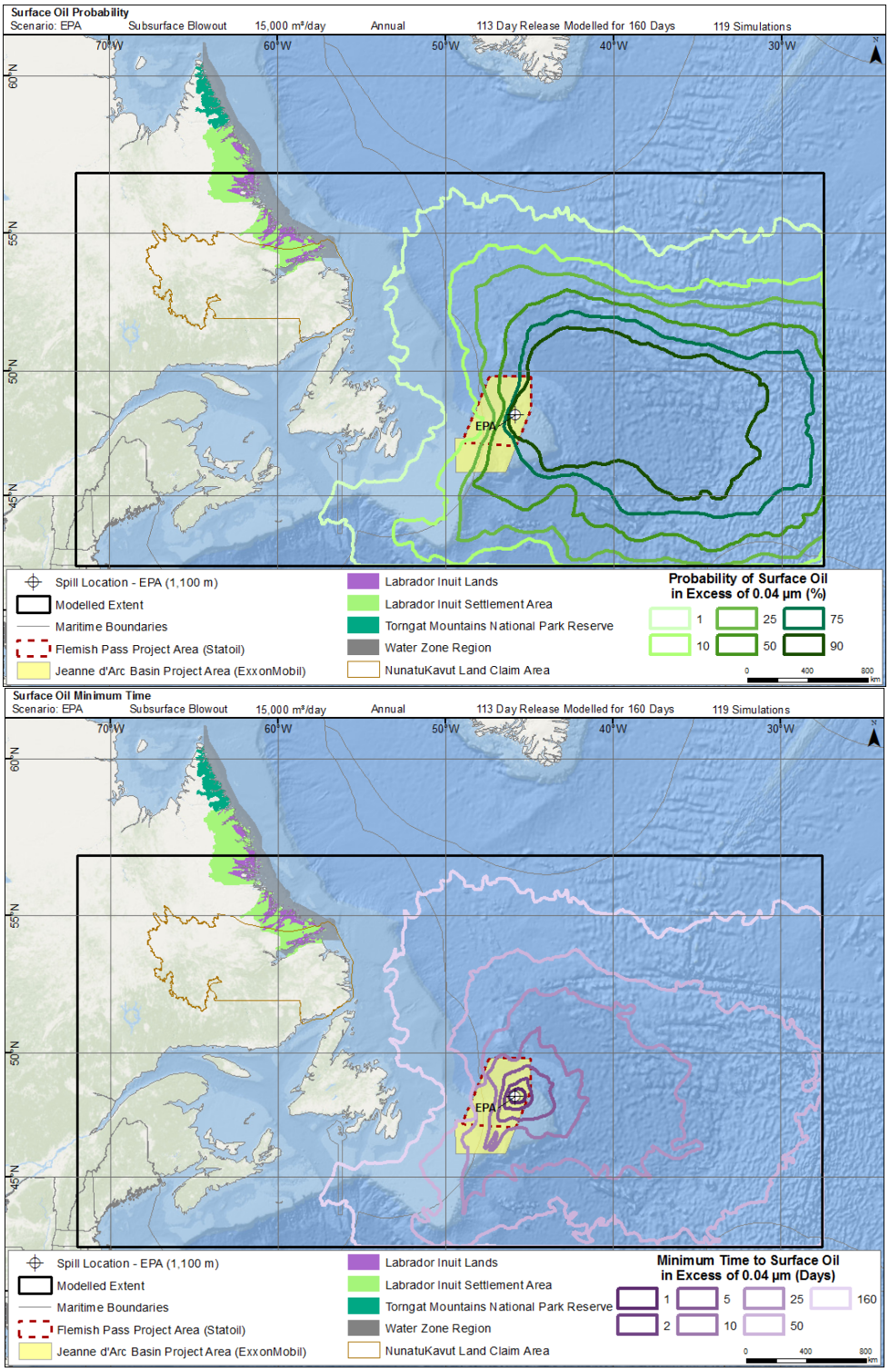


Figure 15-1 Annual probability of average surface oil thickness >0.04 µm (top) and minimum time to threshold exceedance (bottom) resulting from a subsurface blowout at the Eastern Flemish Pass Site

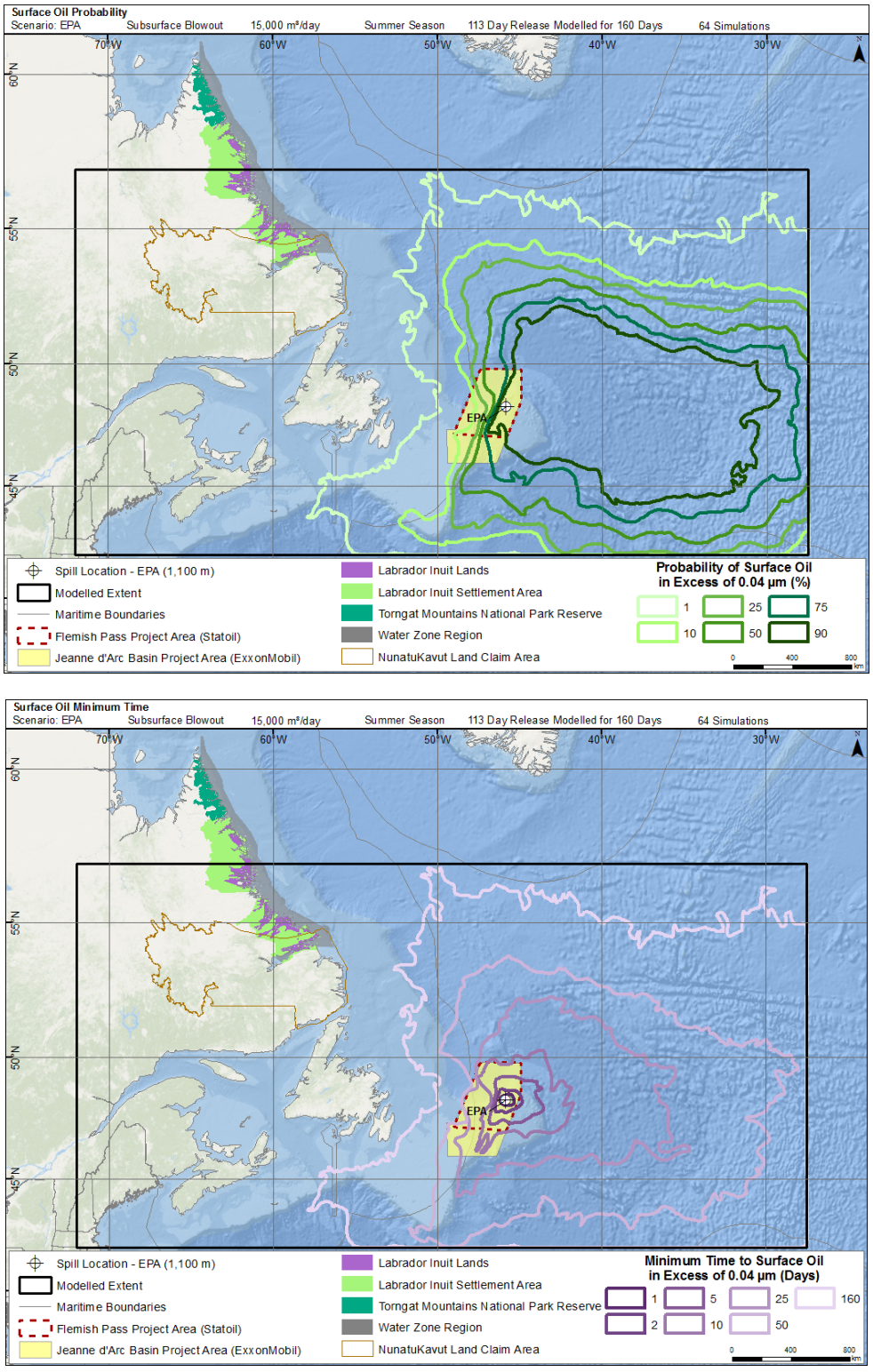


Figure 15-2 Summer probability of average surface oil thickness >0.04 µm (top) and minimum time to threshold exceedance (bottom) resulting from a subsurface blowout at the Eastern Flemish Pass site

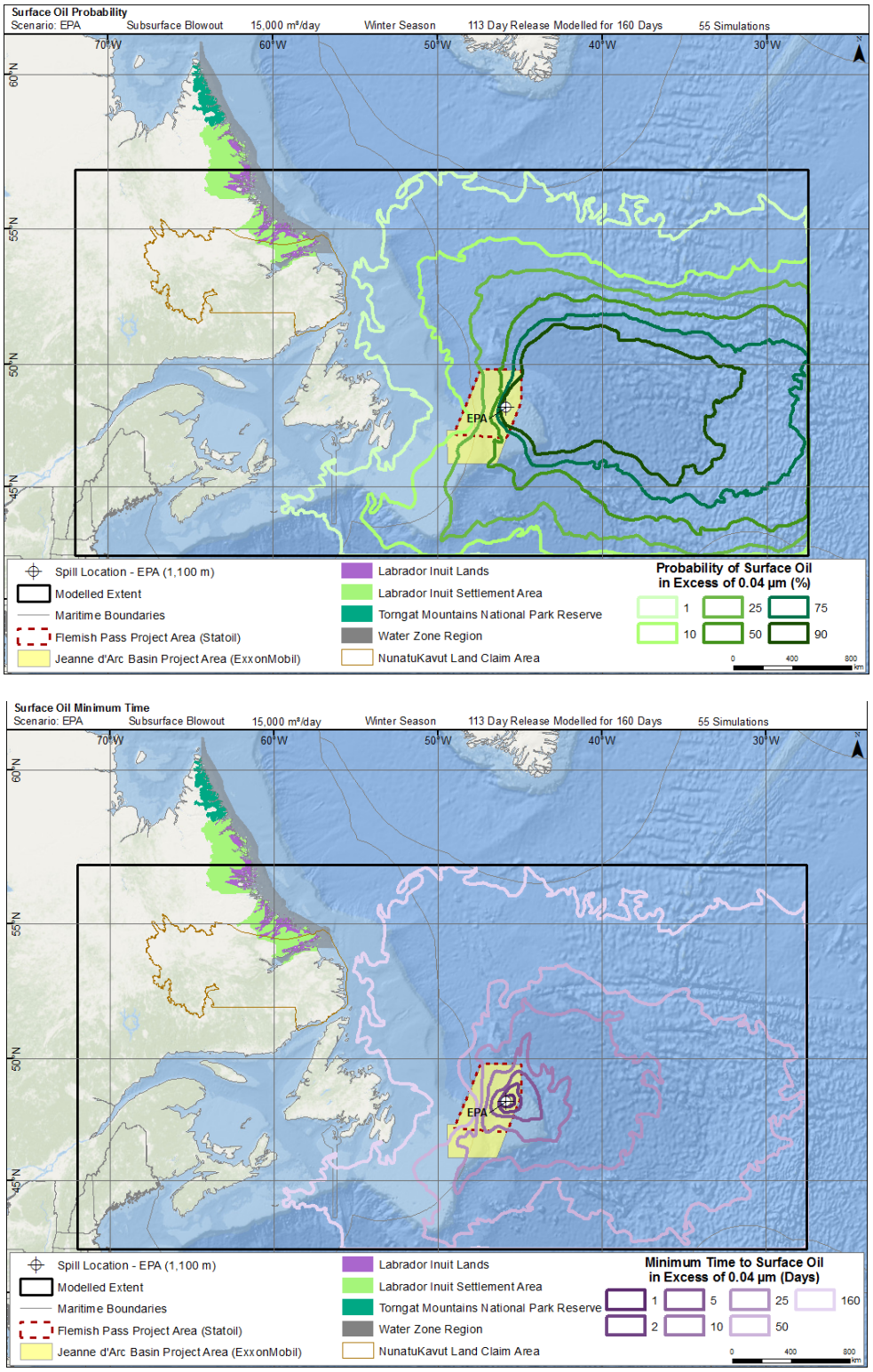


Figure 15-3 Winter probability of average surface oil thickness > 0.04 µm (top) and minimum time to threshold exceedance (bottom) resulting from a subsurface blowout at the Eastern Flemish Pass site

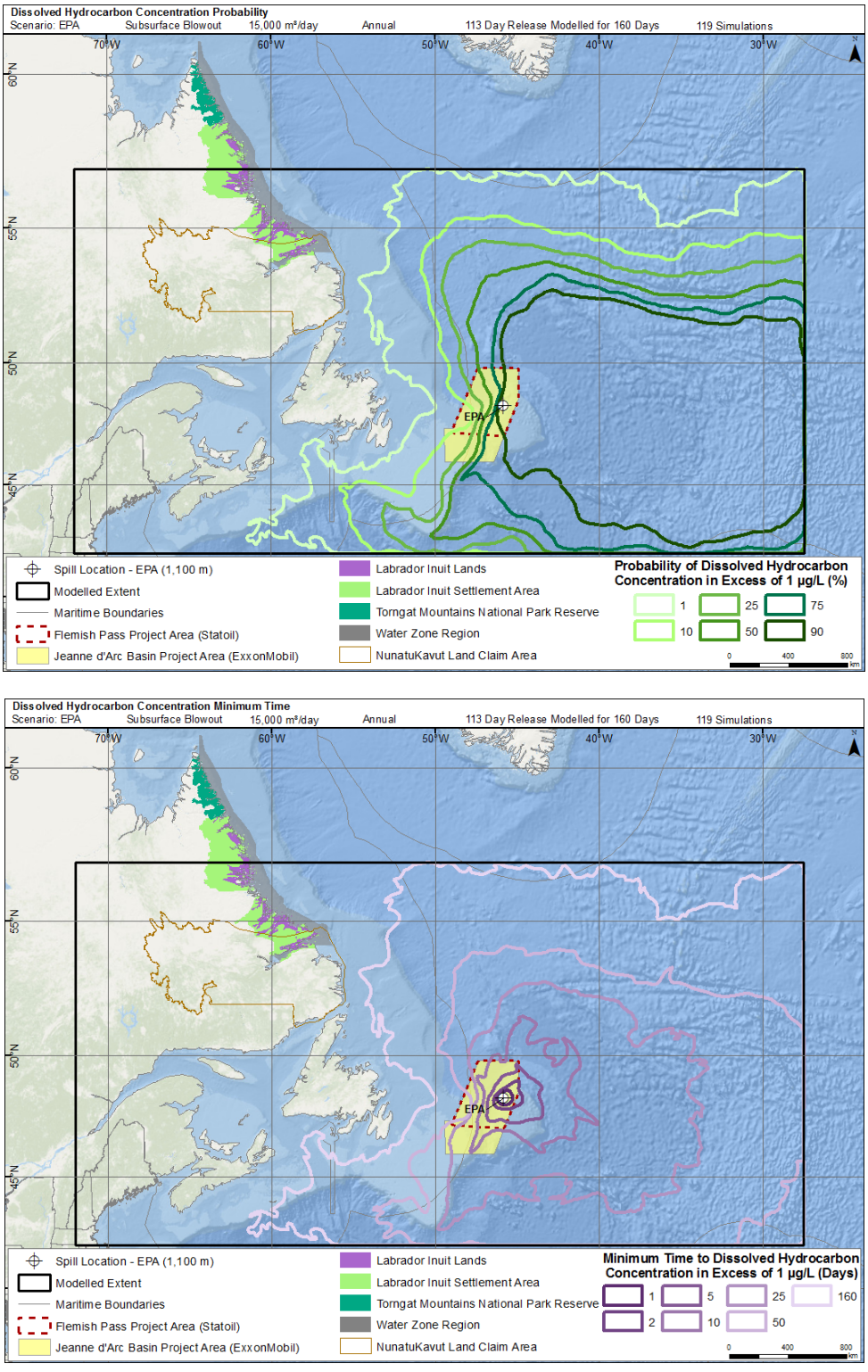


Figure 15-4 Annual probability of dissolved hydrocarbon concentrations >1 µg/L at some depth in the water column (top) and minimum time to threshold exceedance (bottom) resulting from a subsurface blowout at the Eastern Flemish Pass site

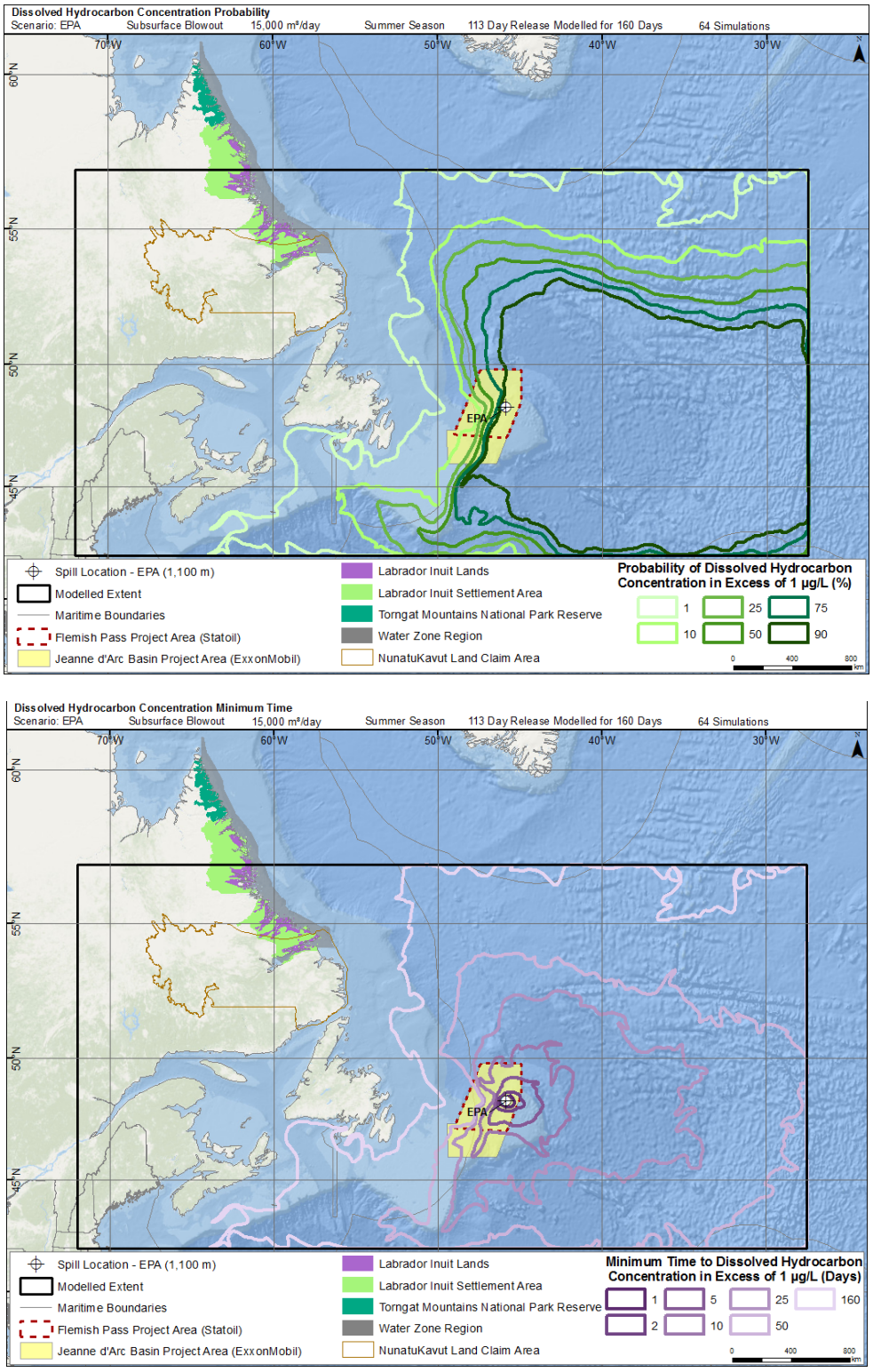


Figure 15-5 Summer probability of dissolved hydrocarbon concentrations >1 µg/L at some depth in the water column (top) and minimum time to threshold exceedance (bottom) resulting from a subsurface blowout at the Eastern Flemish Pass site

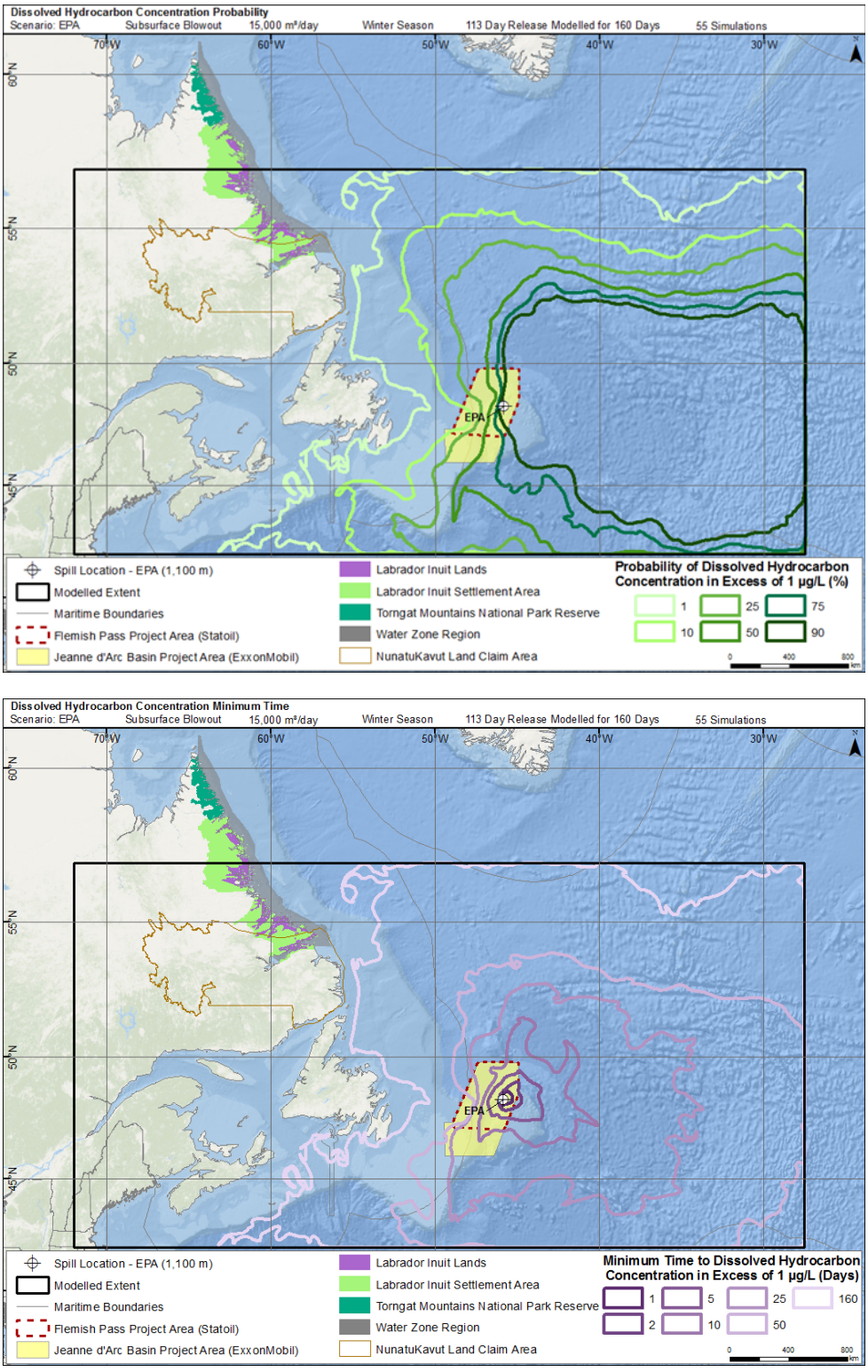


Figure 15-6 Winter probability of dissolved hydrocarbon concentrations >1 µg/L at some depth in the water column (top) and minimum time to threshold exceedance (bottom) resulting from a subsurface blowout at the Eastern Flemish Pass site

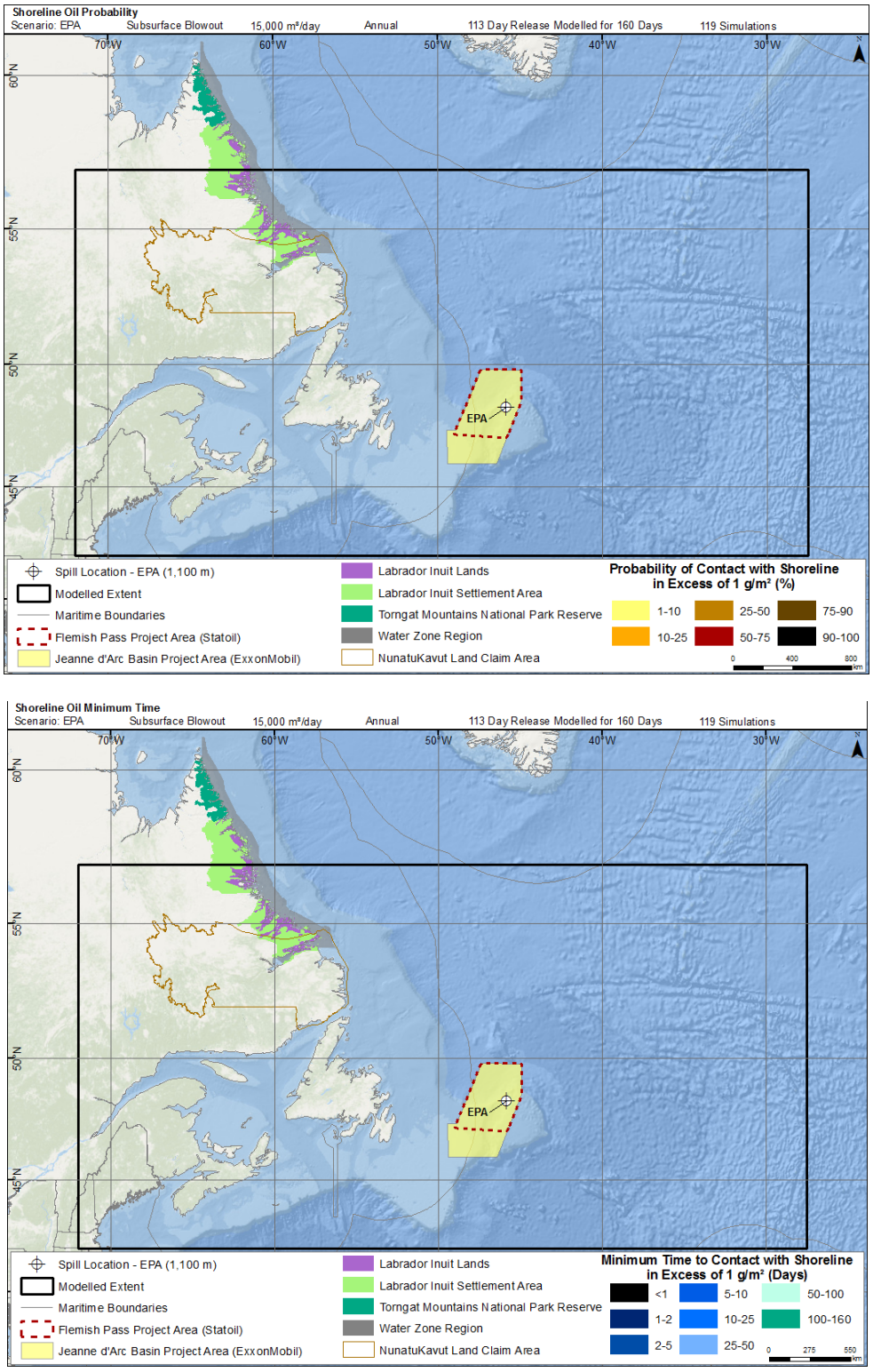


Figure 15-7 Annual probability of shoreline contact >1 g/m² (top) and minimum time to threshold exceedance (bottom) resulting from a subsurface blowout at the Eastern Flemish Pass site

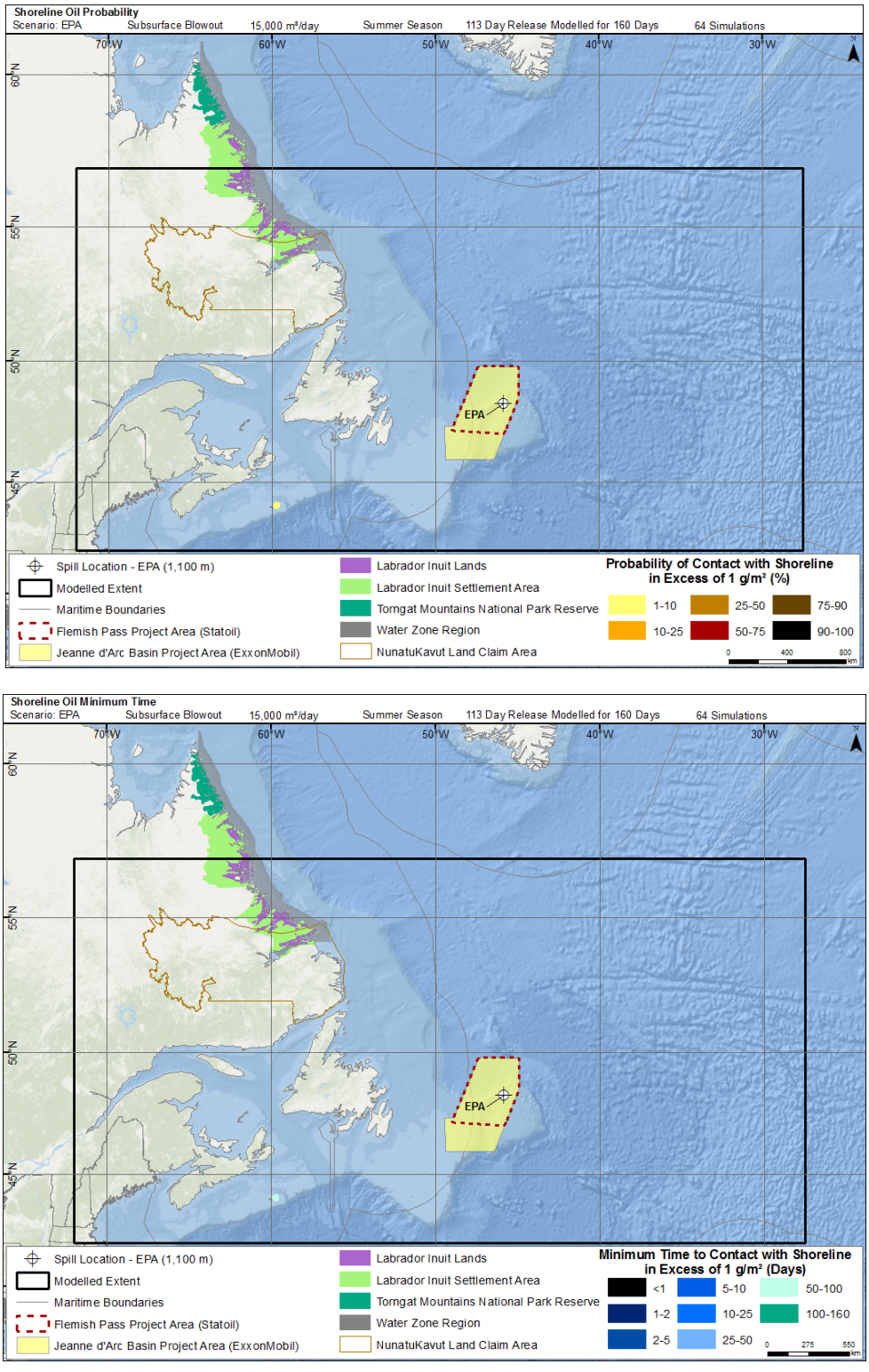


Figure 15-8 Summer probability of shoreline contact >1 g/m² (top) and minimum time to threshold exceedance (bottom) resulting from a subsurface blowout at the Eastern Flemish Pass site

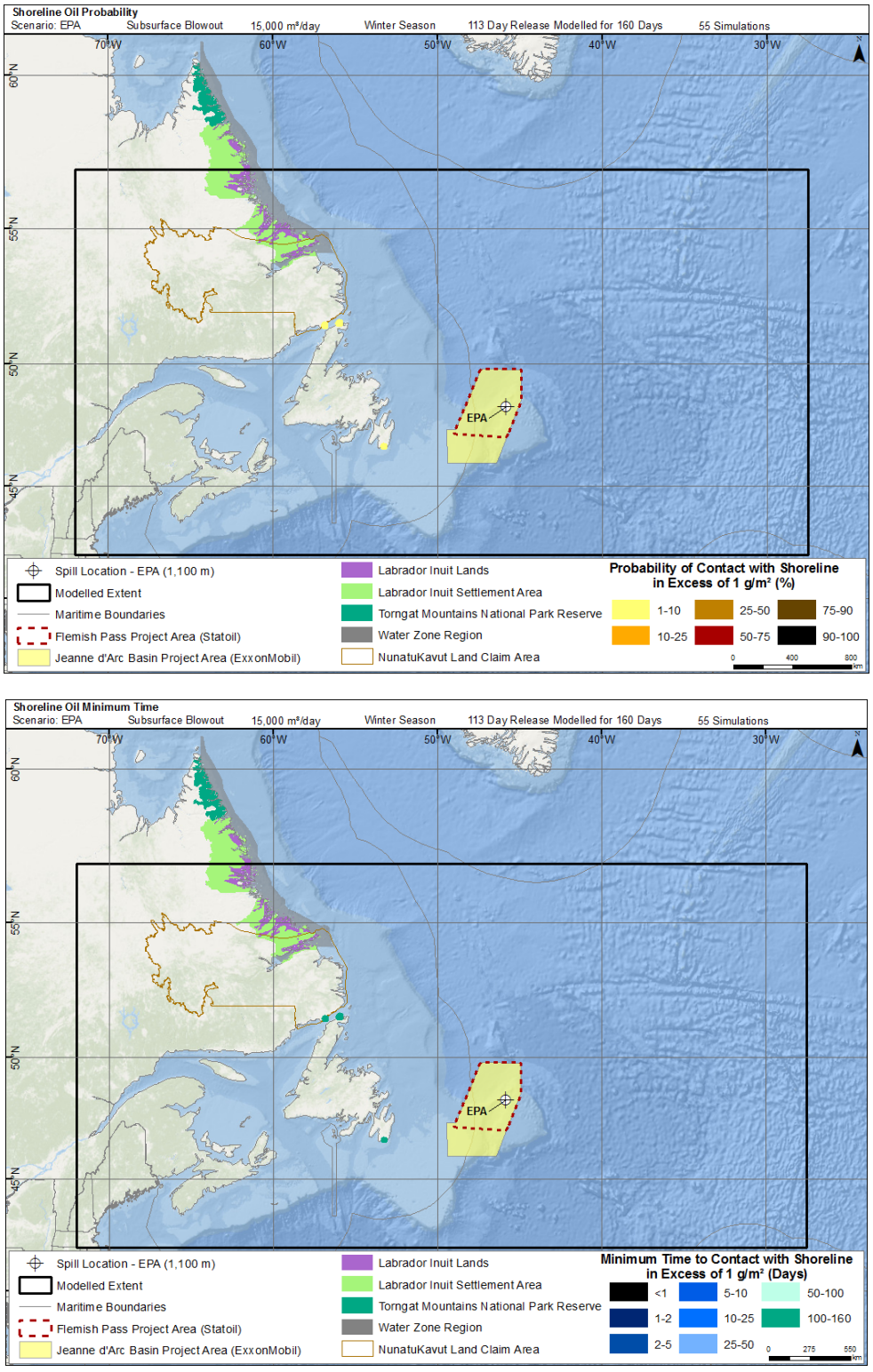


Figure 15-9 Winter probability of shoreline contact >1 g/m² (top) and minimum time to threshold exceedance (bottom) resulting from a subsurface blowout at the Eastern Flemish Pass site

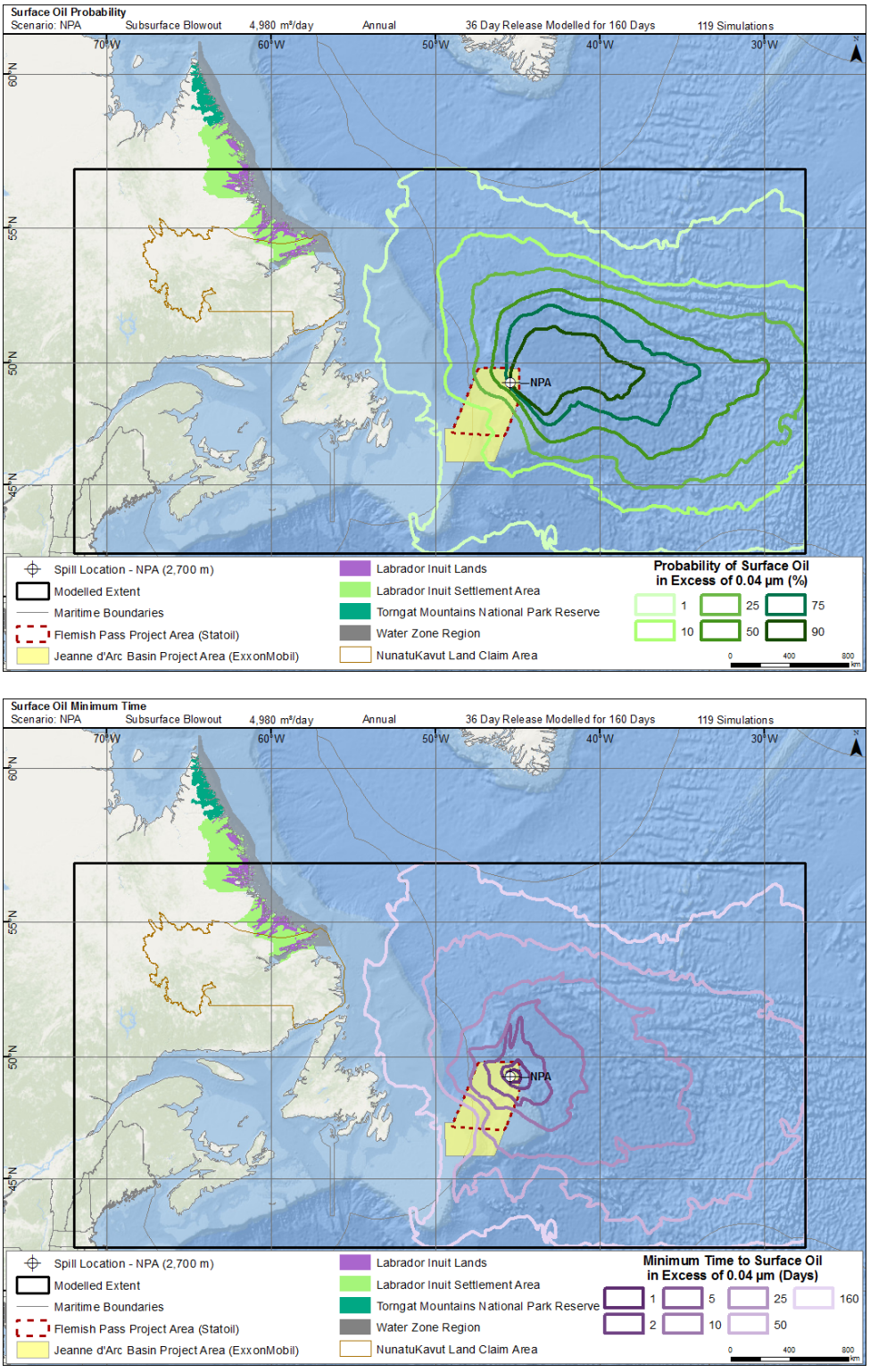


Figure 15-10 Annual probability of average surface oil thickness >0.04 µm (top) and minimum time to threshold exceedance (bottom) resulting from a subsurface blowout at the Northern Flemish Pass site

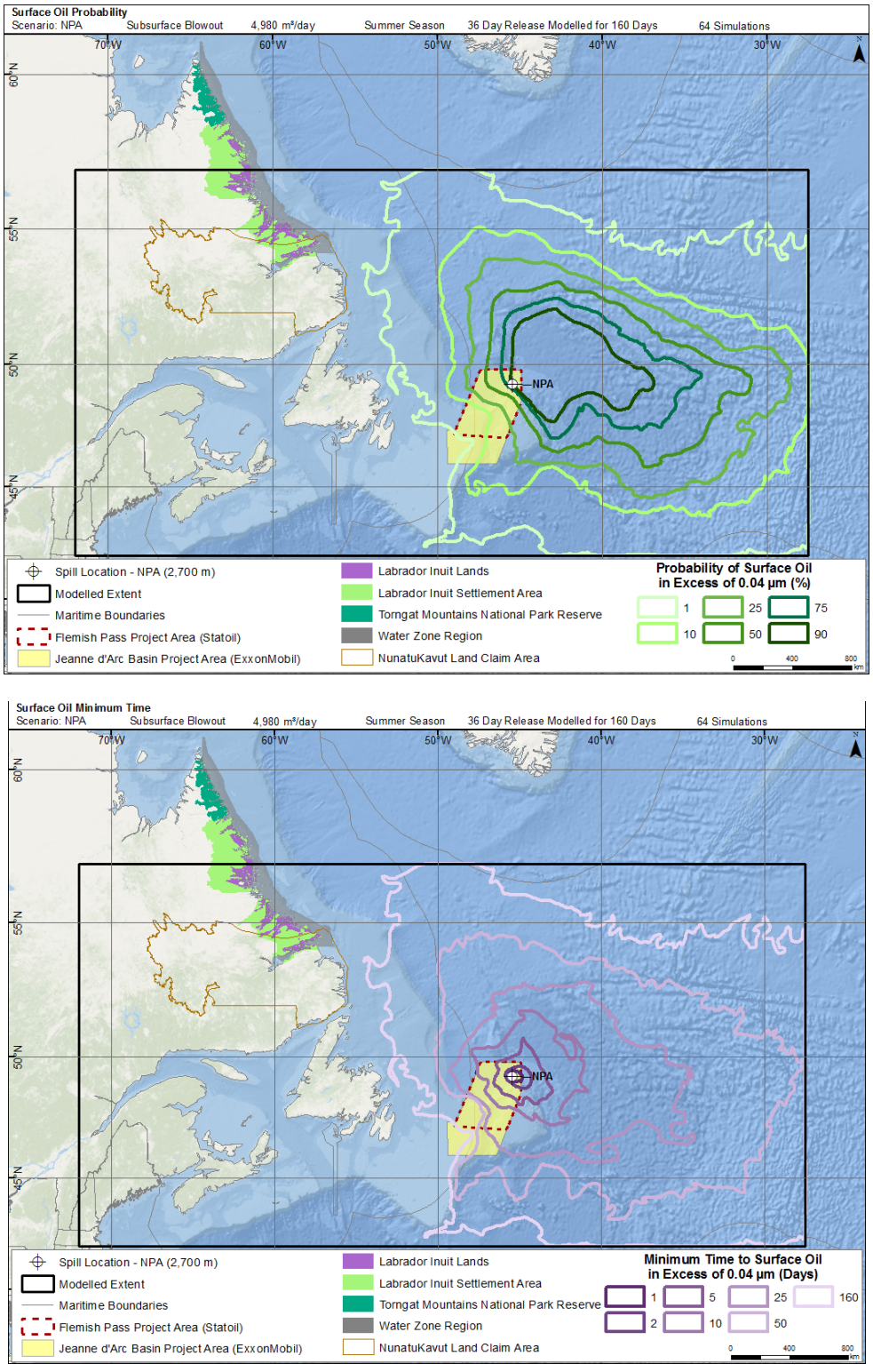


Figure 15-11 Summer probability of average surface oil thickness >0.04 µm (top) and minimum time to threshold exceedance (bottom) resulting from a subsurface blowout at the Northern Flemish Pass site

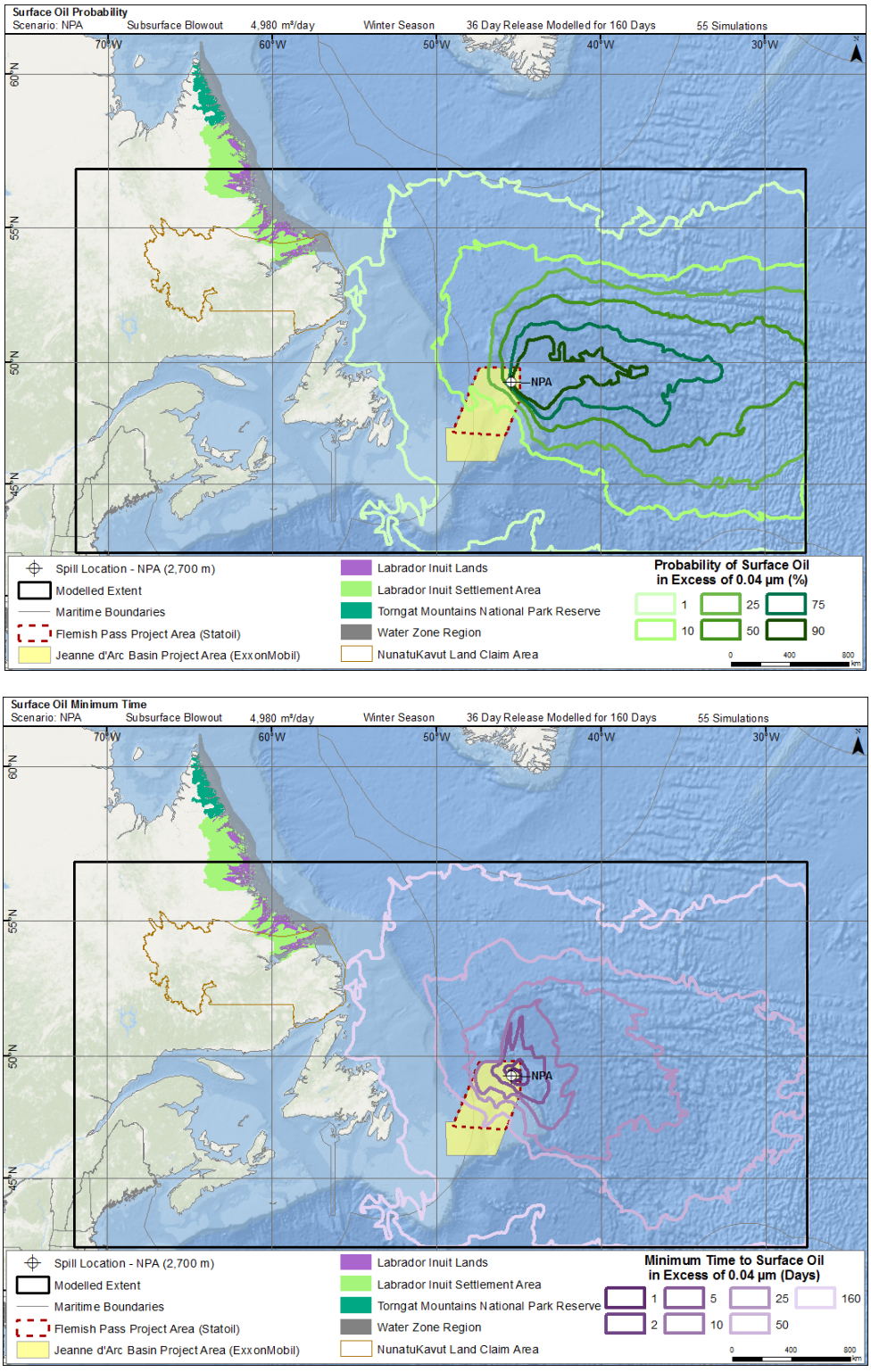


Figure 15-12 Winter probability of average surface oil thickness >0.04 µm (top) and minimum time to threshold exceedance (bottom) resulting from a subsurface blowout at the Northern Flemish Pass site

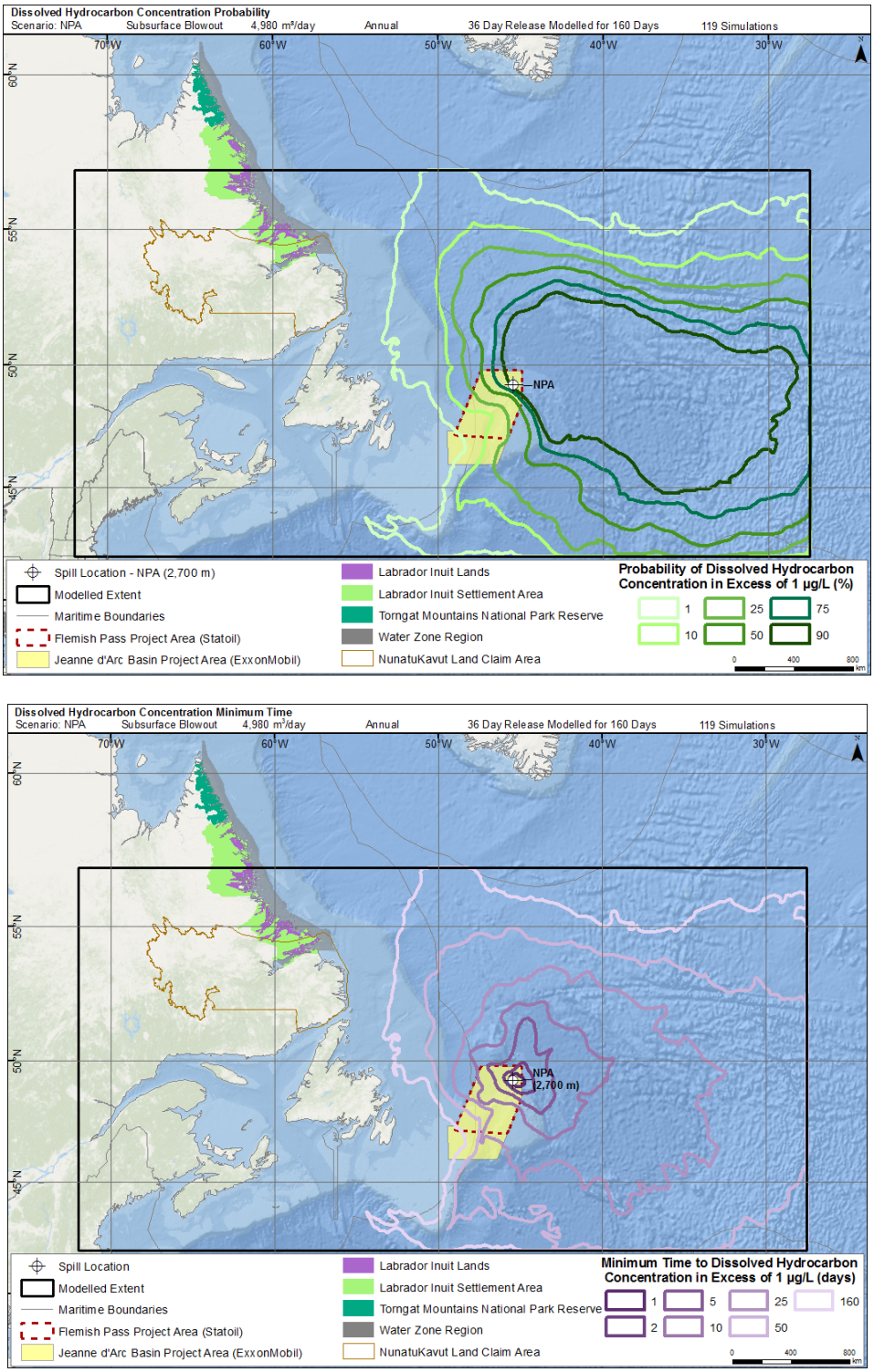


Figure 15-13 Annual probability of dissolved hydrocarbon concentrations >1 µg/L at some depth in the water column (top) and minimum time to threshold exceedance (bottom) resulting from a subsurface blowout at the Northern Flemish Pass site

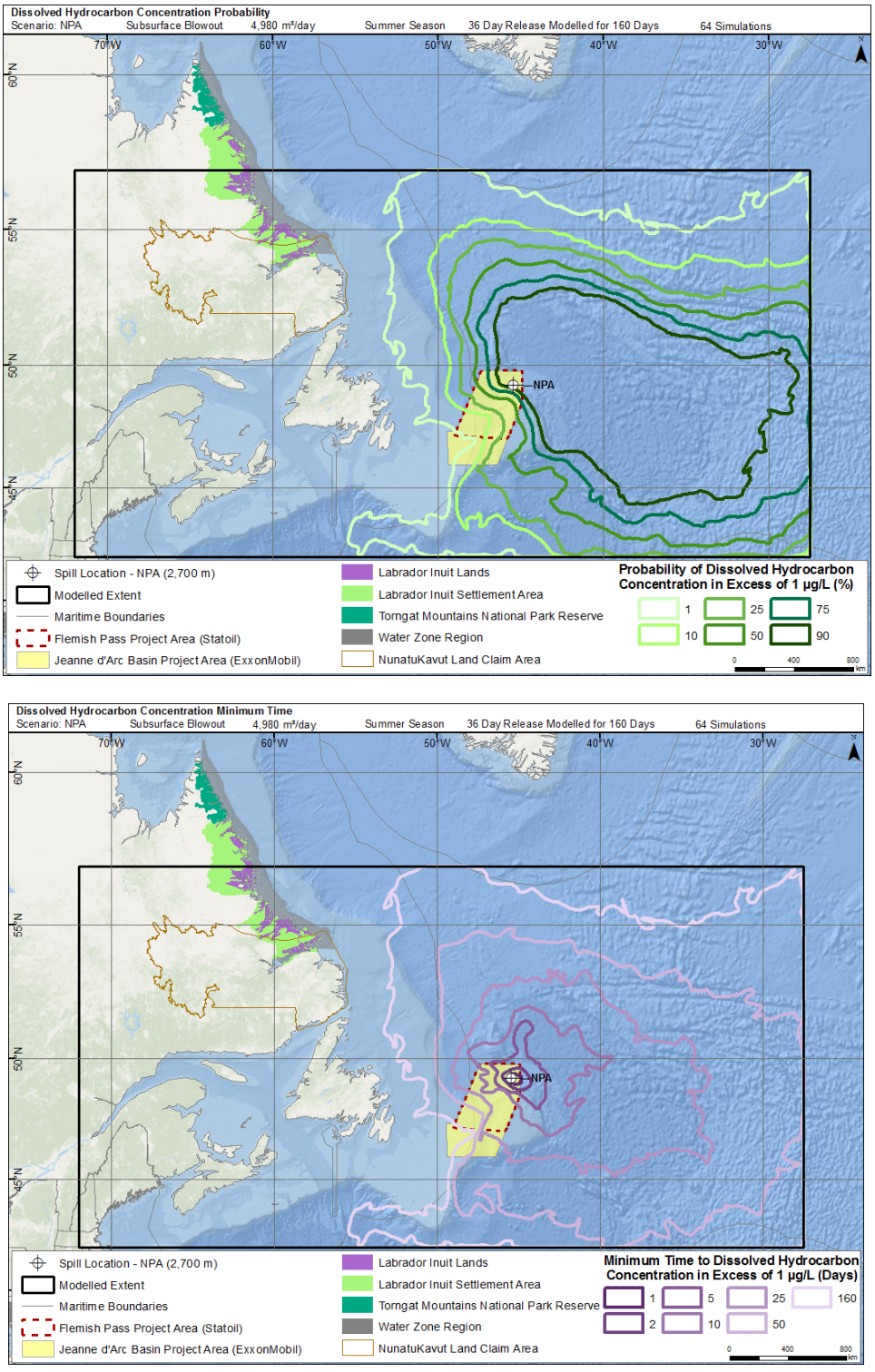


Figure 15-14 Summer probability of dissolved hydrocarbon concentrations >1 µg/L at some depth in the water column (top) and minimum time to threshold exceedance (bottom) resulting from a subsurface blowout at the Northern Flemish Pass site

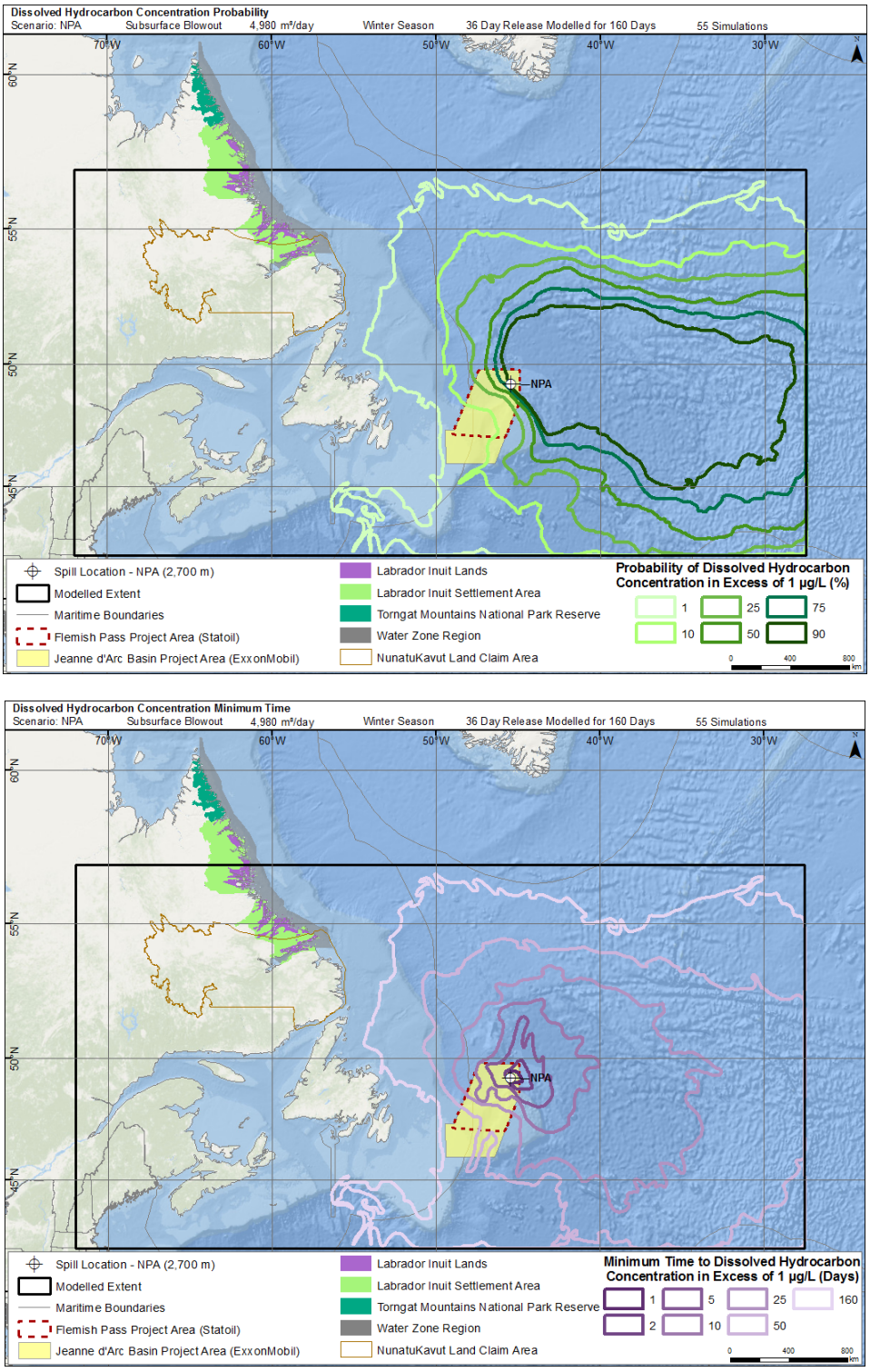


Figure 15-15 Winter probability of dissolved hydrocarbon concentrations >1 µg/L at some depth in the water column (top) and minimum time to threshold exceedance (bottom) resulting from a subsurface blowout at the Northern Flemish Pass site

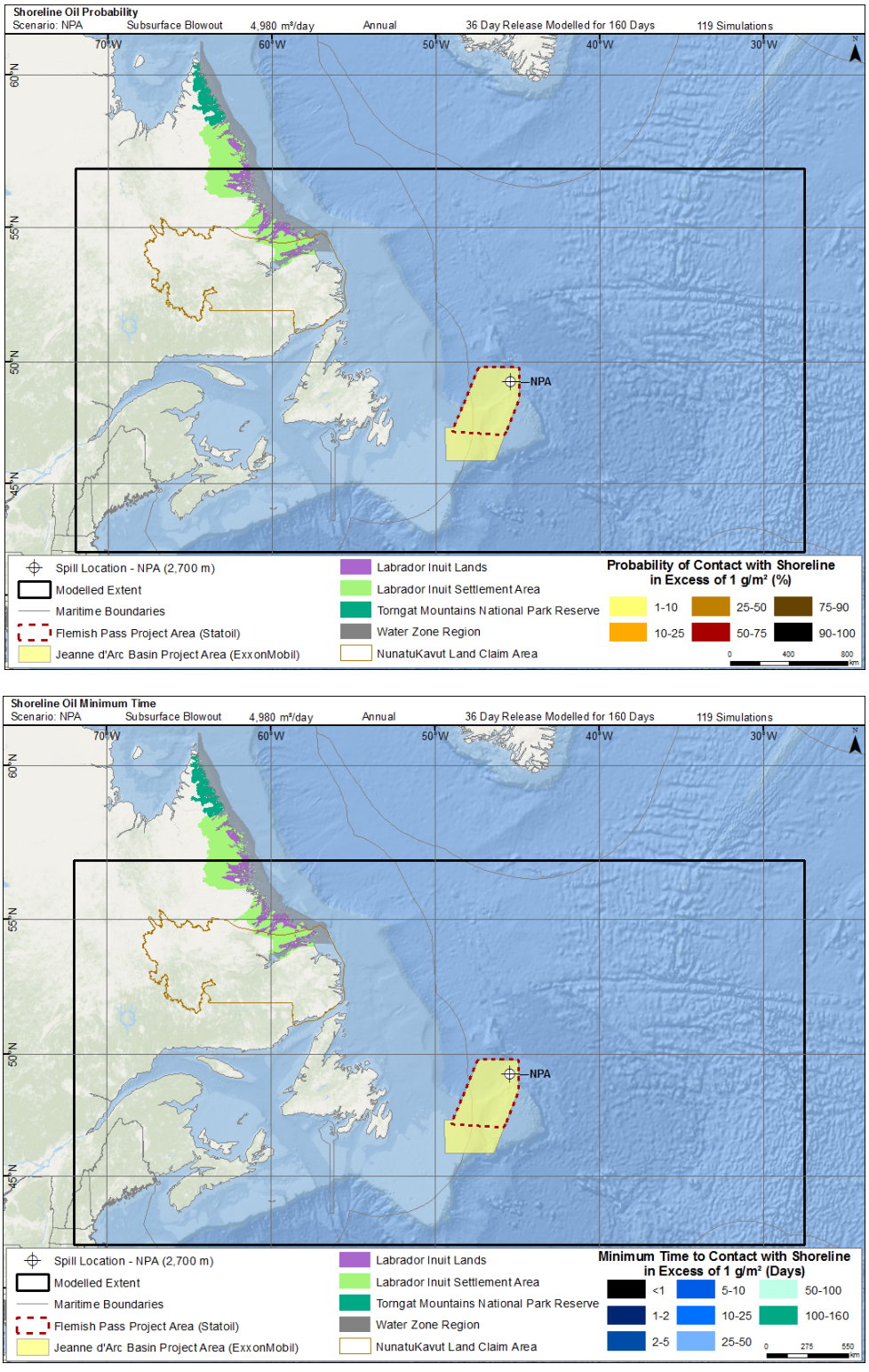


Figure 15-16 Annual probability of shoreline contact >1 g/m² (top) and minimum time to threshold exceedance (bottom) resulting from a subsurface blowout at the Northern Flemish Pass site

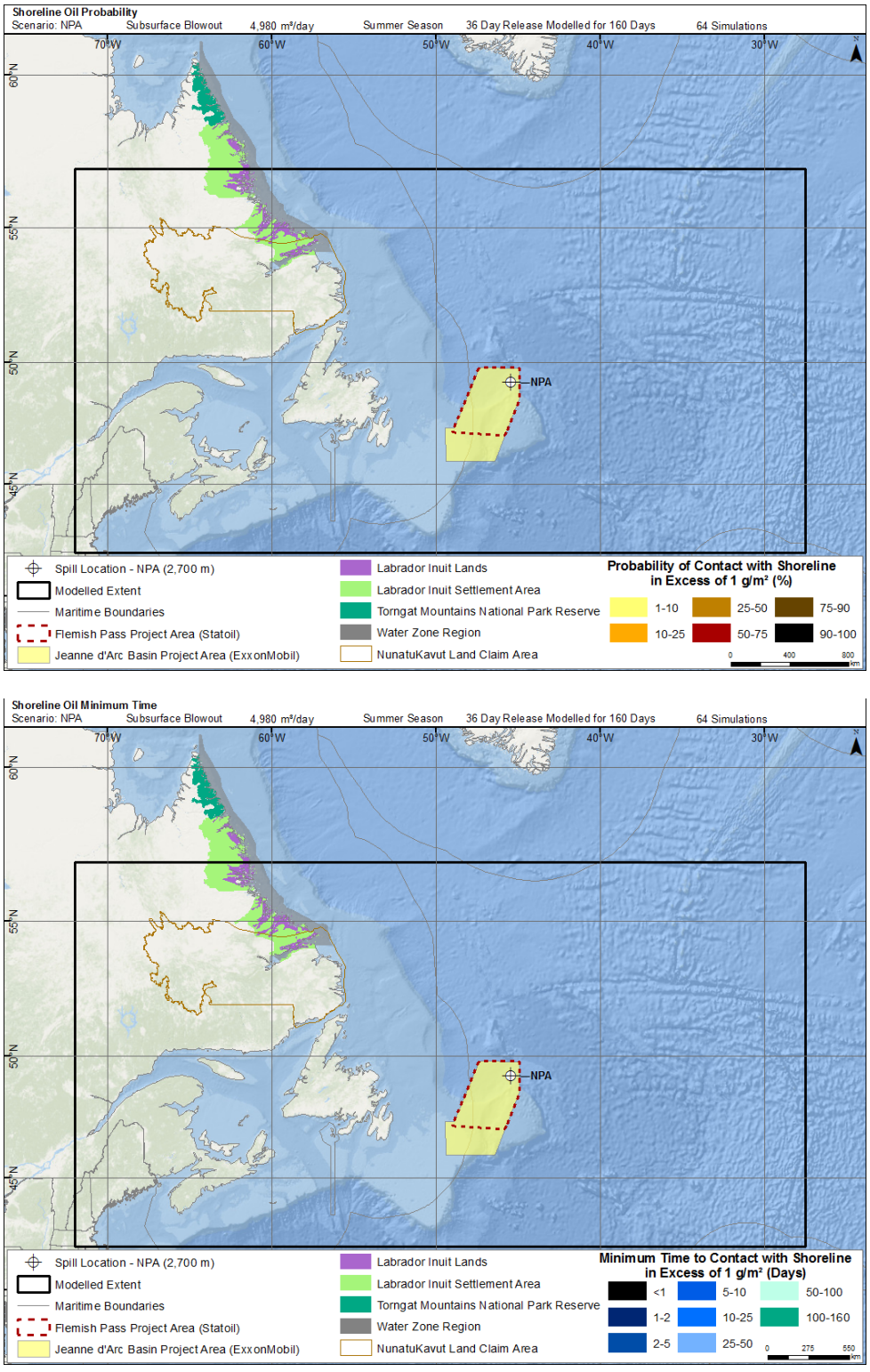


Figure 15-17 Summer probability of shoreline contact >1 g/m² (top) and minimum time to threshold exceedance (bottom) resulting from a subsurface blowout at the Northern Flemish Pass site

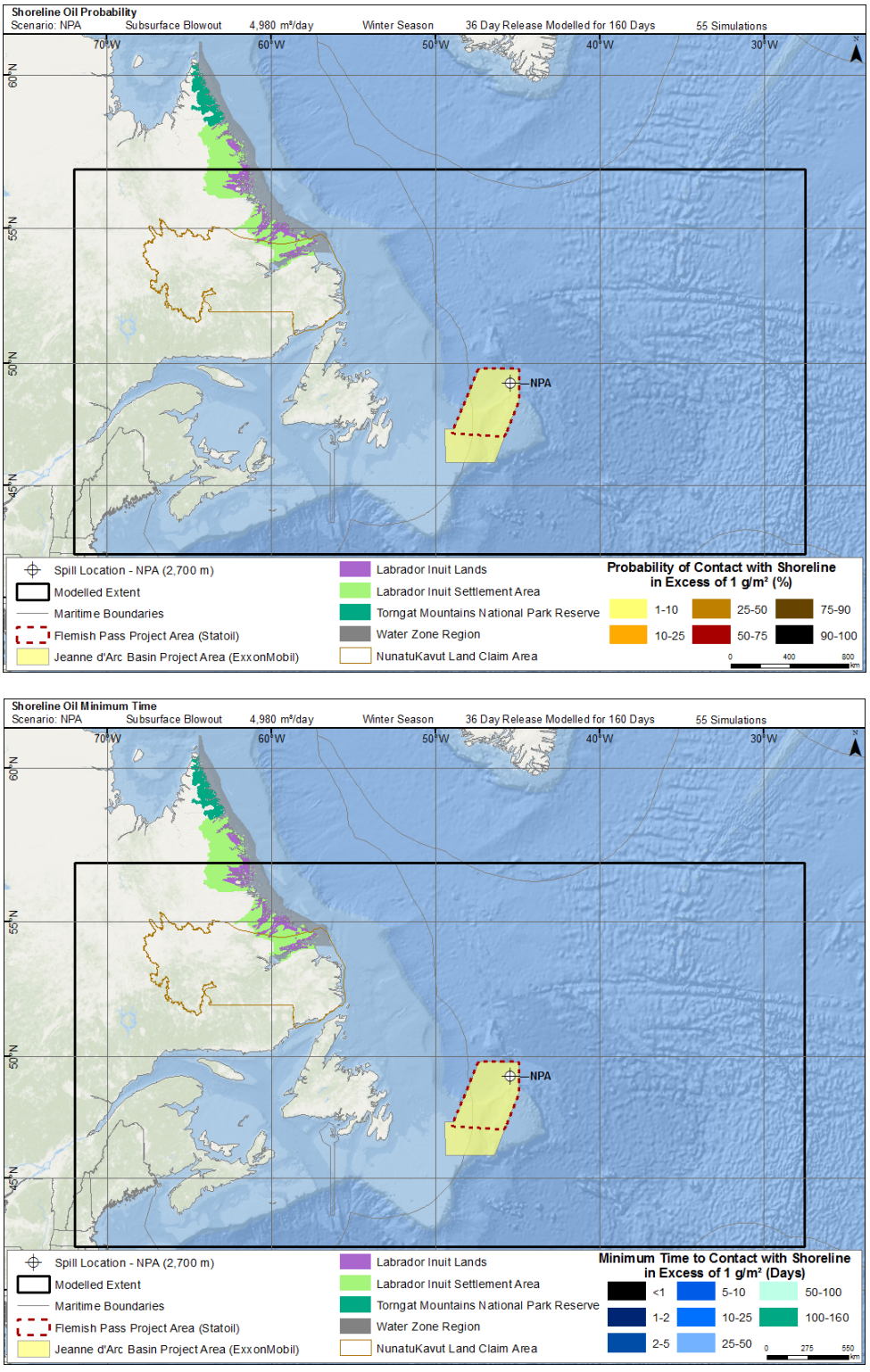


Figure 15-18 Winter probability of shoreline contact >1 g/m² (top) and minimum time to threshold exceedance (bottom) resulting from a subsurface blowout at the Northern Flemish Pass site

Table 15.17 Probability of Shoreline Contamination and Minimum Time for Predicted Oil Exposure Exceeding 1 g/m²

Release Site	Scenario Timeframe	Probability of Shoreline Oil Contact (%)	Minimum Time to Shore (days)	Maximum Time to Shore (days)
EPA	Annual	< 1	78.7	157.4
	Winter	1.9	78.7	157.4
	Summer	1.6	78.7	83.7
NPA	Annual	-	-	-
	Winter	-	-	-
	Summer	-	-	-

EPA = Eastern Flemish Pass
NPA = Northern Flemish Pass

15.4.4.2 Deterministic Results

For most representative deterministic scenarios, the amount of oil remaining in surface waters or on sediments at the end of the 160-day simulation was less than one percent. Entrainment into the water column ranged between 7 percent and 12 percent. Shoreline contact was minimal for these simulations, where even the 95th percentile shoreline contact case was predicted to have less than 0.001 percent of the total volume of released oil reaching shore.

The amount of evaporation and degradation was relatively consistent between model runs. Approximately 40-45 percent of the BdN oil releases was predicted to evaporate and another 40-45 percent was degraded by the end of the 160-day simulation. Most of the variability in the mass balances were associated with the amount of oil found either on the surface or entrained within the water column. There was little to no surface or shoreline oil at the end of the 160-day simulations, while the remaining amount entrained in the water column was predicted to range from 6.5-12 percent.

During modelling, components of oil were tracked as entrained droplets of whole oil, dissolved hydrocarbon constituents, floating surface oil, and stranded oil on shorelines. The figures (Section 4.2 in Appendix E) depict the cumulative footprint of all oil predicted to be within a region over the entire modelled duration. Therefore, the depicted footprints are much larger than the amount of oil that would be present in a region at any given time following the release of oil.

For most representative deterministic scenarios, the amount of oil remaining in surface waters or on sediments at the end of the simulation was less than 1 percent. This is due to the highly volatile and soluble content of the crude oil product leading to large percentages evaporated (42-46 percent) and degraded (40-46 percent). Entrainment into the water column was predicted to range between 7 percent and 12 percent. Shoreline contact was minimal for these simulations, where even the 95th percentile shoreline contact case was predicted to have less than 0.001 percent of oil reaching shorelines. In all simulations, portions (up to 3.7 percent of the total released oil) of the oil mass travelled outside the model grid.

15.4.4.2.1 Surface Oil Exposure Cases

Results for the identified 95th percentile scenarios for floating surface oil exposure > 0.04 µm for the 113-day release at the EPA site and 36-day release at theNPA site are provided in Section 4.2.1 of Appendix E. For both sites, the released oil was predicted to rise rapidly to the surface where it spread, being transported by surface winds and currents where it created discontinuous patchy surface slicks. In both scenarios, surface oil was predicted to be thickest closest to the spill site, with maximum thicknesses corresponding to a visual appearance of a dark brown sheen. The majority of the footprint was predicted to have a maximum thickness closer in appearance to a dull brown sheen. While this surface oil was predicted to form some of the largest predicted cumulative footprints over 160 days, the maximum amount of released oil on the surface never exceeded 20 percent (in the first month) and was typically never more than 5-10 percent of the total mass. The smaller volume release at the NPA site resulted in predicted oil trajectories to the north and east. The larger volume release at the EPA site resulted in a much larger cumulative footprint, with larger areas of thicker oil and predicted trajectories to the northeast and the southwest towards the coast of Newfoundland. The majority of the surface expression is predicted to appear as a discontinuous dull brown sheen, with rainbow sheen possible on the outermost edges.

The combined effects of a subsurface release and the entrainment of surface oil into the water column are predicted to result in concentrations of dissolved and total hydrocarbons in the water column that exceed the identified thresholds. Due to the larger release volume, the release at the EPA site was predicted to result in a larger footprint of dissolved hydrocarbon and total hydrocarbon concentrations (THC), when compared to the NPA site. Neither of the representative surface oil cases was predicted to result in oil contacting shorelines.

At the end of the 160-day simulations, 0-2 percent of the oil was predicted to remain on the water surface, approximately 42 percent evaporated into the atmosphere, 7-11 percent remained entrained within the water column, <0.01 percent adhered to suspended sediment, 42-43 percent degraded, 0 percent made contact with the shore, and 2-4 percent was transported outside of the model domain.

15.4.4.2.2 Water Column Exposure Cases

Results for the identified 95th percentile water column exposure cases for the 113-day release at the EPA and 36-day release at the Northern Flemish Pass are shown in Section 4.2.2 of Appendix E. To reiterate, the combined effects of a subsurface release and the entrainment of surface oil from wind-induced surface-breaking waves into the water column was predicted to result in both dissolved and total hydrocarbon concentrations in the water column that exceed the identified thresholds of interest. Concentrations of dissolved and total hydrocarbons are predicted to be highest around the release site and dissipate as the oil moves away and disperses within the water column. As total hydrocarbons represent the dissolved phase (i.e., soluble fraction making up approximately 1 percent of the whole oil) plus the particulate phase (i.e., whole oil droplets) within the water column, THC has a much larger footprint than the predicted dissolved phase. The EPA site has higher concentrations and has a larger cumulative footprint, compared to that of the NPA site, due to the larger release volume and duration. The footprints of these predicted concentration exceedances are very similar to the surface oil trajectories, with the largest portion of the oil predicted to move towards the east.

While the highest concentrations of THC are predicted near the release site at the trap height, the majority of the predicted THC concentrations are within tens of metres of the surface. This is due to the majority of the predicted THC being the result of entrained oil from wind-induced surface-breaking waves.

There was no shoreline contact from oil released at either site for the 95th percentile water column contamination cases.

At the end of the 160-day simulations, <1 percent of the released volume was predicted to remain floating on the water surface, 44-47 percent evaporated into the atmosphere, 7-12 percent remained entrained in the water column, <0.01 percent adhered to suspended sediment, 0 percent contacted the shore, 40-43 percent degraded, and 3-4 percent was transported outside the modelled domain.

15.4.4.2.3 Shoreline Exposure Case

Results for the identified representative shoreline exposure case for the 113-day release at EPA are shown in Section 4.2.3 of Appendix E. Because the 95th percentile case did not result in shoreline exposure, the 98th percentile trajectory was selected as a representative "worst case." The probability of shoreline oil exposure was very low, as less than 1 percent of the annual scenarios reached the shoreline. The predicted contact occurred on the Avalon Peninsula and southern shores of Newfoundland near Burgeo. However, only a very small portion of the cumulative trajectory was predicted to move in this direction, with only 0.01 percent of the release volume predicted to make contact with the shoreline. Contact with the shoreline was predicted to occur 116 days into the simulation and would be highly weathered oil. There was no predicted shoreline contact for the 36-day release case at the NPA site.

Shoreline oil exposure is highly unlikely due to a combination of the forcing parameters transporting surface and entrained oil predominantly to the east. In particular, the predominately westerly winds tend to transport oil offshore. The surface currents are variable and do not continuously transport oil in any one specific direction for significant periods of time. In addition, the release sites are located approximately 500 km offshore. Therefore, there would be a large amount of time required to pass before any oil made its way to shore, at which point evaporation and degradation would have heavily weathered the oil.

In the case of this 98th percentile shoreline exposure scenario, the combination of wind and current conditions resulted in a very small portion of the release making contact with the shoreline. The total hydrocarbon concentration on shore ranged from 100-500 g/m², which is above the socioeconomic (1 g/m²) and ecological (100 g/m²) thresholds.

15.4.4.3 Marine Diesel Batch Spills

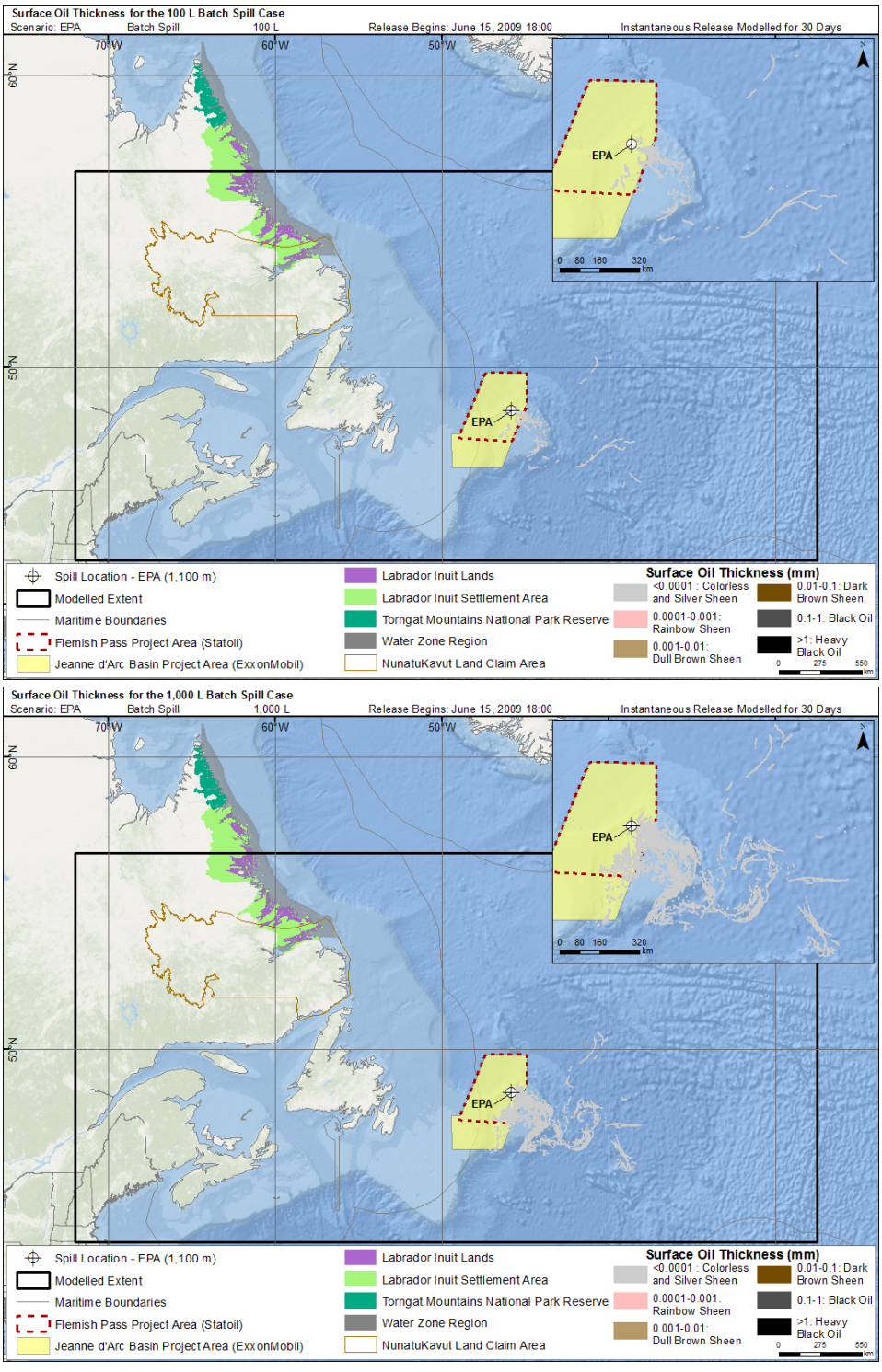
BdN is a light crude oil with low viscosity and a high aromatic content. The marine diesel modelled is a standard diesel that also has a low viscosity and high content of soluble hydrocarbons. The low viscosity and high soluble content of these oil products provides conservative approximations of anticipated concentrations in the water following a release, as a relatively large proportion of constituents have the potential to dissolve into the water column, when compared to oils with lower soluble content. The physical and chemical parameters of BdN are similar to those of Hibernia crude oil, which was used in previous studies (SL Ross 2016; Environmental Science and Technology Center, 2001) as identified in Statoil's response to the C-NLOPB (Statoil 2016). These oils would likely behave similarly in the event of a release, with marine diesel being least persistent.

Accidental discharges from small volume instantaneous batch spills of marine diesel resulted in little predicted contamination (Figures 15-19 to 15-22). By the end of the 30-day simulations, 75-78 percent of the released diesel was predicted to evaporate and 14-17 percent degrade. A small portion of highly weathered diesel may continue to be transported at the surface or in the water column for some distance. None of the batch spills were predicted to reach the Nova Scotia shoreline.

15.4.4.4 Uncertainties

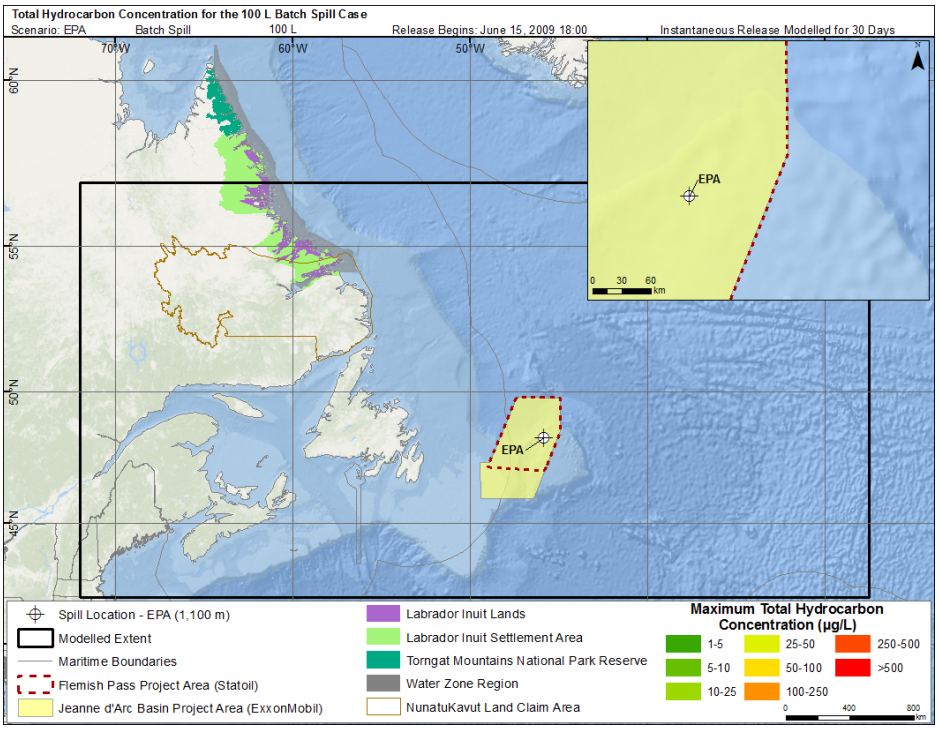
The SIMAP model has been developed over several decades to include past and recent information from laboratory based experiments and real-world releases to simulate the trajectory and fate of discharged oil. However, there are limits to the complexity of processes that can be modelled, as well as gaps in knowledge regarding the affected environment. Assumptions based on available scientific information and professional judgment were made in the development of the model, which represent a best assessment of the processes and potential exposures that could result from oil releases. Some major sources of uncertainty in the oil fate model include the specific chemical and physical properties of the released oil, the state of scientific understanding and algorithms used to model complex physical-chemical processes, the potential for cumulative exposure from other sources of contamination, and the specific environmental and physical parameters used throughout the model domain (e.g. hydrodynamics, winds, water depth). Modelled results are a function of the scenarios simulated and the accuracy of the input data used. The goal of this study was not to forecast every detail that could potentially occur, but to describe a range of possible consequences and exposures of oil releases under various representative scenarios.

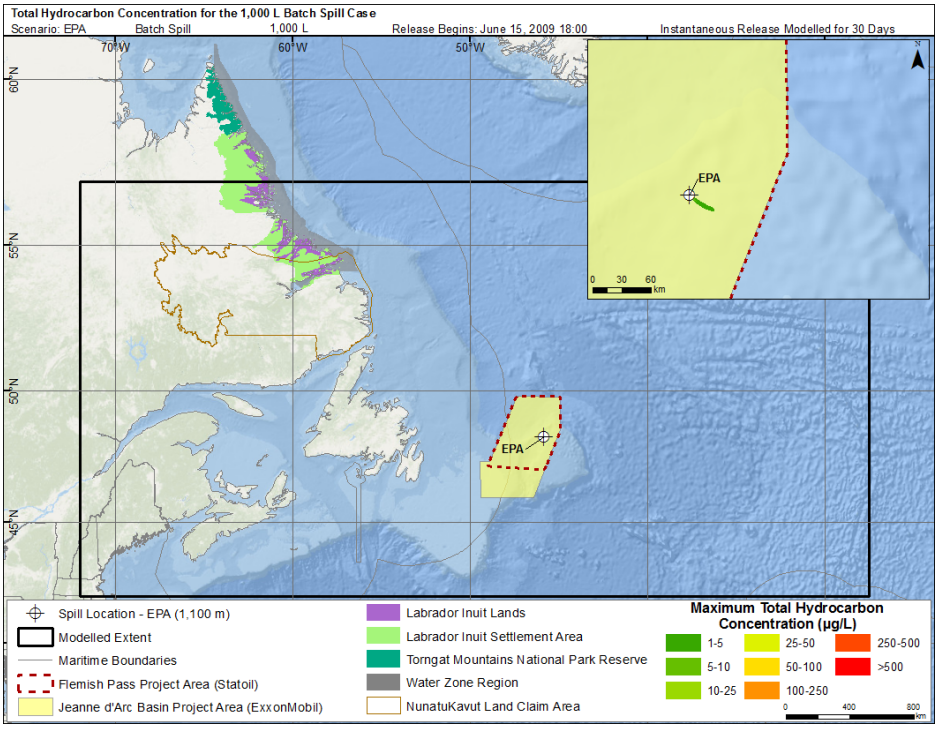
The stochastic modeling provides a range of probabilities and minimum time to the potential effects for shoreline oiling, water column contamination, and surface oil. Each of these endpoints is then represented by a single highly conservative deterministic model run that provides information pertaining to the spatially- and temporally- varying concentrations, thicknesses, and masses of oil in various environmental compartments. An example of useful information from this work would be to identify information such as shorelines that have resources that are at risk and to determine how much time is available to protect them. Decisions are therefore based upon very low probability spill events, and the even less likely targeted scenarios that maximize potential effects. If marginal changes in input data, timing and other factors were to change, it is likely that there would be no substantial changes to the conclusions.



The minimum thickness of surface oil >0.04 µm is displayed (cumulative over all modelled time steps)

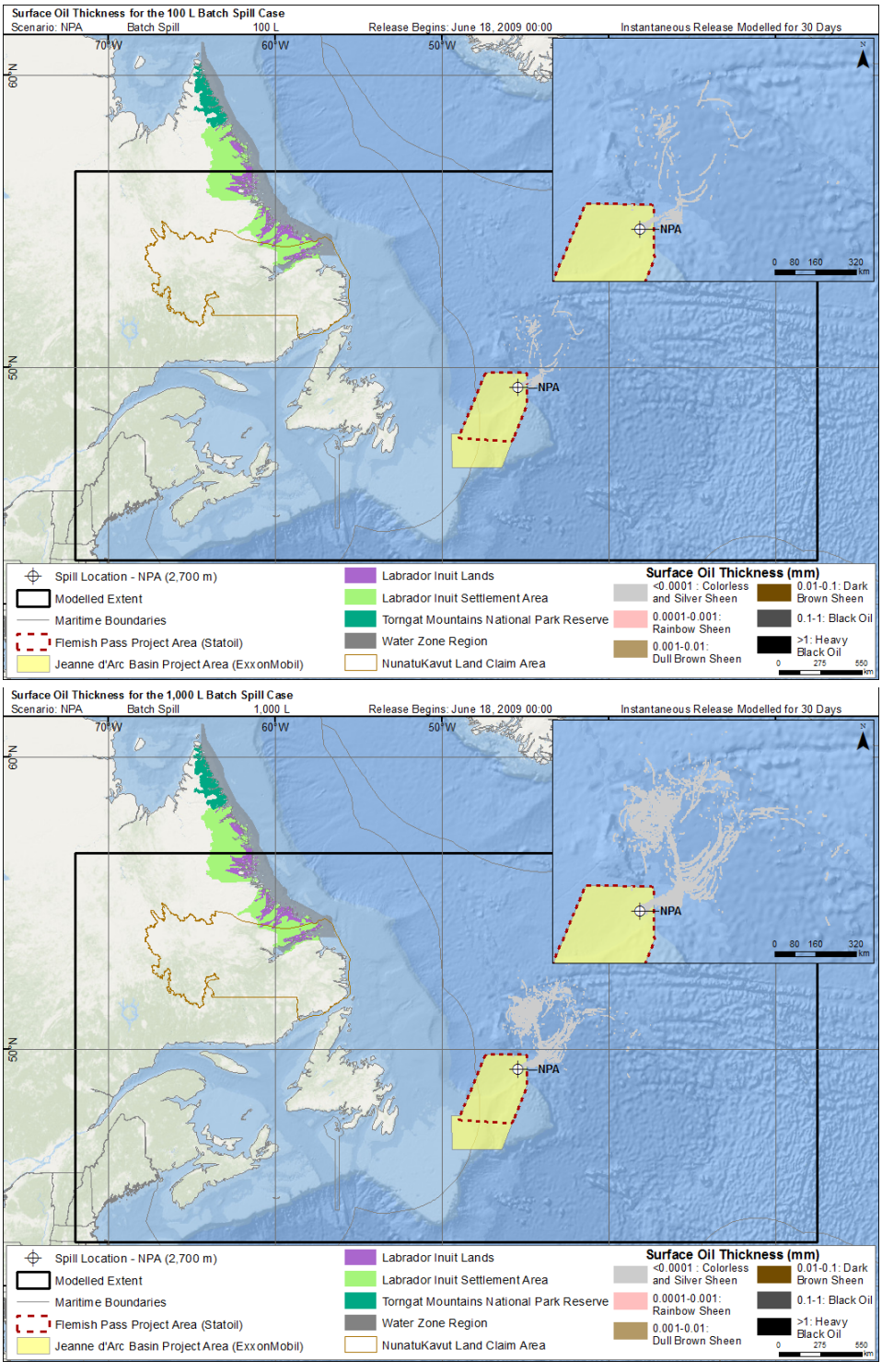
Figure 15-19 Surface oil thickness for marine diesel batch spills of 100 L (top) and 1,000 L (bottom) at the Eastern Flemish Pass site





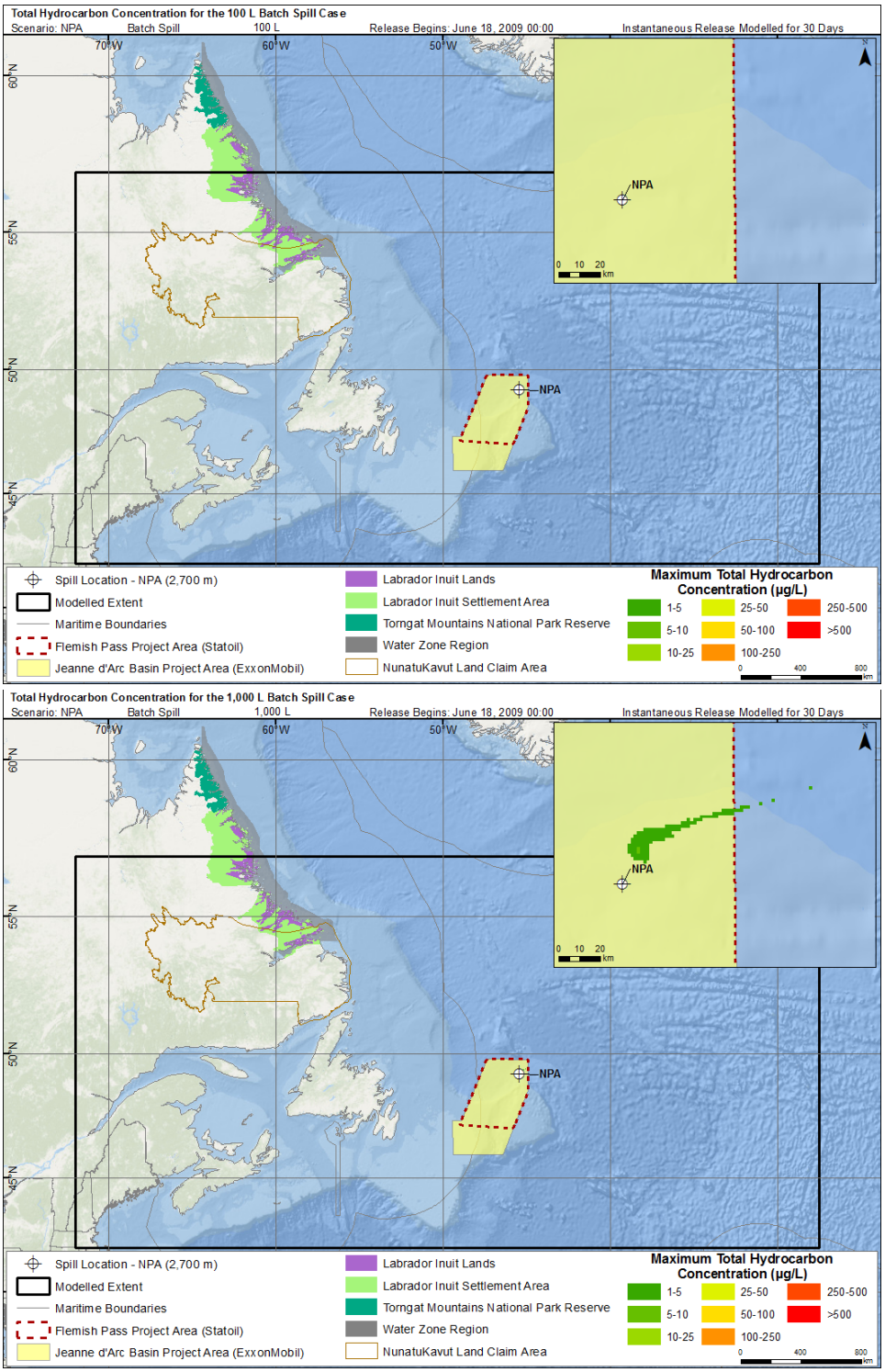
The minimum threshold of THC >1 µg/L is displayed (cumulative over all modelled time steps)

Figure 15-20 Maximum total hydrocarbon concentration (THC) at any depth in the water column for marine diesel batch spills of 100 L (top) and 1,000 L (bottom) at the Eastern Flemish Pass site



The minimum thickness of surface oil >0.04 µm is displayed (cumulative over all modelled time steps)

Figure 15-21 Surface oil thickness for marine diesel batch spills of 100 L (top) and 1,000 L (bottom) at the Northern Flemish Pass site



The minimum threshold of THC >1 µg/L is displayed (cumulative over all modelled time steps)

Figure 15-22 Maximum total hydrocarbon concentration (THC) at any depth in the water column for marine diesel batch spills of 100 L (top) and 1,000 L (bottom) at the Northern Flemish Pass site

15.4.4.5 Summary of Modelling Results

Generally, most surface oil from all release sites was predicted to move eastward due to the prevailing westerly winds. Winds and currents in the Project Area are similar throughout the year, with the most notable differences being wind intensity. The increased winds during winter conditions enhances surface-breaking waves and results in more predicted entrainment of oil, which lowers the likelihood that oil will remain on the surface for extended periods of time. Shoreline contact was not predicted to be likely from releases at either the EPA or NPA sites, with maximum probabilities of shoreline contact 1-2 percent from the EPA site only. Shoreline contact was more likely to occur during winter months, due to the wind speed and direction during the winter period. If shoreline contact was predicted to occur, it would likely be localized to small portions of shoreline, but could occur from the Avalon Peninsula and the southeast coast of Newfoundland to the northern shores of Newfoundland, southeastern shores of Labrador and Sable Island, depending on the conditions.

The hypothetical releases modelled in this study may be considered representative of other potential releases in the Northern Project Area. The depth of release of the EPA and NPA sites (1,100 m and 2,700 m, respectively) are within the range of areas present within the Northern Project Area, with many exploration licenses in the 1,000-1,500 m depth range.

The goal of the modeling is to provide probabilities for various spill effects (e.g., fastest shoreline oiling, maximum oil concentration in the water column, and maximum water surface oiling). Each of those endpoints is then represented by a single highly conservative deterministic model run. The goal of this work is to identify shorelines that have resources that are at risk and to determine how much time is available to protect them.

15.5 Environmental Effects Assessment

This section assesses the potential environmental effects that may result in the very unlikely occurrence of an accidental event. The assessment area is based on spill modelling conducted for this Project (see Section 15.4) which was carried out using a credible worst-case approach for each scenario. No oil spill tactical response measures were applied for the blowout incident scenarios; they are unmitigated spill scenarios. For each VC, the following scenarios were considered:

- 100 litre Diesel Spill
- 1,000 litre Diesel Spill
- Subsurface Blowout – NPA Site
- Subsurface Blowout – EPA Site

There was no predicted shoreline contact from releases at the NPA site. For releases at the EPA site, small volumes of weathered oil exceeding 1 g/m^2 were predicted to reach the shores of Sable Island with a low probability (1-2 percent). During the winter season, small volumes of weathered oil were predicted to reach short and discontinuous sections of the southeastern and northern coasts of the island of Newfoundland and the southeastern coast of Labrador (Section 4.2.3 of Appendix E). Minimim time for oil to make contact with shore is approximately 78 days (Table 4.2 of Appendix E). For all cases, only 0.01 percent of the modelled release volumes were predicted to contact these locations and the oil predicted to make contact with the shoreline is expected to be highly weathered,

patchy and discontinuous. While 98-99 percent of the simulated releases resulted in no oil contact with the shoreline at all within 160 days, oil was predicted to make contact with the shoreline in 1-2 percent of the scenarios. Socioeconomic and ecological thresholds were the basis used for oil amounts reaching shore. Oil was predicted to be found in concentrations between 100-500 g/m² concentration in one area of the Southern Avalon and another area on the south coast near Burgeo. Again, the oil that is predicted to make contact with the shoreline is expected to be highly weathered, patchy and discontinuous.

As detailed in Section 15.4, thresholds for surface oil thickness and shoreline oiling, as well as water column oil, are used to define areas and volumes exposed above levels of concern (Table 15.13). Socioeconomic and ecological thresholds for surface oil are 0.04 g/m^2 and 10 g/m^2 respectively. Socioeconomic and ecological thresholds for shoreline oil are 1 g/m^2 and 100 g/m^2 respectively. Socioeconomic and ecological thresholds for water column oil are 1 ppb dissolved PAH or 100 ppb whole oil.

The assessment below includes the identification and discussion of environmental effect pathways, VC-specific mitigation where appropriate, emergency response and spill management measures described in Section 15.1, characterization of residual effects and the determination of the significance of effects using the same VC-specific definitions used for planned Project components and activities. The assessment of accidental events for each VC addresses the potential effects, based on the modelled spill trajectories and the application of mitigation and response measures. The assessment area for each VC, within which the significance of residual environmental effects is predicted, corresponds to the RSA (Section 4.3.1), which in turn, encompasses the Project Area.

Residual effects are evaluated in consideration of mitigation and preventative actions, which will be incorporated by the Operator into daily operation of the Project to reduce the likelihood of an accident or malfunction occurring (Section 15.1). Spill prevention is paramount during all exploration activities. These actions include frequent maintenance, testing, and inspection of equipment, training, workshops and safety meetings for personnel, the use of best practices, and routine audits of the drilling installation.

Oil spill preventative and response procedures will be submitted to the C-NLOPB for approval as part of the OA process, prior to the start of any drilling activities in offshore Newfoundland and Labrador. These procedures will outline the Operator's methods and strategies for addressing different levels of oil spills and will include, for example, details on measures related to offshore containment and recovery, surveillance and tracking of spills, use of dispersants, and wildlife response. Spill response tactics will be decided in full consideration of potential environmental consequences for all VCs. Section 15.1 provides more information on the Operator's spill response measures.

In the extremely unlikely event of an accidental event such as a spill or a blowout, event-specific environmental monitoring programs may be required, which will be developed and implemented in consultation with the appropriate regulatory agencies.

15.5.1 Marine Fish and Fish Habitat

15.5.1.1 Introduction

The RSA, including the shelf and slope regions of the Grand Bank, areas of the Flemish Cap and parts of the Orphan Basin, contains habitats from relatively shallow shelf zones, through the continental slope to very deep abyssal regions. Secure and at-risk fish and invertebrate species of commercial, cultural and/or ecological value are known to occur in the RSA and could therefore be affected by an accidental event.

Although there is no designated critical habitat for marine fish (Section 6.1) in the RSA, there are several EBSAs, VMEs) and NAFO FCAs within parts of the RSA that are designated due to their importance to Marine Fish and Fish Habitat. This includes the Eastern Avalon Coast, Northeast Shelf and Slope of the Grand Banks, the Northern and Northwest Flemish Cap, the Sackville Spur area, the Flemish Pass, and the Beothuk Knoll (See Section 6.4).

The effects of the release of hydrocarbons in the marine environment on Marine Fish and Fish Habitat are largely dependent on a variety of biotic (species, life histories, behaviour, resistance) and abiotic factors (oceanographic conditions, exposure duration, oil type, oil treatment methods). The extent of the potential effects of the potential effects depends on how the spill trajectory and the various components of the VC overlap in both space and time.

15.5.1.2 Potential Issues and Interactions

The potential environmental effects on Marine Fish and Fish Habitat used in the earlier effects assessment (Chapter 8) were: change in habitat availability and quality, change in fish mortality, injury, and health, and change in fish presence and abundance. These potential effects remain relevant to the assessment of accidental events, although the mechanisms or pathways of effects may be different. Fish habitat may experience a change in habitat availability and quality due to oiling and associated response measures. There may be a change in fish mortality, injury and health if directly exposed to accidentally-released hydrocarbons or associated volatiles and aerosols.

The extent of the potential effects on marine fish and fish habitat depends largely on the level of exposure to the toxic components of the oil. Potential accidental effects that are considered involve varying degrees of hydrocarbon interaction and exposure with fish and fish habitat that include batch spills and surface blowouts. Given the known injury and behavioural responses of marine species to hydrocarbon interactions (as described below), batch spills and surface blowouts were assessed through Project specific modelling that considers various scenarios of hydrocarbon release.

15.5.1.2.1 Effects of Hydrocarbons on Marine Fish and Fish Habitat

Potential effects of hydrocarbons on fish and fish habitat are derived from laboratory studies and known responses of North Atlantic species to anthropogenic effects. As there have not been any large-scale hydrocarbon spill events in the North Atlantic, information on potential effects on fish and fish habitat considers in situ scientific studies that occurred because of recent large scale oil spills in the Gulf of Mexico. This information on effects of actual spills from the Gulf of Mexico Deepwater

Horizon Spill (DWH) is supplemented with recent comprehensive reviews on spilled oil in Arctic marine environments that includes laboratory studies on ecotoxicology of more relevant cold water species (AORST-JP 2014). Olsen et al. (2011) compared the effect of oil on temperature and arctic species and concluded that the data may be comparable for certain species and certain exposures. General themes are presented below that highlight responses to potential accidental events from plankton, fish and invertebrates, and coral and sponge species.

Plankton and Microbes

The response of the plankton and other microbial communities to oil spills is diverse and largely dependent on exposure. In general, plankton and other microorganisms do not have an avoidance response to contaminants as their horizontal movements are controlled by the oceanographic conditions. Certain taxa of coastal and estuarine copepods may be an exception to this as they have shown an avoidance behavior to hydrocarbon-contaminated water (Seuront 2010). Although species specific, in general, crude oil concentrations up to 1.0 mg/L may have stimulant effects on phytoplankton growth, whereas concentrations over 1.0 mg/L may cause growth inhibition, and concentrations over 100 mg/L result in severe or complete growth inhibition (Rabalais 2014). Laboratory studies on Arctic phytoplankton have shown similar results with growth inhibitions for two diatom species found in and around sea ice (Van Baalen and O'Donnell 1984) at crude oil concentrations over 50 mg/L. The responses are also taxa specific with certain diatoms showing growth inhibition whereas green flagellate showing increased growth for an exposure regime of 10 mg/L (Hsiao et al. 1978). Changes in both plankton population (biomass) and community that composes that population have been shown to occur in the phytoplankton community assemblages on the Louisiana Shelf after the DWHspill (Parsons et al. 2015). Some arctic field studies on diatoms from ice algal communities found no decreases in cell densities, chlorophyll *a* concentrations or productivity in ice algal communities exposed to a field release of dispersed weathered oil (Cross 1987).

Laboratory exposure studies have shown lethal and sublethal effects of oil on zooplankton (Sueront 2010; Almeda et al. 2012; AOSRT-JIP 2014) with few documented mass mortality events related to oil slick episodes (Seuront 2010). Sublethal effects range from physiology, feeding fecundity to behavioral responses related to predator avoidance (Almeda et al. 2012). Laboratory exposure studies comparing arctic and temperate-boreal copepod species have found that Arctic species are less sensitive to oil exposure (Hansen et al. 2011; Gardiner et al. 2013) but this may be related to a delayed response time for the Arctic species (Hansen et al. 2011).

Microbes also serve an important role in moving the oil from the surface waters into the deep ocean. Like other natural sources of organic matter, microbes degrade hydrocarbons into marine 'snow' that serves as a flocculating method to shuttle the oil to the deep sea, where the oil will continue to degrade. Flocculated hydrocarbon material may also be ingested by zooplankton and also result in settling of hydrocarbon material to benthic environments (AOSRT-JIP 2014). This natural mechanism is an important link between benthic and pelagic environments that brings important nutrients and organic matter from the surface waters to the deep sea, however, during spill events, this mechanism may serve to contaminate deep sea corals and benthic communities (Rabalais 2014). Base on laboratory and field studies, similar mechanisms of microbial degradation of oil have

been shown in the Arctic (Prince et al. 2013), though at slower rates than in more temperate environments (AOSRT-JIP 2014).

The potentially longer term effects on plankton and microbe mortalities is twofold: firstly, they are an important food source for the higher trophic levels from fish in the water column to benthic organisms, and secondly, most fish and invertebrate species have one or more life stages in a planktonic phase, hence affecting recruitment into the adult fish and invertebrate population. Depending on the persistence of hydrocarbons in the environment, influences on the planktonic phase of fish and invertebrate species may also limit distributions, recovery, and recolonization.

Invertebrates and Fish

As the most acutely toxic compounds are both volatile and water soluble (i.e., polycyclic aromatic hydrocarbons (PAHs)), the primary exposure mechanism for a hydrocarbon spill of marine biota is through dissolved portion in the water column (French-McCay 2009). Exposure studies using the dissolved fraction of the oil have found lethal and sublethal values for fish in the range of 0.3 to 60 µg/L dissolved PAHs (0.03-11 mg/L total petroleum hydrocarbons (TPH)) (Lee et al. 2015). Similar reviews focused on cold water species had comparable ranges with lethal values for fish of 0.7 – 4.0 mg/L TPH (AOSRT-JIP 2014). Therefore, the ecological threshold of 1.0 µg/L dissolved PAHs (corresponding to ~100 µg/L of whole oil or total hydrocarbon concentrations (THC)), was used as a modelling reference in this study and serves as a threshold to predict the effects on the various spill scenarios on marine species. Laboratory exposure studies, in general, have shown more severe effects than measurements taken *in situ* during and after actual spills. It is generally agreed upon that development stages of fish and invertebrates are more sensitive to oil than adult stages (Lee et al. 2015; Sørensen et al 2017), however effects on larval stages does not necessarily result in effects on adult populations (Gallaway et al. 2017).

Acute toxicity (short-term exposures) would be more representative of exposure in a discrete batch spill event. The ecological risks in this kind of exposure are reduced as the more toxic components of the spill, the lower molecular weight compounds (LMW), evaporate and dilute rapidly (Lee et al. 2015). There are however, some sublethal effects such as reduced feeding (Lari et al. 2015) and larval deformities (Mager et al. 2014). Potentially lethal effects (associated with the LMW) include a variety of responses to lipid membrane receptors in effects collectively termed narcosis. These symptoms range from depression in respiratory-cardiovascular activity, tissue hypoxia and ultimately respiratory paralysis (death) if exposure continues. Again, these effects are short term as the LMW volatize from the oil on the order of days (Lee et al. 2015). Cold water invertebrate taxa (bivalves, gastropods, crustaceans) have been shown to have comparable reactions in terms of specific PAHs sensitivities when compared to temperate species (Olsen et al. 2011). These short-term effects can be recoverable if the exposure does not continue.

Chronic, long-term exposures would also have a range of potential effects from genetic and molecular responses of cells to impacts on reproduction, growth, disease, and survival (Lee et al. 2015). The uptake pathways vary but can include respiratory uptake, direct contact, diet, or maternal transfer to eggs (Lee et al. 2015). Studies on finfish have shown that the dissolved oil components can travel across respiratory membranes in gills (Lee et al. 2015). More recent studies have identified that the PAH phenanthrene disrupts cardiac function and is associated with heart malformations in

developing fish and it becomes proportionally more toxic as the spilled oil weathers (Brette et al. 2017). Like invertebrates, deep-sea fish species typically have lower metabolisms, are slower growing, have longer life spans, and would likely be more susceptible to disturbances such as oil spills (Cordes et al. 2016). As previously discussed, the early life stages are likely more sensitive to hydrocarbon exposures than adults (Lee et al. 2015; Sørensen et al. 2017).

Community and population-level effects from the DWH spill on regional fisheries were observed (Felder et al. 2014; Murawksi et al. 2016), however impacts on the productivity of the region's fisheries were relatively short-lived (Murawski et al. 2016). This recovery, however, was largely influenced by fisheries closures (Murawski et. Al 2016). These findings are in general agreement to population modelling studies on Arctic cod (Gallaway et al. 2017) that predicted that even if large mortalities of Arctic cod juvenile and eggs were to occur due to a hypothetical spill event (as the early life stages are potentially the most susceptible to a spill), the effects om the regional cod population would be insignificant (Gallaway et al. 2017). Studies from the DWH spill also showed strong declines in species richness and diversity in the decapod crustacean community post-spill (2010-2012) relative to earlier surveys (2004-2006) (Felder et al. 2014). It has been theorized that hydrocarbon exposure may have caused localized mortalities, reduced the fecundity of surviving females or reduced recruitment (Felder et al. 2014). The number of lesions observed on deep-water shrimp species surveyed after the spill increased nearly threefold (Felder et al. 2014). Similar to fish, it is also important to highlight that deep-sea invertebrate species (less motile, lower metabolism, slower growing, long life spans) are likely to be more sensitive to anthropogenic disturbance (Cordes et al. 2016).

Unlike plankton and microorganisms, fish and invertebrates are generally motile and have more ability to avoid oiled areas in the event of an accidental spill (Lee et al. 2015). However, these reactions are species and life stage specific. The embryonic life stages of both fish and invertebrates are more often less motile than their adult counterparts thereby more susceptible to spills. These effects on the early life stages are further compounded by their lower toxicity thresholds to spilled oils (Lee et al. 2015). Laboratory exposure studies on arctic species such as capelin (Frantzen et al, 2012) and larval sculpin (Gardiner et al. 2013) have found similar results with increased embryo mortality rates and decreased hatching success. The deep-sea species of fish and invertebrates that may be more susceptible to anthropogenic effects (Cordes et al 2016) would also likely to have a less successful avoidance strategy than their more pelagic counterparts.

Deep Sea Corals and Sponges

As described in Section 6.1.6, corals and sponges have an important functional role and act as nurseries, refugia, spawning and breeding grounds for many aquatic species (Beazley et al. 2013; DFO 2015). In the deep sea that is largely composed of flat and featureless soft-bottom areas, corals and sponges serve as ecosystem engineers creating complex three-dimensional features that are critical habitat to other taxa (Beazley et al. 2013; Ragnarsson et al. 2017). In general, their life histories (planktonic larvae, slow growing, long life spans, and slow recovery) and feeding mechanisms (suspension feeding) makes them susceptible to accidental events (Fisher et al. 2014; Cordes et al. 2016). Sessile adult and planktonic larvae of corals and sponges also have no known avoidance mechanisms to oil spill events.

The effects of hydrocarbons on corals are typically assessed *in situ* using visual indicators of stress (White et al. 2012). Visual indicators of coral stress related to the DWH spill included partial tissue loss, excessive mucus production, retracted polyps, partial coverage of brown flocculant sourced to the spill and death (Ragnarsson et al. 2017). Follow-up studies on the DWH spills have shown a patchy distribution of the effects of the spill which are highly site specific. For example, one site 13 km to the southwest of the Macondo wellhead (lease block MC294) showed that over half of the corals were partially covered by a brown flocculant material but follow up survey 16 months later indicated that recovery was occurring (Fisher et al. 2014).

15.5.1.2.2 Effects of Dispersants on Marine Fish and Fish Habitat

As detailed in Section 15.1, a SIMA will be undertaken by Statoil as part of the OSRP during the OA approval process with the C-NLOPB. The SIMA will evaluate benefits and drawbacks of different response tactics, including the use of dispersants. Environmental effects of chemical dispersants in responding to accidental release of oil has been reviewed by AORSRT-JIP (2014). Dispersants do not remove oil from the environment but rather help disperse oil slicks from the sea surface to the water column and results in accelerated microbial degradation of spilled oil (Lee et al. 2013; AORSRT-JIP 2014; Coelho et al. 2017). Dispersant use after a spill has the potential to increase the exposure to the water column (i.e., plankton, pelagic fish) and eventually, the benthos (demersal fish, benthic invertebrates). The dispersant serves to shear the oil slick into small droplets and mixing them in the water column making them more accessible to the marine microbes in the water column that can then metabolize and degrade the hydrocarbons. Although it is generally agreed that dispersants increase the availability of the oil to the microbes in the water column by reducing the oil droplets size, there still remains some debate on the its effects on oil degradation rates (Brakstad et al. 2014, 2015; Kleindienst et al. 2015; Seidal et al. 2016). For example, certain concentrations and ratios of oil to dispersant (15 percent oil:1.5 percent dispersant) have been shown to reduce the effectiveness of certain degradation pathways related to the formation of microbial marine snow (Passow 2016; Seidel et al. 2016).

The more important component in terms of the most toxicological effect is not the effects of the dispersant alone but rather the effects of the water column exposure to chemically dispersed oil (DeLeo et al. 2016). The main toxicological pathway of this water column exposure is to increase water concentrations of the more toxic components of the oil (i.e., PAHs) to taxa occupying the water column (Pace et al. 1995). Chemically dispersed oil has more pronounced effects on the early life stages of fish and invertebrates as opposed to adults; specifically eggs and larvae (Cordes et al. 2016, DeLeo et al. 2016). For example, chemically dispersed oil is known to reduce larval settlement, cause abnormal development, and tissue degradation in sessile invertebrates (Cordes et al. 2016). Similarly, laboratory studies on Atlantic herring eggs showed an increase rate of deformities and mortalities for dispersed oil exposure (1 mg/L total hydrocarbons; up to 14-day exposure) (Greer et al. 2012). As shown with Galloway and others (2017) study modelling the effects of chemically dispersed oil on Arctic cod, indicated that lethal and sublethal effects on juvenile fish may not necessarily have any effects on regional fish populations. This study predicted that even if large mortalities of Arctic cod juvenile and eggs were to occur due to a hypothetical spill event (the life stages most susceptible to a spill), the effects on the regional cod population would be insignificant (Gallaway et al. 2017).

Laboratory studies on deep sea coral from the Gulf of Mexico indicate that dispersed oil solutions were more toxic to the coral than untreated oil solutions (DeLeo et al. 2016). These studies used three target initial oil concentrations of 250 µM (high), 150 µm (medium), and 50 µM (low) with total initial dispersant concentrations of 176.7 mg/L (high), 106.0 mg/L (medium) and 35.3 mg/L (low). Like other invertebrates, the most dramatic effects related to the early (larval) coral life stages decreasing settling abilities and post-settlement survival (DeLeo et al. 2016). While responses to dispersed oil are species-specific, there is evidence that relative sensitivity to dispersed oil is similar among arctic, temperate, and tropical species (Olsen et al. 2011; Bejarano et al 2017).

15.5.1.2.3 Effect of a Drill Mud Spill on Marine Fish and Fish Habitat

As discussed in Section 8.3.4, SBM is a heavy, dense fluid that is used for drilling. An SBM spill would have the potential to result in seabed disturbance (smothering habitat), chemical toxicity, and bioaccumulation (uptake of contaminants by fish and the presence or perception of taint). As discussed in in detail Chapter 8, the acute toxicity of SBMs is considered relatively low and below environmental guidelines and therefore will not results in adverse effects from contamination of marine biota or habitats. A spill of spent WBMs (i.e., mix of WBM drill muds and cutting) would be similar in terms of extent and duration to the effects of drill mud cuttings during normal operations, where a localized increase in total suspended solids would be expected.

15.5.1.3 Residual Environmental Effects Assessment and Evaluation

The residual effects of an oil spill (that is, the effects remaining after the implementation of emergency response measures; Section 15.1), should it occur, are assessed in the following sections.

15.5.1.3.1 Batch Spills

Modelling of batch spills (100 and 1,000 L at NPA site and EPA site) suggest that maximum surface oil thickness is likely to be <0.0001 mm (colourless and silver sheen). Total hydrocarbon concentrations (1-5 µg/L) will be highest in the immediate vicinity of the spill but are predicted to dissipate rapidly (<0.1 percent of the released volume remaining on surface after 30 days) with distance and remain well offshore. The model predicts that no area will exceed the ecological threshold of 100 µg/L THC. These results suggest that both the potential for exposure and the likelihood of adverse effects on fish and fish habitat from a batch release are low. Only fish in the immediate vicinity near the surface at the time of the spill may be exposed, and at the concentrations predicted, change in habitat availability and quality will likewise be of low magnitude. While, batch spills would cause decrease in water quality around the spill site, it would be short-term until the surface slick naturally disperses through surface wave action in the offshore environment.

Plankton communities (including ichthyoplankton) would not be able to avoid exposure of a batch spill and therefore communities in the immediate area may have lethal and sub-lethal effects. Conversely, fish within the immediate area near the surface may be able to avoid exposure until the slick disperses (aided by surface wave action in the offshore environment). Fish unable to avoid the area may be affected by PAH exposure; however, change in fish health, mortality or injury is predicted to be of low magnitude because most of the oil would dissipate quickly; even the risk to those fish in the immediate vicinity unable to avoid the spill is considered relatively low.

Change in fish presence and abundance would be limited due to the short-term nature of batch spills and overall quantity released. Presence of fish in the immediate area may decrease temporarily (mostly due to avoidance) but could return once the slick disperses (8-9 percent oil remaining entrained in water column after 30-day stimulation for 100 L and 1,000 L, respectively). It is plausible that some zooplankton and ichthyoplankton would face mortality in the immediate footprint initially with the potential for an increase in phytoplankton (Rabalais 2014). However, these potential changes would have no effect on the overall population or abundance of the plankton community and therefore have limited effects on higher trophic levels. The model predicts no contact with the benthos, suggesting minimal effects of the benthic community, including corals and sponges. Depending on the timing of the spill such as during seasonal spawning events, there may also be limited mortality and injury to planktonic early life stages of benthic organisms.

With spill prevention plans and response procedures in place, potential effects of a batch spill (100 and 1,000 L) on Marine Fish and Fish Habitat are predicted to be adverse, low to medium in magnitude, short- to medium-term in duration, to occur within the Project Area, and reversible. This was determined with a moderate level of confidence.

15.5.1.3.2 Uncontrolled Well Event

A subsurface blowout has the potential to result in a change in habitat availability and quality, fish mortality, injury and health, and fish presence and abundance. In the event of a blowout scenario, there could be potential effects in the water column, which could affect habitat availability and quality. Dissolved oil fractions in the water column constitute a physical and chemical change to the water column, especially for the first few meters (Appendix E). While the spilled oil itself is not predicted to interact with sediments based on the modelled scenario, interactions with benthic fish habitat are likely with flocculation and sinking events associated with plankton and microbial pathways.

Fish health and mortality may also be affected by an unmitigated spill event. The effect on fish would change depending on the timing of the spill event as some fish exhibit seasonal migrations or seasonally timed life stages. In particular, oil spill events during or soon after seasonal spring and fall phytoplankton blooms are likely to interact with early life stages of various fish and invertebrates that coincide with these natural processes. Adult demersal and pelagic fish could potentially avoid the spill area, but juvenile and early life stages of fish and benthic invertebrates in the immediate areas of the spill could likely experience sublethal and lethal effects as described in the event of a batch spill, but over a greater area and therefore predicted to be moderate in magnitude.

Fish presence and abundance could also be affected by this unmitigated scenario as mobile fish species may temporarily avoid the oiled water. Local reductions in plankton due to injury or mortality from hydrocarbon exposure may also reduce foraging opportunities for fish especially if an accident were to occur during the spring and fall phytoplankton bloom. Further potential effects on fish and fish habitat related to a large oil spill could amplify decreases in populations of fish that are already in decline.

Northern Flemish Pass Site

The Subsurface Blowout – Northern Flemish Pass site release with a 36-day unmitigated flow of 4,980 m^3/day release was modelled for 160 days at 2,700 m depth and results are described in Section 15.4.4. Modelling results indicate that the areas reaching or exceeding the ecological threshold for in-water concentration (1 µg/L PAH or 100 µg/L THC) includes areas in the top northwest corner of the NPA site and most of the area to the east of the NPA site. There was no predicted shoreline contact from releases at the NPA site.

Model results show that the areas predicted to have the highest concentration of in-water oil from an uncontrolled well event include portions of the Orphan Knoll, Flemish Pass, and Flemish Cap. It is important to note that while these areas are quite large, most of this footprint represents a relatively low probability (<10 percent) of in-water oil concentration of 1 µg/L based on a large unmitigated release. A subsurface blowout at the NPA site has the potential to result in a change in habitat availability and quality, fish mortality, injury and health, and fish presence and abundance. The extent of potential effects of a subsurface blowout scenario will depend on how the spill trajectory and fish and fish habitat overlap in both time and space.

As noted in Section 8.4, there are 19 fish species that are known to occur in the in the LSA and/or RSA which are designated as SAR or SOCC. In the extremely unlikely event of an uncontrolled release into the marine environment, these species have the potential to be adversely affected, if the timing of the spill occurs at the same time of fish presence. Potential effects will be similar to those described above for secure species. The likelihood, however, of a subsurface blowout occurring with the relevant mitigations in place has been calculated to be extremely low at a single event once in 37,000 years (Section 15.3.3; Table 15.12). In an actual event, emergency response measures would likely be effective in limiting the magnitude, duration and extent of the spill.

With spill prevention plans and response procedures in place, the potential effects of a subsurface blowout from the NPA site on Marine Fish and Fish Habitat are predicted to be adverse, medium in magnitude, medium to long-term in duration, occur within the RSA, and reversible. This was determined with a moderate level of confidence.

Eastern Flemish Pass Site

The Subsurface Blowout - EPA Site un-mitigated release scenario was a 15,000 m^3/day release of oil for 113 days at 1,100-m depth; modelling of released oil continued up to 160 days. The areas with the highest concentration of oil includes a majority of the Project Area and areas eastward enveloping the Flemish Cap and portions of the Orphan Knoll, and southern slopes of the Grand Bank. It is important to note that while these areas are quite large, most of this footprint represents a relatively low probability (<10 percent) of in-water oil concentration of 1 µg/L based on an unmitigated release.

For releases at the EPA site, small volumes of weathered oil were predicted to reach the shores of Sable Island in only 1-2 percent of the modelled simulations during the summer season, whereas in the winter season, small volumes of weathered oil were predicted to reach short and discontinuous sections of the southeastern and northern coasts of the island of Newfoundland and the southeastern coast of Labrador. Minimum time for oil to make contact with the shoreline is approximately 78 days. Only 0.01 percent of the modelled release volumes were predicted to contact these locations and

the oil that was predicted to make contact with the shoreline is expected to be highly weathered, patchy and discontinuous. While 98-99 percent of the simulated releases resulted in no oil contact with shoreline at all within 160 days, oil was predicted to make contact with the shoreline in 1-2 percent of the scenarios. Socioeconomic (1 g/ m²) and ecological (100 g/m²) thresholds were the basis used for oil amounts reaching shore. As described in Section 15.4.4.2.3, in a worse case scenario, oil was predicted to be found in concentrations between 100-500 g/m² concentration in an area of the Southern Avalon and on the south coast of the island near Burgeo. Given the time to shore, oil that is predicted to make contact with the shoreline is expected to be highly weathered, patchy and discontinuous. With the implementation of mitigation measures, including shoreline protection measures, it is extremely unlikely that oil would reach the shoreline and therefore residual effects on coastal fish populations and coastal fish habitat are considered negligible.

A subsurface blowout at the EPA Site has the potential to result in a change in habitat availability and quality, fish mortality, injury and health, and fish presence and abundance. The extent of potential effects of a subsurface blowout scenario will again depend on how the spill trajectory and fish and fish habitat overlap in both time and space.

The extent of the modelled unmitigated spill (in-water oil concentration of 1 µg/L) includes the Flemish Cap area and the banks and slope. These areas include productive and diverse fish habitat in the RSA and areas of high abundance and biomass of various fish and invertebrate species. The deeper slopes along the Grand Bank and Flemish Cap that contains cold water and deep sea taxa less resilient to perturbations would also be affected. Based on the modelling results, the oil would not accumulate in the sediments, and therefore a large direct impact on benthic fish habitat is not anticipated.

This unmitigated scenario would also affect fish health and mortality. Adult demersal and pelagic fish could potentially avoid the spill areas, but the juvenile and the early life stages of fish and benthic invertebrates in the immediate areas of the spill (Figure 4-28 of Appendix E) would likely suffer from sublethal and lethal effects as described above. A spill of this magnitude would also have potential mortality, injury and sublethal effects on plankton that would have further implications on foraging opportunities and overall health of higher trophic levels.

Fish presence and abundance would also be affected by this unmitigated scenario as mobile fish species would temporarily avoid the spill footprint within the model results. The range of the predicted oil spill indicates potential displacements from highly productive areas including the southern Grand Banks and the Flemish Cap. There would likely be decreased presence and abundance of mobile fish and invertebrates for the duration of the spill, with slow recolonization.

As noted in Section 8.4, there are 19 fish species that are known to occur in the in the LSA and/or RSA which are designated as SAR or SOCC. In the extremely unlikely event of an uncontrolled release into the marine environment, these species have the potential to be adversely affected, if the timing of the spill occurs at the same time of fish presence. Potential effects will be similar to those described above for secure species. The likelihood, however, of this type incident occurring with the relevant mitigations in place has been calculated to be extremely low at a single event once in 28,000 years (Section 15.3.3; Table 15.12). In an actual event, emergency response measures would be effective in limiting the magnitude, duration, and extent of the spill. As indicated by the modelling, an

unmitigated spill is extremely unlikely to reach the shoreline and the implementation of emergency response measures will further reduce this likelihood.

With spill prevention plans and response procedures in place, the potential effects of a subsurface blowout at the EPA site on Marine Fish and Fish Habitat are predicted to be adverse, medium in magnitude, medium to long-term in duration, occur within the RSA, and reversible. This was determined with a moderate level of confidence.

15.5.1.4 Summary

Table 15.18 provides a summary of predicted residual environmental effects of accidental event scenarios for Marine Fish and Fish Habitat, given the conservative approach used for the spill modelling, and the implementation of mitigation measures to prevent and reduce effects from a spill.

Table 15.18 Summary of Residual Accidental Event-Related Environmental Effects on Marine Fish and Fish Habitat

Accidental Event Scenario	Residual Environmental Effects Characterization						
	Nature	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty
Potential Effects: Change in Habitat Availability and Quality, Change in Fish Mortality, Injury, Health, and Change in Fish Presence and Abundance (Behavioral Effects)							
100 litre Diesel Spill	A	L	PA	S	S	R	M
1,000 litre Diesel Spill	A	L-M	PA	M	N	R	M
Subsurface Blowout – Northern Flemish Pass Site	A	M	RSA	M-L	N	R	M
Subsurface Blowout – Eastern Flemish Pass Site	A	M	RSA	M-L	N	R	M

KEY

Nature / Direction:
P Positive
A Adverse
N Neutral (or No Effect)

Magnitude:
L Low
M Medium
H High

Geographic Extent:
L Localized
PA Within Project Area
LSA Within LSA
RSA Within RSA and / or Beyond

Duration:
S Short term
M Medium term
L Long term
P Permanent

Frequency:
N Not likely to occur
O Occurs once
S Occurs sporadically
R Occurs on a regular basis
C Occurs continuously

Reversibility:
R Reversible
I Irreversible

Certainty in Predictions:
L Low level of confidence
M Moderate level of confidence
H High level of confidence

N/A Not Applicable

15.5.1.5 Determination of Significance

In consideration of the present knowledge of marine fish and fish habitat occurrence in the RSA, the result of spill modelling exercises, and planned mitigation, the predicted residual environmental effects from an accidental event scenario on Marine Fish and Fish Habitat is considered not significant.

In the very unlikely event of an offshore oil release, some degree of residual adverse effects to marine fish and fish habitat in the area at the time of the accident or malfunction are expected. The degree of exposure and thus the type and level of any such effects would depend on the type and size of spill, time of year, and the number, location and species of animals within the affected area. Although there is the potential for effects on fish and their habitats in the RSA, these are, with appropriate mitigations, not likely to result in an overall, detectable decline in overall fish abundance or change in the spatial and temporal distribution of fish populations in the overall RSA for multiple generations. Similarly, while any affected individuals could conceivably be part of a species at risk, it is unlikely that the overall abundance, distribution of health of any such species and its eventual recovery will be negatively affected. For the length of accidental offshore oil release, there will be reduction in availability or access to fish habitat. As model predictions indicate minimal interactions with benthic habitats, it is expected there will be limited residual adverse effects on fish habitat and benthic species including sensitive coral and sponge species. However, eventual break down of oil material in marine environments may become transported to benthic habitats through microbial and plankton pathways through sinking and flocculation. In the context of applied mitigations, these adverse environmental effects are considered unlikely and therefore not predicted to have any significant effects on fish habitat. Spill prevention techniques and response strategies will be incorporated into the design and operations for all Project activities as part of contingency planning, which will further help to ensure that effects do not occur, and in the unlikely event they did, that these would not have significant adverse effects to fish populations and fish habitats in the RSA.

15.5.2 Marine and Migratory Birds

15.5.2.1 Introduction

A variety of avifauna species occur within the marine and coastal environments off Eastern Newfoundland at various times of the year, including seabirds and other avifauna that inhabit the region for breeding, feeding, migration and other activities according to their individual life histories and habitat requirements, and could therefore be present in the RSA at the time of an accidental event.

Seabirds, waterfowl and divers, and shorebirds are the most vulnerable to perturbation as they spend much of their life in the marine environment. Some land bird species may also be affected, particularly those associated with coastal habitats and any that migrate nocturnally over offshore waters. The timing of occurrence varies considerably depending on the species, with some taxa abundant year-round (such as large gulls and kittiwakes, many alcid species, fulmars, and shearwaters) while some are more likely to be present in the winter (Ivory Gulls, waterfowl) or fall (Leach's Storm-petrels). Several important habitats for birds have also been identified at locations along the coastline of Newfoundland and Labrador. Although not in the Project Area itself, there are several IBAs, Migratory

Bird Sanctuaries MBSs and breeding sites around coastal Newfoundland, as well as EBSAs in the Northwest Atlantic designated in part due to their importance to seabirds.

The accidental release of hydrocarbons in the marine environment can adversely affect marine and migratory birds and their habitat present in the offshore and potentially the nearshore environment. The extent of the potential effects depends on how the spill trajectory and the VC overlap in both space and time.

15.5.2.2 Potential Issues and Interactions

The potential environmental effects on Marine and Migratory Birds identified and used in the earlier effects assessment (Chapter 9) are: change in mortality or injury level and bird health, change in avifauna presence and abundance, change in habitat availability and quality, and change in food availability or quality. These potential effects remain relevant to the assessment of accidental events, although the mechanisms or pathways of effects are different.

15.5.2.2.1 Effects of Hydrocarbons on Marine and Migratory Birds

Accidental events such as oil spills can have important, adverse consequences for marine-associated birds, leading to potential changes in the presence, abundance, distribution and/or health of marine birds (individuals and populations). Exposure to accidental oil spills from drill rigs or vessels may affect individuals (through physical exposure, ingestion), important habitats and food sources. Marine birds are amongst the biota most at risk from oil spills, as they spend much of their time upon the surface of the ocean (LGL Limited 2005; Barron 2012; Boertmann and Mosbech 2011). In the event of a spill, and depending upon project and area specific factors, coastal birds may also be at risk on beaches and in intertidal zones.

An accidental release of hydrocarbons can result in the direct physical exposure of birds to oil within the affected area. Accidental discharges of hydrocarbons, and even routine operational discharges from vessels and platforms may lead to sheens of crude oil and other substances on the water's surface, to which avifauna (especially pelagic seabirds) may be exposed (Wiese and Robertson 2004; O'Hara and Morandin 2010; Morandin and O'Hara 2016). The possible physical effects of oil exposure on birds include changes in thermoregulatory capability (hypothermia) and buoyancy (drowning) due to feather matting (Clark 1984; Montevecchi et al 1999), as well as oil ingestion from excessive preening (Hartung 1995).

Even small amounts of oil from sheens have been shown to affect the structure and function of seabird feathers (O'Hara and Morandin, 2010), which has the potential to result in water penetrating plumage and displacing the layer of insulating air, resulting in loss of buoyancy and hypothermia. This can cause a heightened metabolic rate (increased energy expenditure), behavioral changes such as increased time spent preening at the expense of foraging and breeding, and potentially death (Morandin and O'Hara 2016). Morandin and O'Hara (2016) reviewed several short and long term studies of marine oil spills, and reinforced that these effects can result in increased mortality rates, physiological impairment, reduced reproductive success and in severe cases, possible long-term population declines. Birds at greatest risk are those that spend a considerable time resting or foraging on the water surface (Wiese and Roberston 2004; Boertmann and Mosbech 2011). The long-lived

nature of many bird species also suggests that oil-related effects can have longer term population effects (Wiese and Roberston 2004). While the primary potential for exposure and thus for direct effects on seabirds occurs within the spatial extent of the spill itself, the ecological effects of oiled areas may be transferred away from the affected site due to the migratory nature of some marine-associated avifauna (Henkel et al 2012).

The possible effects of oil exposure on birds varies between species, as well as with different types of oil (Gorsline et al 1981), weather conditions, times of year, migratory patterns, and other activities (Wiese et al 2001; Montevecchi et al 2012). Mortality rates and potential changes in bird populations due to accidental releases of oil are poorly known, but this is often cited as the main risk to marine birds from the offshore oil and gas industry (Fraser and Ellis 2008; Ellis et al 2013). Seabirds have long lives and very low annual reproductive rates, and so mortality of adults can have serious effects on populations. In years of poor food availability, nesting birds may abandon reproductive attempts, resulting in massive die-offs of chicks but preserving fitness of adult birds to reproduce in subsequent years. Although it is difficult to assess the direct relationship between volume of oil spilled and number of seabirds oiled (Burger 1993), it is clear that the timing and location of a spill (and not just its size) has an important influence on avifauna mortality and injury rates (Weisse et al 2001).

In terms of any possible health effects from oil ingestion, the potential for toxic effects from small amounts of oil is somewhat unclear. While acute toxic effects from exposure to sheens are considered unlikely (Morandin and O'Hara 2016), some studies have shown effects of exposure to low levels of oil on adult birds (Miller et al 1980; Trivelpiece et al 1984; Butler et al 1986, 1988). Ingested oil can cause lethal and sublethal effects (McEwan and Whitehead 1980), including damage to the liver (Khan and Ryan 1991), pneumonia (Hartung and Hunt 1966), brain damage (Lawler et al 1978), immunotoxic effects (Barron 2012) and starvation due to increased energy needs to compensate for heat loss resulting from oiling and loss of insulation (Peakall et al 1980; 1982; MMS 2001). Birds that feed on organisms from affected areas are also at heightened risk of contamination from their food sources (Engelhardt 1983). Other studies have, however, found little or no effects from exposure to low doses of oil on adult seabirds (Ainley et al 1981; Stubblefeld et al 1995; Alonso-Alvarez et al 2007).

15.5.2.2.2 Effects of Dispersants on Marine and Migratory Birds

The use of dispersants, which enhances the natural microbial degradation, may be beneficial for marine and migratory birds within a spill area by reducing the exposure to floating oil on the sea surface. Application of chemical dispersants reduces the risk of adverse effects on marine and migratory birds at the water's surface, and results in a far greater rate of biodegradation of oil to a matter of weeks rather than of years (Baelum et al 2012). This relatively rapid rate of degradation greatly reduces the chance of accidentally released oil reaching shorelines, where it could potentially cause great harm to shorebirds and adversely affect seabird nesting colonies (Prince 2015). Conversely, however, the use of dispersants results in increased oil in the water column, potentially resulting in exposure of food sources (fish and water column invertebrates) to oil, and exposure of diving birds near the dispersed oil. The measured toxicity of dispersants themselves is very low (Prince 2015). The dispersed oil has similar effects to that of oil, as presented earlier, but the size of

the slick and exposure concentrations would be lower than untreated oil. Hence, dispersant mitigates the potential adverse effects of oil on birds compared to untreated oil.

15.5.2.3 Residual Environmental Effects Assessment and Evaluation

The potential residual effects of an oil spill (that is, the effects remaining after the implementation of emergency response measures; Section 15.1), should it occur, are assessed in the following sections.

15.5.2.3.1 Batch Spills

Modelling of batch spills (100 or 1,000 L at the NPA site and the EPA site) suggest that maximum surface oil thickness is likely to be <0.0001 (colourless and silver sheen). Total hydrocarbon concentrations will be highest in the immediate vicinity of the spill but are predicted to dissipate rapidly (<0.1 percent of the released volume remaining on surface after 30 days) with distance and remain well offshore (0 percent predicted to reach the shore). Any batch spills resulting from the Project would cause a temporary decrease in water (and thus habitat) quality around the spill site. This would be short-term in nature, lasting until the slick disperses when aided by surface wave action in the offshore environment. These results suggest that both the potential for exposure and the likelihood of adverse effects on Marine and Migratory Birds from a batch release are low, with only those individuals occupying the immediate footprint of the spill at the time of the spill, being affected.

Observations of sheens in Atlantic Canada are industry-reported to C-NLOPB. Overall, the number of reported sheens off platforms in the Grand Banks is 24 per year (Morandin and O'Hara 2016). Thicker sheens may persist for a day or more; data from ERIN Consulting Ltd and OCL Services Ltd (2003) for example showed that sheens of 1 µm persist for up to 24 h, while thinner (0.1 µm) sheens tended to disperse in less than an hour. Based on the perceived colour of sheens observed in the Grand Banks, the thickness was estimated to be in the range of 0.07 to 1 µm for sheens for which qualitative descriptions were provided, and it is thought that thicker sheens are rare in offshore operations (Morandin and O'Hara 2016).

If a sheen was produced from a Project-related batch spill, it would be temporary (likely less than 24 hours) and limited in size, affecting only birds in the immediate area of the spill itself. There would be an increased risk of mortality for individual birds that encountered the sheen (particularly for diving birds and those that spend large amounts of time on the water), as well as potential sublethal toxicity effects (metabolic rate and chick growth) to species such as Leach's Storm-petrels. Chicks and eggs are more susceptible to negative effects of exposure to oil (even at very low levels), although exposure of breeding adults (and, consequently, eggs and nestlings) of most seabirds to hydrocarbon sheens is unlikely because the Project Area is several hundred kilometers from shore, well outside the foraging range of most seabirds (Morandin and O'Hara 2016). One exception is the Leach's Storm-petrel, which is known to make foraging trips of thousands of kilometers during the breeding season (Pollet et al. 2014), and therefore breeding adults may be exposed to hydrocarbon emissions while foraging within the affected area within 24 hours of the spill. This also has the potential to result in changes in avifauna presence and abundance (behavioral effects), as hydrocarbon exposure could influence the occurrence and success of key life history stages of the

species. The Northern Gannet is also known to make extensive multi-day foraging trips (Garthe et al. 2007).

With spill prevention plans and response procedures in place, potential effects of a batch spill (100 and 1,000 L) on Marine and Migratory Birds are predicted to be adverse, low to medium in magnitude, short- to medium-term in duration, to occur within the Project Area, and reversible. This prediction was made with a moderate level of confidence.

15.5.2.3.2 Uncontrolled Well Event

A well blowout scenario has the potential to result in a change in mortality or injury level and bird health, change in avifauna presence and abundance, change in habitat availability and quality, and change in food availability or quality. Once birds are exposed to oil, and even with rescue and cleaning efforts, the chances of survival are often quite low (French-McCay 2009). If direct exposure to spilled oil equated to near 100 percent mortality of affected birds, the key factor in predicting mortality for marine birds would therefore be the probability of exposure. This probability is largely dependent on both the probability and fate and behavior of the spilled oil, but also the distribution and behaviors of the taxa involved. For example, an aerial species that is migrating through an area with a spill is less likely to become oiled than a species that frequently uses the area for foraging. French-McCay (2009) has developed a number of associated vulnerability indices that are presented here for context:

- 99 percent mortality – birds that sit on the surface are most vulnerable (e.g., dovekies, murres)
- 35 percent mortality – birds that are mostly in flight but dive frequently for prey (e.g., petrels)
- 5 percent mortality – birds that are mostly in flight (migratory birds in transit)

As part of this assessment, the ecological risk to marine birds was assessed by using these metrics in combination with the threshold concentrations for marine birds for the oil floating on the surface (10 g/m², 10µm thickness) and shoreline oil (100 g/m²).

The key implications for seabirds would include seabird-oil interactions when birds are occupying their foraging grounds. Generally, the greatest risk of seabird interactions with an oil spill comes in the winter months when conditions are colder and thermoregulation is most difficult, increasing the likelihood of mortality for affected birds (Morandin and O'Hara 2016). The species at greatest risk of interactions with an oil spill vary with the species' abundance in the area, which depends on the season.

Northern gannets and Leach's storm-petrels are at greatest risk in the fall, when young fledglings depart the colony for rich offshore feeding grounds. Fledgling common murres and thick-billed murres are also vulnerable at this time of year, as chicks are flightless for a period of one to two months as they are accompanied by their male parent to foraging areas.

The waters off Atlantic Canada provide a core wintering area for the world's population of great skuas. Tens of millions of dovekies occur here in the winter months. Black-legged kittiwakes and common and thick-billed murres overwintering over the shelf edge and the waters off Eastern

Newfoundland. Most of the world's great shearwaters are found in the northwest Atlantic during the summer months. These birds breed in our winter months in the Southern Hemisphere and forage in the productive offshore waters of the Northwest Atlantic in their non-breeding season.

Northern Flemish Pass Site

The Subsurface Blowout – Northern Pass site release with a 36-day unmitigated flow of 4,980 m^3/day release was modelled for 160 days at 2,700 m depth and results are described in Section 15.4.4. The unmitigated modelling results indicates that the areas along the northern perimeter of the Project Area will have an oil thickness between 0.01-0.1 mm, reaching the ecological threshold for effects to seabirds. Only 0-2 percent of the oil was predicted to remain on the surface at the end of the 160-day simulations. There was no predicted shoreline contact from releases at the NPA site, therefore the magnitude of residual environmental effects would be negligible.

Based on the vulnerability indices (French-McCay 2009) the mortality rate would range from 35-95 percent for birds that come in contact with the slick in the 0.01-0.1 mm thickness range. Murres and dovekies, which spend most of their time sitting on the water's surface, are most vulnerable (estimated 95 percent mortality), while species that dive or feed at the water's surface for their prey but otherwise spend little time on the water, including Leach's storm-petrels, great shearwaters, and great skuas, are predicted to have a lower mortality rate of 35 percent. Black-legged kittiwakes and northern gannets, which do often sit on the water but spend more time in the air than alcids (murres and dovekies), would be expected to have an intermediate mortality rate.

As noted in Section 9.4, there are two marine-associated avian SAR species that are known to occur in the in the LSA and / or RSA. In the extremely unlikely event of an uncontrolled release into the marine environment, these species have the potential to be adversely affected, if the timing of the spill occurs at the same time of presence of marine-associated avian SAR species. Potential effects will be similar to those described above. The likelihood, however, of a subsurface blowout occurring with the relevant mitigations in place has been calculated to be extremely low, with a single event once in 37,000 years (Section 15.3.3; Table 15.12). In an actual event, emergency response measures such would likely be effective in limiting the magnitude, duration and extent of the spill.

With spill prevention plans and response procedures in place, potential effects of a subsurface blowout from the NPA site on Marine and Migratory Birds are predicted to be adverse, potentially medium to high in magnitude, medium to long-term in duration, occurring within the RSA, and reversible in nature. This was determined with a moderate level of confidence.

Eastern Flemish Pass Site

The Subsurface Blowout - EPA Site un-mitigated release scenario was a 15,000 m^3/day release of oil for 113 days at 1,100-m depth; modelling of released oil continued up to 160 days. The unmitigated modelling results show that areas in the eastern section (Figure 4-22 of Appendix E) would have an oil thickness of between 0.01-0.1 mm, the ecological threshold for effects on seabirds. The ecological threshold exceedance area extends to the north, south and east of the Northern Section of the Project Area. Only 0-2 percent of the oil was predicted to remain on the surface at the end of the 160-day simulations.

For releases at the EPA site, small volumes of weathered oil were predicted to reach the shores of Sable Island in only 1-2 percent of the modelled simulations during the summer season, wheras in the winter season, small volumes of weathered oil were predicted to reach short and discontinuous sections of the southeastern and northern coasts of the island of Newfoundland and the southeastern coast of Labrador. Minimum time for oil to make contact with the shoreline is approximately 78 days. Only 0.01 percent of the modelled release volumes were predicted to contact these locations and the oil that was predicted to make contact with the shoreline is expected to be highly weathered, patchy and discontinuous. While 98-99 percent of the simulated releases resulted in no oil contact with shoreline at all within 160 days, oil was predicted to make contact with the shoreline in 1-2 percent of the scenarios. Socioeconomic (1 g/ m²) and ecological (100 g/m²) thresholds were the basis used for oil amounts reaching shore. As described in Section 15.4.4.2.3, in a worse case scenario, oil was predicted to be found in concentrations between 100-500 g/m² concentration in an area of the Southern Avalon and south coast of the island near Burgeo. Given the time to shore, oil that is predicted to make contact with the shoreline is expected to be highly weathered, patchy and discontinuous. Shoreline oil exposure is highly unlikely due to a combination of the forcing parameters transporting surface and entrained oil predominantly to the east. While the consequences of shoreline oil exposure would be serious for marine birds, particularly on the Avalon Peninsula which is home to important seabird colonies (Section 6.2), shoreline exposure is, as stated above, highly unlikely with the highest predicted potential being 1-2 percent in the event of an unmitigated subsurface release scenario. Sable Island is a bird sanctuary and a breeding area for the Roseate Tern, a SARA species listed as endangered. The probability of oil reaching Sable Island is small (1 – 2 percent of the modelled simulations during the summer season) with a long response time (>78days), increasing the ability to put mitigations in place to further reduce the chances of oil-shoreline interaction.

Based on the vulnerability indices (French-McCay 2009) the estimated mortality rate would range from 35-95 percent (the latter percentage for birds sitting on the water surface such as murres and dovekies, and the former for diving birds such as storm-petrels, shearwaters and skuas) for the birds that come in contact with the slick in the 0.01-0.1 mm thickness (Figure 4-22 of Appendix E).

As noted in Section 9.4, there are two marine-associated avian SAR species that are known to occur in the in the LSA and/or RSA. In the extremely unlikely event of an uncontrolled release into the marine environment, these species have the potential to be adversely affected, if the timing of the spill occurs at the same time of presence of marine-associated avian SAR species. Potential effects will be similar to those described above. The likelihood, however, of a subsurface blowout occurring with the relevant mitigations in place has been calculated to be extremely low, with a single event once in 28,000 years (Section 15.3.3; Table 15.12). In an actual event, emergency response measures such as the BOP would likely be effective in limiting the magnitude, duration and extent of the spill.

With spill prevention plans and response procedures in place, potential effects of a subsurface blowout from the EPA site on Marine and Migratory Birds are predicted to be adverse, potentially medium to high in magnitude, medium to long-term in duration, occurring within the RSA, and reversible in nature. This was determined with a moderate level of confidence.

15.5.2.4 Summary

Table 15.19 provides a summary of predicted residual environmental effects of accidental event scenarios for Marine and Migratory Birds, given the conservative approach used for the spill modelling, and the implementation of mitigation measures to prevent and reduce effects from a spill.

Table 15.19 Summary of Residual Accidental Event-Related Environmental Effects on Marine and Migratory Birds

Accidental Event Scenario	Residual Environmental Effects Characterization						
	Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Potential Effects: Changes in Mortality / Injury Levels and Bird Health (individuals or populations), Changes in Avifauna Presence and Abundance, Change in Habitat Availability and Quality, and Change in Food Availability or Quality							
100 litre Diesel Spill	A	L	PA	S	S	R	M
1,000 litre Diesel Spill	A	M	PA	M	N	R	M
Subsurface Blowout – Northern Flemish Pass Site	A	M-H	RSA	M-L	N	R	M
Subsurface Blowout – Eastern Flemish Pass Site	A	M-H	RSA	M-L	N	R	M

KEY

Nature / Direction:
P Positive
A Adverse
N Neutral (or No Effect)

Magnitude:
L Low
M Medium
H High

Geographic Extent:
L Localized
PA Within Project Area
LSA Within LSA
RSA Within RSA and Beyond

Duration:
S Short term
M Medium term
L Long term
P Permanent

Frequency:
N Not likely to occur
O Occurs once
S Occurs sporadically
R Occurs on a regular basis
C Occurs continuously

Reversibility:
R Reversible
I Irreversible

Certainty in Predictions:
L Low level of confidence
M Moderate level of confidence
H High level of confidence

N/A Not Applicable

15.5.2.5 Determination of Significance

In consideration of the present knowledge of marine and migratory bird occurrence in the RSA, the known effects of oil spills on marine-associated avifauna, the result of spill modelling exercises, and planned mitigation, a precautionary conclusion is drawn that residual environmental effects from an

accidental subsurface blowout on Marine and Migratory Birds are predicted to be significant depending on the specific occurrence and nature and degree of the event, but extremely unlikely to occur.

In the extremely unlikely event of a large scale offshore oil release, some degree of residual adverse effects to marine and migratory birds present in the area at the time of the accident or malfunction are expected. The degree of exposure and thus the type and level of any such effects would depend on the type and size of spill, time of year, and the number, location, and species of animals within the affected area. For the blowout scenarios, these environmental effects however could be significant if it led to a detectable decline in overall bird abundance or change in the spatial and temporal distribution of bird populations in the overall RSA for multiple generations. Again, this is considered extremely unlikely given the very low probability of a large spill to occur and the response mitigations that will be implemented. Spill prevention techniques and response strategies will be incorporated into the design and operations for all Project activities as part of contingency planning, which will further help to ensure that such an incident and its effects do not occur, and in the unlikely event they did, that these would not likely have significant adverse effects to marine and migratory birds.

15.5.3 Marine Mammals and Sea Turtles

15.5.3.1 Introduction

Numerous species of marine mammals and sea turtles, including several SAR/SOCC, are known to occur in the RSA seasonally or year-round, and could therefore be present at the time of an accidental event. While some species of marine mammals occur in the waters off Newfoundland year-round, concentrations and diversity are generally highest from late spring to autumn. There is no designated critical habitat for marine mammals or sea turtles within or near the Project Area; however, there are several EBSAs in the RSA, some of which have been identified as important to marine mammals and sea turtles (see Section 6.4). Most EBSAs that overlap the RSA serve as feeding aggregation areas. For example, the Northeast Shelf and Slope EBSA overlaps with the NPA site and has been noted as having concentrations of cetaceans and seals. Some of the coastally located EBSAs also provide migration corridors or breeding and whelping areas for seals.

The potential for interaction of different species of marine mammals or sea turtles with an accidental event such as a hydrocarbon release will vary based on the timing, location, duration, and extent of the spill. For example, small-toothed whale, dolphin, and porpoise species are expected in both coastal and offshore waters of the RSA, whereas sperm whale sightings are more often associated with continental slope waters. The most commonly expected baleen whale species in the RSA are humpback, minke, fin, and sei whales. Harbour seals are concentrated primarily in coastal areas, while grey, harp, and hooded seals are more widespread and can be found in deeper waters of the RSA when not breeding or whelping on land or pack ice. Leatherback sea turtles are considered most likely to be observed over the continental slope areas off the Grand Banks and south of the Flemish Cap. The likelihood of loggerhead and Kemp's ridley sea turtles occurring anywhere in RSA is considered low.

15.5.3.2 Potential Issues and Interactions

The potential environmental effects on Marine Mammals and Sea Turtles identified and used in the earlier effects assessment (Chapter 10) were: change in mortality or injury (from underwater noise or vessel strikes), change in health (contaminants), change in habitat quality or use (behavioural effects), and change in food availability or quality. These potential effects remain relevant to the assessment of accidental events, although the mechanisms or pathways of effects may be different. Marine mammals and sea turtles may experience a change in mortality or injury (acute or immediate effects) if directly exposed to accidentally-released hydrocarbons or associated volatiles and aerosols. They may experience a change in health (sub-lethal effects) from direct contact with hydrocarbons (including volatiles and aerosols) or consumption of contaminated prey. There may be a change in habitat (marine water or shoreline/haulout) quality due to oiling and associated response measures. The availability and quality of food (prey items) may also be adversely affected by an accidental release event; effects to prey species are discussed in greater detail in Section 15.5.1.

In the unlikely event of an oil release in the Project Area, adverse effects to marine mammals and sea turtles include oil fouling (e.g., fur, flippers, or baleen), ingestion of contaminated food or water, and exposure to volatiles/absorption of oil through the respiratory tract. Inhalation, aspiration, ingestion, or fouling may cause inflammation of mucous membranes, behavioural changes and movement challenges, pneumonia, neurological damage, or in extreme cases death (Geraci and St. Aubin 1990). Secondary effects include potential for loss of prey resources (see Section 15.5.1). The extent of potential effects on marine mammals and sea turtles depends largely on the level of exposure to the toxic components of the oil.

15.5.3.2.1 Effects of Hydrocarbons on Marine Mammals

Although some studies suggest that cetaceans can detect oil spills, they do not appear to consistently avoid contact with most types of oil (St. Aubin et al. 1985, Harvey and Dahlheim 1994, Matkin et al. 1994, St. Aubin et al. 1985, Geraci et al. 1983, Smultea and Würsig 1995). However, there is some evidence that dolphins decrease their respiration rate and increase their dive duration in the presence of surface oil (Smultea and Würsig 1995). Oil has little effect on thermoregulation since cetaceans and pinnipeds rely on a subcutaneous layer of blubber for insulation (Geraci 1990). It is assumed that exposure of the eye to oil may result in temporary or permanent damage (St. Aubin 1990). Oil can coat the baleen of mysticetes and reduce filtration, thereby reducing feeding efficiency (Geraci 1990). This effect is considered reversible once adherent oil is removed (Geraci 1990). Inhalation of volatiles and aspiration of aerosolized oil compounds from an oil spill or blowout can result in inflammation of the mucous membranes and absorption of hydrocarbons into the bloodstream (Geraci 1990). Whales may ingest oil with water or by consuming contaminated prey. Species such as harbour porpoise and harbour seals that feed in more restricted areas (e.g., bays) are likely at greater risk of ingesting oil (Würsig 1990) should spilled substances extend to the shorelines. Ingested oil that is not excreted in vomit or feces can be absorbed into the tissues and have toxic effects (Geraci 1990), although it has been reported that ingested oil may be removed from an animals' system after returning to uncontaminated waters (Engelhardt 1978, 1982, 1983). Bence and Burns (1995) reported that only small traces of oil were found in the blubber of a grey whale and the liver of a killer whale exposed to oil from the *Exxon Valdez* spill. Following the DWH spill in the Gulf

of Mexico, 171 dolphins and whales were collected between April 30, 2010 and February 15, 2011, either through stranding or directed captures in open water (NMFS 2014). Of these, 153 individuals were collected dead, almost 90 percent of which were bottlenose dolphins. Of the 109 marine mammals collected as of November 10, 2010, only six individuals showed visible oiling (NMFS 2014). This spill occurred in warmer waters than those of the North Atlantic; studies to compare the sensitivity of marine mammal and sea turtle species in a colder-water spill scenario as compared to a warmer-water spill scenario using standard laboratory techniques) cannot be performed for ethical, regulatory, or practical reasons. As a result, conclusions regarding potential toxic effects of treated or untreated oil on these species often rely on uncontrolled field exposures following accidental events (e.g., Exxon Valdez and DWH). Despite potential environmental differences between the Project area and considered historic spill event locations, a number of marine mammal and sea turtle species have ocean-basin distributions (for example Atlantic spotted dolphin, false killer whale, killer whale, Risso's dolphin, sperm whale, humpback whale, leatherback and loggerhead sea turtles and others may be found in both the Gulf of Mexico and the Project Area).

Oil spills and blowouts have the potential to result in mortality of some pinnipeds. Mortality has been reported in seals fouled with oil, particularly in seal pups in colder waters (St. Aubin 1990). As in cetaceans, exposure of seals to oil can result in conjunctivitis (Spraker et al. 1994), corneal abrasion and swollen nictitating membranes, or permanent eye damage (St. Aubin 1990) and therefore reduced foraging ability (Levenson and Schusterman 1997). Heavily fouled seals can experience reduced locomotion and even drowning (Davis and Anderson 1976, Sergeant 1991). Harbour seals observed immediately after oiling appeared lethargic and disoriented, a response that may be attributed to lesions observed in the thalamus of the brain (Spraker et al. 1994). Seals may ingest oil by consuming contaminated prey or by nursing contaminated milk. Once ingested, oil absorbed into the tissues can result in minor kidney, liver, or brain lesions (Geraci and Smith 1976, Spraker et al. 1994).

Direct evidence of long-term effects from chronic exposure to hydrocarbons, either through contact or ingestion, is lacking for both marine mammals and sea turtles. However, Spraker et al. (1994) found lesions characteristic of hydrocarbon toxicity in the brains of oiled seals collected several months after the *Exxon Valdez* spill. Killer whales are known to be susceptible to accumulating high concentrations of persistent organic pollutants, as they are long-lived top predators (Ross et al. 2000, 2002). Long-term studies of marine mammals following oil spill events in different parts of the world have demonstrated evidence implicating oil spills with the mortality of cetaceans (e.g., Dahlheim and Matkin 1994; Matkin et al. 2008). Following the *Exxon Valdez* oil spill, sea otters (*Enhydra lutris*), harbour seals, Stellar sea lions (*Eumetopias jubatus*), killer whales, and humpback whales were deemed most affected by the spill (Lee et al. 2015).

15.5.3.2.2 Effects of Hydrocarbons on Sea Turtles

Effects of exposure to oil in sea turtles include reduced lung capacity, decreased oxygen uptake, reduced digestion efficiency, and damaged eyelid and nasal tissues (Lutz and Lutcavage 1989). It has been suggested that sea turtles may be more susceptible to the effects of exposure to hydrocarbons because they demonstrate limited avoidance behaviour (Vargo et al. 1986) and indiscriminate feeding, and take large pre-dive inhalations (NOAA 2010). Loggerhead sea turtles

have presented with skin lesions after exposure to oil, although effects were reversed ten days post-exposure (Bossart et al. 1995). Sea turtles are often found heavily oiled after a spill and approximately 1 percent of sea turtle strandings in the US are associated with oil (Lutcavage et al. 1997, in Milton et al. 2003). NMFS (2014) documented over 600 dead sea turtles after the DWH spill in 2010, 75 percent of which were Kemp's Ridley sea turtles and at least 18 individuals of which were visibly oiled. An additional 450 oiled sea turtles were rescued, rehabilitated, and released; 95 percent of these were loggerhead sea turtles (NMFS 2014).

15.5.3.2.3 Effects of Dispersants on Marine Mammals and Sea Turtles

In general, dispersed oil is predicted to reduce potential adverse environmental effects on marine mammals and sea turtles. Marine mammals are susceptible to floating oil due to the fact they need to surface at regular intervals to breathe. The use of dispersants, which enhances the natural microbial degradation, may be beneficial for mammals within a spill area by reducing the exposure to floating oil on the sea surface. The dispersion of oil; however, may expose swimming or feeding marine mammals to the consumption of contaminated plankton, skin/fur contamination, and potentially the clogging of baleen (Lee et al. 2015). Hydrocarbons consumed by marine mammals through contaminated diets can be metabolized and excreted. Some hydrocarbons, however, may be stored in blubber and other fat deposits which may be released into circulation during periods of physiological stress (low prey availability, migration, lactation) and may be bioavailable and toxic to fetus or newborns (Lee et al. 2015).

15.5.3.3 Residual Environmental Effects Assessment and Evaluation

The residual effects of an oil spill (that is, the effects remaining after the implementation of emergency response measures; Section 15.1), should it occur, are assessed in the following sections. For both the batch spill and blowout scenarios discussed below, fur-bearing marine mammals (i.e., seals) are at higher risk of adverse effects of oil exposure and may encounter oil either in the water, or when hauling out on oiled shorelines.

15.5.3.3.1 Batch Spills

Modelling of batch spills (100 or 1,000 L at NPA site and Easter Flemish Pass site) suggest that maximum surface oil thickness is likely to be <0.0001 (colourless and silver sheen). Total hydrocarbon concentrations will be highest in the immediate vicinity of the spill but are predicted to dissipate rapidly (<0.1 percent of the released volume remaining on surface after 30 days) with distance and remain well offshore. These results suggest that both the potential for exposure and the likelihood of adverse effects on marine mammals and sea turtles from a batch release (e.g., fouling, inhalation of vapours) are low. Only animals in the immediate vicinity at the time of the spill may be exposed, and at the concentrations predicted, change in mortality or injury is considered unlikely and changes in health are predicted to be of low magnitude (e.g., temporary inflammation of mucous membranes). Changes in habitat quality or use will likewise be of low magnitude. Batch spills from either the EPA site or NPA site are not expected to affect haulout areas on distant shorelines. While there will be a decrease in water quality around the spill site, this would be short-term until the slick disperses (aided by surface wave action in the offshore environment).

With spill prevention plans and response procedures in place, potential effects of a batch spill (100 and 1,000 L) on Marine Mammals and Sea Turtles are predicted to be adverse, low in magnitude, short-term in duration, occur sporadically within the Project Area, and be reversible. This was determined with a high level of confidence.

15.5.3.3.2 Uncontrolled Well Event

A subsurface blowout has the potential to result in a change in mortality or injury, change in health, and change in habitat quality or use. Potential for change in habitat quality or use of oceanic habitats (i.e., water quality and air quality at the air-sea interface) will be greater near the location of the subsea release and is predicted to be low to medium in magnitude and short to medium-term in duration, depending on the nature of the spill. The degree of change in mortality or injury and change in health will depend in large part on the occurrence and distribution of marine mammals and sea turtles at the time of the blowout, as well as the duration and extent of oil release (i.e., potential severity of effects will be dependent on the potential for exposure). Given the highly mobile nature of this VC, the magnitude of effects will be higher for subsea releases of larger scale and extended duration, as was observed during the DWH spill in the Gulf of Mexico (e.g., Takeshita et al. 2017). Depending on the exact nature, extent, and duration of a spill, marine mammals and sea turtles in the spill area are likely to experience a combination of exposures from contaminated air, water, and sediment and via a combination of pathways (inhalation, ingestion, aspiration, and adsorption). Marine mammals and sea turtles that are closer to the site of the blowout are more likely to be exposed to a more constant flow and higher concentrations of fresher oil, as compared to nearshore species.

Northern Flemish Pass Site

Modelling of a subsea release at the NPA site did not result in shoreline oiling, and therefore, shorelines and terrestrial areas used by marine mammals as haulouts are not predicted to be affected. Change in habitat quality or use of terrestrial habitats is therefore predicted to be low in magnitude and short-term in duration. Predatory marine mammals that prey on seals (e.g., killer whales) may also experience changes in mortality, injury, or health following consumption of oiled prey species.

As noted in Section 10.4, there are nine marine mammal and two sea turtle SAR / SOCC that are known to occur in the in the LSA and/or RSA. In the extremely unlikely event of an uncontrolled release into the marine environment, these species have the potential to be adversely affected, if the timing of the spill occurs at the same time of presence of marine mammal and / or sea turtles SAR SOCC. Potential effects will be similar to those described above. The likelihood, however, of a subsurface blowout occurring with the relevant mitigations in place has been calculated to be extremely low (single event once in 37,000 years). In an actual event, emergency response measures such as the BOP would likely be effective in limiting the magnitude, duration and extent of the spill.

With spill prevention plans and response procedures in place, potential effects of a subsurface blowout from the NPA site on Marine Mammals and Sea Turtles are predicted to be adverse, low to

medium in magnitude, medium to long-term in duration, within the RSA, and be reversible. This was determined with a moderate level of confidence.

Eastern Flemish Pass Site

For releases at the EPA site, small volumes of weathered oil were predicted to reach the shores of Sable Island in only 1-2 percent of the modelled simulations during the summer season, whereas in the winter season, small volumes of weathered oil were predicted to reach short and discontinuous sections of the southeastern and northern coasts of the island of Newfoundland and the southeastern coast of Labrador. Minimum time for oil to make contact with the shoreline is approximately 78 days. Only 0.01 percent of the modelled release volumes were predicted to contact these locations and the oil that was predicted to make contact with the shoreline is expected to be highly weathered, patchy and discontinuous. While 98-99 percent of the simulated releases resulted in no oil contact with shoreline at all within 160 days, oil was predicted to make contact with the shoreline in 1-2 percent of the scenarios. Socioeconomic (1 g/ m²) and ecological (100 g/m²) thresholds were the basis used for oil amounts reaching shore. As described in Section 15.4.4.2.3, in a worse case scenario, oil was predicted to be found in concentrations between 100-500 g/m² concentration in an area of the Southern Avalon and area on the south coast of the island near Burgeo. Given the time to shore, oil that is predicted to make contact with the shoreline is expected to be highly weathered, patchy and discontinuous. In this scenario, species that haul out on potentially affected shorelines are those most likely to interact with hydrocarbons (e.g., grey seals on Sable Island). However, as noted, the probability of subsurface-released oil reaching shorelines is low. Change in habitat quality or use of terrestrial habitats is therefore predicted to be low in magnitude and short-term in duration. In the unlikely event of shoreline oiling, fur-bearing marine mammals that haul-out in the affected area may experience a change in mortality or injury and a change in health upon exposure to hydrocarbons, although it is probable that only a small proportion of local populations are affected. Predatory marine mammals that prey on seals (e.g., killer whales) may also experience changes in mortality, injury, or health following consumption of oiled prey species.

As noted in Section 10.4, there are nine marine mammal and two sea turtle SAR / SOCC that are known to occur in the in the LSA and/or RSA. In the extremely unlikely event of an uncontrolled release into the marine environment, these species have the potential to be adversely affected, if the timing of the spill occurs at the same time of presence of the marine mammal and/or sea turtle SAR / SOCC. Potential effects will be similar to those described above. The likelihood, however, of a subsurface blowout occurring with the relevant mitigations in place has been calculated to be extremely low (single event once in 28,000 years). In an actual event, emergency response measures such as the BOP would likely be effective in limiting the magnitude, duration and extent of the spill.

With spill prevention plans and response procedures in place, potential effects of a subsurface blowout from the EPA site on Marine Mammals and Sea Turtles are predicted to be adverse, low to medium in magnitude, medium to long-term in duration, within the RSA, and be reversible. This was determined with a moderate level of confidence.

15.5.3.4 Summary

Table 15.20 provides a summary of predicted residual environmental effects of accidental event scenarios on Marine Mammals and Sea Turtles, given the conservative approach that was used for the spill modelling, and the implementation of mitigation measures to prevent and reduce effects from a spill.

Table 15.20 Summary of Residual Accidental Event-Related Environmental Effects on Marine Mammals and Sea Turtles

Accidental Event Scenario	Residual Environmental Effects Characterization						
	Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Potential Effects: Change in Mortality or Injury, Change in Health, and Change in Habitat Quality and Use							
100 litre Diesel Spill	A	L	PA	S	S	R	H
1,000 litre Diesel Spill	A	L	PA	S	N	R	H
Subsurface Blowout – Northern Flemish Pass Site	A	L-M	RSA	M-L	N	R	M
Subsurface Blowout – Eastern Flemish Pass Site	A	L-M	RSA	M-L	N	R	M

KEY

Nature / Direction:
- P Positive
- A Adverse
- N Neutral (or No Effect)

Magnitude:
- L Low
- M Medium
- H High

Geographic Extent:
- L Localized
- PA Within Project Area
- LSA Within LSA
- RSA Within RSA and Beyond

Duration:
- S Short term
- M Medium term
- L Long term
- P Permanent

Frequency:
- N Not likely to occur
- O Occurs once
- S Occurs sporadically
- R Occurs on a regular basis
- C Occurs continuously

Reversibility:
- R Reversible
- I Irreversible

Certainty in Predictions:
- L Low level of confidence
- M Moderate level of confidence
- H High level of confidence

N/A Not Applicable

15.5.3.5 Determination of Significance

In consideration of the present knowledge of marine mammal and sea turtle occurrence in the RSA, the result of spill modelling exercises, and planned mitigation, the residual environmental effects from an accidental event scenario on Marine Mammals and Sea Turtles are predicted to be not significant.

In the unlikely event of an offshore oil release, some degree of residual adverse effects to marine mammals and sea turtles in the area at the time of the accident or malfunction are expected. The degree of exposure and thus the type and level of any such effects would depend on the type and size of spill, time of year, and the number, location, and species of animals within the affected area. Although there is the potential for effects on marine mammals, sea turtles and their habitats in the RSA, these are, with appropriate mitigations, not likely to result in an overall, detectable decline in overall abundance or change in the spatial and temporal distribution of populations in the overall RSA for multiple generations. Similarly, while any affected individuals could conceivably be part of a species at risk, it is unlikely that the overall abundance, distribution of health of any such species and its eventual recovery will be negatively affected. Spill prevention techniques and response strategies will be incorporated into the design and operations for all Project activities as part of contingency planning, which will further help to ensure that effects do not occur, and in the unlikely event they did, that these would not have significant adverse effects to marine mamas and sea turtles.

15.5.4 Special Areas

15.5.4.1 Introduction

Various marine and coastal areas in Newfoundland and Labrador and elsewhere in Atlantic Canada have been designated as protected under provincial, federal or other legislation and processes, or have otherwise been identified as being special or sensitive due to their ecological, historical or socio-cultural characteristics and importance. These Special Areas are valued for environmental, economic and/or socio-cultural reasons, and there is often associated regulatory, stakeholder and Indigenous interest in these areas and their intrinsic ecological or anthropogenic value and uses. These areas and their environmental characteristics may therefore be particularly vulnerable to an accidental event, as any further degradation of their environmental conditions may affect their underlying integrity and value.

15.5.4.2 Potential Issues and Interactions

The potential environmental effects on Special Areas identified and used in the earlier effects assessment (Chapter 11) are: changes in environmental features and/or processes, and changes in human use and/or societal value. These potential effects remain relevant to the assessment of accidental events although the mechanisms or pathways of effects are different. The extent of the potential effects will depend on how the spill trajectory and the VC overlap in both space and time. Potential effects on Special Areas in the event of an accidental release of hydrocarbons includes the degradation of the ecological integrity of the Special Area such that it is not capable of providing the same ecological function for which it is designated. The Special Areas VC is closely linked to the other VCs considered in this assessment, particularly the biological VCs. These potential effects are discussed in Sections 15.5.1 to 15.5.3 for Marine Fish and Fish Habitat, Marine and Migratory Birds and Marine Mammals and Sea Turtles, and are not repeated in this section.

15.5.4.3 Environmental Effects Assessment and Evaluation

The residual effects of an oil spill (that is, the effects remaining after the implementation of emergency response measures; Section 15.1), should it occur, are assessed in the following sections.

15.5.4.3.1 Batch Spills

Based on modelling of batch spills (100 or 1,000 L at the NPA site and EPA site), the total hydrocarbon concentrations will be highest in the immediate vicinity of the spill and would be limited in terms of its overall magnitude, extent and duration, and thus, its potential adverse environmental consequences. Given that such a spill could conceivably occur at any location within the Project Area or along the associated vessel and aircraft traffic routes, it is possible that any such spill could overlap with and to a degree interact with the identified special areas that are located within these boundaries. The Project Area (Northern and Southern Sections) overlaps directly with one EBSA, five VME areas and eight NAFO Fisheries Closure Areas.

The Special Areas that would partially overlap with the affected area exceeding the socioeconomic threshold of 0.04 µm (for the 1,000 L EPA site scenario) are as follows:

- NAFO FCAs: Northern Flemish Cap (7), Northern Flemish Cap (9), Northwest Flemish Cap (10), the Northwest Flemish Cap (11), Flemish Pass \ Eastern Canyon
- VMEs: Northern Flemish Cap, Southern Flemish Pass to Eastern Canyons and Beothuk Knoll

No special areas overlap with the area exceeding the socioeconomic threshold for the 1,000 L NPA site scenario. Modelling predicts that total hydrocarbon concentrations would be within tens of metres of the surface and hydrocarbons would not reach the seabed. This concentration of spilled hydrocarbon from a batch spill will be short-term in duration with less than 0.1 percent of the released volume predicted to remain on the water surface at the end of the 30-day simulation.

Any such spills, in the unlikely event that they did occur, are unlikely to have a detectable effect on any special areas within the Project Area or beyond, and to measurably affect the key environmental and socio-cultural characteristics of these areas. With spill prevention plans and response procedures in place, potential effects of a batch spill (100 and 1,000 L) on Special Areas are predicted to be adverse, low to medium in magnitude, short- to medium-term in duration, within the Project Area and reversible. This was determined with a moderate level of confidence.

15.5.4.3.2 Uncontrolled Well Event

A subsurface blowout has the potential to result in a change in environmental features and/or processes, and changes in human use and/or societal value. Given the potentially large amount of discharged oil that could conceivably be associated with such a blowout event, and the possibility for such a spill to extend to adjacent areas and resources, a well blowout represents the accidental event with the most potential to affect adjacent special areas, and which would be the most widespread and thus of greatest environmental concern.

As shown in the oil spill modelling completed for this EIS, most surface oil from each of the modelled release sites at any time of the year was predicted to move eastward due to the prevailing westerly winds. For both modelled scenarios, the highest concentration of hydrocarbons is predicted to be within tens of meters of the surface of the water. At the end of the 160-day simulation, less than 0.01% of oil adheres to suspended sediment at the seafloor. While the model predicts some shoreline contact with oil, there is very little potential for a spill to reach and adversely affect identified special areas along the coastline of Eastern Newfoundland, or elsewhere in the province or the other Atlantic Provinces. The most potential is therefore for any spilled material from a well blowout to reach and affect a special area in the offshore environment to the east of the wellsite in the Project Area.

Northern Flemish Pass Site

The Subsurface Blowout – NPA site release with a 36-day unmitigated flow of 4,980 m^3/day release was modelled for 160 days at 2,700 m depth and results are described in Section 15.4.4. The effects threshold for oil concentrations in the marine environment for special areas would require consideration of both ecological and socioeconomic thresholds, given the biophysical and socioeconomic elements of these areas and their designations. However, as the socioeconomic thresholds are lower (0.04 µm oil thickness) and therefore more conservative, these are used in the assessment of potential effects on this VC.

The worst-case modelling results (i.e. winter scenario) indicates that the likely areas to be affected by such a spill include:

- NAFO FCAs: Sackville Spur (6), Northern Flemish Cap (8)
- VMEs: Sackville Spur and Northern Flemish Cap

Concentrations are predicted to be highest near the release site with the largest portion of oil moving towards the east. There was no predicted shoreline contact with hydrocarbons for this scenario from the deterministic modelling.

With spill prevention plans and response procedures in place, potential effects of a subsurface blowout from the NPA site on Special Areas are predicted to be adverse, medium in magnitude, medium to long-term in duration, occur within the RSA and reversible. This was determined with a moderate level of confidence.

Eastern Flemish Pass Site

This modelled blowout scenario involved a 113-day partially unmitigated 15,000 m^3/day release at 1,100-m depth, modelled for 160 days. The worst-case modeling results (i.e., winter scenario) indicate that the likely areas to be affected by such a spill include the following:

- NAFO FCAs: Sackville Spur (6), Northern Flemish Cap (7), Northern Flemish Cap (8), Northern Flemish Cap (9), Northwest Flemish Cap (10), and Northwest Flemish Cap (12)
- VMEs: Sackville Spur and Northern Flemish Cap

Concentrations are predicted to be highest near the release site with the largest portion of oil moving towards the east.

For releases at the EPA site, small volumes of weathered oil were predicted to reach the shores of Sable Island in only 1-2 percent of the modelled simulations during the summer season, whereas in the winter season, small volumes of weathered oil were predicted to reach short and discontinuous sections of the southeastern and northern coasts of the island of Newfoundland and the southeastern coast of Labrador. Minimum time for oil to make contact with the shoreline is approximately 78 days. Only 0.01 percent of the modelled release volumes were predicted to contact these locations. While 98-99 percent of the simulated releases resulted in no oil contact with shoreline at all within 160 days, oil was predicted to make contact with the shoreline in 1-2 percent of the scenarios. Socioeconomic (1 g/ m²) and ecological (100 g/m²) thresholds were the basis used for oil amounts reaching shore. As described in Section 15.4.4.2.3, in a worse case scenario, oil was predicted to be found in concentrations between 100-500 g/m² concentration in an area of the Southern Avalon and area on the south coast of the island near Burgeo.

Given that the points of contact are patchy and discontinuous, a worst-case approach was taken to identify Special Areas that may be affected; that is, Special Areas in the vicinity of the points of contact have been identified, although they may not actually be located directly within the point of contact. Special Areas within or near the predicted shoreline contact areas include coastal portions of the Placentia Bay/Grand Banks LOMA, Placentia Bay Extension EBSA, Mistaken Point Provincial Ecological Reserve, Gooseberry Cove Provincial Park, Mistaken Point IBA, and Placentia Bay IBA. Due to the time predicted for the oil to reach shore and the fact it is occurring in the winter season, the oil is expected to be highly weathered, patchy and discontinuous. In the event of a spill, there will be adequate time to plan and implement shoreline response measures before any weathered oil contacts the shoreline.

With spill prevention plans and response procedures in place, potential effects of a subsurface blowout from the EPA site on Special Areas are predicted to be adverse, medium in magnitude, medium to long-term in duration, occur within the RSA and reversible. This was determined with a moderate level of confidence.

15.5.4.4 Summary

Table 15.21 provides a summary of predicted residual environmental effects of accidental event scenarios on Special Areas, given the conservative approach that was used for the spill modelling, and the implementation of mitigation measures to prevent and reduce effects from a spill.

Table 15.21 Summary of Residual Accidental Event-Related Environmental Effects on Special Areas

Accidental Event Scenario	Residual Environmental Effects Characterization						
	Nature	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty
Potential effects: Change in Environmental Features and/or Processes, Change in Human Use and /or Societal Value							
100 litre Diesel Spill	A	L	PA	S	S	R	M
1,000 litre Diesel Spill	A	L-M	PA	M	N	R	M
Subsurface Blowout – Northern Flemish Pass Site	A	M	RSA	M-L	N	R	M
Subsurface Blowout – Eastern Flemish Pass Site	A	M	RSA	M-L	N	R	M

KEY

Nature / Direction:
P Positive
A Adverse
N Neutral (or No Effect)

Magnitude:
L Low
M Medium
H High

Geographic Extent:
L Localized
PA Within Project Area
LSA Within LSA
RSA Within RSA and Beyond

Duration:
S Short term
M Medium term
L Long term
P Permanent

Frequency:
N Not likely to occur
O Occurs once
S Occurs sporadically
R Occurs on a regular basis
C Occurs continuously

Reversibility:
R Reversible
I Irreversible

Certainty in Predictions:
L Low level of confidence
M Moderate level of confidence
H High level of confidence

N/A Not Applicable

15.5.4.5 Determination of Significance

In consideration of the present knowledge of Special Areas within the RSA, the result of spill modelling exercises, and planned mitigation, the predicted residual environmental effects from an accidental event scenario on Special Areas is considered not significant.

In the unlikely event of an offshore oil release, in the modelled sites which are not within a Special Area, some degree of residual adverse effects to special areas that are within or near the zone of influence of the spill may be expected. The degree of exposure and thus the type and level of any such effects would depend on the type and size of spill, time of year, the location relative to special areas and other factors. Although there is the potential for effects on these areas and their associated environmental features and processes these are, with appropriate mitigations, not likely to result in an overall, adverse change in one or more of the important and defining ecological and socio-cultural characteristics of such an area, resulting in a decrease in its integrity, value or use over the long term. Spill prevention techniques and response strategies will be incorporated into the design and operations for all Project activities as part of contingency planning, which will further help to ensure that effects do not occur, and in the unlikely event they did, that these would not have significant adverse effects to special areas. In the extremely unlikely event of a subsurface blowout occurring within a Special Area, significant effects may result, depending on the nature of the Special Area, and the extent and duration of the spill event.

15.5.5 Indigenous Communities and Activities

As described in Section 7.3 of this EIS, a number of Indigenous groups reside in Eastern Canada, including in communities in Newfoundland and Labrador, the Maritime Provinces and Quebec. Although the environmental effects assessment for the Project's planned components and activities (Chapter 12) has predicted no adverse effects upon Indigenous communities and their activities, there is concern about the potential for an accidental event such as an oil spill to adversely affect Indigenous peoples in Eastern Canada. Questions and concerns about the occurrence, and potential effects, of such an accidental event were referenced by a number of Indigenous communities or their representative organizations during the Operator's EIS engagement program (Chapter 3). An accidental event could have adverse effects on Indigenous communities and activities, including effects on fisheries resources and/or fishing activity as well as the various socio-cultural components and activities specified in Section 5(1)c of CEAA 2012. The potential for, and nature and degree of, any such effects depends largely on whether and how the spill trajectory and the various components of this VC overlap in space and time.

15.5.5.1 Potential Issues and Interactions

The potential environmental effects on Indigenous communities and activities identified and used in the earlier environmental effects assessment (Chapter 12) include the following: changes in health and socioeconomic conditions; changes in the current use of lands and resources for traditional purposes; change in physical and cultural heritage; and changes in any structure, site, or thing that is of historical, archaeological, paleontological, or architectural significance. These potential effects remain relevant to the assessment of accidental events, although the mechanisms or pathways of effects are somewhat different as described in this section.

The potential effects of offshore oil and gas activities – including accidental events - on Indigenous communities and activities may again be direct or indirect in nature. They may, for example, result from accidental events such as oil spills extending to and interacting directly with locations and

environmental components that are used or otherwise valued by Indigenous people, including their communities, asserted or established traditional territories and resources, and other components of the health (physical or social), heritage (physical or cultural) and other socioeconomic conditions of an Indigenous group. Indirectly, any biophysical effects resulting from an accidental event such an oil spill on marine fish or other resources that are used for traditional purposes can affect the physical health of persons who encounter these, through either direct exposure with the contaminants or through consumption of affected fish and wildlife (see Section 15.5.6.2 for a discussion of potential effects related to tainting). These biophysical effects may also have consequences for the availability or quality of the water, air, vegetation, fish or wildlife used by Indigenous peoples, thereby affecting the current use of these resources for traditional purposes, and in turn, the overall quality of life and well-being of a community. The Indigenous communities and activities VC is therefore closely linked to the other VCs considered in this assessment, particularly the biological VCs which have been assessed earlier, and for which significant adverse effects are not likely to occur.

Fish Species Used by Indigenous Groups

As described in Chapter 3, a number of individual fish species have been identified through the Operator's EIS engagement program as being used for traditional purposes by various Indigenous groups (Section 12.3.2). Therefore, some additional information related to the potential effects of an oil spill on these species is provided here.

In terms of Atlantic salmon, as stated in Chapter 12, post-smolt and adult salmon are concentrated throughout the year in the Labrador Sea where they feed and overwinter. In the spring, both grilse and multi-sea-winter (MSW) adults appear to congregate in two general locations; near the eastern slope of the Grand Bank of Newfoundland and approximately 480 km east of the Strait of Belle Isle (Reddin and Friedland 1993; Reddin 2006) prior to their spawning migrations back to their natal rivers. Also noted earlier, smolt ages indicate that salmon congregating off the east Grand Bank area are likely from more southern populations from South Newfoundland, a portion of the Gulf of St. Lawrence, as well as Eastern – Southern Nova Scotia and Outer Bay of Fundy. While post-smolt do not likely overwinter in the Flemish Pass area (Reddin and Friedland 1993; Reddin 2006), migration as adults to the east Grand Bank area must occur. Although the exact migration route is not known, it may include areas within and near the Project Area, particularly during time periods when sea-surface temperatures are favourable (over 4°C).

The effects of oil associated with an accidental event on marine fish, including salmon, have principally been described using laboratory studies with farm raised fish or caged fish that are unable to avoid oil exposure (e.g., Barnett and Toews 1977; Thomas and Rice 1987; Fraser 1992; Pineiro et al 1996; Zhou et al 1997; Stagg et al 1998; Meador et al 2006; Stieglitz et al 2016). Many of these studies showed effects on feeding, food conversion, or changes in enzyme levels based on exposure; however, returns to baseline were generally noted in 2-8 weeks (Fraser 1992; Stagg et al. 1998). It is noteworthy that many of the concentrations used in lab studies were high compared to the results of subsurface blowout modelling described above. For example, Stagg et al (1998) investigated the effects of the Braer oil spill on the Shetland Isles, Scotland. They characterized reference sites in the north of Shetland as having oil in water concentrations between 2 and 5 µg/L

and regarded these as being typical background values for the local inshore environment. No effects on farmed salmon enzyme and protein levels were detected at these concentrations. Barnett and Toews (1977) observed no mortality in post-smolt Atlantic salmon during 96-hour acute lethal bioassays with concentrations up to 32 mg/L.

Few studies have been conducted on the avoidance behaviour of returning adult salmon to hydrocarbons in water under natural conditions. Weber et al (1981) conducted a behavioural study on adult Pacific salmon (*Oncorhynchus* sp.) where hydrocarbons that closely approximated the water-soluble fraction of Prudhoe Bay crude oil were added to in one of two fishways as salmon were migrating upriver. They found that migrating salmon substantially avoided (i.e., when 50 percent of fish which were expected to ascend a fishway avoided it) hydrocarbons in the water at concentrations of 3,200 µg/L. Concentrations used in the study ranged from 300 to 6,100 µg/L.

Atlantic cod have occasional presence in the LSA and occur in parts of the RSA, inhabiting offshore shelf areas in winter and onshore areas in summer (Scott and Scott 1988). Resident offshore populations are distinct from inshore populations (Beacham et al. 2002). Rock cod do not occur in the Project Area and LSA, and typically inhabit inshore regions (Scott and Scott 1988). There have been numerous studies assessing the effects of oil and dispersed oil on cod (eg, Khan and Kiceniuk 1984, Kosheleva et al. 1997, Aas et al. 2000, Sturve et al. 2006, Skadsheim et al. 2009, Olsvik et al. 2010, 2011a, 2011b, 2012, Nordtug et al. 2011, Nahrgang et al. 2013). A number of studies have looked at sub-lethal effects of exposure such as transcriptional response to exposure in terms of gene expression (Olsvik et al. 2011), biomarkers (Aas et al. 2000), food assimilation (Nordtug et al. 2011), hematology (Kosheleva et al. 2011) and respiration (Kosheleva et al. 2011). Similar to other marine fish, the long-term effects of an oil spill are generally thought to be relatively low for Atlantic cod with the exception of the more susceptible juvenile life stages (Olsvik et al. 2011). Modelling studies assessing the effects of cod larvae and eggs from a large-scale 90-day oil spill on the Grand Banks suggest that the effects on recruitment in terms of commercial fishing and adult cod populations would be negligible (Hurlbut et al. 1991) This conclusion is similar to modelling studies on other similar species such as Arctic cod (Gallaway et al. 2017). Those studies predicted that even if large mortalities of Arctic cod juvenile and eggs were to occur due to a spill event (the life stages most susceptible to a spill), the effects on the regional cod population would not likely be significant (Gallaway et al. 2017).

Turbot / Greenland halibut occur within the LSA and RSA from shallow depth zones to deeper habitats, but mainly occur on the slopes of the Grand Banks and on shelf areas off Newfoundland (north of the Avalon). They are known to migrate between the Davis Strait and Eastern Newfoundland, indicating the potential for long distance migrations (Bowering 1984; Vis et al 1997). Adult fish in general are likely to avoid an oil spill, and Greenland halibut exhibit a bathypelagic behavior whereby it is known to swim in shallow, mid, and deep waters (Jørgensen, O.A., 1997).

Snow crab occur in parts of the LSA and RSA, but have limited home ranges / movements by adult individuals (Puebla et al. 2008; Christian et al. 2010). The planktonic life stages are generally considered to be more susceptible to oil spill effects, and those within close proximity to a spill could

be affected (Lee et al. 2015), although this would likely represent a small proportion of the planktonic population, minimizing any overall effects to snow crab populations.

American eel are occasionally present in the LSA and RSA as adults migrate from coastal areas to the Sargasso Sea (Scott and Scott 1988). Migrations of adults and larvae generally follow continental shelf areas (Wang and Tzeng 1998), reducing likelihood of passing through the potentially affected area. Like other fish, oil exposure has been shown to induce oil degrading enzymes like CYP1A (Schlezinger and Stegeman 2000) with a 5 mg/kg dose response, a sensitivity that is less than that of other fish. It has been speculated that this is due to the species' life history, as they spend a portion of their life in estuaries where they have increased chance of exposure to contaminants and therefore less sensitivity (Schlezinger and Stegeman 2000).

The LSA and RSA are located within the overall areas used by swordfish, whose overall distribution and migration patterns include most of the North Atlantic Basin (Dewar et al. 2011, Trenkel et al. 2014). Swordfish numbers and their overall ranges and migration patterns (see Section 12.3.2) therefore make it unlikely that they would be present within the affected area during an accidental event, and the highly mobile nature of this species would likely allow individuals to avoid affected areas.

15.5.5.2 Residual Environmental Effects Assessment and Evaluation

The potential, residual environmental effects of an oil spill (that is, the effects remaining after the implementation of spill response measures), should it occur, are assessed in the following sections.

15.5.5.2.1 Batch Spills

Modelling of batch spills (100 or 1,000 L at NPA site and EPA site) suggest that maximum surface oil thickness is likely to be less than 0.0001 mm (colourless and silver sheen). Total hydrocarbon concentrations (1-5 µg/L) will be highest in the immediate vicinity of the spill but are predicted to dissipate rapidly (less than 0.1 percent of the released volume remaining on surface after 30 days) with distance and remain well offshore. A potential batch spill from a Project-related drilling installation or supply vessel, although an undesirable and environmentally important occurrence, will be limited in terms of its overall magnitude, extent and duration, and thus, its potential environmental consequences. The modelling results for both sites also indicate that any such spilled materials are not predicted to travel outside the Project Area, and the batch spill modelling does not indicate that such a spill would reach the identified thresholds for ecological or socioeconomic effects for surface slicks or in-water concentrations.

The geographic extent of such Project-related accidental discharges and their effects, if they did occur, will therefore be localized to the Project Area, which is located in the offshore marine environment several hundred kilometers from the Island of Newfoundland, and thus at considerable distance from any Indigenous communities or their known traditional activities (Section 7.3). No direct effects on Indigenous communities or their activities are therefore predicted to occur as a result of such an accidental event. Moreover, given the distances involved, they will not interact with nor adversely affect the physical and cultural heritage of any Indigenous community. The Project Area is

not known to contain resources of historical, archaeological, paleontological, or architectural significance, and given its location far offshore Eastern Newfoundland, is not likely to contain such resources or materials that are relevant to and valued by any Indigenous group.

Although there is the potential for indirect effects to Indigenous communities and their activities through associated effects on migratory marine species moving through the affected area, given the small and localized nature of a batch spill no adverse effects are anticipated. As described earlier in this Chapter for the various preceding biophysical VCs (Section 15.5.1 to 15.5.3), any such batch spill events, if they did occur, are not expected to result in any significant adverse effects upon marine fish, birds, or mammals (including those known to be or potentially used for traditional purposes), and the various environmental mitigation initiatives identified and proposed throughout this EIS will help avoid or reduce any associated effects on these species. There is therefore almost no potential for the biophysical effects of the Project to have an adverse effect on the presence, abundance, distribution or quality such resources in any area, and especially, on their overall availability for resource use activities by Indigenous groups within their traditional harvesting areas at least several hundred kilometers away. There will therefore be no potential for any such biophysical effects (should they occur) to translate into any decrease in the overall nature, intensity, distribution (location or timing), quality or cultural value of these traditional activities by any Indigenous community. Similarly, any such effects are unlikely to extend to or affect the physical (through, for example, ingestion of toxic materials) or social health and well-being of any Indigenous persons or communities.

With spill prevention plans and response procedures in place, there is a very low probability of such a batch spill event occurring. In the event that such a spill did occur, it is not likely to directly interact with or adversely affect Indigenous communities and activities, nor to have effects on marine-associated resources used by these groups in a manner or to a degree that would affect their availability, quality or use. This conclusion was determined with a high level of confidence.

15.5.5.2.2 Uncontrolled Well Event

Given the potentially large amount of discharged oil that could conceivably be associated with such a blowout event, and the possibility for such a spill to extend to areas beyond the well site and Project Area, a well blowout represents the accidental event with the most potential to affect Indigenous communities and activities in Newfoundland and Labrador and elsewhere in the larger Eastern Canada region.

Notwithstanding the much larger size and magnitude of such a blowout as compared to a smaller batch spill during routine operations, most of the potential issues, key considerations and general principles associated with the potential effects of a batch spill on this VC, as described above, are also generally relevant here. Specifically, the potential for direct interaction between the oil spilled during a potential blowout event and any Indigenous community and its activities are extremely low, given the overall distances between the Project Area and any such Indigenous communities and activities, and the lack of known traditional activities that occur in the LSA and surrounding region. Of particular interest, however, is the potential for such an oil spill in the marine environment to spread to and directly affect Indigenous communities and activities elsewhere in Eastern Canada.

As describe below, while the oil spill modelling indicates a potentially large area being affected in the event of an unmitigated event, many of the areas delineated have very low probabilities of being affected, and in an actual incident, appropriate spill response measures will be implemented to help reduce the magnitude, duration and geographic extent of the spill and thus its environmental effects.

Northern Flemish Pass Site

The Subsurface Blowout – Northern Pass site release with a 36-day unmitigated flow of 4,980 m^3/day release was modelled for 160 days at 2,700 m depth, with its results being described in Section 15.4.4. Based on the unmitigated scenario, it is predicted that such a release of hydrocarbons into the marine environment is likely to move eastward due to the prevailing westerly winds, and thus away from any Indigenous communities and territories in Newfoundland and Labrador, the Maritime Provinces or Quebec. There was no predicted shoreline contact from the releases at the NPA site. Such a spill is therefore unlikely to result in any effects on any community or its activities or other interests, including physical and cultural heritage or any structure, site or thing that is of historical, archaeological, paleontological, or architectural significance.

In terms of potential indirect effects on such activities, the environmental effects assessment for this VC again considers whether and how Project-related changes in and effects on the biophysical environment within the potential zone of influence of such a spill may affect resources that are used for traditional purposes by Indigenous groups, including as a result of the known migration and movement patterns of marine-associated biota that are known to be used for these purposes. Chapter 12 provided a listing of the key marine-associated species that have been identified through engagement as being used by each Indigenous group listed in the EIS Guidelines, based on their identified interests, as well as an evaluation of whether (based on existing and available scientific literature) individuals from these species are known or likely to be present in the potentially affected area at any time of year before making their way into areas of traditional use by one or more Indigenous community. Any adverse effects to these species has the potential to result in adverse effects to resource availability or quality, which may have associated cultural implications. These effects can vary depending on the spill location, seasonal timing, and the quantity of oil that reaches the land area or resource in question.

While it is obviously not possible to determine with absolute certainty whether any particular individual of any species (in any life history stage) used for traditional purposes by any group may be present in the affected area before moving to an area that is the subject of traditional harvesting activity, as illustrated in Chapter 12 there is limited potential for any degree of connection. As also described for the various preceding biophysical VCs (Sections 15.5.1 to 15.5.3) any such accidental events are, with appropriate mitigation in place, not expected to result in any significant adverse effects upon marine fish, birds, or mammals (including those used for traditional purposes). There is therefore little potential for any effects on marine-associated species in general (and individuals in particular) to translate into a detectable effect on the use of such species for traditional purposes by an Indigenous group elsewhere in Eastern Canada. Adverse effects on the health of Indigenous peoples are also not predicted to occur as a result of the Project as a result of these factors, and given the imposition of a temporary harvesting closure around the affected area.

As noted throughout, the probability of such a spill occurring is extremely low, and with spill prevention plans and response procedures in place, the potential effects of a subsurface blowout from the NPA site on Indigenous communities and activities are predicted to be advserse, negligible low in magnitude, medium to long-term in duration, occurring within the RSA, and being reversible in nature. This conclusion has been reached with a moderate level of confidence.

Eastern Flemish Pass Site

For a potential large spill event at the EPA site small volumes of weathered oil were predicted to reach the shores of Sable Island in only 1-2 percent of the modelled simulations during the summer season, wheras in the winter season, small volumes of weathered oil were predicted to reach short and discontinuous sections of the southeastern and northern coasts of the island of Newfoundland and the southeastern coast of Labrador. Minimum time for oil to make contact with the shoreline is approximately 78 days.in. Only 0.01 percent of the modelled release volumes were predicted to contact these locations and the oil that was predicted to make contact with the shoreline is expected to be highly weathered, patchy and discontinuous. While 98-99 percent of the simulated releases resulted in no oil contact with shoreline at all within 160 days, oil was predicted to make contact with the shoreline in 1-2 percent of the scenarios. Socioeconomic (1 g/ m²) and ecological (100 g/m²) thresholds were the basis used for oil amounts reaching shore. As described in Section 15.4.4.2.3, in a worse case scenario, oil was predicted to be found in concentrations between 100-500 g/m² concentration in an area of the Southern Avalon and area on the south coast of the island near Burgeo. Given the time to shore, oil that is predicted to make contact with the shoreline is expected to be highly weathered, patchy and discontinuous.

As described in the preceding analysis, there is therefore very little potential for any such spill to reach and adversely affect any communities in Eastern Newfoundland or elsewhere in Eastern Canada. It is thus unlikely to result in any effects on any Indigenous community or its activities or other interests, including physical and cultural heritage or any structure, site or thing that is of historical, archaeological, paleontological, or architectural significance.

In terms of potential indirect effects due to associated biophysical changes resulting from such a spill, while it is again obviously not possible to determine with certainty whether a migratory individual of any species used for traditional purposes by any group may be present in the affected area before moving to an area that is the subject of traditional harvesting activity, as illustrated in Chapter 12 there is limited potential for any degree of interaction. The probability of a spill occurring is extremely low, and in the event of a spill, the species (individual fish, bird or marine mammal) would have to be present in the area at that time to be potentially affected. As described for the various preceding biophysical VCs (Sections 15.5.1 to 15.5.3) any such accidental events are, with appropriate mitigation in place, not expected to result in any significant adverse effects upon marine fish, birds, or mammals. There is therefore little potential for any effects on marine-associated species in general (and individuals in particular) to translate into a detectable effect on the use of such species for traditional purposes by an Indigenous group elsewhere in Eastern Canada.

With regards to Atlantic salmon in particular, based on laboratory experiments as described in Section 15.5.5.2, it is unlikely that concentrations comparable to laboratory-observed effects would be present during an accidental event beyond the immediate Project Area. In situ experiments

indicate that salmon in natural conditions (not in a lab or a cage) can likely detect hydrocarbons at concentrations approximately ten percent of those shown to cause mortality and avoid them. As shown in the accidental release modelling, predicted concentrations will generally be lower than those shown to cause avoidance in salmon and spill trajectories are in a predominantly eastern and south-eastern direction. If an accidental release occurred during the spring migration and/or congregation of returning Atlantic salmon to the east of the Grand Banks, concentrations near the release area, particularly the EPA site, could have concentrations (500 or greater µg/L) of dissolved hydrocarbons in the water column that salmon have been shown to avoid. However, given the predicted extent of these concentrations, it is unlikely that migration and behaviour would be affected to the extent that they would not be capable of navigating to their home river.

For all species, as noted throughout, the probability of such a spill occurring is extremely low, and in the event of a spill, the resources in question) would have to be present in the area at that time to be potentially affected. With spill prevention plans and response procedures in place, any adverse effects of a subsurface blowout from the EPA site on Indigenous communities and activities are predicted to be adverse, negligible to low in magnitude, medium to long-term in duration, occurring within the RSA, and being reversible in nature. This conclusion has been reached with a moderate level of confidence.

15.5.5.3 Summary

Table 15.22 provides a summary of predicted residual environmental effects of the various accidental event scenarios on Indigenous communities and activities.

15.5.5.4 Determination of Significance

In consideration of the location and extent of Indigenous communities and their activities within the RSA, the result of spill modelling exercises, and planned mitigation, any predicted residual environmental effects from an accidental event scenario on Indigenous communities and activities are considered not significant.

There are no Indigenous communities or activities located within or near the Project Area itself, and the oil spill modelling completed for this EIS indicate very limited potential for oil to reach these communities and their traditional areas. Any potential for effects would therefore be largely indirect in nature, and related to the possibility of marine-associated species that are used by these groups to be affected by a spill. The degree of exposure and occurrence of effects would depend on the type and size of spill, time of year, and the number, location, and species of migratory/mobile animals within the affected area. In any event, there will be little potential for such direct and/or indirect biophysical effects to translate into a detectable decrease in the overall nature, intensity, distribution, quality, or cultural value of traditional activities by Indigenous communities of other aspects of their existing socioeconomic conditions. Spill prevention techniques and response strategies will be incorporated into the design and operations for all Project activities as part of contingency planning, which will further help to ensure that effects do not occur, and in the unlikely event they did, that these would not have significant adverse effects to Indigenous communities and their activities.

Table 15.22 Summary of Residual Accidental Event-Related Environmental Effects on Indigenous Communities and Activities

Accidental Event Scenario	Residual Environmental Effects Characterization						
	Nature	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty
Potential Effects: Changes in Health and Socioeconomic Conditions; Changes in the Current Use of Lands and Resources for Traditional Purposes; Change in Physical and Cultural Heritage; and Changes in any Structure, Site, or Thing that is of Historical, Archaeological, Paleontological or Architectural Significance.							
100 litre Diesel Spill	N	-	-	-	-	-	H
1,000 litre Diesel Spill	N	-	-	-	-	-	H
Subsurface Blowout – Northern Flemish Pass Site	A	N-L	RSA	M-L	N	R	M
Subsurface Blowout – Eastern Flemish Pass Site	A	N-L	RSA	M-L	N	R	M

KEY

Nature / Direction:
P Positive
A Adverse
N Neutral (or No Effect)

Magnitude:
L Low
M Medium
H High

Geographic Extent:
L Localized
PA Within Project Area
LSA Within LSA
RSA Within RSA and Beyond

Duration:
S Short term
M Medium term
L Long term
P Permanent

Frequency:
N Not likely to occur
O Occurs once
S Occurs sporadically
R Occurs on a regular basis
C Occurs continuously

Reversibility:
R Reversible
I Irreversible

Certainty in Predictions:
L Low level of confidence
M Moderate level of confidence
H High level of confidence

N/A Not Applicable

15.5.6 Commercial Fisheries and Other Ocean Users

15.5.6.1 Introduction

Commercial fishing activity for a variety of different species occurs within the RSA year-round in offshore Newfoundland and Labrador, and is most intense during the summer months, when seasonal fisheries are most active. Commercial fishing activity is highest on the edges of the Grand Banks, along the continental shelf slope. Snow crab, northern shrimp, and Greenland halibut, among other invertebrate, groundfish, and pelagic species, are commonly harvested in the RSA. The level of commercial fishing activity is higher in the Project Area-Southern Section than in the Project Area-

Northern Section. Snow crab and northern shrimp are the most common species fished in both the Project Area – Northern Section and Project Area – Southern Section, while Greenland halibut is commonly harvested in the Project Area – Northern Section. Marine research and military activities also have the potential to occur during all times of the year, including annually scheduled DFO research surveys.

Accidental batch spills or subsurface blowouts could interact with Commercial Fisheries and Other Ocean Users by potentially impeding the ability of fishers to harvest fish, affecting the biological health of commercial fish species, reducing the marketability of commercial fish products, and interfering with marine research activities or offshore military exercises. The potential for an interaction between an accidental event and Commercial Fisheries and Other Ocean Users varies, and is based on several factors such as the time of year, species composition, oil characteristics, oceanic conditions, volume of oil, and location and duration of the hydrocarbon release. These conditions will determine the severity of a spill, and whether there will be effects on commercial fishing and other ocean use.

15.5.6.2 Potential Issues and Interactions

The potential environmental effects on Commercial Fisheries and Other Ocean Users identified and used in the earlier effects assessment (Chapter 13) are: direct interference, resulting in a change in the distribution, intensity, or function of commercial fishing and other ocean uses; damage to fishing gear, vessels, and other equipment and components; and a change in the abundance, distribution and quality of marine resources. These effects remain relevant to the assessment of accidental events, although the pathways have changed slightly.

15.5.6.2.1 Effects of Hydrocarbons on Commercial Fisheries and Other Ocean Users

Direct interference with commercial fishing activity and other ocean uses could occur if areas are closed to fishing due to a spill in or near popular fishing grounds, or during times of the year when commercial fishing activity is high. With respect to commercial fishing, these closures could translate into direct economic effects as fishers may have to delay or cease fishing activity until the area has been re-opened, or move to other fishing grounds that may be available, delaying their fishing schedule (European Union 2013). For example, after the DWH spill in 2010, short-term losses in the Gulf of Mexico included the closure of approximately 207,200 km² (80,000 square miles) of the United States EEZ to fishing activity (DFO 2013). The magnitude of these effects would depend on the size of area closed to commercial fishing, time of year, and the length of closure time. With respect to other ocean users, the quality of marine research could be affected through closure of survey areas, fouling research gear, or contaminating research results due to the presence of hydrocarbons on surface water or in the water column. Offshore training exercises such as military training activities could also be affected if areas are closed due to a spill.

Damage to fishing vessels and gear could result from the potential fouling from contact with the spilled oil, which may then affect the quality of harvest for commercial fishers or cause them to stop fishing, and may compromise the results of research surveys. Fouling could also affect commercial fishers harvests and have direct economic effects on their operations if a spill ceases or delays fishing operations for a period of time (IPIECA 1997).

A change in abundance, distribution, and quality of marine resources would be associated with biological effects on fish species of commercial value, which could indirectly affect commercial fishers through issues such as tainting, or fish avoiding an area for periods of time. The assessment of accidental events on Marine Fish and Fish Habitat are addressed in Section 15.5.1.

Spills can also affect consumer perceptions on quality, which may affect the price and volume of catch that harvesters can market (ITOPF 2004, n.d.; IPIECA 1997). Tainting or potential tainting may lead to reduced economic returns from fish harvests if the catch is deemed tainted or unfit (IPIECA 1997). Tainting occurs when fish species are exposed to hydrocarbons and absorb oil-derived substances into their tissues, which can cause unpleasant odours and flavours. Tainting is usually lost through the normal processes of metabolism in fish species, and chemical analysis and sensory testing are usually conducted before a species is declared safe to consume. The potential for tainting varies depending on the species affected; many free-swimming fish can metabolize hydrocarbons rapidly, while other species such as shell fish and cannot readily do so (ITOPF 2004). Even if an oil spill does not reach commercial fishing grounds and fish species are determined not to be tainted, accidental events can affect consumer perceptions on fish harvested in the surrounding area, potentially reducing market value of the product and subsequent economic returns. Consumer behaviour, and resulting effects based on consumer perceptions of fish that may be caught in an area near a spill, are difficult to predict. Loss of confidence in the market and public health concerns can have direct effects on the marketability and value of commercial fish landings (ITOPF n.d.).

There are no aquaculture or recreational activities that take place within the Project Areas. However, in the event of a spill, if oil were to reach the shoreline then effects to these operations could also occur (e.g., gear fouling, public perception of taint). This would result in similar economic effects on aquaculture and inshore commercial fisheries as those that would occur offshore, and recreational activities may be restricted in certain areas until deemed safe.

15.5.6.2.2 Effects of Dispersants on Commercial Fisheries and Other Ocean Users

As noted in Section 15.5.1, the use of chemical dispersants has the potential to affect fish and fish habitat, and therefore, has the potential to indirectly affect commercial fisheries through potential tainting of fish species. Effects from an oil spill on fish and fish habitat, including the use of dispersants on an oil spill is assessed in Section 15.5.1. Indirect effects from the use of dispersants can also affect other ocean users such as researchers. If targeted fish species for research become tainted due to absorption of hydrocarbons that may be present in the water column, then it may negatively influence the research results. After the DWH spill, the US Food and Drug Administration conducted laboratory tests on the effects of a commonly used dispersant on Eastern oyster, blue crab, and red snapper and found little to no bioaccumulation; the dispersant was depurated from the organisms' tissues with 24 to 72 hours (Tjeerdema et al. 2013). Seafood species collected during the DWH spill detected dioctylsulfosuccinate sodium salt, a highly water-soluble component of dispersants, in 4 of 299 tissue samples and determined that it was unlikely to pose a risk to aquatic receptors due to low tissue concentrations, low bioaccumulation, and rapid depuration (Tjeerdema et al. 2013). It is anticipated that most free-swimming fish may be able to avoid interactions from a hydrocarbon release; however, if oil managed to reach the sea floor, some slow moving or sessile organisms could be exposed to hydrocarbons. With the implementation of mitigation measures, it is

not anticipated that there would be a long-term exposure of fish to hydrocarbons either at the surface or within the water column. The ability of some fish species to metabolize and depurate hydrocarbons also promotes a short-term interaction.

15.5.6.3 Residual Environmental Effects Assessment and Evaluation

In addition to the mitigation and response measures detailed in Section 15.1, the Operator will develop and implement a compensation program for damages suffered by fish harvesters resulting from Project activities. This compensation program will be developed in consideration of relevant best practices and industry guidelines, including the C-NLOPB Compensation Guidelines Respecting Damages relating to Offshore Petroleum Activities (2002 and as revised) and CAPP Non-Attributable Fisheries Damage Compensation Program (2007 and as revised). This program will outline compensation procedures for actual loss or damages to commercial fishers attributable to the Operator resulting from a spill or debris, or expenses incurred in taking remedial action. Losses and damages includes loss of income, future loss of income and, with respect to any Indigenous peoples of Canada, loss of hunting, fishing, and gathering opportunities. Requirements from the C-NLOPB include the ability of an operator to demonstrate the financial resources to meet a liability obligation of $1 billion relating to damages, and to pay a deposit of $100 million for financial responsibility in the unlikely occurrence of an accidental event. In addition to these guidelines and programs, One Ocean is currently developing a Best Practices document for Compensation Processes and Procedures. This Best Practices document will provide additional details and information on the processes and procedures for applying and receiving compensation in the event of an incident and address lessons learned in other jurisdictions. Actual loss or damage includes loss of income or future income; loss of hunting, fishing, or gathering opportunities; and costs and expenses incurred for action taken to remedy a situation involving a spill, including measures to control or clean a spill. The Operator will also provide timely issuance of Notices to Shipping of an accidental event that has occurred and the associated coordinates, and providing early and ongoing communication with commercial fishers and other industry stakeholders within the RSA.

15.5.6.3.1 Batch Spill

Modelling results of unmitigated batch spills of 100 L and 1,000 L at both release sites for 30 days suggest that surface oil from a diesel spill would have a thickness of <0.0001 mm (or 0.1µm) around the affected area, appear as a colourless silver sheen, and not extend beyond the Project Area (see Figures 15-19 to 15-22). Total hydrocarbon concentrations will be the highest within the immediate vicinity of the spill location, but oil is expected to dissipate and weather rapidly (<0.1 percent of the released volume remaining on surface after 30 days) with distance from the spill site, due to natural ocean conditions (see Appendix E). For the 100 L batch spills at the EPA site and NPA site, surface oil is expected to spread rapidly, and with surface thickness not exceeding 0.04 µm on average. The larger 1,000 L spill scenario predicted surface oil areas ranging from 17 km² to 22 km². At the end of the 30-day simulation, less than 0.1 percent of the released volume was predicted to remain floating on the surface, with approximately 74-78 percent of the oil predicted to evaporate.

The predicted area where diesel may spread overlaps with active commercial fishing grounds. In the event of a batch spill, there is potential for temporary closure of commercial fish harvesting in the

immediate area due to the potential of gear fouling; however, it is expected that this closure would be short-term. The potential for tainting of fish species exists in the event of a spill, and is discussed in Section 15.5.6.2. Due to the oceanic conditions and expected quick weathering of the slick, and the ability of mobile adult fish species to either avoid the spill or metabolize and depurate hydrocarbons, it is anticipated that this interaction would also be limited to the immediate area of the spill, and short-term in duration.

It is anticipated that with the quick dispersion and weathering of the slick (see Appendix E), and with the implementation of mitigation measures, the geographic extent and concentration of a spill would be reduced. A change in the distribution or quality of marine resources, including commercial fish species, is considered unlikely, given that the oceanic conditions and mitigation measures would likely result in the spill being contained to a smaller area and for a shorter period of time.

With spill prevention plans and response procedures in place, potential effects of a batch spill (100 and 1,000 L) on Commercial Fisheries and Other Ocean Users are predicted to be adverse, low in magnitude, short to medium-term in duration, to occur within the Project Area, and reversible. This was determined with a high level of confidence.

15.5.6.3.2 Uncontrolled Well Event

The effects from an uncontrolled well event on Commercial Fisheries and Other Ocean Users include direct effects resulting from potential fisheries closure areas and fouling of fishing gear, vessels and equipment, and indirect effects related to the biophysical effects on fish species that may be targeted as part of a commercial fishery. Effects from an oil spill on fish and fish habitat, including the use of dispersants on an oil spill is assessed in Section 15.5.1. It is anticipated that most free-swimming mature fish species may be able to avoid exposure to oil in the water column; however, if oil managed to reach the sea floor, some slow moving or sessile organisms could be exposed to interactions with hydrocarbons. With the implementation of mitigation measures, it is not anticipated that there would be a long-term exposure of fish to hydrocarbons either at the surface or within the water column. The ability of some fish species to metabolize and depurate hydrocarbons also promotes a short-term interaction. It was predicted that effects on marine fish and fish habitat, including behavioural effects from an unlikely accidental event scenario, would be not significant, given the implementation of mitigation measures (Section 15.5.1).

Northern Flemish Pass Site

The Subsurface Blowout – Northern Pass site release with a 36-day unmitigated flow of 4,980 m^3/day release was modelled for 160 days at 2,700 m depth and results are described in Section 15.4.4. Modelling results indicate that the areas reaching or exceeding the socioeconomic threshold for surface oil thickness (0.04 µm) includes areas in the top northwest corner of the NPA site and most of the area to the east of the NPA site. There was no predicted shoreline contact from releases at the NPA site.

Oil from an unmitigated subsurface blowout at the NPA site is predicted to cover a large area where surface oil could be found exceeding 0.04 µm in thickness. Potential interactions with commercial fisheries and other ocean users includes fisheries closure areas and the fouling of gear and/or

vessels. It is important to note that these models represent a very large blowout with no mitigation measures being implemented. The subsequent effects to commercial fishing and other ocean uses will depend on the volume of oil released, the time of year, and the implementation of mitigation and response measures. Although a temporary closure of one or more areas to fishing activities and other ocean use may result, the geographic and temporal extent will be reduced through the implementation of mitigation and response measures. The issuance of a Notice to Shippers will provide timely notice of closure areas, giving fishers opportunity to make alternate plans, thereby reducing effects to commercial harvesting activity and notifying fishers to avoid the area, and reducing potential gear/vessel fouling. In the event of gear fouling, the compensation program for damages will be activated, mitigating the cost of damaged or lost fishing gear. Likewise, other commercial damages or losses associated with the spill will be addressed through the compensation program and best practices currently under development by One Ocean (joint fishing and petroleum industry initiative). Fouling also has the potential to affect other ocean users, as equipment and vessels related to research and military training could be fouled, and result in adverse effects on those operations. With the implementation of mitigation measures, combined with the extremely unlikely event of a blowout occurring, the potential for fisheries closures and fouling of vessels, gear, and equipment is considered low.

With spill prevention plans and response procedures in place, potential effects of a subsurface blowout at the NPA site on Commercial Fisheries and Other Ocean Users are predicted to be adverse, low in magnitude, short to medium-term in duration, to occur within the RSA, and reversible. This was determined with a moderate level of confidence.

Eastern Flemish Pass Site

The Subsurface Blowout - EPA Site un-mitigated release scenario was a 15,000 m^3/day release of oil for 113 days at 1,100m depth; modelling of released oil continued up to 160 days. The areas with the highest concentration of oil includes much of the Project Area and areas eastward enveloping the Flemish Cap and portions of the Orphan Knoll, Flemish Pass, and southern slopes of the Grand Bank.

Oil produced from an unmitigated subsurface blowout from the EPA site is predicted to cover a large area where surface oil could be found exceeding 0.04 µm in thickness (see Figures 15-2 and 15-3). It is important to note that while these areas are quite large, most of this footprint represents a very low probability (<10 percent) of surface oil thickness of 0.04 µm or more, based on an unmitigated release. This release could result in interactions with commercial fishing activity and other ocean uses, including the implementation of fisheries closure areas and the fouling of gear and vessels. It is important to note that these models represent the worst-case scenario possible with no mitigation measures being implemented. The subsequent effects to commercial fishing and other ocean uses will depend on the volume of oil released, the time of year, and the implementation of mitigation and response measures. Although a temporary closure of one or more areas to fishing activities and other ocean use may result in the event of a subsurface blowout, the geographic and temporal extent will be reduced through the implementation of mitigation and response measures. In addition, the issuance of a Notices to Shippers will provide timely notice of closure areas, providing fishers opportunity to make alternate plans, thereby reducing effects to commercial harvesting activity. In the event of gear fouling, the compensation program for damages will be activated, alleviating the

cost of damaged or lost fishing gear. Likewise, other commercial damages or losses associated with the spill will be addressed through the compensation program and best practices currently under development by One Ocean (joint fishing and petroleum industry initiative). Fouling also has the potential to affect other ocean users, as equipment and vessels related to research and military training could be fouled, and result in adverse effects on those operations. With the implementation of mitigation measures, including compensation, the residual environmental effects from fisheries closures and fouling of fishing vessels, gear, and equipment are likely to be low in magnitude and short-term.

For releases at the EPA site, small volumes of weathered oil were predicted to reach the shores of Sable Island in only 1-2 percent of the modelled simulations during the summer season, whereas in the winter season, small volumes of weathered oil were predicted to reach short and discontinuous sections of the southeastern and northern coasts of the island of Newfoundland and the southeastern coast of Labrador. Minimum time for oil to make contact with the shoreline is approximately 78 days. Only 0.01 percent of the modelled release volumes were predicted to contact these locations and the oil that was predicted to make contact with the shoreline is expected to be highly weathered, patchy and discontinuous. While 98-99 percent of the simulated releases resulted in no oil contact with shoreline at all within 160 days, oil was predicted to make contact with the shoreline in 1-2 percent of the scenarios. Socioeconomic (1 g/ m²) and ecological (100 g/m²) thresholds were the basis used for oil amounts reaching shore. As described in Section 15.4.4.2.3, in a worse case scenario, oil was predicted to be found in concentrations between 100-500 g/m² concentration in an area of the Southern Avalon and area on the south coast of the island near Burgeo. Given the time to shore, oil that is predicted to make contact with the shoreline is expected to be highly weathered, patchy and discontinuous.

Inshore operations such as aquaculture and commercial fishing, and recreational use of coastal waters, could be affected if surface oil from a blowout scenario reached the shoreline, modelled to be extremely unlikely and only occurring after 78 days, at which time it would be highly weathered. The modelling results show that the locations where oil is predicted to make contact with the shoreline do not currently have aquaculture operations. Given the length of time required before making contact with the shore, and the condition of the oil when it would arrive at the shoreline, it is not expected that it would interact in a way that would produce adverse environmental effects with aquaculture operations. The implementation of mitigation measures by the Operator would further reduce the likelihood of shoreline contact.

With spill prevention plans and response procedures in place, potential effects of a subsurface blowout from the EPA site on Commercial Fisheries and Other Ocean Users are predicted to be adverse, low in magnitude, medium to long-term in duration, to occur within the RSA, and reversible. This was determined with a moderate level of confidence.

15.5.6.4 Summary

Table 15.23 provides a summary of predicted residual environmental effects of accidental event scenarios on Commercial Fisheries and Other Ocean Users, given the conservative approach that was used for the spill modelling, and the implementation of mitigation measures to prevent and reduce effects from a spill.

Table 15.23 Summary of Residual Accidental Event-Related Environmental Effects on Commercial Fisheries and Other Ocean Users

Accidental Event Scenario	Residual Environmental Effects Characterization						
	Nature	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty
Potential Effects: Direct Interference, Resulting in a Change in the Distribution, Intensity, or Function of Commercial Fishing and Other Ocean Uses, Damage to Fishing Gear, Vessels, and Other Equipment and Components, Change in the Abundance, Distribution and Quality of Marine Resources							
100 L Diesel Spill	A	L	PA	S	S	R	H
1,000 L Diesel Spill	A	L	PA	M	N	R	H
Subsurface Blowout – Northern Flemish Pass Site	A	L	RSA	M-L	N	R	M
Subsurface Blowout – Eastern Flemish Pass Site	A	L	RSA	M-L	N	R	M

KEY

Nature / Direction:
P Positive
A Adverse
N Neutral (or No Effect)

Magnitude:
L Low
M Medium
H High

Geographic Extent:
L Localized
PA Within Project Area
LSA Within LSA
RSA Within RSA and Beyond

Duration:
S Short term
M Medium term
L Long term
P Permanent

Frequency:
N Not likely to occur
O Occurs once
S Occurs sporadically
R Occurs on a regular basis
C Occurs continuously

Reversibility:
R Reversible
I Irreversible

Certainty in Predictions:
L Low level of confidence
M Moderate level of confidence
H High level of confidence

N/A Not Applicable

15.5.6.5 Determination of Significance

In consideration of commercial fishing and other ocean activities within the RSA, the result of spill modelling exercises, and planned mitigation and financial compensation, the predicted residual environmental effects from an accidental event scenario on Commercial Fisheries and Other Ocean Users is considered not significant. Not only is a large spill extremely unlikely, but its extent and duration will be reduced through response measures, and affected fishers will be compensated in consideration of the C-NLOPB Compensation Guidelines Respecting Damages relating to Offshore Petroleum Activities, including compensation for lost and future lost income from an accidental event. Spill prevention techniques and response strategies will be incorporated into the design and operations for all Project activities as part of contingency planning, which will further help to ensure

that effects do not occur, and in the unlikely event they did, that these would not have significant adverse effects to Commercial Fisheries and Other Ocean Users.

15.6 References

Aas, E., Baussant, T., Balk, L., Liewenborg, B. and Andersen, O.K., 2000. PAH metabolites in bile, cytochrome P4501A and DNA adducts as environmental risk parameters for chronic oil exposure: a laboratory experiment with Atlantic cod. *Aquatic Toxicology*, *51*(2), pp.241-258.

Ainley, D.G., Grau, C.R., Roudybush, T.E., Morrell, S.H. and Utts, J.M. 1981. Petroleum ingestion reduces reproduction in Cassin's auklets. Mar. Pollut. Bull., 12(9): 314-317.

Almeda, R., Wambaugh, Z., Wang, Z., Hyatt, C., Liu, Z. and Buskey, E.J. 2013. Interactions between zooplankton and crude oil: toxic effects and bioaccumulation of polycyclic aromatic hydrocarbons. *PloS one*, *8*(6), p.e67212.

Alonso-Alvarez, C., Pérez, C. and Velando, A. 2007. Effects of acute exposure to heavy fuel oil from the Prestige spill on a seabird. Aquat. Toxicol. 84(1): 103-110.

AOSRT-JIP (Arctic Oil Spill Response Technology Joint Industry Program). 2014. Environmental Impacts of Arctic Oil Spills and Arctic Spill Response Technologies: Literature Review and Recommendations. 205 pp.

Baelum, J., Borglin, S., Chakraborty, R., Fortney, J. L., Lamendella, R., Mason, O. U., Auer, M., Zemla, M., Bill, M., Conrad, M. E., Malfatti, S. A., Tringe, S. G., Holman, H. Y., Hazen, T. C., Jansson, J. K. 2012. Deep-sea bacteria enriched by oil and dispersant from the Deepwater Horizon spill. Environmental Microbiology 14, 2405−2416.

Barnett, J. and D. Toews. 1977. The effects of crude oil and the dispersant, Oilsperse 43, on respiration and coughing rates in Atlantic salmon (*Salmo salar*). Can. J. Zool., 56: 307-310.

Barron, M.G. 2012. Ecological impacts of the Deepwater Horizon oil spill: implications for immunotoxicity. Toxicol. Pathol., 40: 315-320.

Beacham, T.D., Brattey, J., Miller, K.M., Le, K.D. and Withler, R.E., 2002. Multiple stock structure of Atlantic cod (Gadus morhua) off Newfoundland and Labrador determined from genetic variation. *ICES Journal of Marine Science*, *59*(4), pp.650-665.

Beazley, L.L., E.L. Kenchington, F.J. Murillo and M. del Mar Sacau. 2013. Deep-sea sponge grounds enhance diversity and abundance of epibenthic megafauna in the northwest Atlantic. ICES J. Mar. Sci., 70(7) 1471-1490, doi:10.1093/icesjms/fst124.

Bejarano, A. C., Gardiner, W. W., Barron, M. G., & Word, J. Q. 2017. Relative sensitivity of Arctic species to physically and chemically dispersed oil determined from three hydrocarbon measures of aquatic toxicity. Marine Pollution Bulletin, 122(1-2), 316-322.

Bence, A.E. and W.A. Burns. 1995. Fingerprinting hydrocarbons in the biological resources of the *Exxon Valdez* spill area. Pp. 84-140. In: P.G. Wells, J.N. Butler and J.S. Hughes (eds.). *Exxon*

Valdez Oil Spill: Fate and Effects in Alaskan Waters. ASTM STP 1219. American Society for Testing and Materials, Philadelphia, PA. 965 pp.

Boertmann, D. and Mosbech, A. (Eds.). 2011. The western Greenland Sea, a strategic environmental impact assessment of hydrocarbon activities. Aarhus University, DCE – Danish Centre for Environment and Energy, 268 pp. - Scientific Report from DCE – Danish Centre For Environment and Energy no. 22.

Bonn Agreement, 2011. Bonn Agreement Oil Appearance Code Photo Atlas. Available: http://www.bonnagreement.org/site/assets/files/1081/photo_atlas_version_20112306-1.pdf. Accessed: April 2017.

Bonn Agreement. 2009. Bonn Agreement Aerial Operations Handbook, 2009. London, UK. Available: http://www.bonnagreement.org/site/assets/files/1081/ba-aoh revision 2 April 2012-1.pdf, Accessed 4 June 2015.

Bossart, G.D., M. Lutcavage, B. Mealey and P. Lutz. 1995. The dermatopathologic effects of oil on loggerhead sea turtles (*Caretta caretta*). Pp. 180-181. In: L. Frink, K. Ball-Weir and C. Smith (eds.). Wildlife and Oil Spills: Response, Research, and Contingency Plan. Tri-State Bird Rescue and Research, DE. 182 pp.

Bowering, W.R., 1984. Migrations of Greenland halibut, Reinhardtius hippoglossoides, in the Northwest Atlantic from tagging in the Labrador-Newfoundland region. *Journal of Northwest Atlantic Fishery Science*, *5*(1), pp.85-91.

Brakstad, O.G., Daling, P.S., Faksness, L.G., Almås, I.K., Vang, S.H., Syslak, L. and Leirvik, F. 2014. Depletion and biodegradation of hydrocarbons in dispersions and emulsions of the Macondo 252 oil generated in an oil-on-seawater mesocosm flume basin. *Marine pollution bulletin*, *84*(1), pp.125-134.

Brakstad, O.G., Nordtug, T. and Throne-Holst, M. 2015. Biodegradation of dispersed Macondo oil in seawater at low temperature and different oil droplet sizes. *Marine pollution bulletin*, *93*(1), pp.144-152.

Brette, F., Shiels, H.A., Galli, G.L., Cros, C., Incardona, J.P., Scholz, N.L. and Block, B.A. 2017. A novel cardiotoxic mechanism for a pervasive global pollutant. *Scientific Reports*, *7*, p.414

Burger, A.E. 1993. Estimating the mortality of seabirds following oil spills: effects of spill volume. *Marine pollution bulletin*, *26*(3), pp.140-143.

Butler, R.G., Harfenist, A., Leighton, F.A and Peakall, D.B. 1988 Impact of Sublethal Oil and Emulsion Exposure on the Reproductive Success of Leach's Storm-Petrels: Short and Long-Term Effects. J. Appl. Ecol., 25(1): 125-143.

Butler, R.G., Peakall, D.B., Leighton, F.A., Borthwick, J. and Harmon, R.S. 1986. Effects of crude oil exposure on standard metabolic rate of leach's storm-petrel. Condor, 88(2), pp.248-249.

Canadian Association of Petroleum Producers (CAPP). 2007. Canadian East Coast Offshore Operators Non-attributable Fisheries Damage Compensation Program. Available at: http://www.capp.ca/publications-and-statistics/publications/117754

Christian, J.R., Grant, C.G.J., Meade, J.D. and Noble., L.D. 2010. Habitat Requirements and Life History Characteristics of Selected Marine Invertebrate Species Occurring in the Newfoundland and Labrador Region. Can. Manuscr. Rep. Fish. Aquat. Sci. 2925: vi + 207 p.

Clark, R.B. 1984. Impact of Oil Pollution on Seabirds. Environ. Poll., 33:1-22.

C-NLOPB (Canada-Newfoundland and Labrador Offshore Petroleum Board) and CNSOPB (Canada Nova Scotia Offshore Petroleum Board). 2017. Drilling and Production Guidelines. 136 pp.

C-NLOPB (Canada-Newfoundland and Labrador Offshore Petroleum Board). 2002. Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity. Available at: http://www.cnlopb.ca/pdfs/guidelines/compgle.pdf?lbisphpreq=1

C-NLOPB and Canada-Nova Scotia Offshore Petroleum Board. 2017. Drilling and Production Guidelines. 136 pp.

Coelho, G.M., A.G. Slaughter and J.C. Staves 2017. Spill Impact Mitigation Assessment in Support of Statoil Canada Ltd Drilling Program in the Flemish Pass. Sponson Group Inc., Mansfield, TX. Sponson Group Technical Report 17-02: v + 71 pp.

Cordes, E.E., Jones, D.O., Schlacher, T.A., Amon, D.J., Bernardino, A.F., Brooke, S., Carney, R., DeLeo, D.M., Dunlop, K.M., Escobar-Briones, E.G. and Gates, A.R. 2016. Environmental impacts of the deep-water oil and gas industry: a review to guide management strategies. Frontiers in Environmental Science.

Cormack, D. and J.A. Nichols. 1977. The Concentrations of Oil in Sea Water Resulting from Natural and Chemically Induced Dispersion of Oil Slicks. 1977 International Oil Spill Conference.

Cross, W.E. 1987. Effects of Oil and Chemically Treated Oil on Primary Productivity of High Arctic Ice Algae Studied in" Situ". *Arctic*, pp.266-276.

Dahlheim M.E. and C.O. Matkin. 1994. Assessment of injuries to Prince William Sound killer whales. Pp. 163-172. In: T.R. Loughlin (ed.). Marine Mammals and the 'Exxon Valdez', Academic Press, San Diego, CA, xix + 395 pp.

Daling, P.S. and G. Indrebo. 1996. Recent Improvements in Optimizing Use of Dispersants as a Cost-effective Oil Spill Countermeasure Technique. International Conference on Health, Safety and Environment, New Orleans, 9-12 June 1996.

Davis, J.E. and S.S. Anderson. 1976. Effects of oil pollution on breeding grey seals. Mar. Poll. Bull., 7(6):115-118.

DeLeo, D.M., Ruiz-Ramos, D.V., Baums, I.B. and Cordes, E.E. 2016. Response of deep-water corals to oil and chemical dispersant exposure. *Deep Sea Research Part II: Topical Studies in Oceanography*, *129*, pp.137-147.

Dewar, H., Prince, E.D., Musyl, M.K., Brill, R.W., Sepulveda, C., Luo, J., Foley, D., Orbesen, E.S., Domeier, M.L., Nasby-Lucas, N. and Snodgrass, D. Laurs, R.M., Hoolihan, J.P., Block, B.A. and McNaughton, L.M., 2011. Movements and behaviors of swordfish in the Atlantic and Pacific Oceans examined using pop-up satellite archival tags. Fisheries Oceanography, 20(3), pp.219-241.

DFO (Fisheries and Oceans Canada). 2013. Fisheries and Oceans Canada Provides Expertise to Assess the Impacts of Gulf of Mexico Oil Spill. Available online at: http://www.dfo-mpo.gc.ca/science/publications/article/2012/07-06-12-eng.html

DFO (Fisheries and Oceans Canada). 2015. Coral and sponge conservation strategy for Eastern Canada 2015.

Ellis, J., Wilhelm, S., Hedd, A., Fraser, G., Robertson, G., Rail, J.F., Fowler, M. and Morgan, K. 2013. Mortality of migratory birds from marine commercial fisheries and offshore oil and gas production in Canada. Avian Conserv. Ecol., 8(2).

Engelhardt, F.R. 1978. Petroleum hydrocarbons in Arctic ringed seals, *Phoca hispida*, following experimental oil exposure. Pp. 614 628. In: Proceedings of the Conference on the Assessment of the Ecological Impacts of Oil Spills, 14 17 June 1978, Keystone, CO. American Institute of Biological Science.

Engelhardt, F.R. 1982. Hydrocarbon metabolism and cortisol balance in oil exposed ringed seals, *Phoca hispida*. Compar. Biochem. Physiol., 72C: 133-136.

Engelhardt, R.F. 1983. Petroleum effects on marine mammals. Aquat. Toxic., 4: 199-217.

Environment Canada. 2016. *Regulations Establishing a List of Spill-treating Agents* (*Canada Oil and Gas Operations Act*). http://www.gazette.gc.ca/rp-pr/p2/2016/2016-06-15/html/sor-dors108-eng.php#footnoteRef.53232. Accessed 16 June 2017.

Environmental Science and Technology Center. 2001. Release Technology Database, Oil Technology Database. Available at: http://www.etc-cte.ec.gc.ca/databases/OilProperties/oil_prop_e.html. Accessed: 2016.

ERIN Consulting Ltd. and OCL Services Ltd. (E.C.L. Ltd a. O.S. Ltd). 2003. Sheens associated with produced water effluents – Review of causes and mitigation options. ERIN Consulting Ltd. and OCL Services Ltd. for Environmental Studies Research Funds Report 142.

European Union Parliament. 2013. Directorate-General for Internal Policies: The Impact of Oil and Gas Drilling Accidents on EU Fisheries. Available at: http://www.europarl.europa.eu/RegData/etudes/note/join/2014/513996/IPOL-PECH_NT(2014)513996_EN.pdf.

Felder DL, Thoma, B.P., Schmidt, W.E., Sauvage, T, Self-Krayesky, S.L., Chistoserdov, A, Bracken-Grissom, H,D. and Fredericq, S. 2014. Seaweeds and decapod crustaceans on Gulf deep banks after the Macondo Oil Spill. Bioscience, 64(9): 808-19.

Fisher, C.R., Demopoulos, A.W., Cordes, E.E., Baums, I.B., White, H.K. and Bourque, J.R. 2014. Coral communities as indicators of ecosystem-level impacts of the Deepwater Horizon spill. BioScience, 64(9): 796-807.

Frantzen M, IB Falk-Pettersen, J Nahrgang, T Smith, GH Olsen, TA Hagstad, L Camus. 2012. Toxicity of crude oil and pyrene to the embryos of beach spawning capelin (*Mallotus villosus*). Aquat Toxicol 108:42-52

Fraser, A. 1992. Growth and food conversion by Atlantic salmon parr during 40 days exposure to crude oil. Trans Am. Fish. Soc, 121(3): 322-332.

Fraser, G.S., Ellis, J. and Hussain, L. 2008. An international comparison of governmental disclosure of hydrocarbon spills from offshore oil and gas installations. Mar. Poll. Bull., 56(1): 9-13.

French McCay, D., Reich, D., Michel, J., Etkin, D., Symons, L., Helton, D., and J. Wagner. 2012. Oil Spill Consequence Analyses of Potentially-Polluting Shipwrecks. In: Proceedings of the 34th AMOP Technical Seminar on Environmental Contamination and Response, Emergencies Science Division, Environment Canada, Ottawa, ON.

French McCay, D., Reich, D., Rowe, J., Schroeder, M., and E. Graham. 2011. Oil Spill Modeling Input to the Offshore Environmental Cost Model (OECM) for US-BOEMRE's Spill Risk and Cost Evaluations. In: Proceedings of the 34th AMOP Technical Seminar on Environmental Contamination and Response, Emergencies Science Division, Environment Canada, Ottawa, ON.

French McCay, D.P. 2002. Development and application of an Oil Toxicity and Exposure Model, OilToxEx. Environmental Toxicology and Chemistry, 21(10): 2080-2094.

French McCay, D.P. 2004. Oil release impact modelling: Development and validation. Environmental Toxicology and Chemistry, 23(10): 2441-2456.

French McCay, D.P. 2009. State-of-the-art and research needs for oil release impact assessment modelling. Pp. 601-653. In: Proceedings of the 32nd AMOP Technical Seminar on Environmental Contamination and Response, Emergencies Science Division, Environment Canada, Ottawa, ON.

French McCay, D.P. and J.R. Payne. 2001. Model of Oil Fate and Water Concentrations with and without Application of Dispersants. Pp: 611-645. In: The Proceedings of the 24th Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, Environment Canada, Ottawa, ON.

French McCay, D.P., J.J. Rowe, W. Nordhausen and J.R. Payne. 2006. Modelling Potential Impacts of Effective Dispersant Use in Aquatic Biota. Pp. 855-878. In: The Proceedings of the 29th Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, Environment Canada, Ottawa, ON.

French, D., M. Reed, K. Jayko, S. Feng, H. Rines, S. Pavignano, T. Isaji, S. Puckett, A. Keller, F.W. French III, D. Gifford, J. McCue, G. Brown, E. MacDonald, J. Quirk, S. Natzke, R. Bishop, M. Welsh, M. Phillips, and B.S. Ingram, 1996. Final Report, The CERCLA Type A Natural Resource Damage Assessment Model for Coastal and Marine Environments (NRDAM/CME), Technical Documentation, Vol. I - V., Office of Environmental Policy and Compliance, U.S. Department of the Interior, Washington, DC, Contract No. 14-0001-91-C-11.

French-McCay, D. 2016. Comparison of oil fate and exposure from a deep-sea blowout, with and without subsea dispersant injection treatment. 2016 Clean Gulf Conference, Tampa. Presentation retrieved from http://www.cleangulf.org/paperarchive/#results.

French-McCay. 2009. Proceedings of the 32nd AMOP Technical Seminar on Environmental Contamination and Response, Emergencies Science Division, Environment Canada, Ottawa, ON, pp. 601-653.

Gallaway, B.J., Konkel, W.J. and Norcross, B.L. 2017. Some Thoughts on Estimating Change to Arctic Cod Populations from Hypothetical Oil Spills in the Eastern Alaska Beaufort Sea. *Arctic Science*, (ja).

Gardiner, W.W. and Word, J.Q. 2015. Relative Sensitivity of Arctic and Non-Arctic Marine Species to Physically and Chemically Dispersed Crude Oil. *Society of Environmental Toxicology and Chemistry*.

Gardiner, W.W., Word, J.Q., Word, J.D., Perkins, R.A., McFarlin, K.M., Hester, B.W., Word, L.S. and Ray, C.M. 2013. The acute toxicity of chemically and physically dispersed crude oil to key arctic species under arctic conditions during the open water season. *Environmental toxicology and chemistry*, *32*(10), pp.2284-2300.

Garthe, S., Montevecchi, W.A., Chapdelaine, G., Rail, J.F. and Hedd, A. 2007. Contrasting foraging tactics by northern gannets (*Sula bassana*) breeding in different oceanographic domains with different prey fields. Mar. Biol., 151(2), pp.687-694.

Geraci, J.R. 1990. Cetaceans and oil: Physiologic and toxic effects. Pp. 167-197. In: J.R. Geraci and D.J. St. Aubin (eds.). Sea Mammals and Oil: Confronting the Risks. Academic Press, San Diego, CA. 282 pp.

Geraci, J.R. and D.J. St. Aubin. 1990. Sea Mammals and Oil: Confronting the Risks. Academic Press, New York, NY.

Geraci, J.R. and T.G. Smith. 1976. Direct and indirect effects of oil on ringed seals (P*hoca hispida*) of the Beaufort Sea. J. Fish. Res. Brd. Canada, 33: 1976-1984.

Geraci, J.R., D.J. St. Aubin and R.J. Reisman. 1983. Bottlenose dolphins, *Tursiops truncatus*, can detect oil. Can. J. Fish. Aquat. Sci., 40**,** 1516-1522.

Gorsline, J., Holmes, W.N., and Cronshaw, J. 1981. The Effects of Ingested Petroleum on the Naphthalene-metabolizing Properties of Liver Tissue in Seawater-adapted Mallard Ducks (*Anas platyrhynchos*). Environ. Res., 24, 377-390.

Greer, C.D., Hodson, P.V., Li, Z., King, T. and Lee, K. 2012. Toxicity of crude oil chemically dispersed in a wave tank to embryos of Atlantic herring (Clupea harengus). *Environmental toxicology and chemistry*, *31*(6), pp.1324-1333.

Hansen, B.H., Altin, D., Rørvik, S.F., Øverjordet, I.B., Olsen, A.J. and Nordtug, T. 2011. Comparative study on acute effects of water accommodated fractions of an artificially weathered crude oil on Calanus finmarchicus and Calanus glacialis (Crustacea: Copepoda). *Science of the Total Environment*, *409*(4), pp.704-709.

Hartung, R. and Hunt, G.S. 1966. Toxicity of Some Oils to Waterfowl. J. Wildl. Manage., 30: 564-570.

Hartung. R. 1995. Assessment of the Potential for Long-term Toxicological Effects of the *Exxon Valdez* Oil Spill on Birds and Mammals. In P.G. Wells, J.N. Butler, and J.S. Hughes (Eds.), *Exxon Valdez* oil spill: fate and effects in Alaskan waters (pp. 693-725). Philadelphia, PA: American Society for Testing and Materials.

Harvey, J.T. and M.E. Dahlheim. 1994. Cetaceans in oil. Pp. 257-264. In: T.R. Loughlin (ed.). Marine Mammals and the *Exxon Valdez*. Academic Press, San Diego, CA. 395 pp.

Henkel, J.R., Sigel, B.J., and Taylor, C.M. 2012. Large-scale impacts of the Deepwater Horizon oil spill: can local disturbance affect distant ecosystems through migratory shorebirds? Bioscience, 62: 676-685.

Holand, P. 2006. Blowout and Well Release Characteristics and Frequencies. SINTEF Report STF50 F06112. SINTEF Technology and Society. Trondheim, Norway. 77 pp.

Holand, P. 2013. Blowout and Well Release Characteristics and Frequencies, 2013. SINTEF Report F25705. SINTEF Technology and Society. Trondheim, Norway. 114 pp.

Holand, P. 2016. Loss of Well Control Occurrence and Size Estimators. US Bureau of Safety and Environmental Enforcement (BSEE). BSEE Report No. ES201471/1. 15 September 2016. Prepared by ExproSoft AS, Trondheim, Norway.164 pp.

Hsiao, S.I., Kittle, D.W. and Foy, M.G. 1978. Effects of crude oils and the oil dispersant Corexit on primary production of arctic marine phytoplankton and seaweed. *Environmental Pollution (1970)*, *15*(3), pp.209-221.

Hurlbut, D.P., French, D.P., and Taylor B.J., 1991. Evaluation of the potential effects of major oil spills on Grand Banks commercial fish species as a result of impacts on eggs and larva. Environmental Studies Research Funds report No. 110. Calgary. 53 pp.

Intertek, 2016. Preliminary Laboratory Report for Statoil Petroleum AS. Analysis of water sample from L 76-z. Intertek West Lab AS, Tananger Norway. 23 February 2016.

IPIECA (International Petroleum Industry Environmental Conservation Association). 1997. Biological Impact of Oil Pollution: Fisheries. IPIECA Report Series, Volume 8. Available online at: http://www.amn.pt/DCPM/Documents/Fisheries.pdf.

ITOPF (International Tanker Owners Pollution Federation Limited). No date. Effects of Oil Pollution on Fisheries and Mariculture: Technical Information Paper. Available online at: http://www.itopf.com/fileadmin/data/Documents/TIPS%20TAPS/TIP11EffectsofOilPollutiononFisheriesandMariculture.pdf.

ITOPF (International Tankers Owners Pollution Federation Limited). 2004. Oil Spill Effects on Fisheries. Available online at: http://www.cleancaribbean.org/.

Jørgensen, O.A., 1997. Pelagic occurrence of Greenland halibut, Reinhardtius hippoglossoides (Walbaum), in west Greenland waters. *Journal of Northwest Atlantic Fishery Science*, *21*, pp.39-50

Khan, R. A. and Ryan, P. 1991. Long term effects of crude oil on Common Murres (*Uria aalge*) following rehabilitation. Bull. Environ. Contam. Toxic.. 46:216-222.

Khan, R.A. and Kiceniuk, J., 1984. Histopathological effects of crude oil on Atlantic cod following chronic exposure. *Canadian journal of zoology*, *62*(10), pp.2038-2043.

Kleindienst, S., Seidel, M., Ziervogel, K., Grim, S., Loftis, K., Harrison, S., Malkin, S.Y., Perkins, M.J., Field, J., Sogin, M.L. and Dittmar, T., 2015. Chemical dispersants can suppress the activity of natural oil-degrading microorganisms. *Proceedings of the National Academy of Sciences*, *112*(48), pp.14900-14905.

Kosheleva, V. V., Novikov, N. A., Migalovski, I. P., Gorbacheva, E. A. and Lapteva, A. N. 1997. Response of the Barents Sea organisms on contamination during offshore development in the Barents Sea PINRO; Murmansk. 92 pp. (in Russian)

Lari, E., Abtahi, B., Hashtroudi, M.S., Mohaddes, E. and Døving, K B. 2015. The effect of sublethal concentrations of the water-soluble fraction of crude oil on the chemosensory function of Caspian roach, *Rutilus caspicus* (YAKOVLEV, 1870). Environ. Toxicol. Chem., 34(8), 1826-1832.

Lawler, G.C., Loong, W., and Laseter, J.L. 1978. Accumulation of Aromatic Hydrocarbons in Tissues of Petroleum-exposed Mallard Ducks (*Anas platyrhynchos*). Environ. Sci. Technol. Res. 12:51-54.

Lee, K., M. Boufadel, B. Chen, J. Foght, P. Hodson, S. Swanson and A. Venosa. 2015. Expert Panel Report on the Behavior and Environmental Impacts of Crude Oil Released into Aqueous Environments. Royal Society of Canada, Ottawa, ON.

Lee, K., T. Nedwed, R.C. Prince and D. Palandro. 2013. Lab tests on the biodegradation of chemically dispersed oil should consider the rapid dilution that occurs at sea. Mar. Poll. Bull., 73(2013):314-318.

Levenson, D.H. and R.J. Schusterman. 1997. Pupillometry in seals and sea lions: ecological implications. Can. J. Zool., 75: 2050-2057.

Lewis, A. 2007. Current Status of the BAOAC; Bonn Agreement Oil Appearance Code. A report to the Netherlands North Sea Agency Directie Noordzee. Alan Lewis Oil Release Consultant.

LGL Limited. 2005. Orphan Basin Exploration Drilling Program Environmental Assessment. LGL Rep. SA825. Rep. by LGL Limited, St. John's, NL, Canning & Pitt Associates, Inc., St. John's, NL, SL Ross Environmental Research Limited, Ottawa, ON, Oceans Limited, St. John's, NL, Lorax Environmental, Vancouver, BC, and PAL Environmental Services, St. John's, NL, for Chevron Canada Limited, Calgary, AB, ExxonMobil Canada Ltd., St. John's, NL, Imperial Oil Resources Ventures Limited, Calgary, AB and Shell Canada Limited.

Lutz, P.L. and M. Lutcavage. 1989. The effects of petroleum on sea turtles: Applicability to Kemp's ridley. Pp. 52-54. In: C.W. Caillouet and A.M. Landry (eds.) Proceedings of the First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation and Management. TAMU-SG-89'-105: 260 pp.

Mager, E.M., Esbaugh, A.J., Stieglitz, J.D., Hoenig, R., Bodinier, C., Incardona, J.P., Scholz, N.L., Benetti, D.D. and Grosell, M. 2014. Acute embryonic or juvenile exposure to Deepwater Horizon crude oil impairs the swimming performance of mahi-mahi (Coryphaena hippurus). Environ. Sci. Technol., 48(12): 7053-7061.

Matkin, C.O., E.L. Saulitis, G.M. Ellis, P. Olesiuk and S.D. Rice. 2008. Ongoing population-level impacts on killer whales Orcinus orca following the 'Exxon Valdez' oil spill in Prince William Sound, Alaska. Mar. Ecol. Prog. Ser., 356: 269-281.

Matkin, C.O., G.M. Ellis, M.E. Dahlheim and J. Zeh. 1994. Status of killer whales in Prince William Sound, 1985-1992. Pp. 141-162. In: T.R. Loughlin (ed.). Marine Mammals and the Exxon Valdez, Academic Press, San Diego, CA. 395 pp.

McAuliffe, C.D., J.C. Johnson, S.H. Greene, G.P. Canevari and T.D. Searl. 1980. Disperion and weathering of chemically treated crude oils on the ocean. Environ. Sci. Technol., 14(12): 1509-1518. Doi: 10.1021/es60172a012

McEwan, E.H. and Whitehead, P.M. 1980. Uptake and Clearance of Petroleum Hydrocarbons by the Glaucous-winged Gull (Laras glaucescens) and the Mallard Duck (Anas platyrhynchos). Can. J. Zool.. 58:723-726.

Meador, J.P., F.C. Sommers, G.M. Ylitalo, and C.A. Sloan. 2006. Altered growth and related physiological responses in juvenile Chinook salmon (Oncorhynchus tshawytscha) from dietary exposure to polycyclic aromatic hydrocarbons (PAHs). Can. J. Fish. Aquat. Sci. 63: 2364-2376.

Miller, D.S., Butler, R.G., Trivelpiece, W., Janes-Butler, S., Green, B., Peakall, G., Lambert, G. and Peakall, D.B. 1980. Crude oil ingestion by seabirds: Possible metabolic and reproductive effects. Bull. Mt. Desert Isl. Biol. Lab. 20: 137-138.

Milton, S., P. Lutz and G. Shigenaka. 2003. Chapter 4. Oil Toxicity and Impacts on sea turtles. Pp. 35-48. In: G. Shigenaka (ed.). Oil and Sea Turtles: Biology, Planning and Response. NOAA, Seattle, WA.

MMS (Minerals Management Service - Pacific OCS Region). 2001. Delineation Drilling Activities in Federal Waters Offshore Santa Barbara County, CA. Draft Environmental Impact Statement. Camarillo, CA: US Department of the Interior Minerals Management Service.

Montevecchi, W., Fifield, D., Burke, C., Garthe, S., Hedd, A., Rail, J.F. and Robertson, G., 2012. Tracking long-distance migration to assess marine pollution impact. Biol. Letters, 8(2), pp.218-221.

Montevecchi, W.A., Wiese, F.K., Davoren, G., Diamond, A.W., Huettmann, F., and Linke, J. 1999. Seabird Attraction to Offshore Platforms and Seabird Monitoring from Offshore Support Vessels and Other Ships: Literature Review and Monitoring Design. St. John's, NL: Canadian Association of Petroleum Producers.

Morandin, L.A. and O'Hara, P.D., 2016. Offshore oil and gas, and operational sheen occurrence: is there potential harm to marine birds? Environ. Reviews, 24(3), pp.285-318.

Murawski, S.A., Fleeger, J.W., Patterson III, W.F., Hu, C., Daly, K., Romero, I. and Toro-Farmer, G.A., 2016. How Did the Oil Spill Affect Coastal and Continental Deepwater Horizon Shelf Ecosystems of the Gulf of Mexico?. *Oceanography*, *29*(3), pp.160-173.

Nahrgang J., Brooks, S., Evenset, A., Camus, L., Jonsson, M., Smith, T., Lukina, J., Frantzen, M., Giarratano, E., Renaud. P.E., .2013. Seasonal variation in biomarkers in blue mussel (Mytilus edulis), Icelandic scallop (Chlamys islandica) and Atlantic cod (Gadus morhua) – implications for environmental monitoring in the Barents Sea. Aquat Toxicol 127:21– 35

National Energy Board, Canada-Newfoundland and Labrador Offshore Petroleum Board and Canada-Nova Scotia Offshore Petroleum Board. 2011. Environmental Protection Plan Guidelines. viii + 20 pp.

National Research Council of the National Academies. 2005. Oil Spill Dispersants - Efficacy and Effects. The National Academic Press. Washington DC. ISBN 978-0-309-09562-4 (http://www.nap.edu/catalog/11283/oil-spill-dispersants-efficacy-and-effects).

National Research Council. 2005. Understanding Oil Spill Dispersants: Efficacy and Effects. National Academy Press, Washington, DC. 396 pp.

NMFS (US National Marine Fisheries Service). 2011. Sea Turtles, Dolphins, and Whales and the Gulf of Mexico Oil Spill. Accessed September 2017. Available at: http://www.nmfs.noaa.gov/pr/health/oilspill/gulf2010.htm

NOAA [National Oceanic and Atmospheric Administration]. 2010. Deepwater Horizon Response Consolidated Fish and Wildlife Collection Report. 2010 Nov 2: Operational Period 196. Available at:

http://www.restorethegulf.gov/sites/default/files/documents/pdf/Consolidated%20Wildlife%20Table%20110210.pdf.

Nordtug, T., Olsen, A.J., Altin, D., Meier, S., Overrein, I., Hansen, B.H. and Johansen, Ø., 2011. Method for generating parameterized ecotoxicity data of dispersed oil for use in environmental modelling. *Marine pollution bulletin*, *62*(10), pp.2106-2113.

O'Hara, P, Morandin, L.A., 2010. Effects of sheens associated with offshore oil and gas development of the feather microstructure of pelagic seabirds. Mar. Pol. Bull. 60(5): 672-678.

OGP (International Association of Oil & Gas Producers). 2010. Blowout Frequencies. OGP Report No. 434-2. March 2010. 20 p.

Olsen, G.H., Smit, M.G., Carroll, J., Jæger, I., Smith, T. and Camus, L., 2011. Arctic versus temperate comparison of risk assessment metrics for 2-methyl-naphthalene. *Marine environmental research*, *72*(4), pp.179-187.

Olsvik, P.A., Hansen, B.H., Nordtug, T., Moren, M., Holen, E. and Lie, K.K., 2011a. Transcriptional evidence for low contribution of oil droplets to acute toxicity from dispersed oil in first feeding Atlantic cod (Gadus morhua) larvae. *Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology*, *154*(4), pp.333-345

Olsvik, P.A., Lie, K.K., Nordtug, T. and Hansen, B.H., 2012. Is chemically dispersed oil more toxic to Atlantic cod (Gadus morhua) larvae than mechanically dispersed oil? A transcriptional evaluation. *BMC genomics*, *13*(1), p.702.

Olsvik, P.A., Nordtug, T., Altin, D., Lie, K.K., Overrein, I. and Hansen, B.H., 2010. Transcriptional effects on glutathione S-transferases in first feeding Atlantic cod (Gadus morhua) larvae exposed to crude oil. *Chemosphere*, *79*(9), pp.905-913.

Olsvik, P.A., Waagbø, R., Pedersen, S.A. and Meier, S., 2011b. Transcriptional effects of dietary exposure of oil-contaminated Calanus finmarchicus in Atlantic herring (Clupea harengus). *Journal of Toxicology and Environmental Health, Part A*, *74*(7-9), pp.508-528.

Pace, C.B., Clark, J.R. and Bragin, G.E., 1995, February. Comparing crude oil toxicity under standard and environmentally realistic exposures. In International Oil Spill Conference (Vol. 1995, No. 1, pp. 1003-1004). American Petroleum Institute.

Parsons, M.L., Morrisson, W., Rabalais, N.N., Turner, R.E., and Tyre, K.N. 2015. Phytoplankton and the Macondo Spill: A comparison of the 2010 phytoplankton assemblage to baseline conditions on the Louisiana Shelf. Envir. Poll. 207: 152-160.

Passow, U., Ziervogel, K., Asper, V. and Diercks, A., 2016. Marine snow formation in the aftermath of the Deepwater Horizon oil spill in the Gulf of Mexico. Environmental Research Letters, 7(3), p.035301.

Peakall, D.B., Hallett, D.J., Bend, J.R., Foureman, G.L., and Miller, D.S. 1982. Toxicity of Prudhoe Bay crude oil and its aromatic fractions to nestling herring gulls. Environ. Resour.. 27:206-215.

Peakall, D.B., Hallett, D.J., Miller, D.S., Butler, R.G., and Kinter, W.B.1980. Effects of ingested crude oil on black guillemots: A combined field and laboratory study. Ambio. 9:28-30.

Pineiro, M.E.A., M.A.L. Yusty, S.T.C. Gonzales-Barros, and J.S. Lozano. 1996. Aliphatic Hydrocarbon Levels in Turbot and Salmon Farmed Close to the Site of the Aegean Sea Oil Spill. Bull. Environ. Contam. Toxicol. 57: 811-815.

Pollet, I.L., Hedd, A., Taylor, P.D., Montevecchi, W.A. and Shutler, D., 2014. Migratory movements and wintering areas of Leach's Storm-Petrels tracked using geolocators. J. Field Ornithol., 85(3), pp.321-328.

Prince, R.C. (2015). Oil spill dispersants: boon or bane? Environmental Science and Technology, 49: 6376 - 6384.

Prince, R.C., McFarlin, K.M., Butler, J.D., Febbo, E.J., Wang, F.C. and Nedwed, T.J., 2013. The primary biodegradation of dispersed crude oil in the sea. *Chemosphere*, *90*(2), pp.521-526.

Puebla, O., Sévigny, J.M., Sainte-Marie, B., Brêthes, J.C., Burmeister, A., Dawe, E.G. and Moriyasu, M., 2008. Population genetic structure of the snow crab (Chionoecetes opilio) at the Northwest Atlantic scale. *Canadian Journal of Fisheries and Aquatic Sciences*, *65*(3), pp.425-436.

Rabalais N. 2014. Assessing early looks at biological responses to the Macondo event. BioScience, 64(9):757-9.

Ragnarsson, S. Á., Burgos, J. M., Kutti, T., van den Beld, I., Egilsdóttir, H., Arnaud-Haond, S., and Grehan, A. 2017. The Impact of Anthropogenic Activity on Cold-Water Corals. Pp. 989-1023. In. S. Rossi, L. Bramanti, A. Gori and C. Orejas (eds.). Marine Animal Forests: The Ecology of Benthic Biodiversity Hotspots, Springer International Publishing. 1366 pp.

Reddin, D.G. 2006. Perspectives on the marine ecology of Atlantic salmon (*Salmo salar*) in the Northwest Atlantic. Canadian Science Advisory Secretariat Research Document, 2006/018.

Reddin, D.G. and K.D. Friedland. 1993. Marine environmental factors influencing the movement and survival of Atlantic salmon. Pp. 79-103. in: D. Mills (ed.). Salmon in the Sea and New Enhancement Strategies. Atlantic Salmon Federation, Fishing New Books/Blackwell Publishing, ON.

RMRI. No Date. Newfoundland Oil Spill Risk Assessment. RMRI Report Ref CAN/0179.R001.

Ross, P.S. G. Ellis, J.K.B. Ford and L.G. Barrett-Lennard. 2002. Toxic chemical pollution and Pacific killer whales (Orcinus orca). Pp. 126-130. In: Fourth International Orca Symposium and Workshops, September 23-28, 2002, CEBC-CNRS, France.

Ross, P.S., G.M. Ellis, M.G. Ikonumou, L.G. Barrett-Lennard and R.F. Addison. 2000. High PCB concentrations in free-ranging Pacific Killer whales, Orcinus orca: effects of age, sex and dietary preference. Mar. Pollu. Bull., 40: 504-515.

Scandpower Risk Management AS. 2006. Blowout and Well Release Frequencies. Report No. 90.005.001/R2.Sergeant, D.E. 1991. Harp seals, man and ice. Can. Spec. Pub. Fish. Aquat. Sci., 114: 153 pp.

Scandpower Risk Management AS. 2006. Blowout and Well Release Frequencies. Report No. 90.005.001/R2.

Schlezinger, J.J. and Stegeman, J.J., 2000. Induction of cytochrome P450 1A in the American eel by model halogenated and non-halogenated aryl hydrocarbon receptor agonists. *Aquatic toxicology*, *50*(4), pp.375-386.

Scott, W.B., and Scott, M.G. (1988). Atlantic fishes of Canada. Canadian Bulletin of Fisheries and Aquatic Sciences. 219: 731 p.

Seidel, M., Kleindienst, S., Dittmar, T., Joye, S.B. and Medeiros, P.M., 2016. Biodegradation of crude oil and dispersants in deep seawater from the Gulf of Mexico: Insights from ultra-high resolution mass spectrometry. Deep Sea Research Part II: Topical Studies in Oceanography, 129, pp.108-118.

Sergeant, D.E. 1991. Harp seals, man and ice. Can. Spec. Public. Fish. Aquat. Sci. 114:1-153.

Seuront L. 2010. Zooplankton avoidance behaviour as a response to point sources of hydrocarbon-contaminated water. Mar. Freshw. Res., 61(3): 263-270.

Skadsheim, A., Sanni, S., Pinturier, L., Moltu, U.E., Buffagni, M. and Bracco, L., 2009. Assessing and monitoring local and long-range-transported hydrocarbons as potential stressors to fish stocks. *Deep Sea Research Part II: Topical Studies in Oceanography*, *56*(21), pp.2037-2043.

SL Ross Environmental Research Ltd. 2016. Release-related Properties of BdNL-76Z Ti-3 DST Dead Oil. 30 pp. + Appendices.

Smultea, M.A. and B. Würsig. 1995. Behavioral reactions of bottlenose dolphins to the Mega Borg oil spill, Gulf of Mexico 1990. Aquatic Mamm., 21: 171-181.

Sørensen, L., Sørhus, E., Nordtug, T., Incardona, J. P., Linbo, T. L., Giovanetti, L., ... & Meier, S. (2017). Oil droplet fouling and differential toxicokinetics of polycyclic aromatic hydrocarbons in embryos of Atlantic haddock and cod. PloS one, 12(7), e0180048.

Spraker, T.R., L.F. Lowry and K.J. Frost. 1994. Gross necropsy and histopathological lesions found in harbor seals. Pp. 281-311 In: T.R. Loughlin (ed.). Marine Mammals and the Exxon Valdez, Academic Press, San Diego, CA. 395 pp.

St. Aubin, D.J. 1990. Physiologic and toxic effects on polar bears. Pp. 235-239 In: J.R. Geraci and D.J. St. Aubin (eds.). Sea Mammals and Oil: Confronting the Risks. Academic Press, San Diego, CA. 282 pp.

St. Aubin, D.J., J.R. Geraci, T.G. Smith and T.G. Friesen. 1985. How do bottlenose dolphins, Tursiops truncatus, react to oil films under different light conditions? Can. J. Fish. Aquat. Sci., 42: 430-436.

Stagg, R.M., C. Robinson, A.M. McIntosh, and C.F. Moffat. 1998. The Effects of the "Braer" Oil Spill, Shetland Isles, Scotland, on P4501A in Farmed Atlantic Salmon (Salmo salar) and the Common Dab (Limanda limanda). Mar. Environ. Res., 46(1-5): 301-306.

Stieglitz, J.D., M.M. Edward, R.H. Hoenig, D.D. Benetti, and M. Grosell. 2016. Impacts of Deepwater Horizon Crude Oil Exposure on Adult Mahi-Mahi (Coryphaena hippurus) Swim Performance. Environ. Toxicol. Chem., 35(10): 2613-2622.

Stubblefield, W.A., Hancock, G.A., Ford, W.H. and Ringer, R.K. 1995. Acute and Subchronic Toxicity of Naturally Weathered Exxon-Valdez Crude-Oil in Mallards and Ferrets. Environ. Toxicol. Chem. 14(11): 1941-1950.

Sturve, J., Hasselberg, L., Fälth, H., Celander, M. and Förlin, L., 2006. Effects of North Sea oil and alkylphenols on biomarker responses in juvenile Atlantic cod (Gadus morhua). *Aquatic toxicology*, *78*, pp.S73-S78.

Takeshita, R., L. Sullivan, C. Smith, T. Collier, A. Hall, T. Brosnan, T. Rowles and L. Schwacke. 2017. The Deepwater Horizon oil spill marine mammal injury assessment. *Endangered Species Research* 33:95-106.

Thomas, R.E. and S.D. Rice. 1987. Effect of water-soluble fraction of Cook Inlet crude oil on swimming performance and plasma cortisol in juvenile coho salmon (Oncorhynchus kisutch). Comp. Biochem. Physiol., 87(1): 177-180.

Tjeerdema, R., A.C. Bejarano and S. Edge. 2013. Biological Effects of Dispersants and Dispersed Oil on Surface and Deep Ocean Species. From the Oil Spill Dispersant- Related Research Workshop, hosted by the Center for Spills in the Environment. March 12-13, 2013. Baton Rouge, LA.

Trenkel, V.M., Huse, G., MacKenzie, B.R., Alvarez, P., Arrizabalaga, H., Castonguay, M., Goñi, N., Grégoire, F., Hátún, H., Jansen, T. and Jacobsen, J.A., 2014. Comparative ecology of widely distributed pelagic fish species in the North Atlantic: implications for modelling climate and fisheries impacts. *Progress in Oceanography*, *129*, pp.219-243

Trivelpiece, W.Z., Butler, R.G., Miller, D.S. and Peakall, D.B., 1984. Reduced survival of chicks of oil-dosed adult leach's storm-petrels. The Condor, 86(1), pp.81-82.

Trudel, B.K., R.C. Belore, B.J. Jessiman and S.L. Ross., 1989. A Micro-computer-based Release Impact Assessment System for Untreated and Chemically Dispersed Oil Releases in the U.S. Gulf of Mexico. 1989 International Oil Release Conference.

Van Baalen, C. and O'Donnell, R., 1984. Sensitivity of two psychrophilic diatoms to crude oil and fuel oil. *Marine environmental research*, *12*(1), pp.63-68.

Vargo, S., P. Lutz, D. Odell, E. Van Vleet and G. Bossart. 1986. Study of the Effects of Oil on Marine Turtles. Final report to Minerals Management Service MMS Contract No. 14-12-0001-30063. 181 pp.

Vis, M.L., Carr, S.M., Bowering, W.R. and Davidson, W.S., 1997. Greenland halibut (Reinhardtius hippoglossoides) in the North Atlantic are genetically homogeneous. *Canadian Journal of Fisheries and Aquatic Sciences*, *54*(8), pp.1813-1821.

Wang, C.H. and Tzeng, W.N., 1998. Interpretation of geographic variation in size of American eel Anguilla rostrata elvers on the Atlantic coast of North America using their life history and otolith ageing. *Marine Ecology Progress Series*, pp.35-43.

Weber, D.D., D.J. Maynard, W.D. Gronlund, and V. Konchin. 1981. Avoidance reactions of migrating adult salmon to petroleum hydrocarbons. Can J. Fish. Aquat. Sci. 38: 779-781.

White, H.K., Hsing, P.Y., Cho, W., Shank, T.M., Cordes, E.E., Quattrini, A.M., Nelson, R.K., Camilli, R., Demopoulos, A.W., German, C.R. and Brooks, J.M. 2012. Impact of the Deepwater Horizon oil spill on a deep-water coral community in the Gulf of Mexico. Proceedings of the National Academy of Sciences, 109(50):.20303-20308.

Wiese, F.K. and G.J. Robertson. 2004. Assessing seabird mortality from chronic oil discharges at sea. J. Wildl. Manage. 68:627-638.

Wiese, F.K., Montevecchi, W.A., Davoren, G.K., Huettmann, F., Diamond, A.W., and Linke, J. 2001. Seabirds at risk around offshore oil platforms in the Northwest Atlantic. Mar. Poll. Bull.. 42(12):1285-1290.

Würsig, B. 1990. Cetaceans and oil: Ecologic perspectives. Pp. 129-1653. In: J.R. Geraci and D.J. St. Aubin (eds.). Sea Mammals and Oil: Confronting the Risks, Academic Press, San Diego, CA.

Zhou, S., H. Heras, R.G. Ackman. 1997. Role of adipocytes in the muscle tissue of Atlantic salmon (Salmo salar) in the uptake, release and retention of water-soluble fraction of crude oil hydrocarbons. Mar. Biol., 127: 545-553.

16.0 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

The planning and conduct of offshore oil and gas exploration and other marine activities offshore eastern Newfoundland are often influenced by environmental factors, including climatological and meteorological conditions (wind, precipitation, fog, and visibility), oceanographic conditions (waves, currents), the seasonal presence of sea ice and icebergs, geology and seismicity, and other environmental features and conditions. An appropriate understanding and consideration of these environmental characteristics and phenomena are therefore required so that offshore activities can be designed and implemented appropriately, and in a manner where the safety and protection of workers, equipment and infrastructure, and the environment are protected. This includes the consideration of these environmental characteristics in the design, review, and conduct of the planned and routine components and activities of offshore exploration. It also includes taking appropriate measures to avoid or reduce the potential for incidents and accidents (and resulting environmental effects) that may occur as a result of unplanned interactions between exploration activity and the physical environment.

As per Section 19(1)(h) of CEAA, 2012 (any change to the designated project that may be caused by the environment), this chapter considers how existing environmental conditions in and around the Project Area and potential natural hazards could adversely affect the Project, and in turn, potentially result in adverse effects on the environment.

Key components of the environment that could potentially affect the Project include:

- Weather conditions
- Oceanographic conditions
- Sea ice, icebergs, and superstructure icing
- Geological stability and seismicity

The chapter also describes how these issues will be considered and addressed as part of ongoing and future Project planning, design, and eventual implementation. This includes discussing how relevant engineering and environmental design criteria, industry standards, guidelines. and regulatory conditions will be applied and will be relevant to the mitigation of such effects of the environment on the Project.

16.1 Key Environmental Considerations

The following sections provide an overview description of several key aspects of the existing environmental setting of the Project Area, particularly those which are relevant to the assessment of the potential effects of the environment on the Project as outlined above. This comprises a high-level summary of these factors, with more detailed information on these and other aspects of the existing physical environment provided in Chapter 5 of this EIS, as well as in other existing and available sources, most notably the Eastern Newfoundland SEA (AMEC 2014).

16.1.1 Weather Conditions

The overall Project Area exhibits spatial and temporal (seasonal) variability in its meteorological conditions, including the potential for, and nature and degree of, associated severe or extreme weather conditions.

Existing and available climatological information for five MSC50 hindcast data grid points within the Project Area (three in the Northern Section and two in the Southern Section) indicate that air temperatures are coolest in January or February and warmest from July through September. Air temperatures exhibit strong seasonal variations and also vary by geography. Daily mean values can range from -0.4°C in winter to 13°C in summer in the Project Area – Northern Section and -0.1°C in January to 14.4°C in August in the Project Area – Southern Section. Prevailing winds in the area are from the west to northwest in winter and from the southwest in summer. Extreme wind gusts greater than 51 m/s (100 knots) have been measured in winter and in association with tropical and post-tropical weather systems (Bowyer 1995). Mean hourly wind speeds can range from 6 to 7 m/s in July to 12 m/s in January in the Project Area – Northern Section and 6 to 6.3 m/s in July to 11.3 m/s in January in the Project Area – Southern Section. The strongest wind speeds in winter can reach 31 to 32.4 m/s in February (based on available climatology MSC50 data created by Oceanweather).

Precipitation varies within localized regions of the Project Area. Rain or drizzle can occur at any time of year and is most likely to occur with southerly or south-westerly winds. Snow and freezing rain are possible any time from October through May, and snow can accompany winds of any direction. Freezing rain is most common with easterly or north-easterly winds, and frequently persists for days in the spring along the East Coast. There is also a year-round potential for thunderstorms and hail, with hail most likely in winter, and thunderstorms most frequently reported in summer. In general, visibility is most favourable in fall and winter and most frequently restricted in summer and spring with some of the highest occurrences of marine fog in North America (AMEC 2014). The freezing of salt spray results when the air temperature is below -1.8°C, sea temperature is below 6°C and wind speeds are greater than 10 m/s. Freezing precipitation is likewise an important consideration in this area (Amec 2014).

16.1.2 Oceanographic Conditions

Within the Project Area and surrounding marine environments, the largest seas are typically found farthest offshore, usually during the winter season. Mean significant wave heights range from approximately 1.8 m in July to 4.6 m in January, with maximum significant wave heights of 13.8 m in December to January in the Project Area - Northern Section and 0.7 m in July to 3.4 m in January, with maximum significant wave heights of up to 14.2 m in December and January in the Project Area – Southern Section. Circulation, which includes the continental shelf waters, is dominated by a generally southward flow of the cold Labrador Current, which includes an inshore branch that flows along the Newfoundland coast and over the Grand Banks at speeds of approximately 10 cm/s and an offshore branch flowing along the outer edge of the Grand Banks at speeds of approximately 40 cm/s. Over parts of the Grand Banks, the mean currents are generally weak (less than 10 cm/s) and flow southward, dominated by wind-induced and tidal current variability. Mean sea surface temperatures generally range from 1.6°C in March to 5.2°C in in August in the Project Area - Northern

Section and 0.6°C in April to 10.9°C in September in the Project Area - Southern Section. Near-bottom sea temperatures generally range from 3°C to 4°C on average year-round (AMEC 2014).

The annual 100-year extreme significant wave height ranges from 15.6 m in the Project Area – Northern Section to 17.2 m in the Project Area – Southern Section. The 100-year extreme wind speed ranges from 34.0 m/s in the Project Area – Northern Section to 34.6 m/s in the Project Area – Southern Section (see Section 5.5.3).

16.1.3 Sea Ice, Icebergs and Superstructure Icing

Like other parts of the Eastern Newfoundland offshore area, the Project Area are subject to seasonal intrusions of sea ice and icebergs, as well as vessel icing during meteorological conditions. Sea ice and iceberg conditions vary each year and by location, and are influenced by colder or milder winter conditions over Newfoundland and the surrounding waters, and seasonal wind patterns. Cold and dry winds from the west through north have the effect of moving ice further offshore, while north-easterly winds tend to bring ice towards shore. Refer to Section 5.7 for more information regarding sea ice and icebergs.

Sea ice is most prevalent over the southwestern quadrant of the Project Area – Northern Section as this region sees the greatest influx of ice that drifts south from Labrador and the northeast coast of Newfoundland and out onto the Grand Banks and east over the Orphan Basin and Flemish Pass. Ice is present here as early as the week of 15 January and as late as the last week of May, although in May it is only in the form of small intrusions into the western portion of the Project Area – Northern Section. Over the northwestern quadrant of the Project Area – Northern Section, there is a 1 to 15 percent likelihood of sea ice in any week, from the first week of February through the first three weeks of April, although this ice presence is generally confined to the south or west. The southeastern quadrant of the Project Area – Northern Section has a likelihood of sea ice similar to that of the northwestern portion, with ice present 1 to 15 percent of the time from the first week of February through the first three weeks of April, with the exception that in March the likelihood is generally 16 to 33 percent in the western portion. Based on the atlas, sea ice in the northeastern quadrant of the Project Area – Northern Section is infrequent and generally confined to the south reaches at approximately 48°N to 49°N. Sea ice is most likely to occur over the northern portion of the Project Area – Southern Section and with a frequency of occurrence of 16 to 33 percent (or every three to six years). The sea ice presence here may typically last from mid-to-late February to the beginning of April. Sea ice is also expected over virtually all portions of the Project Area – Southern Section though somewhat less frequently, 1 to 15 percent of the time (or approximately every six to seven years) during mid-January to the end of April, though by mid-April the western portions are mostly ice free. May is generally free of ice throughout the Project Area – Southern Section.

The iceberg season typically lasts from January through August with growlers (less than 1 m height) to very large (100 to 200 m in length) icebergs. Ice islands, broken away from an Arctic ice shelf, may have areas of a few thousand square metres to 500 km², although they do not occur every year. The International Ice Patrol annual count of icebergs south of 48°N is highly variable but has an annual mean of approximately 550 icebergs and range from 0 to 2,202 icebergs (based on data through 2006) (AMEC 2014). In the Project Area – Northern Section, 18 percent of the 3,773 icebergs for which size is known are growlers or bergy bits, 70 percent are small or medium, 11 percent are

large, and 1 percent are very large. In the Project Area – Southern Section, 22 percent of the 3,625 icebergs for which size is known are growlers or bergy bits, 64 percent are small or medium, 12 percent are large, and 1 percent are very large.

A number of factors can contribute to vessel icing potential at any given time. These include environmental parameters such as air and sea temperature, wind speed, wave height and precipitation. The size, shape, and configuration of the vessel itself are also critical factors for icing potential. With sub-zero temperatures and strong winds common, especially in the northern parts of the Project Area, icing of the ships superstructure can be an important consideration and risk. A few tens of centimetres of ice over a complex deck and superstructure represents many tonnes of loading. Vessel icing in this region is likely to occur in the period between November and May, with the highest frequency typically occurring in February (Amec 2014).

16.1.4 Geological Stability and Seismicity

The geology of the Eastern Newfoundland offshore area is complex and dynamic, and the current bedrock and surficial characteristics of the area have been shaped by various natural and human factors and processes over time.

Canada's eastern continental margin is tectonically passive and seismicity is relatively rare throughout much of the region. Natural Resources Canada (NRCan) (2016a) estimates that approximately 450 earthquakes occur each year in Eastern Canada. Seismicity generally occurs randomly along the Grand Banks margin. The most recent edition of the Seismic Hazard Map prepared by NRCan (2017) indicates that the Project Area has been classified as having a low seismic hazard (see Figure 5-4; Section 5.1.3). According to the National Earthquake Database (NRCan 2016b), there have been two seismic events recorded within the Project Area – Northern Section in the 1985 to 2017 period. The magnitudes of these events have been fairly low, ranging from 4.3 to 4.5 on the Richter scale, with an average magnitude of 4.4 and a median magnitude of 4.4. There have been seven seismic events recorded within the Project Area – Southern Section in the 1985 to 2017 period. The magnitudes of these events have been fairly low, ranging from 3.0 to 4.5, with an average magnitude of 3.9 and a median magnitude of 4.0. The majority of the recorded events had epicentres in the southwest portion of the Project Area, and are possibly related to the various tectonic lineaments in the area. The active seismic zone in the Laurentian Slope, as determined by historical earthquake occurrences, is at least 300 to 500 km from the Project Area. Unless there was an earthquake of 8 or greater in the Laurentian Slope active seismic zone (which has not been recorded to date) it does not appear likely that an earthquake would cause substantive destruction of wells resulting in spillage (Environmental Research Consulting 2017).

The largest seismic event near Newfoundland occurred in 1929 and measured 7.2. A 200-km long slump of slope deposits was caused by a rupture in the slope within the Laurentian Channel. The resulting turbidity current destroyed numerous telegraph cables and created a tsunami that led to 27 deaths in southern Newfoundland (Basham and Adams 1983). Submarine landslides could also potentially be associated with storms, as those associated with hurricanes (e.g., Hurricane Camilla in 1969 and Hurricane Ivan in 2004) are known to be potentially damaging to offshore platforms (Environmental Research Consulting 2017).

Other potential offshore geohazards include slope instability, sediment loading, venting of shallow gas, gas hydrates, seabed instabilities and ice scour. Sediment failure is essentially a consequence of gradient, magnitude of seismic acceleration and sediment strength. Most continental margin sediments, except on slopes of more than a few degrees, are relatively stable and would require seismic accelerations associated with a large earthquake (magnitudes of five or greater) to fail (Nadim et al. 2005). NRCan analysis indicates that in any given area offshore Eastern Canada, there is a risk of a major landslide every 20,000 years and a minor one every few thousand years. Most of the large failures on the seabed date back more than 10,000 years during periods of glaciations when large amounts of sediment were deposited directly onto the slope of the continental shelf (NRCan 2013). The Flemish Pass area itself, for example, is a mid-slope basin bounded to the west by the Grand Banks of Newfoundland and to the east by the isolated Flemish Cap (Piper and Campbell 2005). In this area, large, complex landslides have been mapped along a 65-km length of the northeast flank of the Flemish Pass, which extends approximately 20 km downslope. Failed sediments have run out as far as 20 km onto the floor of the Flemish Pass, forming mass transport deposits typically 50 m thick. These major sediment failures occurred 27,000 and 20,500 years ago and are believed to have been a result of earthquake triggers (Cameron et al. 2014). Similarly, Piper and Campbell (2005) have presented a brief regional geohazard assessment of the Flemish Pass area and also suggested that most large debris flow deposits in the area are the result of earthquake triggered slumps on both flanks of the Flemish Pass. It would likely take a major earthquake in the northern Flemish Pass to trigger future landslides; Cameron et al. (2014) estimated such a quake would occur every approximately 10,000 years in a worst-case scenario. This is consistent with the findings of a review of existing geophysical and geotechnical data from the Flemish Pass region, used to develop a geohazard assessment (Fugro 2017). The results of a slope stability evaluation in the Project Area – Northern Section indicate that a triggering event of greater magnitude than the 3,000-year recurrence interval Abnormal Level Earthquake event is required for slope instability over large areas of the Flemish Pass flanks. This is consistent with the age estimates and observed recurrence intervals of the three basin-wide slope failure events / mass-transport deposits, the results of which indicate relatively low landslide likelihood across a large proportion of the Project Area – Northern Section (Fugro 2017).

Oil and gas activities are conducted safely in areas where submarine landslides have occurred. Ormen Lange is a production (gas) field in 850 to 1,100 m water in the Norwegian Sea and is located at the site of a submarine clay landslide. The submarine landslide occurred in approximately 300 to 2,500 m of water approximately 8,200 years ago and was likely triggered by an extremely strong, low-probability earthquake (Kvalstad et al. 2005) combined with excess pore pressure (Leynaud et al. 2007). The slide area was approximately 90,000 m², moving a volume of 3,500 km³ approximately 800 km out into deep water (Solheim et al. 2005; Statoil 2011). The slide generated a tsunami approximately 10 to 20 m high that made landfall on the Norwegian coast (Norsk Oljemuseum 2011), Scotland, and the Faeroes (Nadim et al. 2005). The Ormen Lange field development activities had negligible effects on stability and was determined to not trigger tsunami-generating slides, as a slide risk assessment indicated that only natural causes (i.e., extremely strong earthquake) are a realistic trigger mechanism. The annual probability of a slide with a run out of the field development area is almost zero (Scandpower 2004). Hazards related to the Ormen Lange subsea processing facilities from landslide risks were determined to be negligible (10^{-6}/year) (Nadim et al. 2005; Lloyd's Register Consulting 2013).

16.2 Assessing and Mitigating Potential Effects of the Environment on the Project

Existing environmental conditions (both typical and extreme conditions or events) influence key aspects of the design and conduct of offshore oil and gas activities. The selection of the drilling installation is based on a consideration of existing and anticipated conditions at site, including water depth, met-ocean conditions, and presence of sea ice and icebergs. Some types of oil and gas activities in the marine environment, such as the deployment and use of geophysical or geotechnical gear, also have specific operational parameters and restrictions which require that they only be commenced and completed during environmental conditions. The potential for, and occurrence of, extreme meteorological and oceanographic conditions may also affect other project components, activities, and schedules, including the timing of associated vessel movements and drilling activity.

The primary measures for mitigating risks associated with effects from the environment on the Project are engineering design that incorporates environmental criteria so that the physical conditions of the Project Area can be tolerated, and sound planning that includes adherence to regulatory design and fitness standards. Engineering design of drilling installations used offshore Newfoundland adhere to national and international standards, which inform and guide Project design that is suitable for the requirements for site-specific normal and extreme physical environmental conditions. These national and international standards consider physical environmental criteria (e.g., temperature, wind, snow, waves, ice loading, drainage), as well as the life of the expected life of the design (i.e., choosing materials with sufficient durability and corrosion resistance).

An Operations Authorization is required from the C-NLOPB to conduct an exploration drilling program. That Authorization, and the *Newfoundland Offshore Certificate of Fitness Regulations*, require an Operator obtain a Certificate of Fitness from an independent, third-party Certifying Authority for a drilling installation prior to onset of drilling. The third-party Certifying Authority will review the installation to confirm it meets the requirements of the Regulations, is fit for purpose, can function as intended, and remains in compliance with the regulations without compromising safety and polluting the environment. In addition, modifications/repairs to the installation that affects its strength, stability, integrity, operability, safety, or regulatory compliance need to be reviewed and accepted by the Certifying Authority to ensure the continued validity of the certificate. The Regulations require that offshore installations must be designed, constructed, transported, and installed in accordance with Parts I to III of the *Newfoundland Offshore Petroleum Installations Regulations*.

Other mitigation includes:

- Selection criteria for drilling installations where the installation is capable of operating at required water depths and in environmental conditions prevalent in the Northwest Atlantic Ocean
- Third party certification – a certificate of fitness – of the drilling installation and other facilities as required to obtain an Operations Authorization issued by the C-NLOPB
- Physical environment data observations, weather forecasting, and reporting will be conducted in accordance with the Offshore Physical Environmental Guidelines

- Implementation of an Ice Managementn Plan. Options to be investigatedfor ice management include: ice detecting radar on drilling installations, use of satellite data to monitor for presence of ice
- Ability to quick disconnect riser in event of emergency

16.2.1 Weather Conditions

Poor visibility resulting from fog, heavy rain, or snow conditions can hinder helicopter transits, which could potentially delay supply and personnel movement to and from a drilling installation. The potential for accidental events (e.g., a vessel or helicopter collision potentially resulting in a spill) could also increase due to poor visibility. There are set visibility requirements for helicopter flights. If these requirements are not met, flights will not occur. In addition, there are specific navigational lighting requirements on the drilling installation helipad and exterior. Vessels can operate in most weather conditions, however, reduce visibility may result in slower speeds. The drilling installation and offshore supply vessels will maintain obstruction lights, navigation lights, and foghorns in working condition. Radio communication systems will be in place to contact other marine vessels. The drilling installation, offshore supply vessels, and shore bases will have systems in place allowing to communicate with each other.

Severe and/or extreme weather conditions, such as high wind and wave conditions, have the potential of delaying cargo or personnel transit. Adequate food and water supplies are stored on the drilling installation to accommodate such delays. Extreme wind and wave conditions could also result in accidental spills, suspension or delay of Project activities, evacuation of the drilling installation, and in extreme cases, fatalities. Extreme weather conditions such as high wind, high waves and freezing precipitation can cause increased stress conditions on the drilling installation superstructure and vessels, and potentially result in failure of the superstructure or, in extreme cases, capsizing. To mitigate these risks, the Project will comply with Canadian regulations for engineering design and will adhere to international standards where applicable, mitigating potential effects from extreme weather conditions. For example, an Operations Authorization and Approval to Drill a Well permit are required from the C-NLOPB to conduct a drilling program. A Certificate of Fitness (from an independent third party Certifying Authority) for the drilling installation is required in accordance with the *Newfoundland Offshore Certificate of Fitness Regulations*, prior to the onset of a drilling program. These regulations require that offshore installations are designed, constructed, transported, and installed or established in accordance with the *Newfoundland Offshore Petroleum Installations Regulations*, requiring components of an installation be designed using good engineering practice, and taking into account the specific activities of the installation and the environment surrounding the installation. Engineering design is based on analyses, model tests, and/or simulations under foreseeable transportation, installation, and operating conditions. Pursuant to Parts I to III of the *Newfoundland Offshore Petroleum Installations Regulations*, engineering design of an installation must take into account (among other factors) the type and magnitude of loads imposed by ice, sea ice, snow, waves, currents, tides, wind, or by a combination of those phenomena) and operating ambient temperatures.

The drilling installation selected for this Project will be a deep-water, all-weather drillship or semi-submersible that is specifically designed to operate in harsh environments. It will have the capability

to disconnect the riser from the well in a short period to reduce the risk of damage to the well, riser, and the drilling installation during extreme weather events. The offshore supply vessels used on this Project will also be equipped for safe all-weather operations, including stability in rough sea conditions and inclement weather. Offshore supply vessels undergo internal auditing by the Operator, as well as additional external inspections / audits by the C-NLOPB as part of its pre-authorization inspection process.

The collection and analysis of detailed and site-specific information on climatic and meteorological conditions (winds, waves, precipitation, and temperatures) and oceanographic characteristics (including waves, currents, sea ice and icebergs) are also typically part of an operator's overall planning and design of an offshore program and its associated regulatory review and approval requirements. Appropriate design and planning based on this information, such as in program scheduling, equipment selection and the development and implementation of appropriate operational procedures, helps to facilitate the safety of personnel, equipment, vessels, and the natural environment during the execution of offshore exploration activities. In addition to pre-commencement analysis and planning, meteorological and oceanographic monitoring programs are implemented throughout offshore programs to forecast and respond to severe environmental conditions.

Physical environment data observations, forecasting, and reporting will be conducted in accordance with the Offshore Physical Environmental Guidelines. The Operator obtains daily weather forecasts for the area of operations from a contracted third-party forecaster. In addition, Environment and Climate Change Canada issues marine weather observations, forecast bulletins and warnings through the MSC, Weatheradio, and regional Storm Prediction Centres. Weatheradio continuously broadcasts weather reports over VHF or FM radio and it, and MSC's Automated Telephone Answering Device, provide hourly updated observations and forecast bulletins. The marine weather and wave height information, consisting of a weather watch, warning, and amendment services for waters around Newfoundland and Labrador (out to approximately 250 nautical miles) are provided year-round by the Newfoundland and Labrador Weather Office in Gander (DFO 2015).

Monitoring of these forecasts provides offshore supply vessels, helicopters, and the drilling installation a forewarning of extreme weather conditions. Vessel captains, helicopter pilots and the drilling installation Offshore Installation Manager will have the authority to suspend or modify operations in case of adverse weather that could compromise the safety of offshore supply vessel, helicopter, or drilling installation operations. If required, the riser will be disconnected from the well, and the drilling installation will be moved to reduce the risk of damage and/or injury during extreme weather.

16.2.2 Oceanographic Conditions

This section focuses on currents and extreme oceanographic events such as a tsunami (a series of waves caused by the displacement of a large volume of water). Extreme wave conditions resulting from storm events are addressed in Section 16.2.1.

Currents have the potential to increase stress on drilling installation surfaces, including the riser (and vessels), resulting in operations disruption. Moored current measurements in the Flemish Pass (2002 to 2005) estimated a mean transport of approximately $7x10^6$ m^3/s for the Labrador Current with a

seasonal cycle range (that peaks in winter) of approximately 3 x 10^6 m^3/s (Loder and Yashayaev 2005), with average speeds through the Flemish Pass of approximately 20 to 25 cm/s. drilling installations and vessels incorporate water current loads into their design. The Offshore Physical Environmental Guidelines require an operator implement a physical environmental monitoring program, including metocean monitoring and onsite weather observation, as well as ice management.

There is potential for the Project to be affected by a tsunami triggered by a seismic event (see Section 16.2.4 for a discussion of seismicity). Offshore, a passing tsunami has a small wave height, on the order of 1 m or less (Husky Energy 2012); therefore, in the unlikely event a tsunami occurs, it is not expected to be an issue for the offshore operation of the drilling installation due to the long wave period and resulting small wave height. A tsunami could have an associated current speed up to 70 cm/s, which could possibly affect moorings. Vessel and helicopter transits would likely be delayed in the event of a tsunami. Adequate food and water supplies are stored on the drilling installation to accommodate such delays. Given the relatively short duration of Project activities, it is unlikely a tsunami would occur during the life of the Project. The drilling installation design requirements described in Section 16.2 will also mitigate risks associated with a tsunami event. The drilling installation is designed in accordance with the *Newfoundland Offshore Certificate of Fitness Regulations*, which takes into account potential environmental loads imposed by naturally occurring phenomena. If necessary, modern drilling installation have the capability to disconnect the riser from the well in a short period of time, reducing the risk of damage to the well, riser, and drilling installation, in the unlikely event of a tsunami.

16.2.3 Sea Ice, Icebergs, and Superstructure Icing

Sea ice and icebergs are navigational hazards that may hinder offshore supply vessel transportation and the operation of the drilling installation. Supply and personnel movement to and from the drilling installation can be delayed and the drilling installation could be moved off the well site to avoid being struck by an iceberg. Sea ice and icebergs can also increase the risk of an accidental event (e.g., a vessel collision potentially and/or impact with the drilling installation, potentially resulting in a spill), and human health risk, and/or irreparable damage to the drilling installation superstructure.

As illustrated in Figure 5-3 (Seabed Features), the risk of iceberg scour is low for most of the Project Area – Northern Section. There are few observations of icebergs for the northern parts of the Project Area – Northern Section (there are none with estimates of draft from the NRC-PERD Iceberg Sighting Database) and depths in this region are generally 800 or 1,000 m or much deeper and are sufficiently large that there would be no iceberg scour risk.

There is low to moderate (“low” where few (<10%) scours are reported in Figure 5-3; “moderate” where abundant (>10%) is reported in Figure 5-3) risk of iceberg scour farther south for the southern portions of the Project Area – Northern Section. The greatest risk here is likely along the western slopes of the Flemish Pass, and to a lesser degree on the northeastern portion of the Grand Banks and approaching the Sackville Spur, and along the eastern slopes of the Flemish Pass and the Flemish Cap.

An indication of possible iceberg drafts which might be encountered is provided by the NRC-PERD Iceberg Sighting Database. For the Flemish Pass southeast sub-region, based on seven values, the mean draft is 77 m with a maximum draft of 151 m. For the Flemish Pass southwest sub-region, based on 304 values, the mean draft is 49 m with a maximum draft of 276 m. This maximum draft was for a very large, tabular, iceberg of length 900 m and width 740 m tracked from 23 April to 4 May 2012 that was observed to drift south through the Flemish Pass into the eastern portion of the Project Area – Southern Section and northeast to the Flemish Cap.

There is low to moderate risk of iceberg scour over the western two-thirds of the Project Area – Southern Section with the greatest risk along the eastern slopes of the Grand Banks leading to the Flemish Pass, and to a lesser degree along the western slopes of the Flemish Cap. Again, from the NRC-PERD database, in the Project Area – Southern Section, based on 857 observations, the mean and maximum iceberg drafts are 48 m and 136 m for the western sub-region and a mean and maximum of 43m and 185 m for the eastern sub-region. In the deeper (approximately 1,000 m or greater) waters of the southeastern portion of the Project Area – Southern Section there is no iceberg scour risk.

Therefore, as briefly assessed, given the large range of water depths and associated iceberg distributions and associated scour risk in the Project Area, the risk to substrate infrastructure would need to be further quantified for any specific areas of interest, and appropriate mitigation measures (e.g., sea floor excavations to protect wellheads and equipment) would need be identified. Ice management has been conducted by the Newfoundland and Labrador offshore oil and gas industry since the early 1970s (Bruneau and Dempster 1971, in Husky Energy 2012) and has been continually developed since that time. Today, ice management is a proactive operation provided in the Offshore Physical Environmental Guidelines. In accordance with these Guidelines an Operator is required to prepare and submit an Ice Management Plan as part of the application for Drilling Program Authorization. Accordingly, operators working in the Newfoundland offshore have an ice management plan and often develop project-specific plans. Ice management is typically comprised of:

- Detection
- Monitoring and assessment
- Physical management

Sea ice and icebergs are detected and tracked through a number of initiatives. Over 5,000 hours of airborne reconnaissance are conducted annually by radar-equipped aircraft over the Grand Banks and areas to the north by the Canadian and American governments and private industry (Husky Energy 2012). Areas off Canada's East Coast are also surveyed daily by long-range, shore-based radars and satellite-based sensors. During the ice season, a daily summary of ice distribution is created by integrating data from these sources. The summary is available to oil and gas operators, allowing them to detect and monitor ice conditions in the vicinity of the unit. Ice that moves south of 48°N is monitored using dedicated radar-equipped ice reconnaissance aircraft, which can detect very small ice targets. This information is then used to plan an operational response to manage site-specific ice conditions, if required. Satellite images may also be acquired to assist with the identification and tracking of sea ice and icebergs. Specific commercial satellite imaging sensors (C-SAR (C-band Synthetic Aperture Radar)) imaging sensor can acquire images of the Earth's surface

independent of cloud-cover and solar illumination. SAR sensors are employed to map sea ice conditions and detect icebergs. Identified targets (including vessels) can be incorporated in the ice surveillance plans for the Project.

When detected, ice is monitored to establish its movement, including speed, direction, general classification (type of ice or iceberg), and a determination of its general drift track. More detailed information, such as physical dimensions, iceberg draft or depth, and accurate drift, is required the closer that sea ice or an iceberg approaches a drilling installation. The Operator may also obtain satellite data to provide additional information in icebergs / sea ice within the vicinity of the drill sector.

Once this information has been collected, a situational assessment is possible, which considers the following questions:

- Is the drift likely to pose a collision risk or disrupt operations?
- Is the draft sufficient to scour or strike components of a project?
- Is the ice in excess of the offshore facility / facilities design criteria?

A 'no' response to each of these questions needs no further management other than monitoring the ice / iceberg for drift changes. A 'yes' response to one or more of these questions results in the application of a physical ice management procedure or securing the facility (e.g., drilling installation) for a possible move.

Physical iceberg management (towing or deflecting the iceberg off its free-drifting track) is typically conducted far upstream to move hazardous ice and/or icebergs safely past offshore exploration operations. Iceberg towing (either using ropes or an iceberg tow net) has been conducted since 1971 (Bruneau et al. 1977, in Husky Energy 2012) and has remained the staple of iceberg management. There have been over 500 documented iceberg tows.

Management procedures for sea ice, such as breaking up sea ice to assist shipping, is a commonplace occurrence in Canadian waters. These management procedures typically use support vessels to break up large ice floes that meet or exceed the design limits of supply vessels or the offshore facility. Another management procedure uses water cannons on a support vessel stationed a few hundred metres from an offshore facility; this procedure opens a path / lead in the pack as it advances towards the offshore facility. Oil and gas operators on the Grand Banks have adopted a coordinated ice management approach as of 1988, which shares ice information and management resources.

In addition to the conditions described in Section 16.1.3, superstructure icing can result in a raised centre of gravity, slower vessel speed, and maneuvering difficulty, as well as problems with cargo-handling equipment (DFO 2012). Delays from superstructure icing can result if operations are slowed (or suspended) to remove ice accumulations. As described in Section 16.1.3, if icing is not managed, damage to the superstructure could occur. The drilling installation selected for this Project will be an all-weather semi-submersible or drillship, specifically designed to operate in deep-water, harsh environments, including during inclement weather.

16.2.4 Geological Stability and Seismicity

A seismic event could disrupt Project activities and increase the risk of potential accidental events. A seismic event could also contribute to sediment and seafloor instability. The Project Area has been classified as having a low seismic hazard (Section 5.1.3).

An earthquake of sufficient magnitude to cause structural damage to offshore facilities directly or indirectly through landslides or tsunamis caused by earthquakes is conservatively estimated to be magnitude 6 or greater. According to data obtained from the Natural Resources Canada National Earthquake Database, which has records of earthquakes since 1985, there have been no incidents of magnitude 6 or higher anywhere within 1,000 km of the Project Area. Based on one incident of magnitude 7.2 (the 1929 Grand Banks or Laurentian Slope earthquake) in records going back to at least 1663 (when there was a 7.0-magnitude earthquake in Charlevois-Kamouraska, Quebec), the probability of earthquakes affecting the Newfoundland and -Labrador is 0 .0028 per year (based on 1 in 354 years). (There were no other incidents exceeding magnitude 6 in the region in that time period) (Environmental Research Consulting 2017). It can be assumed that submarine landslides, whether caused by earthquakes or storms, as well as tsunamis brought on by earthquakes, could potentially affect the risk of spillage for the Project. However, as Project activities are of short duration (35 to 65 days to drill one well), the probability of a major seismic event (and resulting landslides or tsunamis) occurring during the life of the Project is considered low.

In accordance with the *Newfoundland Offshore Certificate of Fitness Regulations*, a drilling installation is required to have a Certificate of Fitness, which requires a drilling installation be designed with potential environmental loads imposed by earthquakes and other naturally occurring phenomena taken into account. If necessary, modern drill ships and rigs have the capability of disconnecting a riser from a well in a short period of time, reducing the risk of damage to the well, riser, and the drilling installation and associated environmental effects.

16.3 Residual Effects Summary

A significant adverse residual effect of the environment on the Project is defined as one that results in one or more of the following if:

- Project infrastructure is damaged, causing harm to Project workers or the public
- A substantial impact to the Project schedule delaying ongoing Project activities by one season or resulting in a shutdown of drilling operations for three months or more
- Project infrastructure is damaged, resulting in repairs that are not technically or economically feasible

The key environmental factors that may affect the Project include severe and/or extreme weather conditions, sea ice, icebergs and superstructure icing, oceanographic conditions, and geological stability and seismicity (unlikely due to low probability of occurrence). Engineering design, operational procedures, and mitigation measures discussed in Section 16.2 will reduce the potential adverse effects to the Project.

The short-term duration of offshore activities between 2018 and 2027 (i.e., 35 to 65 days drilling per well (up to 30 wells), the absence of fixed offshore infrastructure, the harsh-weather design criteria

for the drilling installation, the requirements of the C-NLOPB's Operations Authorization for drilling an exploration well, the requirements of the *Newfoundland Offshore Certificate of Fitness Regulations* and the Offshore Physical Environmental Guidelines also reduce the potential for, and possible magnitude of, effects of the environment on the Project. Meteorological and oceanographic conditions are constantly monitored, and stop-work procedures have been developed should unsafe conditions arise.

Based on the significance criteria defined above, and with the application of the engineering and environmental design standards, operational procedures, regulations (e.g., *Newfoundland Offshore Certificate of Fitness Regulations*, *Newfoundland Offshore Petroleum Installations Regulations*), and adherence to the Offshore Physical Environmental Guidelines, it is predicted that there will be no significant adverse residual effects of the environment on the Project.

There is potential for effects of the environment on the Project to result in the Project having an accidental event or experiencing a malfunction. Potential environmental effects of Project-related accidents and malfunctions are assessed in Chapter 14.

16.4 References

AMEC Environment and Infrastructure. 2014. Eastern Newfoundland Offshore Area Strategic Environmental Assessment. Prepared for the Canada-Newfoundland and Labrador Offshore Petroleum Board, St. John's, NL.

Basham, P.W. and J. Adams. 1983. Earthquakes on the continental margin of Eastern Canada: Need future large events be confined to the locations of large historical events? Pp. 456-467. In: W.W. Hays and P.L. Gori (eds.). Proceedings of Conference XX, A Workshop on The 1886 Charleston, South Carolina Earthquake and its Implications for Today. USGS Open File Report OFR-83-843.

Bowyer, P. (Editor). 1995. Where the Wind Blows. A Guide to Marine Weather in Atlantic Canada. Environment Canada: xiii + 178 pp.

Cameron, G.D.M., Piper, D.W.J., and A. MacKillop. 2014. Sediment Failures in Northern Flemish Pass. Geological Survey of Canada Open File 7566: 141 pp. (including appendices).

DFO (Fisheries and Oceans Canada). 2012. Ice Navigation in Canadian Waters. Icebreaking Program, Navigational Services Directorate, Fisheries and Oceans Canada, Canadian Coast Guard, Ottawa, ON. Available from: http://www.ccg-gcc.gc.ca/folios/00913/docs/ice-navigation-dans-les-galces-eng.pdf.

DFO (Fisheries and Oceans Canada). 2015. Radio Aids to Marine Navigation 2015 (Atlantic, St. Lawrence, Great Lakes, Lake Winnipeg and Arctic). Available at: http://www.ccg-gcc.gc.ca/folios/01148/docs/RAMN-2015-ATLANTIC-eng.pdf.

Environmental Research Consulting. 2017. Analysis of Probability of Potential Blowouts and Spills from Offshore Wells and Activities: Statoil Newfoundland Southern PA & Northern PA Environmental Impact Assessment. Draft report prepared for Statoil Canada Ltd., Stantec Consulting Ltd., and RPS ASA. 131 pp.

Fugro. 2017. Desktop Geohazards Study: Northern Flemish Pass. Fugro Document No.: 20170018-RPT-001 Rev 0, prepared for Statoil Canada Ltd. xi + 74 pp. + Appendices.

Husky Energy. 2012. Husky Energy White Rose Extension Project Environmental Assessment. Prepared by Stantec Consulting Ltd., St. John's, NL, for Husky Energy. St. John's, NL.

Kvalstad, T.J., Nadim, F., Kaynia, A.M., Mokkelbost, K.H. and P. Byrn. 2005. Soil conditions and slope stability on the Ormen Lange area. Mar. Petrol. Geol., 22: 299-310.

Leynaud, D., Sultan, N. and J. Mienert. 2007. The role of sedimentation rate and permeability in the slope stability of the formerly glaciated Norwegian continental margin: The Storegga slide model. Landslides, 4: 294-309.

Lloyd's Register Consulting. 2013. Pushing the Limits – Hazards Related to Subsea Processing Facilities. Presentation at INTSOK Deep Water Conference, 14 November 2014, Perth Australia.

Loder, J. and I. Yashayaev. 2005. Moored Current Measurements and Hydrographic Programs in Flemish Pass and Orphan Basin. ASOF Newsletter, 4: 19.

Nadim, F., Kvalstad. T.J. and T. Guttormsen. 2005. Quantification of risks associated with seabed instability. Marine and Petroleum Geology, 22: 311-318.

NEB (National Energy Board), Canada-Newfoundland and Labrador Offshore Petroleum Board, and Canada-Nova Scotia Offshore Petroleum Board. 2008. Offshore Physical Environmental Guidelines. vii + 28 pp. + Appendices

Norsk Oljemuseum. 2011. Oil and Gas in Norway: Industrial Heritage Plan.

NRCan (Natural Resources Canada). 2013. National Earthquake Database, http://www.earthquakescanada.nrcan.gc.ca/stndon/NEDB-BNDS/bull-eng.php

NRCan (Natural Resources Canada). 2016a. Earthquake Zones in Eastern Canada. http://earthquakescanada.nrcan.gc.ca/zones/eastcan-en.php.

NRCan (Natural Resources Canada). 2016b. National Earthquake Database. http://earthquakescanada.nrcan.gc.ca/stndon/NEDB-BNDS/bull-en.php

NRCan (Natural Resources Canada). 2017. Simplified Seismic Hazard Map for Canada. http://earthquakescanada.nrcan.gc.ca/hazard-alea/simphaz-en.php.

Piper, D.J.W. and D.C. Campbell. 2005. Quaternary Geology of Flemish Pass and its Application to Geohazard Evaluation for Hydrocarbon Development. Pp. 29-43. In: R. Hiscott and A. Pullham (eds.). Petroleum Resources and Reservoirs of the Grand Banks, Eastern Canadian Margin, Geological Association of Canada, Special Paper 43.

Scandpower Risk Management AS. 2004. Slide Risk Assessment in the Ormen Lange Field Development Area. Presentation.

Solheim, A., Byrn, P., Sejrup, H.P., Meinart, J. and K. Berg. 2005. Ormen Lange – An integrated study for the safe development of a deep-water gas field within the Storegga Slide Complex, NE Atlantic continental margin: Executive Summary. Mar. Petrol. Geol., 22: 1-9.

Statoil. 2011. Example of a field development Ormen Lange. Presentation. Available at: http://www.uio.no/studier/emner/matnat/math/MEK4450/h11/undervisningsmateriale/modul-1/2%20-%20Field%20development.pdf

17.0 ENVIRONMENTAL ASSESSMENT AND SUMMARY AND CONCLUSIONS

This chapter provides a summary of the potential environmental interactions that may occur between the VCs selected for assessment in this EIS and the Project, and the resulting residual environmental effects, including their predicted significance.

17.1 Summary of Potential Effects

As a first step in assessing the potential effects of the Project on the selected VCs, interactions between Project activities included in the scope of the EIS and each VC are identified. A summary of the potential interactions between the VCs and planned Project activities, which formed the basis for the effects analysis, are presented in Table 17.1.

17.2 Summary of Mitigation and Commitments

Mitigation is proposed to reduce or eliminate adverse environmental effects. Design features and mitigation measures have been incorporated into the Project to prevent or reduce potential environmental effects. These design-feature mitigation measures, in combination with VC-specific mitigation measures will reduce environmental effects to acceptable levels. A summary of mitigation and commitments set out in the EIS is provided in Table 17.2.

17.3 Residual Environmental Effects

The residual environmental effects (i.e., after mitigation has been applied) for each VC for planned Project-related interactions as well as for cumulative environmental effects are evaluated and presented in Chapters 8 to 14 of the EIS. Table 17.3 summarizes the residual effect findings for each VC and indicates the significance of these effects. Where an effect is predicted to be significant (refer to the specific VC-chapter of the EIS for predefined criteria for each VC), the likelihood of that effect occurring is also presented. With the implementation of proposed mitigation measures (refer to Table 17.2), residual adverse environmental effects of routine Project activities and components are predicted to be not significant for all VCs.

The residual environmental effects related to accidental events are presented in Chapter 15 of the EIS. Table 17.4 summarizes the residual effect findings for each VC and indicates the significance of these effects. Spill prevention techniques and response strategies (e.g., cap stacks, spill clean-up processes detailed in Section 15.1 of the EIS) will be incorporated into the design and operations for Project activities as part of contingency planning.

Table 17.1 Potential Project-VC Interactions Summary

Potential Environmental Effects	Project Component / Activity						
	Presence and Operation of Drilling Installation (Including lights, noise, air emissions, anchoring)	Drilling and Associated Marine Discharges (including fluids and cuttings)	Formation Flow Testing with Flaring	Wellhead Decommissioning	Geophysical, Geohazard, Wellsite, Seabed, and VSP Surveys	Geological, Geotechnical and Environmental Surveys	Supply and Servicing
Fish and Fish Habitat							
Change in Habitat Availability and Quantity	•	•			•		
Change in Fish Mortality / Injury Risk and Fish Health	•	•			•		•
Change in Fish Presence and Abundance (Behavioral Effects)	•	•	•	•	•		•
Marine and Migratory Birds							
Change in Mortality / Injury Levels and Bird Health (Individuals or Populations)	•	•	•		•	•	•
Change in Avifauna Presence and Abundance (Behavioral Effects)	•				•	•	•
Change in Habitat Availability and Quality	•				•		
Change in Food Availability or Quality	•	•					

Table 17.1 Potential Project-VC Interactions Summary

Potential Environmental Effects	Project Component / Activity						
	Presence and Operation of Drilling Installation (Including lights, noise, air emissions, anchoring)	Drilling and Associated Marine Discharges (including fluids and cuttings)	Formation Flow Testing with Flaring	Wellhead Decommissioning	Geophysical, Geohazard, Wellsite, Seabed, and VSP Surveys	Geological, Geotechnical and Environmental Surveys	Supply and Servicing
Marine Mammals and Sea Turtles							
Change in Mortality or Injury (Underwater Noise)	•				•		
Change in Habitat Quality or Use (Behavioural Effects)	•	•	•	•	•	•	•
Change in Mortality or Injury (Vessel Strikes)	•	•	•	•	•	•	•
Change in Food Availability or Quality	•	•	•	•	•	•	•
Change in Health (Contaminants)		•	•				
Special Areas							
Change in Environmental Features and/or Processes	•	•	•	•	•	•	•
Change in Human Use and/or Societal Value	•	•			•	•	•

Table 17.1 Potential Project-VC Interactions Summary

Potential Environmental Effects	Project Component / Activity						
	Presence and Operation of Drilling Installation (Including lights, noise, air emissions, anchoring)	Drilling and Associated Marine Discharges (including fluids and cuttings)	Formation Flow Testing with Flaring	Wellhead Decommissioning	Geophysical, Geohazard, Wellsite, Seabed, and VSP Surveys	Geological, Geotechnical and Environmental Surveys	Supply and Servicing
Indigenous Communities and Activities							
Change in Health and Socio-Economic Conditions	•	•					•
Change in the Current Use of Lands and Resources for Traditional Purposes	•	•	•	•	•	•	•
Change in Physical and Cultural Heritage and Change in any Structure, Site, or Thing that is of Historical, Archaeological, Paleontological or Architectural Significance	•	•			•	•	•
Commercial Fisheries and Other Ocean Users							
Direct Interference, Resulting in a Change in the Distribution, Intensity and/or Function (Effectiveness /Efficiency) of Commercial Fishing and Other Ocean Uses	•			•	•	•	•

Table 17.1 Potential Project-VC Interactions Summary

Potential Environmental Effects	Project Component / Activity						
	Presence and Operation of Drilling Installation (Including lights, noise, air emissions, anchoring)	**Drilling and Associated Marine Discharges (including fluids and cuttings)**	**Formation Flow Testing with Flaring**	**Wellhead Decommissioning**	**Geophysical, Geohazard, Wellsite, Seabed, and VSP Surveys**	**Geological, Geotechnical and Environmental Surveys**	**Supply and Servicing**
Damage to Fishing Gear, Vessels, and Other Equipment and Components		•		•	•	•	•
Change in the Abundance, Distribution, and Quality of Marine Resources, Resulting in a Change in Distribution, Intensity and/or Function (Effectiveness / Efficiency) of Commercial Fishing and Other Ocean Uses	•	•		•	•	•	•

Table 17.2 Summary of Mitigation and Commitments

No.	Operator Commitment
General*	
1	Adherence to C-NLOPB guidelines (environmental and drilling/production) and compliance with regulations, as applicable.
2	Operator will provide an update of planned activities to fishers and fish processors that will include timing of exploration activities and locations of planned wells. In addition, the Operator will provide an EA update to the C-NLOPB each year that offshore operations are planned. The EA update will provide an overview of planned activities as defined by the scope of the Project, update on recent and on-going engagement activities and their outcomes, and an overview of any new information regarding commercial fishing activities and updates to Species at Risk, if applicable, as well as outlining the proposed work for the coming year and evaluating the continued applicability and validity of the EIS predictions and mitigation measures.
3	A copy of the EA update will be sent to all Indigenous groups and stakeholders identified in Chapter 3 of the EIS. The Operator will follow up with Indigenous groups and stakeholders on any questions arising from the EA update.
4	Use of existing and common travel routes for vessels and helicopters will be used where possible and practicable.
5	Low-level aircraft operations will be avoided where it is not required per Transport Canada protocols.
6	Operational discharges will be treated prior to release in accordance with the OWTG (2016) and other applicable regulations and standards.
7	The selection and screening of chemicals to be discharged, including drilling fluids, will be in accordance with the Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands.
8	During formation flow testing with flaring, produced hydrocarbons and produced water will be flared. If there is a large amount of produced water encountered, it will be treated in accordance with the relevant regulatory requirements prior to ocean discharge, or shipped to shore for appropriate disposal.
9	Appropriate handling, storage, transportation and on-shore disposal of solid and hazardous waste.
10	Spill prevention plans and procedures as required by the C-NLOPB, will be developed and submitted for approval to the C-NLOPB as a requirement of the Operations Authorization and will include, at a minimum, the following: • Training of project personnel in spill prevention and response • Spill Response equipment for containment (e.g., booms) and/or removal • Implementation of measures to deter birds from contacting spilled oil (e.g., bird scaring devices) • Shoreline response measures, if oil is predicted to contact shoreline • Shoreline clean-up measures, if in the event oil contacts shoreline • Measure to be implemented for the rehabilitation and recovery of oiled seabirds • Overview of monitoring that could be conducted in relation to various spill events
Air Emissions	
11	Sulphur content in diesel fuel will meet the *Sulphur in Diesel Fuel Regulations* and will comply wit the sulfur limits in fuels for large marine diesel engines, per the *Vessel Pollution and Dangerous Chemicals Regulations* under the CSA.

Table 17.2 Summary of Mitigation and Commitments

No.	Operator Commitment
12	Adherence with the *Canadian Environmental Protection Act*, the Newfoundland *Air Pollution Control Regulations* for specified criteria air contaminants in exhaust emissions, relevant regulations under MARPOL, and use of the National Ambient Air Quality Objectives as the benchmark for assessing air quality
Marine Fish and Fish Habitat	
13	Prior to the start of a drilling campaign, a pre-drill coral survey will be undertaken (see Section 2.5 of the EIS for details). A report summarizing the coral mapping, risk assessment and planned mitigation measures (if corals are identified) will be prepared and submitted to C-NLOPB/DFO for review and acceptance.
14	Relocation of well and/or redirection of WBM cuttings discharge location in the event that the pre-drill coral survey and risk assessment identifies mitigations required to protect sensitive benthic habitat (i.e. corals and sponges)
15	SBM-related drill cuttings will be returned to the drilling installation and treated in accordance with the OWTG before being discharged to the marine environment. WBM-related drill cuttings will be discharged without treatment.
16	Use of explosives will not be employed for removal of wellheads.
17	At the time of decommissioning a well, the well will be inspected in accordance with applicable regulatory requirements.
Marine and Migratory Birds	
18	The Operator will avoid, where possible, established bird colonies. Helicopters will avoid known coastal seabird colonies per requirements of the NL *Seabird Ecological Reserve Regulations, 2015*
19	During drilling operations, routine observations of seabirds, following the CWS protocols will be undertaken from the drilling installation.
20	Routine searches for stranded birds will be conducted on the platform and supply vessels, and appropriate programs and protocols for the collection and release of marine and migratory birds will be implemented for any birds that become stranded (i.e., "ECCC-CWS's Oiled Birds Protocol and Protocol for Collecting Dead Birds From Platforms. Best Practices for Stranded Birds Encountered Offshore Atlantic Canada (Draft 2)". and Williams and Chardine (n.d): The Leach's Storm Petrel: General Information and Handling Instructions).
21	The Operator will obtain a Seabird Handling permit from ECCC-CWS.
22	Maceration of sewage and kitchen waste, in accordance with the OWTG to 6 mm particle size.
23	Operators are required to notify the C-NLOPB for plans to flare associated with formation flow testing for exploration drilling. The C-NLOPB then consults with ECCCC-CWS to determine a safe timeline to proceed to minimize effects on migrating birds
Marine Mammals and Sea Turtles	
24	Project associated vessel traffic will be approximately eight to ten trips per month for one drilling installation. Use of existing and common travel routes will be used where possible and practical. Vessels will maintain a steady course and safe vessel speed whenever possible.
25	Use of explosives will not be employed for removal of wellheads.
26	As required in the Geophysical, Geological, Environmental and Geotechnical Program Guidelines (C-NLOPB 2017), mitigation measures applied during the Project's geophysical surveys will be consistent with those outlined in the Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment (SOCP) (DFO 2007). The following is a partial list of those mitigation measures.

Table 17.2 Summary of Mitigation and Commitments

No.	Operator Commitment
	• Trained MMOs will be used to monitor and report on marine mammal and sea turtle sightings during VSP and geophysical surveys where seismic source arrays are used. • A ramp-up of the source array (i.e., gradually increasing seismic source elements over a period of at least 20 minutes until the operating level is achieved) starting from a single source element. • MMOs will implement a pre-ramp up watch of 30 minutes prior to the start of the air source. Ramp-up will be delayed if any marine mammal or sea turtle is sighted within the safety zone. • Shut down of the seismic source array if a marine mammal or sea turtle listed as endangered or threatened on SARA Schedule 1.
Indigenous Communities and Activities	
27	The mitigation measures outlined elsewhere in this EIS will serve to avoid or reduce Project-related environmental emissions, disturbances and resulting environmental changes by minimizing reducing the nature, degree, extent and duration of these changes, and therefore, reducing the potential for these to interact with and adversely affect the various components and activities that comprise this VC. A copy of the EA update will be sent to all Indigenous groups and stakeholders identified in Chapter 3 of the EIS. The Operator will follow up with Indigenous groups and stakeholders on any questions arising from the EA update. The Operator will continue to communicate with relevant Indigenous communities and representative organizations, through established and/or informal engagement processes, as required and requested. The specific nature, frequency, subject matter and format of such future engagement will be determined in discussion with the Indigenous organizations and outlined in an Indigenous Communities Fisheries Communication Plan.
Commercial Fisheries and Other Ocean Users	
28	Establishment of a safety zone around drilling installations in accordance with the *Newfoundland Offshore Petroleum Drilling and Production Regulations*.
29	Issuance of Notices to Shipping, Notices to Mariners (where appropriate) regarding planned project activities.
30	Ongoing communications with commercial fishers through One Ocean, FFAW-Unifor and seafood producers regarding planned project activities, including timely communication of drilling locations, safety zone and decommissioned wellsites. This information will also be communicated to Indigenous commercial fishers in accordance with the Indigenous Communities Fisheries Communication Plan.
31	Ongoing communications with the NAFO Secretariat, through DFO as the Canadian representative, regarding planned project activities, including timely communication of drilling locations, safety zone and decommissioned wellsites.
32	In accordance with the One Ocean "Risk Management Matrix Guidelines," the need for a Fisheries Liaison Officer (FLO) and/or fisheries guide vessels during drilling installation movement from port to its offshore location will be determined in consideration of the guidelines. Use of a FLO during geophysical programs will also be determined in consideration of these guidelines.
33	A single point of contact (SPOC) will be established during project activities to facilitate communications between fishers and the operator regarding gear loss//damage and other compensation matters.

Table 17.2 Summary of Mitigation and Commitments

No.	Operator Commitment
34	Develop and implement a compensation program for damages resulting from Project activities. This compensation program will be developed in consideration of C-NLOPB guidelines, including the Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activities (March 2002) and as revised. This program will outline compensation procedures for actual loss or damages to commercial fishers, including Commercial-communal fishers, attributable to the operator resulting from a spill or debris, or expenses incurred in taking remedial action. Actual loss or damage includes loss of income or future income; loss of hunting, fishing, or gathering opportunities; and costs and expenses incurred for action taken to remedy a situation involving a spill, including measure to control or clean a spill.
35	The communication of suspended and/or abandoned wellsite locations to the appropriate authorities for inclusion on nautical charts for use by commercial fishers and other mariners.
36	Contact DFO regarding timing and locations of planned DFO research surveys
37	Contact DND regarding timing of planned offshore military exercises
Effects of the Environment on the Project	
38	Selection criteria for drilling installations where the installation is capable of operating at required water depths and in environmental conditions prevalent in the Northwest Atlantic Ocean.
39	Third party certification – a Certificate of Fitness – of the drilling installation and other facilities, as required to obtain an Operations Authorization issued by the C-NLOPB.
40	Physical environment data observations, weather forecasting, and reporting will be conducted in accordance with the Offshore Physical Environmental Guidelines.
41	Implementation of an Ice Management Plan. Options to be investigated for ice management include: ice detecting radar on drilling installations, use of satellite data to monitor for presence of ice
42	Ability to quick disconnect riser in event of emergency.
*General mitigation measures are applicable to the assessment of potential environmental effects on all identified VCs.	

Table 17.3 Summary of Residual Effects for Planned Project Components and Activities

Valued Component	Area of Federal Jurisdiction (CEAA, 2012 s.5 "environmental effect")	Potential Effect	Project Activity	Mitigation	Residual Effect Characterization						Other Criteria Used to Determine Significance (Ecological / Socio-economic Context)	Significance of Resideual Effect	Likelihood of Significant Effect
					Nature / Direction	Magnitude	Extent	Duration	Frequency	Reversibility			
Marine Fish and Fish Habitat	s. 5(1)(a)(i)	• Change in Habitat Availability and Quality • Change in Fish Presence and Abundance • Change in Fish Mortality, Injury, Health	Presence and Operation of Drilling Installation (Including lights, noise, air emissions, anchoring)	See Table 7.1	A	L	L-PA	S-M	R	R	Ecological / Socioeconomic Context as summarized in Section 8.5 of the EIS	N	N/A
		• Change in Habitat Availability and Quality • Change in Fish Presence and Abundance • Change in Fish Mortality, Injury, Health	Drilling and Associated Marine Discharges (including fluids and cuttings)		A	L	L-PA	M-L	R	R		N	N/A
		• Change in Fish Presence and Abundance • Change in Fish Mortality, Injury, Health	Formation Flow Testing with Flaring		A	L	L	S	S	R		N	N/A
		• Change in Fish Presence and Abundance • Change in Fish Mortality, Injury, Health	Wellhead Decommissioning		A	N-L	L	S	S	R		N	N/A
		• Change in Fish Presence and Abundance • Change in Fish Mortality, Injury, Health	Geophysical, Geohazard, Wellsite, Seabed and Vertical Seismic Profiling Surveys		A	L	PA	S	S	R		N	N/A
		• Change in Habitat Availability and Quality • Change in Fish Presence and Abundance • Change in Fish Mortality, Injury, Health	Geological, Geotechnical, and Environmental Surveys		A	N-L	L	S	S	R		N	N/A
		• Change in Fish Presence and Abundance • Change in Fish Mortality, Injury, Health	Supply and Servicing		A	L	L	S	R	R		N	N/A

Table 17.3 Summary of Residual Effects for Planned Project Components and Activities

Valued Component	Area of Federal Jurisdiction (CEAA, 2012 s.5 "environmental effect")	Potential Effect	Project Activity	Mitigation	Residual Effect Characterization						Other Criteria Used to Determine Significance (Ecological / Socio-economic Context)	Significance of Resideual Effect	Likelihood of Significant Effect
					Nature / Direction	Magnitude	Extent	Duration	Frequency	Reversibility			
Marine and Migratory Birds	s. 5(1)(a)(iii)	• Change in Mortality / Injury Levels and Bird Health • Change in Avifauna Presence and Abundance • Change in Habitat Availability and Quality • Change in Food Availability or Quality	Presence and Operation of Drilling Installation (Including lights, noise, air emissions, anchoring)	See Table 7.1	A	L	L-PA	S-M	R	R	Ecological / Socioeconomic Context as summarized in Section 9.5 of the EIS	N	N/A
		• Change in Mortality / Injury Levels and Bird Health • Change in Food Availability or Quality	Drilling and Associated Marine Discharges (including fluids and cuttings)		A	L	L	S	S	R		N	N/A
		• Change in Mortality / Injury Levels and Bird Health •	Formation Flow Testing with Flaring		A	L	L-PA	S	S	R		N	N/A
		• None expected	Wellhead Decommissioning		N	-	-	-	-	-		N	N/A
		• Change in Mortality / Injury Levels and Bird Health • Change in Avifauna Presence and Abundance • Change in Habitat Availability and Quality	Geophysical, Geohazard, Wellsite, Seabed and Vertical Seismic Profiling Surveys		A	N	L-PA	S	S	R		N	N/A
		• None expected	Geological, Geotechnical, and Environmental Surveys		N	-	-	-	-	-		N	N/A
		• Change in Mortality / Injury Levels and Bird Health • Change in Avifauna Presence and Abundance	Supply and Servicing		A	L	L	S	R	R		N	N/A

Table 17.3 Summary of Residual Effects for Planned Project Components and Activities

Valued Component	Area of Federal Jurisdiction (CEAA, 2012 s.5 "environmental effect")	Potential Effect	Project Activity	Mitigation	Residual Effect Characterization						Other Criteria Used to Determine Significance (Ecological / Socio-economic Context)	Significance of Resideual Effect	Likelihood of Significant Effect
					Nature / Direction	Magnitude	Extent	Duration	Frequency	Reversibility			
Marine Mammals and Sea Turtles	s. 5(1)(a)(ii)	• Change in Mortality or Injury (Underwater Noise) • Change in Habitat Quality or Use • Change in Mortality or Injury (Vessel Strike) • Change in Food Availability or Quality	Presence and Operation of Drilling Installation (Including lights, noise, air emissions, anchoring)	See Table 7.1	A	L-M	PA-LSA	S-M	R	R	Ecological / Socioeconomic Context as summarized in Section 10.4 of the EIS	N	N/A
		• Change in Habitat Quality or Use • Change in Mortality or Injury (Vessel Strike) • Change in Food Availability or Quality • Change in Health (Contaminants)	Drilling and Associated Marine Discharges (including fluids and cuttings)		A	L	L-PA	S	R	R		N	N/A
		• Change in Habitat Quality or Use • Change in Mortality or Injury (Vessel Strike) • Change in Food Availability or Quality	Formation Flow Testing with Flaring		A	N-L	L-PA	S	S	R		N	N/A
		• Change in Habitat Quality or Use • Change in Mortality or Injury (Underwater Noise) • Change in Mortality or Injury (Vessel Strike) • Change in Food Availability or Quality	Wellhead Decommissioning		A	N-L	L-PA	S	S	R		N	N/A
		• Change in Mortality or Injury (Underwater Noise)) • Change in Habitat Quality or Use • Change in Mortality or Injury (Vessel Strike) • Change in Food Availability or Quality	Geophysical, Geohazard, Wellsite, Seabed and Vertical Seismic Profiling Surveys		A	N-L	L-LSA	S-M	S	R		N	N/A

Table 17.3 Summary of Residual Effects for Planned Project Components and Activities

Valued Component	Area of Federal Jurisdiction (CEAA, 2012 s.5 "environmental effect")	Potential Effect	Project Activity	Mitigation	Residual Effect Characterization						Other Criteria Used to Determine Significance (Ecological / Socio-economic Context)	Significance of Resideual Effect	Likelihood of Significant Effect
					Nature / Direction	Magnitude	Extent	Duration	Frequency	Reversibility			
Marine Mammals and Sea Turtles	s. 5(1)(a)(ii)	• Change in Habitat Quality or Use • Change in Mortality or Injury (Vessel Strike) • Change in Food Availability or Quality	Geological, Geotechnical, and Environmental Surveys	See Table 7.1	A	N	L-PA	S	S	R	Ecological / Socioeconomic Context as summarized in Section 10.4 of the EIS	N	N/A
		• Change in Habitat Quality or Use • Change in Mortality or Injury (Vessel Strike) • Change in Food Availability or Quality	Supply and Servicing		A	L	L-LSA	S	R	R		N	N/A
Special Areas	s. 5(1)(b)(i)	• Possible direct interactions with special areas • Possible effects through associated changes to the biophysical environment • Possible interactions (interference or disturbances) with other human activities	Presence and Operation of Drilling Installation (Including lights, noise, air emissions, anchoring)	See Table 7.1	A	N-L	L-PA	S-M	R	R	Ecological / Socioeconomic Context as summarized in Section 11.4 of the EIS	N	N/A
			Drilling and Associated Marine Discharges (including fluids and cuttings)		A	N-L	L-PA	S-M	R	R		N	N/A
			Formation Flow Testing with Flaring		N	-	-	-	-	-		N	N/A
			Wellhead Decommissioning		A	N-L	L	S	S	R		N	N/A
			Geophysical, Geohazard, Wellsite, Seabed and Vertical Seismic Profiling Surveys		A	N-L	L-PA	S	S	R		N	N/A
			Geological, Geotechnical and Environmental Surveys		N	-	-	-	-	-		N	N/A
			Supply and Servicing		N	-	-	-	-	-		N	N/A

Table 17.3 Summary of Residual Effects for Planned Project Components and Activities

Valued Component	Area of Federal Jurisdiction (CEAA, 2012 s.5 "environmental effect")	Potential Effect	Project Activity	Mitigation	Residual Effect Characterization						Other Criteria Used to Determine Significance (Ecological / Socio-economic Context)	Significance of Resideual Effect	Likelihood of Significant Effect
					Nature / Direction	Magnitude	Extent	Duration	Frequency	Reversibility			
Indigenous Communities and Activities	s.5(1)(c)(i) s.5(1)(c)(iii)	• Possible direct interactions (interference or disturbances) with Indigenous communities and their activities Possible effects through associated changes to the biophysical environment (health, resource availability or quality, physical structure, site, or thing))	Presence and Operation of Drilling Installation	See Table 7.1	N	-	-	-	-	-	Ecological / Socioeconomic Context as summarized in Section 12.4 of the EIS	N	N/A
		• As above	Drilling and Associated Marine Discharges		N	-	-	-	-	-		N	N/A
		• As above	Formation Flow Testing with Flaring		N	-	-	-	-	-		N	N/A
		• As above	Wellhead Decommissioning		N	-	-	-	-	-		N	N/A
		• As above	Geophysical, Geohazard, Wellsite, Seabed and Vertical Seismic Profiling Surveys		N	-	-	-	-	-		N	N/A
		• As above	Geological, Geotechnical and Environmental Surveys		N	-	-	-	-	-		N	N/A
		• As above	Supply and Servicing		N	-	-	-	-	-		N	N/A

Table 17.3 Summary of Residual Effects for Planned Project Components and Activities

Valued Component	Area of Federal Jurisdiction (CEAA, 2012 s.5 "environmental effect")	Potential Effect	Project Activity	Mitigation	Residual Effect Characterization						Other Criteria Used to Determine Significance (Ecological / Socio-economic Context)	Significance of Resideual Effect	Likelihood of Significant Effect
					Nature / Direction	Magnitude	Extent	Duration	Frequency	Reversibility			
Commercial Fisheries and Other Ocean Users	s. 5(2)(b)(i)	• Direct Interference, Resulting in a Change in the Distribution, Intensity, and/or Function of Commercial Fishing and Other Ocean Uses • Damage to Fishing Gear, Vessels, and other Equipment and Components • Change in Abundance, Location, and Quality of Marine Resources	Presence and Operation of Drilling Installation	See Table 7.1	A	L	L	S	C	R	Ecological / Socioeconomic Context as summarized in Section 13.4 of the EIS	N	N/A
		• As above	Drilling and Associated Marine Discharges		A	L	L	S	R	R		N	N/A
		• None expected	Formation Flow Testing with Flaring		N	-	-	-	-	-		N	N/A
		• Direct Interference • Damage to Fishing Gear, Vessels, and Equipment	Wellhead Decommissioning		A	L	L	L	C	R		N	N/A
		• Direct Interference • Damage to Fishing Gear, Vessels, and Equipment • Change in Abundance, Location, and Quality of Marine Resources	Geophysical, Geohazard, Wellsite, Seabed and Vertical Seismic Profiling Surveys		A	L	L	S	S	R		N	N/A
		• Direct Interference • Damage to Fishing Gear, Vessels, and Equipment • Change in Aabundance, Location, and Quality of Marine Resources	Geological, Geotechnical and Environmental Surveys		A	L	L	S	S	R		N	N/A
		• Direct Interference • Damage to Fishing Gear, Vessels, and Equipment • Change in Abundance, Location, and Quality of Marine Resources	Supply and Servicing		A	L	L	S	R	R		N	N/A

Table 17.3 Summary of Residual Effects for Planned Project Components and Activities

Valued Component	Area of Federal Jurisdiction (CEAA, 2012 s.5 "environmental effect")	Potential Effect	Project Activity	Mitigation	Residual Effect Characterization						Other Criteria Used to Determine Significance (Ecological / Socio-economic Context)	Significance of Resideual Effect	Likelihood of Significant Effect
					Nature / Direction	Magnitude	Extent	Duration	Frequency	Reversibility			
Key/Note: **Environmental Effects under CEAA, 2012:** 5(1) (a) a change that may be caused to the following components of the environment that are within the legislative authority of Parliament: (i) fish as defined in Section 2 of the *Fisheries Act* and fish habitat as defined in subsection 34(1) of that Act, (ii) aquatic species as defined in subsection 2(1) of the *Species at Risk Act*, (iii) migratory birds as defined in subsection 2(1) of the *Migratory Birds Convention Act*, 1994, and (iv) any other component of the environment that is set out in Schedule 2 of [CEAA, 2012]; (b) a change that may be caused to the environment that would occur (i) on federal lands, (ii) in a province other than the one in which the act or thing is done or where the physical activity, the designated project or the project is being carried out, or (iii) outside Canada; and (c) with respect to Aboriginal peoples, an effect occurring in Canada of any change that may be caused to the environment on (i) health and socioeconomic conditions, (ii) physical and cultural heritage, (iii) the current use of lands and resources for traditional purposes, or (iv) any structure, site or thing that is of historical, archaeological, paleontological or architectural significance. Certain additional environmental effects must be considered under Section 5(2) of CEAA, 2012 where the carrying out of the physical activity, the designated project, or the project requires a federal authority to exercise a power or perform a duty or function conferred on it under any Act of Parliament other than CEAA, 2012. 5(2) (a) a change, other than those referred to in paragraphs (1)(a) and (b), that may be caused to the environment and that is directly linked or necessarily incidental to a federal authority's exercise of a power or performance of a duty or function that would permit the carrying out, in whole or in part, of the physical activity, the designated project or the project; and (b) an effect, other than those referred to in paragraph (1)(c), of any change referred to in paragraph (a) on (i) health and socioeconomic conditions, (ii) physical and cultural heritage, or (iii) any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.					Nature / Direction: A – Adverse P – Positive N – Neutral (or no effect) - = Rating not required because the effect is not expected to occur	Magnitude: N - Negligible L - Low M - Medium H – High - = Rating not required because the effect is not expected to occur or because the effect is neutral	Extent: L - Localized PA - Within Project Area LSA -Within LSA RSA -Within RSA or Beyond - = Rating not required because the effect is not expected to occur or because the effect is neutral	Duration: S - Short term (for duration of the activity, or for duration of accidental event) M - Medium term (beyond duration of activity, or for duration of threshold exceedance of accidental event – weeks or months) L - Long term (beyond duration of activity, or beyond the duration of threshold exceedance for accidental event – years) P – Permanent (recovery unlikely) - = Rating not required because the effect is not expected to occur or because the effect is neutral	Frequency: N - Not likely to occur O - Occurs once S - Occurs sporadically R - Occurs on a regular basis C - Occurs continuously - = Rating not required because the effect is not expected to occur or because the effect is neutral	Reversibility: R – Reversible (will recover to baseline) I – Irreversible (permanent) - = Rating not required because the effect is not expected to occur or because the effect is neutral		N: Not significant S: Significant Likelihood: N/A: Not Applicable L: Low M – Moderate H – High	

Table 17.4 Summary of Residual Effects for Accidental Events

Valued Component	Area of Federal Jurisdiction (CEAA, 2012 s.5 "environmental effect")	Potential Effect	Project Activity	Mitigation	Residual Effect Characterization						Significance of Residual Effect	Likelihood of Significant Effect
					Nature / Direction	Magnitude	Extent	Duration	Frequency	Reversibility		
Marine Fish and Fish Habitat	s. 5(1)(a)(i)	• Change in Habitat Availability and Quality • Change in Fish Mortality, Injury, Health • Change in Fish Presence and Abundance	100 litre Diesel Spill	See Table 7.1	A	L	PA	S	S	R	N	N/A
			1,000 litre Diesel Spill		A	L-M	PA	M	N	R	N	N/A
			Subsurface Blowout – Northern Flemish Pass Site		A	M	RSA	M-L	N	R	N	N/A
			Subsurface Blowout – Eastern Flemish Pass Site		A	M	RSA	M-L	N	R	N	N/A
Marine and Migratory Birds	s. 5(1)(a)(iii)	• Change in Mortality / Injury Levels and Bird Health • Change in Avifauna Presence and Abundance • Change in Habitat Availability and Quality • Change in Food Availability or Quality	100 litre Diesel Spill	See Table 7.1	A	L	PA	S	S	R	N	N/A
			1,000 litre Diesel Spill		A	M	PA	M	N	R	N	N/A
			Subsurface Blowout – Northern Flemish Pass Site		A	M-H	RSA	M-L	N	R	S	L
			Subsurface Blowout - Eastern Flemish Pass Site		A	M-H	RSA	M-L	N	R	S	L
Marine Mammals and Sea Turtles	s. 5(1)(a)(ii)	• Change in Mortality or Injury • Change in Health • Change in Habitat Quality or Use	100 litre Diesel Spill	See Table 7.1	A	L	PA	S	S	R	N	N/A
			1,000 litre Diesel Spill		A	L	PA	S	N	R	N	N/A
			Subsurface Blowout – Northern Flemish Pass Site		A	L-M	RSA	M-L	N	R	N	N/A
			Subsurface Blowout – Eastern Flemish Pass Site		A	L-M	RSA	M-L	N	R	N	N/A
Special Areas	s. 5(1)(b)(i)	• Change in Environmental Features and/or Processes • Change in Human Use and /or Societal Value	100 Litre Diesel Spill	See Table 7.1	A	L	PA	S	S	R	N	N/A
			1,000 Litre Diesel Spill		A	L-M	PA	M	N	R	N	N/A
			Subsurface Blowout – Northern Flemish Pass Site		A	M	RSA	M-L	N	R	N	N/A
			Subsurface Blowout – Eastern Flemish Pass Site		A	M	RSA	M-L	N	R	N	N/A

Table 17.4 Summary of Residual Effects for Accidental Events

Valued Component	Area of Federal Jurisdiction (CEAA, 2012 s.5 "environmental effect")	Potential Effect	Project Activity	Mitigation	Residual Effect Characterization						Significance of Residual Effect	Likelihood of Significant Effect
					Nature / Direction	Magnitude	Extent	Duration	Frequency	Reversibility		
Indigenous Communities and Activities	s.5(1)(c)(i) s.5(1)(c)(iii)	• Change in health and socioeconomic conditions • Change in the current use of lands and resources for traditional purposes • Change in physical and cultural heritage • Change in any structure, site, or thing that is of historical, archaeological, paleontological or architectural significance	100 litre Diesel Spill	See Table 7.1	N	-	-	-	-	-	N	N/A
			1,000 litre Diesel Spill		N	-	-	-	-	-	N	N/A
			Subsurface Blowout – Northern Flemish Pass Site		A	N-L	RSA	M-L	N	R	N	N/A
			Subsurface Blowout – Eastern Flemish Pass Site		A	N-L	RSA	M-L	N	R	N	N/A
Commercial Fisheries and Other Ocean Users	s. 5(2)(b)(i)	• Direct Interference, Resulting in a Change in the Distribution, Intensity, or Function of Commercial Fishing and Other Ocean Uses • Damage to Fishing Gear, Vessels, and Other Equipment and Components • Change in the Abundance, Distribution and Quality of Marine Resources	100 L Diesel Spill	See Table 7.1	A	L	PA	S	S	R	N	N/A
			1,000 L Diesel Spill		A	L	PA	M	N	R	N	N/A
			Subsurface Blowout – Northern Flemish Pass Site		A	L	RSA	M-L	N	R	N	N/A
			Subsurface Blowout – Eastern Flemish Pass Site		A	L	RSA	M-L	N	R	N	N/A

17.4 Follow-Up and Monitoring

The Operator will obtain the required permits, approvals, and authorizations for the Project, and the Operator and its contractors will comply with these and relevant regulations and guidelines in planning and implementing the Project. This includes the mitigation measures summarized in the preceding sections, the implementation of which will be directed, managed, and tracked in accordance with the Operator's existing policies and procedures.

17.4.1 Follow-up Programs

Under CEAA 2012, a follow-up program is defined as a program for "verifying the accuracy of the environmental assessment of a designated project" and "determining the effectiveness of mitigation measures". In determining whether a follow-up program is required the following factors should be considered:

- Whether the project will impact environmentally sensitive areas / VCs or protected areas or areas under consideration for protection
- The nature of Indigenous and public concerns raised about the project
- The accuracy of predictions
- Whether there is a question about the effectiveness of mitigation measures or the proponent proposes to use new or unproven techniques and technology
- The nature of cumulative environmental effect
- The nature, scale, and complexity of the program
- Whether there was limited scientific knowledge about the effects in the EA

Based on the information presented in the EIS, and the conclusion of the effects assessment, a follow-up program will be undertaken in consideration of sensitive benthic habitat. Follow-up monitoring will occur if drilling is undertaken in the following circumstances:

1) Within an identified VME or FCA
2) Adjacent / near to an identified VME or FCA, such that drill cuttings dispersion model predicts that drill cuttings deposition may occur within the VME or FCA at levels above the biological effects threshold, or
3) In an area where the results of the pre-drill coral survey and risk assessment (DFO/C-NLOPB reviewed and accepted) indicate that monitoring is required

The purpose of the follow-up monitoring program would be to determine the effectiveness of mitigation measures in protecting the sensitive benthic habitat. The monitoring program may include parameters such as:

- Sediment traps and/or seabed core samples to measure drill cuttings deposition
- Current and turbidity measurements
- Visual assessments using high-definition images / video

Detailed design of a follow-up monitoring program would be based on the pre-drill coral survey, potential zone of influence as estimated in the drill cuttings dispersions modelling, location of the well in proximity to the sensitive benthic habitat, other site-specific information collected during planning, and industry experience in conducting similar monitoring programs (e.g. Norwegian Continental Shelf

experience). If exploration wells are planned to be drilled under the circumstances identified above, a follow-up monitoring program plan will be developed and submitted for C-NLOPB/DFO review and acceptance at least 60 days prior to drilling.

The effects of exploration drilling activities are well understood, and mitigation measures are effective, allowing for a high level of confidence in the environmental effects predictions. Therefore, follow-up monitoring is not proposed for other VCs, including SAR.

Results of indigenous and stakeholder engagement to date have not identified concerns that could be addressed by follow-up monitoring.

17.4.2 Environmental Monitoring and Observations

As indicated in the relevant sections of the EIS, the Operator undertakes visual observation programs regarding presence of marine and migratory birds, and marine mammals and sea turtles. In particular, during a geophysical survey, involving an air source array, visual monitoring for marine mammals will be undertaken based on the protocols outlined in the SOCP and the ESRF marine mammal monitoring protocol. Data from these observation programs will be provided to the C-NLOPB no later than six months after termination of the fieldwork.

In the case of marine and migratory birds, routine seabird observations will be undertaken from the drilling installation, following CWS seabird observation protocols from fixed platforms. In addition, regular inspections of the decks of the drilling installation will be undertaken to look for stranded and/or oiled seabirds. As stated previously, if stranded wildlife are encountered they will be handled and released in accordance with ECCC-CWS protocols (see Section 9.3.2). All observation and stranded seabird data will be submitted to ECCC-CWS within 12 months of completion of the drilling campaign.

Environmental compliance monitoring programs refers to activities used to ensure compliance with regulatory requirements. Compliance monitoring is to assure the regulator and the public that environmental regulations and requirements are being followed. Requirements for compliance monitoring are outlined in the OWTG and the Environmental Protection Plan Guidelines (NEB et al. 2011). The Operator's EPCMP details the environmental compliance monitoring plans, procedures, and reporting requirements that the Operator will follow. Some of these monitoring requirements are outlined in Section 2.11. The EPCMP must be reviewed and accepted by the C-NLOPB in order to obtain an Operations Authorization. Operations Authorization applications for drilling programs are normally submitted at least 4 months in advance of drilling programs but this time frame can vary depending on the Drilling Installation and specific circumstances.

In addition to reporting requirments outlined in the Operator's own plans and procedures, the Operator will be responsible for reporting to the C-NLOPB in accordance with the Drilling and Production Regulations and Data Acquisition and Reporting Guidelines. The Drilling and Production Guidelines (C-NLOPB and CNSOPB 2017) and Data Acquisition and Reporting Guidelines (C-NLOPB 2011) describe the operational testing, measurement, monitoring, and reporting requirements to be conducted during an exploratory well drilling program. These are primarily related to engineering and technical aspects of the operations. Incidents will be reported in accordance with the Incident Reporting and Investigation Guidelines (C-NLOPB and CNSOPB 2012).

In the event of a spill, an environmental effects monitoring program may be required, depending on the magnitude of the spill. This monitoring program will be developed in consultation with the C-NLOPB and other relevant regulatory authorities.

A summary of follow-up and compliance monitoring and observational programs is provided in Table 17.5.

17.4.3 Adaptive Management Measures

As part of the EIS, the Operator has also identified and committed to a number of measures and processes to avoid or reduce the potential for adverse interactions with, and effects upon, fisheries and other marine activities and users in the region. These include on-going communication and cooperation mechanisms throughout the operational life of this Project, which are intended to allow for continued discussion of Project related activities and issues as they may arise during Project implementation, as well as to cooperatively and collaboratively plan and implement adaptive management measures throughout the life of the Project.

In years when exploration activities are planned, the Operator will provide an annual update of planned activities to fishers and fish processors that will include timing of exploration activities and locations of planned wells. In addition, the Operator will provide an EA update to the C-NLOPB. The EA update will provide an overview of planned activities as defined by the scope of the Project, update on recent and on-going engagement activities and their outcomes, an overview of any new information regarding commercial fishing activities, updates to Species at Risk, if applicable evaluate the continued applicability and validity of the EIS predictions and mitigation measures. A copy of this EA update will be sent to all Indigenous groups and stakeholders identified in Chapter 3. The Operator will follow up with Indigenous groups and stakeholders on any questions arising from the EA update.

In addition, to the EA Update process, the Operator will continue to communicate with relevant Indigenous groups and representative organizations, through established and/or informal engagement processes, as required and requested. The specific nature, frequency, subject matter and format of such future engagement will be determined in discussion with the Indigenous organizations and outlined in an Indigenous Communities Fisheries Communication Plan.

Table 17.5 Summary of Monitoring Programs for Routine Project Activities

Proposed Monitoring Program	Program Overview	Applicable VC(s)	Proposed Intervention / Adaptive Management	Schedule	Reporting
Benthic Sedimentation Monitoring in VMEs / FCAs and / or Other Sensitive Benthic Habitat	Site specific monitoring program to be developed based on results of coral mapping and risk assessment. Monitoring program to be reviewed and accepted by C-NLOPB / DFO. May include: • sediment traps and/or seabed core samples to measure drill cuttings deposition • current and turbidity measurements • visual assessments using high-definition images / video	Marine Fish and Fish Habitat	Survey is for data gathering purposes. Coral mapping, risk assessment, and mitigation processes may be improved based on the results and learnings.	Drilling and Post-Drilling	A monitoring report will be provided to the C-NLOPB / DFO within 12 months of completing the monitoring program
Migratory Bird Observations	Operational program including: • A trained Environmental Observer will be onboard to record marine bird (and marine mammals) sightings during Project operations, which will be undertaken in accordance with CWS's monitoring protocol from fixed platforms • Regular searches of vessel decks will be undertaken and accepted protocols for the collection / handling of bird mortalities and release of birds that become stranded	Migratory and Marine Birds	Survey is for data gathering purposes.	Mobilization to well decommissioning	If a Species at Risk is found alive (stranded) or dead on the drilling installation or survey vessel, a report will be sent to CWS for identification. Seabird observations report will be submitted to the C-NLOPB within 90 days of well suspension and/or decommissioning An annual report summarizing stranded and/or seabird handling will be submitted to the CWS in accordance with the Seabird Handling permit requirements.

Table 17.5 Summary of Monitoring Programs for Routine Project Activities

Proposed Monitoring Program	Program Overview	Applicable VC(s)	Proposed Intervention / Adaptive Management	Schedule	Reporting
Marine Mammal and Sea Turtle Observations	Operational program for marine mammals during geophysical surveys where sound source is used, including VSP • A trained MMO will be onboard to record marine mammal and sea turtle sightings during Project operations • A marine mammal and sea turtle monitoring plan will be submitted to the applicable regulators for review at least 30 days prior to the commencement of the first geophysical survey • Visual monitoring for the presence of marine mammals and sea turtles within a pre-determined exclusion zone will take place during geophysical operations where an air source array is used • Observational / shutdown procedures will follow the SOCP	Marine Mammals and Sea Turtles	Survey is for data gathering purposes and reducing potential interactions	Geophysical surveys with use of sound source, VSP Surveys; as required	A report of the observational program will be submitted annually to the C-NLOPB and DFO, including documentation of marine mammal and sea turtle sightings. Vessel strikes involving marine mammals or sea turtles will be reported to DFO within 24 hours.

Table 17.5 Summary of Monitoring Programs for Routine Project Activities

Proposed Monitoring Program	Program Overview	Applicable VC(s)	Proposed Intervention / Adaptive Management	Schedule	Reporting
Environmental Compliance Monitoring	Environmental compliance monitoring is a requirement of the *Drilling and Production Regulations*. Monitoring of volumes and hydrocarbon concentration for the following treated effluents is completed in accordance with regulatory requirements: • Bilge and ballast water • Deck drainage • Drill cuttings	All			Monthly compliance monitoring report submitted to C-NLOPB during drilling operations. Final compliance monitoring report submitted to C-NLOPB within 90 days of completion of drilling activities.

Buidling on the experience in the Norweigian Continental Shelf, the Operator proposes to use the NOROG guideline approach to pre-drilling coral identification / mapping and risk assessment, as it is considered an industry best practice approach in areas with potentially high concentrations of corals (e.g., VME or FCAs within the Project Area). This approach will be adapated for application in the Canada-NL Offshore Area. It is recognized that details of the coral survey, risk assessment, mitigation requirements and follow-up monitoring program may be refined and improved over time by the Operator, C-NLOPB / DFO as technology develops, operational experience offshore Newfoundland is gained, scientific research is published, and further data are collected in the area. The Operator will collaborate with C-NLOPB / DFO to adapt and improve these processes and plans over time as appropriate.

17.5 Summary of Predicted Environmental Changes and Effects and Their Relationship to Federal Jurisdiction and Decisions

In keeping with the requirements of Sections 5(1) and 5(2) of CEAA 2012, the EIS assesses and evaluates the potential environmental changes and resulting environmental effects that may result from the Project, including:

(a) *Changes that may be caused to components of the environment that are within federal government jurisdiction (CEAA 2012, Section 5(1)(a)*
(b) *Changes that may be caused to the environment that would occur on federal lands, in another province, or outside Canada (CEAA 2012, Section 5(1)(b)*
(c) *Changes that may be caused to the environment and that are directly linked or necessarily incidental to a federal decision (CEAA 2012, Section 5(2))*

This section of the EIS Summary provides an overview of these factors, in order to address the following requirements of the EIS Guidelines (Part 2, Section 6.2):

- The EIS will include stand-alone sections that summarize those changes that may be caused by the project on the components of the environment listed in paragraph 5(1)(a) of CEAA 2012, namely fish and fish habitat, aquatic species and migratory birds.
- The EIS will include a stand-alone section that summarizes any change the project may cause to the environment that may occur on federal lands or lands outside the province in which the project is to be located (including outside of Canada).
- In situations where the project requires one or more federal decisions identified in section 5(2), the EIS will also include a stand-alone section that describes any change that may be caused by the project on the environment that is directly linked or necessarily incidental to these decisions (e.g. changes to commercial fishing).

Each of these factors are addressed in a comprehensive and fully integrated manner as part of the environmental effects assessment presented in the EIS. Therefore, and rather than repeat the detailed information and analysis provided throughout the document, the sections below provide a brief identification of the various environmental components, changes and effects that relate to each of these factors and requirements, and an indication of where and how these have been addressed.

The EIS Guidelines (Section 6.1.9) also state that "should there be the potential for a change to the environment arising as a result of a federal decision(s), or on federal lands, lands in another province or lands outside Canada, the EIS will include baseline information on the environmental component likely to be affected (if this information is not already covered in other subsections of these guidelines)." As noted in the definition of the RSAs and in the existing environment descriptions in Chapters 5-8, these sections of the EIS provide environmental baseline information for the identified VCs and the potential effects of the Project on them throughout their geographic extents. Finally, Section 6.3.8 of the EIS Guidelines require that if there is the potential for a change to the environment arising as a result of a federal decision and/or occurring within or outside areas of federal jurisdiction, the EIS should include a description of the specific project components involved and an assessment of any other VCs (not already covered in other subsections) that may be affected. Again, these items and requirements are considered addressed as relevant in a fully integrated and comprehensive manner as part of the scope of the Project assessed herein, and as part of the VCs identified and focused on in the environmental effects assessments presented in the EIS.

17.5.1 Changes to Environmental Components with Federal Jurisdiction

Section 5(1) of CEAA 2012 states that the environmental effects that are to be taken into account in relation to a designated project include:

> *(a) a change that may be caused to the following components of the environment that are within the legislative authority of Parliament:*
>
> *(i) fish and fish habitat as defined in subsection 2(1) of the Fisheries Act,*
> *(ii) aquatic species as defined in subsection 2(1) of the Species at Risk Act,*
> *(iii) migratory birds as defined in subsection 2(1) of the Migratory Birds Convention Act, 1994*

As described in Chapter 8, offshore exploration drilling and associated activities may affect Marine Fish and Fish Habitat in a number of ways, including possible injury, mortality, or behavioral effects due to noise or other disturbances in the marine environment, effects to benthic communities through the alteration of marine habitats, and change in habitat quality from discharges or accidental events. The Project will interact with fish and their habitats within the LSA, although as described in Chapter 8 it will entail a relatively minor, localized and short-term environmental disturbance at any one location. Marine discharges will be treated prior to release in accordance with regulatory requirements, reducing associated potential effects on the environment. Modelling of released drilling muds and cuttings has also indicated that they would be highly dispersed into the environment, causing low sedimentation reducing the potential for smothering effects on benthic species. To further reduce the potential for effects on sensitive benthic habitats (corals), pre-drill coral surveys will be carried out and appropriate setbacks applied where these species are observed within the immediate vicinity of a planned well site. Acoustic noise from VSP will largely be directed into the well, resulting in reduced area of potential effect over a short period. Furthermore, employed mitigation measures, including gradual ramp-up of air-guns, promote temporary avoidance of the area by mobile species while operations are ongoing and will help to reduce exposure to species. Other planned Project activities likewise represent localized and short-term activities and associated environmental disturbances, which are addressed through standard mitigation measures and which

are not anticipated to adversely affect this VC. With the implementation of the various mitigation measures outlined in this EIS, the Project will not result in significant adverse effects to marine fish and fish habitat.

Potential interactions with, and effects on, Marine and Migratory Birds as a result of the Project relate primarily to possible attraction and/or disorientation of the birds around the drilling installation and vessels due to artificial light sources, as well as possible effects from noise and possible waste discharges. As described in the environmental effects assessment for this VC (Chapter 9), the planned activities associated with this Project will operate for a short period of time in any one location, resulting in a short-term disturbance within a relatively limited zone of influence. Platform attraction associated with lighting and increased foraging opportunities may lead to some increased potential for mortality or injury, particularly in the spring and fall migration periods and during specific meteorological conditions such as fog or inclement weather; however, these conditions and potential effects will be short-term in duration. Discharges from the drilling installation and vessels may interact with birds both directly and indirectly, particularly in the winter months when thermoregulatory stress is highest. These discharges will be managed through adherence to relevant regulations and guidelines. Vessel and aircraft traffic in nearshore environments may also have potential interactions due to disturbance effects, but they will be reduced through adherence to common traffic routes and avoidance of known bird colonies. Because such effects are anticipated to minor, and spatially and temporally limited, and given the typically wide variation in marine bird presence and distribution in space and time throughout this large offshore area, the number of individuals affected by the Project is not expected to have population-level effects. With the implementation of the mitigation measures outlined earlier, the Project will not result in significant adverse environmental effects on marine and migratory birds.

As discussed in Chapter 10, potential interactions with, and effects on, Marine Mammals and Sea Turtles as a result of the Project relate to possible injury or disturbance from the movement, noise, lights, and possible waste materials associated with the drilling installations and other related vessel and aircraft traffic. The primary pathways for potential residual effects on marine mammals are those associated with increases in underwater noise and vessel traffic that may result in change in mortality or injury or change in habitat quality or use (behavioral effects). Other potential pathways include change in food availability or quality (effects on prey) or change in health (contaminants). Mitigation measures that will be applied across a number of Project components and activities and that are designed to prevent or reduce potential interactions with and effects on marine mammals and sea turtles are as summarized earlier in this chapter. With the application of these mitigation measures, potential for Project-VC interactions is thus likely to be highly transient and temporary for individual marine mammals or sea turtles, especially in consideration of anticipated large-scale daily and seasonal fluctuations in presence within the assessment areas and the alternate habitats available throughout the RSA. The Project will therefore not result in significant adverse environmental effects on this VC.

An accidental event such as a large-scale oil spill would have adverse effects on each of the environmental components discussed above, which would vary between VCs and would depend on the specific nature and magnitude of the event and its duration and geographic extent. While for most VCs such an accidental event would not likely to result in significant adverse environmental effects

according to the significance definitions developed and used in this EIS, others such as marine and migratory birds could conceivably see significant effects depending on the amount of oil spilled, time of year, types and numbers or birds present at that time in the affected area, and other factors. As described in Chapter 15, a variety of oil spill prevention and response measures have been identified and are committed to in this EIS, which will help prevent such an accidental event from occurring, as well as responding to one in the unlikely event that it did, thereby reducing the potential magnitude, extent and duration of its potential effects. With the implementation of these mitigation measures, the Project is not likely to result in significant environmental effects on the above listed environmental components within federal jurisdiction (including both stable species and species at risk).

17.5.2 Changes to the Environment that Would Occur on Federal Lands, in Another Province, or Outside Canada

Section 5(1)(b) of CEAA 2012 states that the environmental effects that are to be taken into account in relation to a designated project include: (b) Changes that may be caused to the environment that would occur on federal lands, in another province, or outside Canada.

As described in Section 1.3 of the EIS, Project activities are planned to take place within the offshore marine environment, which are considered "federal lands" under CEAA 2012. CEAA 2012 specifically defines "federal lands" as including "(i) the internal waters of Canada, in an area of the sea not within a province, (ii) the territorial sea of Canada, in an area of the sea not within a province, (iii) the exclusive economic zone of Canada, and (iv) the continental shelf of Canada.".

A number of regulatory regimes have jurisdiction over various components of the environment within and adjacent to the Project Area, LSAs and RSAs. For marine fish and fish habitat, for example, the Government of Canada manages fish stocks within the 200-mile EEZ and sedentary species occurring on the extended continental shelf. In these areas, the federal Fisheries Act (2012) provides protection to commercial, recreational, and Aboriginal fisheries by managing the fish resources and habitats that support these activities. Groundfish outside the EEZ and the benthic organisms beyond the extended continental shelf are managed by NAFO. In addition, in the case of the special areas VC, the Project Area / LSA and RSA overlap with areas that have been designated as protected or otherwise special by provincial, federal and international organizations and processes. In the case of the latter item, this includes a number of NAFO FCAs and VMEs off Eastern Newfoundland. In addition, commercial fisheries are undertaken by a number of foreign countries in the Project Area and larger LSAs and RSAs, which includes fisheries and resources that are managed by NAFO.

Planned and routine Project activities that take place within the area of Canada's jurisdiction are not anticipated to result in environmental changes and direct interactions that will extend to the environment outside Newfoundland and Labrador or outside the marine waters under the jurisdiction of Canada. Although the direct environmental zone of influence of the Project components and activities that occur within the area of Canada's jurisdiction are not expected to extend to other jurisdictions, the Project may, however, affect environmental components (such as migratory fish, aquatic species, or birds) that extend to and/or move both within and outside the areas under the jurisdiction of Canada, as described in detail in Chapters 6 and 8-11. In addition, Project activities or disturbances that will or may interact with areas of international jurisdiction (such as NAFO designated special areas or in locations where internationally managed fishing or other marine

activities are taking place), has the potential to affect these environmental components. As the Project and its associated activities and resulting environmental interactions are not planned to occur on-land or otherwise in proximity to Indian Reserves or Treaty lands, it will not affect these areas of jurisdiction.

As illustrated throughout the EIS and summarized above, however, the Project is not likely to have significant adverse environmental effects on these environmental components. The preceding section provided a summary of the effects assessment for each of the identified environmental components that come under federal jurisdiction, namely marine fish and fish habitat, marine and migratory birds, and marine mammals and sea turtles. The predicted effects on the other VCs are summarized here.

In terms of the Special Areas VC, many of the identified special areas in Eastern Newfoundland are in nearshore and onshore areas and therefore would not have direct interaction with the Project-related activities. These include provincial (ecological reserves, parks and protected areas and historic sites), national (MPAs, fisheries closures within the EEZ, MBSs, parks and historic sites) and international (IBAs and WHSs) designations, none of which will be directly affected by the Project. Several of the special areas off Eastern Newfoundland or portions of them overlap with the Project Area (Northern and/or Southern Sections) and potential vessel and aircraft traffic routes including several EBSAs, VMEs and NAFO FCAs. Four of the ELs that may be drilled as part of this Project overlap with portions of these types of Special Areas, and there are no prohibitions of the types of activities being planned as part of this Project. Given the overall nature of the planned Project activities, the overall and defining physical, biological, and socioeconomic environments within these areas will not be adversely affected by the Project. Many of the offshore activities and associated disturbances that will occur as a result of this Project will be relatively localized and of a short-term nature at a given location, and the implementation of the various environmental protection measures and procedures outlined throughout this EIS will serve to further address direct (or indirect) potential effects on the existing environmental characteristics and conditions of these special areas.

Given the nature, location and timing of the various marine activities and associated Project induced changes to the environment likely to occur as a result of this Project, it is not expected to have adverse effects on Indigenous communities and activities. As most Project-related activities will take place in the offshore marine environment, hundreds of kilometers from land and thus from communities (Indigenous or otherwise) and because associated emissions and other disturbances are expected to be quite localized and short-term in nature (Chapter 8 to 10), they are unlikely to extend to or affect the health (physical or social) and well-being or other socioeconomic conditions of Indigenous peoples. While some Indigenous groups are known to undertake commercial fishing activities off Eastern Newfoundland, including some fisheries included under commercial-communal licences, the Operator is not aware that these or other Indigenous peoples assert Aboriginal or Treaty rights within or near the Project Area and LSA. Moreover, there are no documented food, social or ceremonial licenses in this area, nor do Indigenous groups otherwise undertake the current use of lands and resources for traditional purposes in this area. There are also no other known aspects of the physical and cultural heritage of these groups located in proximity to, or which may otherwise be affected by, the Project. The environmental effects analysis also indicates that few of the marine associated resources (species) that are known to be used by these Indigenous groups migrate

through the Project Area / LSA and are thus likely to be affected by Project activities and disturbances, and the implementation of the various mitigation measures and procedures outlined throughout the EIS will serve to further address direct or indirect potential effects on these resources. There is therefore almost no potential for the availability or quality of resources that are currently used for traditional purposes by Indigenous groups to be reduced or negatively affected in other ways as a result of the Project, especially to a nature and to a degree that would alter the nature, location, timing, intensity or value of these activities or the health or heritage of Indigenous peoples.

For Commercial Fisheries and Other Ocean Users, possible Project-induced changes may result from a loss of access due to the presence of a temporary safety zone around Project equipment during exploration activities, potential interference between Project components and fishing equipment, and biophysical changes to fish and fish habitat from Project activities that may affect the quality and availability of commercial fish resources. These interactions and potential effects may result in lost time, reduced catch volumes, lower economic returns on catches, and increased operational costs for fishers and other ocean users in the area. However, due to the localized nature and short-term duration of Project activities, and the implementation of standard mitigation measures, it is predicted that there will be no significant adverse environmental effects on this VC (Chapter 13). Although the presence of the drilling installation and its safety zone and other planned Project activities will temporarily reduce access for fishing and other activities in certain areas, such interactions will be localized, short term, and reversible once Project activity ceases at a well or survey site. To help mitigate such effects, Notice to Shippers, Notice to Mariners, and other communication protocols will be implemented. In the unlikely event of fishing gear damage, the Operator will implement a fishing gear damage compensation program, consistent with previous oil and gas exploration drilling programs.

For all VCs in the EIS, an accidental event such as a large-scale oil spill could possibly result in transboundary effects by extending to other provinces of Canada or outside an area of Canada's jurisdiction, as well as by affecting environmental components (such as migratory fish, birds, or marine mammals and sea turtles) that extend across or move both within and outside the areas under the jurisdiction of Canada (Chapter 15). A variety of oil spill prevention and response measures have been identified and are committed to in this EIS, which will help safeguard against such an accidental event occurring, as well as responding to one in the unlikely event it did, thereby reducing the potential magnitude, extent and duration of its potential effects. With the implementation of these mitigation measures, the Project is not likely to result in significant environmental effects upon any environmental component, in any jurisdiction.

17.5.3 Changes to the Environment that are Directly Linked or Necessarily Incidental to Federal Decisions

Section 5(2)(a)a of CEAA 2012 requires consideration of additional changes that may be caused to the environment that are directly linked or necessarily incidental to a federal authority's exercise of a power or performance of a duty or function that would permit the carrying out, in whole or in part, of the designated project.

The primary federal government approval related to this Project that is of relevance to the scope and content of this EIS is the associated requirement for EA approval under CEAA 2012. Each of the

various potential changes to the environment and associated effects that have been assessed and evaluated in this EIS are therefore linked directly to the eventual federal EA decision that will be made following review of this EIS.

A number of other federal decisions will or may also be required in relation to the Project. Petroleum exploration activities offshore Newfoundland and Labrador are, for example, managed by the C-NLOPB, a joint federal-provincial regulatory agency. The C-NLOPB's responsibilities under the Accord Acts include but are not limited to: the issuance and administration of petroleum and exploration and development rights; administration of statutory requirements regulating offshore exploration, development and production; and approval of Canada-NL Benefits and Development Plans. In addition to EA requirements under CEAA 2012, the C-NLOPB also requires that project-specific EAs be completed in relation to certain types of petroleum activities in the Canada-NL Offshore Area, as part of their required authorizations pursuant to Section 138(1)b of the Canada-Newfoundland and Labrador Atlantic Accord Implementation Act and Section 134(1)b of the Canada-Newfoundland and Labrador Atlantic Accord Implementation Newfoundland and Labrador Act. It is understood that the EA review for this Project under CEAA 2012 involves C-NLOPB participation, and that this EIS will also address the C-NLOPB's EA requirements.

The C-NLOPB's regulatory responsibilities also include issuing a number of authorizations and approvals pertaining to offshore oil and gas exploration projects and activities in the Canada-NL Offshore Area. Before carrying out work or activity respecting oil and gas operations, an Operator must, for example, obtain an OL which is a prerequisite for oil and gas activity in the Canada-NL Offshore Area involving fieldwork. Various authorizations and approvals are also required for specific activities and other matters, which may - depending on the specific nature and scope of the activity being planned - include applying for and obtaining an Operations Authorization (OA) from the C-NLOPB. Other required approvals may also involve the approval of certain documents, plans or other matters as specified by the relevant legislation or regulations, or the approval of specific activities conducted under an earlier authorization. Of particular relevance to this Project, an ADW is required for operations involving drilling within or under the marine environment. A separate ADW is required for each well in a proposed drilling program, with the process involving the provision and review of specific details about the drilling program and well design.

Fish and fish habitat, and the potential effects of the Project on this VC, are subject to the relevant provisions of the federal Fisheries Act and its associated Regulations, which provides protection to commercial, recreational, and Aboriginal fisheries by protecting the fish resources and habitats that support these activities. Authorization from the Minister of Fisheries and Oceans under Section 35(2) of the Fisheries Act has not been required in the past for offshore exploration drilling projects. Therefore, such an authorization is not anticipated to be required in support of this Project.

The introductory chapter of the EIS (Chapter 1, Table 1.2) provides a listing of various other federal legislation and regulations and potential permitting requirements that will or may be relevant to the Project.

As the above noted federal decisions and approvals – such as the required OL, OA and ADW from the C-NLOPB – would have the effect of allowing the various planned Project components and activities to be initiated and completed, each of the various potential environmental changes

assessed and evaluated in this EIS (on all VCs) "would be directly linked or necessarily incidental to a federal authority's exercise of a power". These environmental components and predicted environmental changes and effects are identified and summarized in the preceding sections and are therefore not repeated here.

For completeness, Table 17.6 provides a summary of the Project's potential effects on several environmental components that are not treated as VCs in the EIS, namely the: 1) atmospheric environment, 2) terrestrial environment; and 3) aquatic (freshwater) environment.

Table 17.6 Other Potential Environmental Changes Linked to the Exercise of Power or Performance of Duty or Function by a Federal Authority

Environmental Component	Potentially Applicable Federal Decisions or Actions	Summary of Potential Environmental Changes
Atmospheric Environment	C-NLOPB licences, approvals and authorizations (see Table 1.2)	• Although not been considered as a specific, individual VC per se in the environmental effects assessment, aspects of the atmospheric environment were addressed as part of the overall discussion of potential Project-related emissions and their management in the EIS Project Description Chapter (Section 2.9). • This includes a description of the anticipated types and levels of Project-related air emissions and their contribution to regional ambient air quality and GHG levels. • This analysis shows that the Project will make a negligible contribution to regional atmospheric emissions, and these emissions will be within applicable regulations and standards. Chapter 2 also provides a description and discussion of the various mitigation measures that will be put into place related to Project-related air quality and GHG emissions.

Table 17.6 Other Potential Environmental Changes Linked to the Exercise of Power or Performance of Duty or Function by a Federal Authority

Environmental Component	Potentially Applicable Federal Decisions or Actions	Summary of Potential Environmental Changes
Terrestrial Environment and Aquatic Environment	C-NLOPB licences, approvals and authorizations (see Table 1.2)	• The Project is located in the marine offshore environment and will not involve the development and use of new on-land or nearshore infrastructure or Project-related expansions or modifications to existing infrastructure. • Project-related supply and support activities will take place at existing, established onshore industrial facilities operated by a third-party contractor, which have been previously approved under applicable regulatory processes and currently provide services to multiple offshore and other industrial operators. No Project-specific construction or expansion of such facilities or other on-shore infrastructure is required or planned. • upport vessel and aircraft services and their transits to and from the Project Area from these supply bases will likewise be contracted from third party suppliers and will take an essentially “straight line” route to active drill sites in the Project Area, avoiding interaction with the coastal or on-land environments. • Planned Project activities will therefore not interact with or adversely affect components of the terrestrial or aquatic environments. • The environmental effects assessment for accidental events (and particularly, for a large-scale oil spill) in Chapter 15 assessed the potential for oil to reach land, and concluded that this is extremely unlikely to occur, particularly with the implementation of oil spill prevention and response measures.
Others	C-NLOPB approvals and authorizations (see Table 1.2)	• No other components of the biophysical or socioeconomic environments have been identified as having the potential to be directly and adversely affected by the Project which would necessitate or justify their inclusion in the environmental effects assessment presented in this EIS.

Finally, Section 5(2)(b) of CEAA 2012 also requires the EIS to consider effects other than those listed above resulting from the above described federal decisions on (i) health and socioeconomic conditions, (ii) physical and cultural heritage, or (iii) any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.

Relevant aspects of the human environment that have the potential to be affected by the Project are considered and addressed as part of the other socioeconomic VCs identified above. This includes other commercial and recreational ocean users, physical heritage items such as shipwrecks, and other components. Human health is considered within those VCs to the extent that it may be affected by the Project's planned activities or unplanned events, such as through direct interaction with other marine activities and equipment or through resource tainting in the event of a spill. However, given the location of most Project components and activities far offshore (and thus, at considerable distance from communities or human activities), adverse effects on other aspects of human health are not anticipated. Similarly, given the nature and location of the Project, adverse effects on other components of the human environment, such as on-land or nearshore aspects of communities and their overall socioeconomic conditions and well-being, physical and cultural heritage, and other aspects of existing socioeconomic conditions in Eastern Newfoundland and beyond are not anticipated.

Although an accidental event such as a large-scale oil spill could potentially result in such effects, the results of the oil spill modeling indicate little potential for oil to reach land or other otherwise affect people and communities and their health and well-being. A variety of oil spill prevention and response measures have been identified and are committed to in the EIS, which will help safeguard against such an accidental event occurring, as well as responding to one in the unlikely event that one did, thereby reducing the potential magnitude, extent and duration of its potential effects. With the implementation of these mitigation measures, the Project is not likely to result in significant adverse environmental effects on these components.

17.6 Conclusion

A summary of the residual adverse effects for each VC from Project-related interactions, accidental events, and cumulative effects is provided in Table 17.7.

In conclusion, this Project is not expected to result in significant adverse residual environmental effects on the environment, and will not cumulatively interact with other industries in the Canada - NL Offshore Area, including other oil and gas operations, in a way that would cause significant environmental effects. The Project has the potential to provide economic benefits to Newfoundland and Labrador, and Canada, while posing a low risk of environmental effects.

Table 17.7 Summary of Residual Environmental Effects for Routine Operations, Accidental Events, and Cumulative Effects

VC	Routine Operations	Accidental Effects		Cumulative Effects
	Significance of Residual Environmental Effect	Significance of Residual Environmental Effect	Likelihood of Significant Effect	Significance of Residual Environmental Effect
Fish and Fish Habitat	N	N	N/A	N
Marine and Migratory Birds	N	S	L	N
Marine Mammals and Sea Turtles	N	N	N/A	N
Special Areas	N	N	N/A	N
Indigenous Communities and Activities	N	N	N/A	N
Commercial Fisheries and Other Ocean Users	N	N	N/A	N

Key:
N = Not significant residual environmental effect (adverse)
S = Significant residual environmental effect (adverse)
L = Low likelihood
N/A = Not Applicable

The Operator is proposing to conduct an oil and gas exploration program offshore Eastern Newfoundland over the period 2018 to 2027 / 2029, which will include the drilling, testing, and eventual decommissioning of exploratory wells within various Operator-held ELs in the region, as well as possible delineation drilling in the case of a hydrocarbon discovery, geohazard / wellsite surveys, vertical seismic profiling, possible batch drilling, formation flow testing with flaring, geotechnical surveys, environmental surveys, ROV / video surveys, and eventual wellhead decommissioning / removal, as well as associated supply and service activities.

The Project requires review and approval pursuant to the requirements of CEAA 2012 and the Accord Acts. This document comprises the required EIS for this proposed exploration program, in accordance with the requirements of CEAA 2012 and the C-NLOPB's EA process, and provides information and analysis related to the following:

- Project purpose
- Project description (components, activities, schedule)
- Project alternatives
- Changes to the Project that may be caused by the environment

- Existing environmental setting (biophysical and socioeconomic)
- Governmental, stakeholder and Indigenous engagement activities
- Environmental effects of the Project (planned activities and potential accidents)
- Mitigation measures to avoid or reduce environmental effects
- Residual effects and their significance
- Cumulative environmental effects
- Environmental monitoring and follow-up

As illustrated throughout this EIS, each of the potential environmental interactions, resulting environmental changes and associated effects that could be associated with the Project can be avoided or otherwise mitigated through the use of good planning and proven operational practices, which are industry standard and/or are well established and outlined in relevant regulation and guidelines, and which have been identified and committed by the Operator as part of this EIS. Additional, Project and VC-specific mitigation measures have also been identified and committed to throughout this document, as required and applicable.

Overall, the planned components and activities that will be associated with the Project will entail highly localized, short-term, and transient disturbances in the marine environment at any one location within an EL and time throughout the operational life of this exploration program, the potential effects of which will be effectively avoided or minimized through the various regulated or otherwise implemented mitigations referenced above. The Project is therefore not anticipated to disturb, displace, or otherwise affect marine fish, birds, mammals, turtles, Indigenous communities and activities, fisheries or other human components and activities in such a way that causes negative and detectable effects to populations, species at risk or human activities in any location.

The Operator recognizes that of particular concern to government regulators, Indigenous groups, stakeholder organizations and the general public is the potential for an accidental event to occur during offshore drilling activities, and the potential environmental consequences of any such incident. Although each of the potential accidental events that have been assessed herein (batch spills and blowouts) have the potential to adversely affect any biophysical and socioeconomic components that come into contact with them, clearly the potential for, and possible magnitude of, any such effects will depend on the specific probability, nature, degree and other characteristics of the event, inducing the type and amount of material spilled, its eventual geographic extent, and the persistence of these materials in the environment. As noted through the oil spill probability analysis completed for this EIS, a blowout event is an extremely unlikely occurrence, and would be avoided through oil spill prevention measures and if it occurred, would be acted upon quickly. In addition, the subsequent (post-EA) regulatory approvals process that apply to the Project are amongst the most rigorous and stringent in the world, where operators are required to demonstrate that they have the ability and capacity to undertake such activities in a safe and environmentally responsible manner through various project design measures, operational procedures, and response mechanisms. These Operator-implemented mitigations and associated regulatory review processes will help to ensure that such an accidental event does not occur, and in the unlikely event that one did, will serve to reduce any potential environmental effects.

The Project is therefore not likely to result in significant adverse environmental effects.

The Operator is committed to obtaining all required permits, approvals and authorizations for the Project, and the company and its contractors will adhere to with these and all relevant regulations and guidelines in planning and implementing the proposed marine exploration program that is the subject of this EIS. This includes the various mitigations identified and committed to in the preceding sections, the implementation and effectiveness of which will be directed, managed, and monitored in accordance with the Operator's applicable policies and procedures. It will also prepare and submit EA Updates to the C-NLOPB in relation to this multi-year exploration program, that will describe the previous year's Project activities, any recent and on-going engagement activities and their outcomes, as well as outlining the proposed exploration work for the coming year and evaluating the continued applicability and validity of the EIS predictions and associated mitigations.

In conclusion, the proposed Project represents a technically sound, economically beneficial, and environmentally and socially responsible means of conducting offshore exploration drilling and other associated activities within the various Operator-held land holdings off Eastern Newfoundland that are the subject of this EIS. It will allow the Operator to meet its exploration and expenditure obligations under the terms of these ELs, while at the same time providing important direct and indirect socioeconomic benefits to the province and elsewhere, as well as contributing information and experience to help advance the future development of Newfoundland and Labrador offshore oil and gas industry and overall economy.

17.7 References

C-NLOPB (Canada-Newfoundland and Labrador Offshore Petroleum Board). 2002. Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity. Available at: http://www.cnlopb.ca/pdfs/guidelines/compgle.pdf?lbisphpreq=1

C-NLOPB (Canada-Newfoundland and Labrador Offshore Petroleum Board). 2011. Data Acquisition and Reporting Guidelines. 54 pp. Available at: http://www.cnlopb.ca/pdfs/guidelines/data_aq_guide.pdf?lbisphpreq=1

C-NLOPB (Canada-Newfoundland and Labrador Offshore Petroleum Board). 2017. Geophysical, Geological, Environmental and Geotechnical Program Guidelines. vii + 56 pp.

C-NLOPB (Canada-Newfoundland and Labrador Offshore Petroleum Board). 2017. Geophysical, Geological, Environmental and Geotechnical Program Guidelines. Available at: http://www.cnlopb.ca/pdfs/guidelines/ggegpg.pdf?lbisphpreq=1

C-NLOPB (Canada-Newfoundland and Labrador Offshore Petroleum Board) and Canada-Nova Scotia Offshore Petroleum Board. 2011. Incident Reporting and Investigation Guidelines. Available at: http://www.cnlopb.ca/pdfs/guidelines/incrptgl.pdf?lbisphpreq=1

C-NLOPB (Canada-Newfoundland and Labrador Offshore Petroleum Board) and Canada-Nova Scotia Offshore Petroleum Board. 2017. Drilling and Production Guidelines. 124 pp.

DFO (Fisheries and Oceans Canada). 2007. Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment. Available at: http://www.dfo-mpo.gc.ca/oceans/publications/seismic-sismique/index-eng.html

Environment Canada. 2015. Best Practices for Stranded Birds Encountered Offshore Atlantic Canada. Draft 2 – April 17, 2015. Available at: http://www.cnlopb.ca/pdfs/mg3/strandbird.pdf.

NEB (National Energy Board), Canada-Newfoundland and Labrador Offshore Petroleum Board, and Canada-Nova Scotia Offshore Petroleum Board. 2008. Offshore Physical Environmental Guidelines. vii + 28 pp. + Appendices.

NEB (National Energy Board), Canada-Newfoundland and Labrador Offshore Petroleum Board and Canada-Nova Scotia Offshore Petroleum Board). 2010. Offshore Waste Treatment Guidelines. vi + 28 pp.

NEB (National Energy Board), Canada-Newfoundland and Labrador Offshore Petroleum Board and Canada-Nova Scotia Offshore Petroleum Board). 2011. Environmental Protection Plan Guidelines. viii + 20 pp.

Williams, U. and J. Chardine. 1999. The Leach's Storm Petrel: General Information and Handling Instructions. 4 pp. Available at: http://www.cnlopb.nl.ca/pdfs/mkiseislab/mki_app_h.pdf.