6.0 ENVIRONMENTAL EFFECTS ASSESSMENT SCOPE AND METHODS

6.1 SCOPE OF ASSESSMENT

6.1.1 Scope of the Project

The Project under assessment is an offshore exploratory drilling program comprising the drilling, testing and abandonment of up to seven exploration wells within a Project Area encompassing ELs 2431, 2432, 2433, and 2434. The Project Area is located approximately 230 km to 370 km southeast of Halifax on the Scotian Slope (see Figure 2.2.1).

The scope of the Project to be assessed under CEAA, 2012 includes the following Project activities and components (refer to Section 2 for details):

- presence and operation of MODU;
  - establishment of a safety (exclusion) zone, and light and sound emissions associated with MODU presence and operation; and
  - well drilling and testing operations
- waste management;
  - discharge of drill muds and cuttings; and
  - other discharges and emissions (including drilling and well flow testing emissions);
- VSP operations;
- supply and servicing operations;
  - helicopter transportation; and
  - PSV operations (including transit and transfer activities);
- well abandonment.

These activities reflect the scope of the Project as outlined in the EIS Guidelines and represent physical activities that would occur throughout the life of the Project. These activities form the basis of the effects assessment in Section 7. Malfunctions and accidental events, which are unlikely to occur, are assessed separately in Section 8.

6.1.2 Factors to be Considered

Pursuant to section 19 of CEAA, 2012, the federal environmental assessment (EA) of a designated project must take into account the following factors:

(a) the environmental effects of the designated project, including the environmental effects of malfunctions or accidents that may occur in connection with the designated project and any cumulative environmental effects that are likely to result from the designated project in combination with other physical activities that have been or will be carried out;

(b) the significance of the effects referred to in paragraph (a);

(c) comments from the public – or, with respect to a designated project that requires that a certificate be issued in accordance with an order made under section 54 of the National Energy Board Act, any interested party – that are received in accordance with this Act;

(d) mitigation measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the designated project;

(e) the requirements of the follow-up program in respect of the designated project;

(f) the purpose of the designated project;

(g) alternative means of carrying out the designated project that are technically and economically feasible and the environmental effects of any such alternative means;

(h) any change to the designated project that may be caused by the environment;

(i) the results of any relevant study conducted by a committee established under section 73 or 74 [of CEAA, 2012]; and

(j) any other matter relevant to the environmental assessment that the responsible authority, or – if the environmental assessment is referred to a review panel – the Minister, requires to be taken into account.

The EIS gives full consideration to all of the applicable factors outlined in section 19 of CEAA, 2012.

The scope of the factors to be considered focuses the assessment on the relevant issues and concerns. As per section 5(1) of CEAA, 2012, 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:

(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 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.

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. This is the case for the Project, as BP will require authorizations from the CNSOPB under the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation (Nova Scotia) Act* in order for the Project to proceed. Therefore, the following environmental effects have also been considered:

(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 socio-economic conditions,

(ii) physical and cultural heritage, or

(iii) any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.

These categories of direct and indirect environmental effects have been taken into account in defining the scope of the assessment, including the scope of factors to be considered in the assessment. The EIS Guidelines (CEA Agency 2015a) have also been taken into consideration in determining the scope of the factors to be considered, including the selection of Valued Components (VC) and the identification of spatial and temporal boundaries (refer to Section 6.2.2 and Section 6.2.3.4, respectively).

6.2 ENVIRONMENTAL ASSESSMENT METHODS

6.2.1 Overview of Approach

The method used to conduct the EA for the Project is based on a structured approach that is consistent with international best practices for conducting environmental impact assessments, including the International Association for Impact Assessment's *Principles of Environmental Impact Assessment Best Practice* (IAIA 1999), and with the method used by Stantec for environmental assessments of other major projects assessed by the CEA Agency including the Shelburne Basin Venture Exploration Drilling Project (Stantec 2014a). The assessment method is structured to:

- identify the issues and potential effects that are likely to be important;
- consider key issues raised by Aboriginal peoples, stakeholders, and the public; and
- integrate engineering design and programs for mitigation and follow-up into a comprehensive environmental planning process.

This method is focused on the identification and assessment of potential adverse environmental effects of the Project on VCs. VCs are environmental attributes associated with the Project that are of particular value or interest because they have been identified to be of concern to Aboriginal peoples, regulatory agencies, BP, resource managers, scientists, key stakeholders, and/or the general public.

It is noted that "environment" is defined to include not only ecological systems but also human, social, cultural, and economic conditions that are affected by changes in the biophysical environment. VCs therefore include ecological, social, and economic systems that comprise the environment (refer to Section 6.2.2).

The potential environmental effects of Project activities and components are assessed in Section 7 using a standard framework to facilitate assessment of each VC. Evaluation tables and matrices are used to document the assessment. Residual Project-related environmental effects (*i.e.*, those environmental effects that remain after the planned mitigation measures have been applied) are characterized for each individual VC using specific analysis criteria (*i.e.*, magnitude, geographic extent, duration, frequency, reversibility, and context). The significance of residual Project-related environmental effects is then determined based on pre-defined standards or thresholds (*i.e.*, significance rating criteria) specific to each VC.

The environmental effects associated with potential accidental events as well as the effects of the environment on the Project are considered separately in this EIS (Sections 8 and 9, respectively).

Cumulative environmental effects are assessed in Section 10 and consider whether there is potential for the residual environmental effects of the Project to interact cumulatively with the residual environmental effects of other past, present, and future (*i.e.*, certain or reasonably foreseeable) physical activities in the vicinity of the Project. The significance of any identified cumulative environmental effects is also assessed in Section 10.

Figure 6.2.1 illustrates the environmental assessment framework used in this EIS.

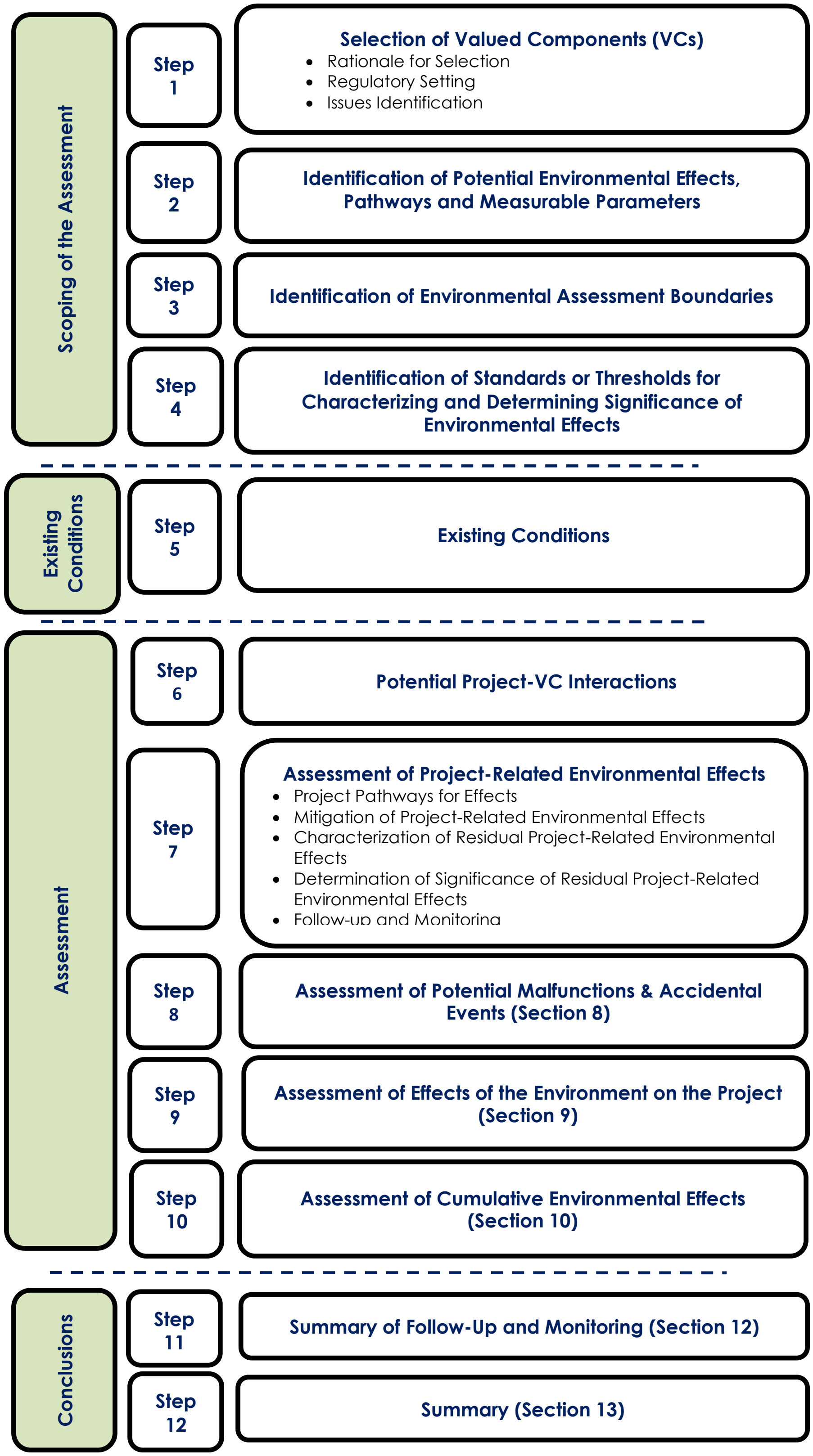


Figure 6.2.1 Overview of Environmental Assessment Process

6.2.2 Selection of Valued Components

The selection of VCs was carried out in consideration of:

- regulatory guidance and requirements, including the Project-specific EIS Guidelines provided by the CEA Agency (CEA Agency 2015a);
- issues raised by regulatory agencies, key stakeholders, and the public (refer to Section 3);
- issues raised by Aboriginal peoples, including traditional ecological knowledge obtained through completion of a TUS for the Project (refer to Section 4 and Appendix B);
- technical aspects of the Project (*i.e.*, the nature and extent of Project components and activities) (refer to Section 2);
- existing environmental conditions in the Project Area and interconnections between the biophysical and socio-economic environment (refer to Section 5);
- experience and lessons learned from similar offshore projects (*e.g.*, Shelburne Basin Venture Exploration Drilling Project) as well as SEAs completed for the Scotian Shelf and Slope; and
- the professional judgment of the EA Study Team.

Section 5 of CEAA, 2012 was also influential in selecting appropriate VCs for the assessment (refer to Section 6.1.2 of this EIS for a discussion of CEAA, 2012 section 5 requirements).

Candidate VCs for consideration were selected from various sections throughout the EIS Guidelines (CEA Agency 2015a) including components listed for baseline conditions (Section 6.1 of EIS Guidelines) and components with predicted changes (Sections 6.2 and 6.3 of the EIS Guidelines). Table 6.2.1 presents the VCs assessed in this EIS and the rationale for their selection or exclusion. Relevant sections of the EIS are referenced where applicable.

The following six VCs were selected to facilitate a focused and effective EA process that complies with government requirements and supports public review:

- Fish and Fish Habitat;
- Marine Mammals and Sea Turtles;
- Migratory Birds;
- Special Areas;
- Commercial Fisheries; and
- Current Aboriginal Use of Lands and Resources for Traditional Purposes.

Specific candidate VCs identified in the EIS Guidelines which were not selected as stand-alone VCs in this EIS include Marine Plants, Federal Species at Risk, Air Quality and Greenhouse Gas Emissions, and Human Environment. Marine plants are addressed, as relevant, in the Fish and Fish Habitat VC. Species at risk and species of conservation concern are considered as part of the

Fish and Fish Habitat VC, the Marine Mammals and Sea Turtles VC, and the Migratory Birds VC rather than as a stand-alone VC to eliminate repetition throughout the EIS.

Some candidate VCs identified in the EIS Guidelines have been addressed throughout the EIS, however because no interactions are predicted, they have not been selected for a focused assessment as stand-alone VCs. For example, air quality and greenhouse gas emissions are addressed in Section 2.8.1 of this EIS. It has been determined that in light of the distance offshore and the lack of any sensitive receptors in close proximity to the Project Area, as well as the limited atmospheric emissions predicted for the Project that the environmental effects on the atmospheric environment and climate do not warrant focussed assessment. Human environment aspects are discussed in Section 5.3, however given the lack of predicted interactions with most aspects of the human environment (as demonstrated in Table 6.2.1), it was not selected as a VC.

Table 6.2.1 Selection of Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
Biophysical Environment			
Atmospheric Environment and Climate (including Air Quality and Greenhouse Gas Emissions)	In consideration of the environmental context and the mitigation referred to in the next column, it has been determined that environmental effects on atmospheric environment and climate do not warrant focused assessment. This component has therefore not been selected as a VC; however, potential changes to the atmospheric environment are addressed elsewhere in the EIS.	• All nearshore and offshore Project-related vessel operations will take place in Canada's portion of the North American ECA, which was established under amendments to the *Dangerous Chemicals Regulations* pursuant to the *Canada Shipping Act* that were adopted in 2013 under Annex VI to MARPOL. New standards have been implemented for the ECA that are designed to reduce allowable emissions of key air pollutants by ships such that, by 2020, emissions of sulphur oxide will be reduced by 96% and nitrogen oxides by 80% (TC 2013). • Given its distance offshore and the limited atmospheric emissions predicted for the Project as described in Section 2.7.2, the Project Area does not contain any receptors that would be sensitive to atmospheric emissions from Project activities and components. • Changes to the atmospheric environment (sound and light) are assessed with respective to potential biological receptors.	• *Section 2.8.1:* Description of project atmospheric emissions • *Sections 2.8.5* and *7.1.1:* Changes related to ambient sound levels • *Section 5.1.2:* Existing conditions regarding the atmospheric environment and climate • *Sections 7.2* and *7.3:* Changes to sound levels and associated effects on fish and fish habitats and marine mammals and sea turtles • *Section 7.4:* Changes in lighting levels and effects on migratory birds • *Section 9:* Effects of the environment on the Project (including the effects of climate change) • *Section 11.1.3:* Summary of changes to the atmospheric environment since the Project requires a federal decision as identified in section 5(2) of CEAA, 2012
Marine Environment	Project activities will result in changes to the marine environment; however these changes are evaluated in the context of other marine VCs (*e.g.*, Fish and Fish Habitat,	• Effects of the Project on the marine environment are evaluated as applicable in the context of all the other VCs in the EIS. • Potential changes to marine water quality and benthic environment are evaluated in the context of the Fish and Fish Habitat VC.	• *Section 5:* Description of biophysical and socio-economic aspects of the marine environment • *Section 7.2:* Fish and Fish Habitat, *Section 7.3:* Marine Mammals and Sea Turtles, *Section 7.4:* Migratory Birds, and

Table 6.2.1 Selection of Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
	Marine Mammals and Sea Turtle) where the analysis of effects and mitigation can be more specific. Marine Environment has therefore not been selected as a VC.	Changes to underwater ambient noise and vibration levels are evaluated in the context of the Fish and Fish Habitat VC, Marine Mammal and Sea Turtles VC, Special Areas VC, Commercial Fisheries VC, and Current Aboriginal Use of Resources for Traditional Purposes VC. • Important and critical habitat for marine species is addressed in the context of the relevant biological VC.	*Section 7.5:* Special Areas • *Section 7.6:* Commercial Fisheries, and *Section 7.7:* Current Aboriginal Use of Resources for Traditional Purposes
Fish and Fish Habitat	Environmental effects on fish (including applicable SAR and SOCC) and fish habitat are assessed within the Fish and Fish Habitat VC. This VC is included in consideration of its ecological importance, the socio-economic importance of fisheries resources (*i.e.*, target fish species), the legislated protection of fish and fish habitat and applicable SAR and SOCC, and the nature of potential Project-VC interactions.	• Several species of fish (including SAR and SOCC) are known to occur in the vicinity of the Project Area and have potential to be affected (including effects on fish habitat) by Project activities and components as well as accidental events associated with the Project. • Project effects on fish and fish habitat has been identified as an issue of concern during Aboriginal and stakeholder engagement (refer to Sections 3 and 4). • Fish and fish habitat are protected under the *Fisheries Act*. • Section 5(1)(a) of CEAA, 2012 requires consideration of project-related environmental effects associated with a change to a component of the environment within the legislative authority of Parliament (*e.g.*, fish and fish habitat as defined in the *Fisheries Act*).	• *Sections 5.1* and *5.2:* Existing conditions regarding fish and fish habitat • *Section 7.2:* Project-related environmental effects on fish and fish habitat • *Section 8.5:* Environmental effects of potential accidental events • *Section 10.2:* Cumulative environmental effects

Table 6.2.1 Selection of Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
Marine Plants	Marine plants are addressed within the Fish and Fish Habitat VC where applicable. Marine Plants has therefore not been selected as a VC.	• Marine plants are not located in the Project Area (given water depth) and routine Project activities are not predicted to interact with marine plants which occur in the nearshore. • Accidental events that could potentially interact with the nearshore environment and therefore potentially affect marine plants, are addressed in the assessment of Fish and Fish Habitat.	• *Section 5.2.3:* Existing conditions regarding marine plants • *Section 7.2:* Project-related environmental effects on marine plants • *Section 8.5:* Environmental effects of potential accidental events
Migratory Birds and their Habitat	Environmental effects on migratory birds (including applicable SAR and SOCC and migratory bird habitat) are assessed within the Migratory Birds VC. This VC is included in consideration of its ecological importance, the legislated protection of migratory birds and other applicable SAR and SOCC, and the nature of potential Project-VC interactions.	• Several species of migratory birds (including SAR and SOCC) are known to occur in the vicinity of the Project Area and have potential to be affected by Project activities and components as well as accidental events associated with the Project. • Migratory birds are protected under the MBCA. • Section 5(1)(a) of CEAA, 2012 requires consideration of project-related environmental effects associated with a change to a component of the environment within the legislative authority of Parliament (*e.g.*, migratory birds as defined in the MBCA).	• *Section 5.2.6:* Existing conditions regarding migratory birds • *Section 7.4:* Project-related environmental effects on migratory birds • *Section 8.5:* Environmental effects of potential accidental events • *Section 10.2:* Cumulative environmental effects

Table 6.2.1 Selection of Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
Species at Risk and Species of Conservation Concern	To reduce redundancy and promote EA efficiency, environmental effects on SAR and SOCC are assessed as part of the Fish and Fish Habitat VC, Marine Mammals and Sea Turtles VC, and the Migratory Birds VC rather than as a stand-alone VC. Effects and/or mitigation specific to SAR and SOCC will be highlighted as applicable.	• SAR and SOCC include the following: o Federally protected species listed as "endangered", "threatened", or of "special concern" on Schedule 1 of SARA, and their critical habitat o species assessed as "endangered", "threatened", or of "special concern" by the federal Committee on the Status of Endangered Wildlife of Canada (COSEWIC) o species listed as "endangered", "threatened", or "vulnerable" under the *Species at Risk Regulations* pursuant to the Nova Scotia *Endangered Species Act* (NS ESA), which are provincially protected • Several SAR and SOCC are known to occur in the vicinity of the Project Area, including fish, other aquatic species (*e.g.*, marine mammals, sea turtles) and migratory birds, and have potential to be affected by routine Project activities as well as accidental events associated with the Project. • SAR and SOCC can be more vulnerable to changes in their habitat or population levels than secure species and therefore require special consideration. However, in general, evaluation of potential environmental effects and mitigation measures taken to protect SAR and SOCC are also protective of secure	• *Section 5.2.9:* Summary of marine SAR and SOCC (including applicable species of fish, mammals, turtles, and birds) with potential to be affected by the Project • *Section 7.2:* Assessment of project-related environmental effects on fish SAR and SOCC • *Section 7.3:* Assessment of project-related environmental effects on marine mammal and sea turtle SAR and SOCC • *Section 7.4:* Project-related environmental effects on migratory bird SAR and SOCC • *Section 8.5:* Environmental effects of potential accidental events • *Section 10.2:* Cumulative environmental effects

Table 6.2.1 Selection of Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
		species. • With respect to marine mammals and sea turtles, many of the species found in the area are considered SAR or SOCC; therefore separate VCs to assess secure species and SAR/SOCC would be redundant. SAR/SOCC for these species have therefore been addressed within the Marine Mammals and Sea Turtles VC.	
Marine Mammals	Environmental effects on marine mammals (including applicable SAR and SOCC) are assessed within the Marine Mammals and Sea Turtles VC. This VC is included in consideration of its ecological importance, the legislated protection of applicable SAR, and the nature of potential Project-VC interactions. Marine mammals and sea turtles are considered within the same VC due to the similarities in their potential interactions with the Project.	• Several species of marine mammals (including SAR and SOCC) are known to occur in the vicinity of the Project Area and have potential to be affected by Project activities and components as well as accidental events associated with the Project. • Section 5(1)(a) of CEAA, 2012 requires consideration of project-related environmental effects associated with a change to a component of the environment within the legislative authority of Parliament (*e.g.*, aquatic species as defined in SARA).	• *Section 5.2.6:* Existing conditions regarding marine mammals • *Section 7.3:* Project-related environmental effects on marine mammals • *Section 8.5:* Environmental effects of potential accidental events • *Section 10.2:* Cumulative environmental effects

Table 6.2.1 Selection of Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
Marine Turtles	Environmental effects on marine turtles (including applicable SAR and SOCC) are assessed within the Marine Mammals and Sea Turtles VC. This VC is included in consideration of its ecological importance, the legislated protection of applicable SAR, and the nature of potential Project-VC interactions. Marine mammals and sea turtles are considered within the same VC due to the similarities in their potential interactions with the Project.	• Marine turtles (including SAR and SOCC) are known to occur in the vicinity of the Project Area and have potential to be affected by Project activities and components as well as accidental events associated with the Project. • Section 5(1)(a) of CEAA, 2012 requires consideration of project-related environmental effects associated with a change to a component of the environment within the legislative authority of Parliament (*e.g.*, aquatic species as defined in SARA).	• *Section 5.2.7:* Existing conditions regarding sea turtles • *Section 7.3:* Project-related environmental effects on sea turtles • *Section 8.5:* Environmental effects of potential accidental events • *Section 10.2:* Cumulative environmental effects
Special Areas	Environmental effects on Special Areas are assessed within the Special Areas VC. This VC is included in consideration of its ecological and/or socio-economic importance, the legislated protection of applicable Special Areas, and the nature of potential Project-VC interactions.	• Several Special Areas (*i.e.*, areas designated as being of special interest due to their ecological and/or conservation sensitivities, including those protected under federal legislation) are known to occur in the vicinity of the Project Area and have potential to be affected by Project activities and components as well as accidental events associated with the Project. • Special areas provide important (and sometimes "critical") habitat for certain SAR/SOCC.	• *Section 5.2.10:* Existing conditions regarding Special Areas • *Section 7.5:* Project-related environmental effects on Special Areas • *Section 8.5:* Environmental effects of potential accidental events • *Section 10.2:* Cumulative environmental effects

Table 6.2.1 Selection of Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
Human Environment			
Aboriginal Peoples	Environmental effects on the current use of lands and resources for traditional purposes by Aboriginal peoples are assessed with respect to the Current Aboriginal Use of Lands and Resources for Traditional Purposes VC. This VC is included in consideration of its socio-economic, socio-cultural and/or traditional importance; in recognition of potential or established Aboriginal and Treaty rights; and due to the nature of potential Project-VC interactions.	• Aboriginal communal commercial fishing activity is known to occur in the vicinity of the Project Area and has potential to be affected by Project activities and components as well as accidental events associated with the Project. • Aboriginal commercial and traditional fishing activities are also carried out under communal commercial licences and food, social and ceremonial (FSC) licences in the nearshore waters of Nova Scotia. • Project activities can potentially interact with fisheries species harvested offshore or nearshore, particularly migratory species. Section 5(1)(c) of CEAA, 2012 requires consideration of project-related environmental effects, with respect to Aboriginal peoples, associated with a change to the environment on the current use of lands and resources for traditional purposes.	• *Section 4:* Context for Aboriginal organizations (including locations of reserves and communities) • *Section 5.3.5:* Existing conditions regarding the current Aboriginal use of lands and resources for traditional purposes • *Section 7.7:* Project-related environmental effects on the current Aboriginal use of lands and resources for traditional purposes • *Section 8.5:* Environmental effects of potential accidental events • *Section 10.2:* Cumulative environmental effects • *Section 11.2.1:* Effects of Changes to the Environment on Aboriginal People • *Appendix B:* The TUS undertaken in support of the Project
Commercial Fisheries	Environmental effects on commercial fisheries are assessed with respect to the Commercial Fisheries VC. This VC is included in consideration of its economic importance and the potential	• Commercial fishing activity is known to occur in the vicinity of the Project Area and has potential to be affected by Project activities and components as well as accidental events associated with the Project. • Commercial fishing activity in the nearshore waters of Nova Scotia has potential to be affected by accidental events associated	• *Section 5.3.5:* Existing conditions regarding commercial fisheries • *Section 7.6:* Project-related environmental effects on commercial fisheries • *Section 8.5:* Environmental effects of potential accidental events

Table 6.2.1 Selection of Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
	for Project-VC interactions.	with the Project. • Project activities can potentially interact with fisheries species harvested offshore or nearshore, including migratory species. • Environmental effects on Aboriginal fisheries (including communal commercial fisheries) are assessed with respect to the Current Aboriginal Use of Lands and Resources for Traditional Purposes VC.	• *Section 10.2:* Cumulative environmental effects
Recreational Fisheries and other Areas used for Recreational Activities	In consideration of the environmental context and the mitigation referred to in the next column, the environmental effects on recreational fisheries and other recreation do not warrant focused assessment. This component has therefore not been selected as a VC. Changes to the environment potentially affecting species targeted for recreational fishing are addressed elsewhere in the EIS (*e.g.*, accidental events).	• Recreational fisheries and other forms of recreation are not known to occur in the vicinity of the Project Area. These activities are located closer to the nearshore and therefore are not predicted to interact with routine Project activities. PSVs will use existing shipping routes and are not expected to interfere with nearshore recreational activities. • Recreational activity (including fishing) in the nearshore waters of Nova Scotia has potential to be affected by accidental events associated with the Project. • Mitigation measures for the protection of nearshore commercial fishing activity (and associated target fish species) from Project-related accidental events are also protective of nearshore recreational fishing activity (and associated target fish species). It is therefore anticipated that mitigation proposed for the Fish and Fish Habitat VC and the Commercial	• *Section 5.3.4:* Existing conditions regarding recreational activities • *Section 7.2:* Project-related environmental effects on fish and fish Habitat • *Section 7.6:* Project-related environmental effects on commercial fisheries • *Section 8.5:* Environmental effects of potential accidental events

Table 6.2.1 Selection of Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
		Fisheries VC are sufficient to mitigate similar environmental effects on recreational fisheries.	
Other Ocean Use (*e.g.*, shipping, research, oil and gas, military activities, ocean infrastructure)	In consideration of the environmental context and the mitigation referred to in the next column, environmental effects on other ocean use do not warrant assessment as a VC. This component has therefore not been selected as a VC. However, "other ocean use" is discussed generally in the EIS as indicated.	• Offshore oil and gas exploration in Canadian waters is a highly regulated activity. Standard guidelines and protocols govern nearly every aspect of exploration activities, including avoidance of conflicts with other ocean use such as military activities and scientific research. In particular, Notices to Shipping and Notices to Mariners are issued to notify other ocean users of the presence of potential navigational obstructions posed by exploration activities. • Other ocean users with potential to be affected by the Project will be notified regarding the timing and location of Project activities and components (*e.g.*, through direct communications and/or the issuance of Notices to Shipping) to mitigate potential disruption.	• *Section 5.3.4:* Existing conditions regarding offshore ocean uses and infrastructure • *Section 10:* Potential interactions between residual Project-related environmental effects and the residual environmental effects of projects or activities carried out by other offshore users are considered in the cumulative environmental effects assessment
Human Health, and Socio-economic Conditions	In consideration of the environmental context and the mitigation referred to in the next column, environmental effects on human health and socio-economic conditions do not warrant focused assessment. This component therefore has not been selected as a VC.	• Socio-economic benefits associated with the Project are discussed in Section 1.4. • Given its distance offshore, the Project would be unlikely to affect any receptors that would be sensitive to atmospheric air or noise emissions from routine Project activities and components, or from accidental events. • Project activities and components are not anticipated to result in any changes to the	• *Section 1.4:* Benefits of the Project • *Section 2.7.2:* Routine waste discharges and emissions associated with the Project • *Section 5.3.2:* Existing conditions regarding labor and economy • *Section 5.3.3:* Existing conditions regarding human health

Table 6.2.1 Selection of Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
		environment that would have an effect on human health. Emissions will be discharged in accordance with allowable concentrations stated in the OWTG. • Accidental events (*i.e.*, spills) associated with the Project could result in contamination of fish species commonly harvested for human consumption through commercial, recreational, and/or Aboriginal fisheries. However, fisheries closures would be imposed in the event of such an incident, thereby preventing human exposure to contaminated food sources. Similarly, the imposition of an exclusion zone around the affected area(s) would minimize the potential for human contact with spilled oil.	• *Section 8.4:* Spill response measures • *Section 8.5:* Environmental effects of potential accidental events
Physical and Cultural Heritage (including structures, sites or things of historical, archaeological, paleontological or architectural significance)	In consideration of the environmental context and the mitigation referred to in the next column, the environmental effects on physical and cultural heritage do not warrant focused assessment. This component has therefore not been selected as a VC.	• Project activities and components are not anticipated to result in any changes to the environment that would have an effect on physical and cultural heritage. • BP's imagery based seabed survey will confirm the absence of heritage resources at proposed wellsites. • PSV and helicopter transport activities will not result in any ground/seabed disturbance. Therefore, they will not affect heritage resources.	• *Section 2.2:* Details regarding site surveys to be undertaken in the Project Area in advance of drilling • *Section 5.3.7:* Existing conditions regarding physical and cultural heritage

Table 6.2.1 Selection of Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
Rural and Urban Settings	In consideration of the exclusion of the onshore supply base as part of the Project scope, the environmental effects on rural and urban settings do not warrant focused assessment. This component has therefore not been selected as a VC.	• Routine Project activities are not anticipated to result in any changes to the environment that would have an effect on rural and urban settings. • Accidents and malfunctions that could potentially interact with the mainland Nova Scotia coastline are assessed in terms of ecological and socio-economic receptors and are not expected to result in a change in rural and urban settings.	• *Section 5.3.1:* Existing conditions regarding land use and nearshore ocean use • *Section 8.5:* The environmental effects of potential accidental events

6.2.3 Scoping of the Assessment

The following section describes the approach and organization of the effects assessment undertaken for each VC.

6.2.3.1 Regulatory Setting

The regulatory context is described for each individual VC, including an overview of applicable regulations, policies, or administrative mechanisms. This section helps to establish key aspects of the scope of assessment including relevant definitions under legislation, measureable parameters and significance thresholds, where applicable.

6.2.3.2 The Influence of Engagement on the Assessment

Any VC-specific issues that have been raised during stakeholder and Aboriginal engagement activities are summarized in this section including the extent to which identification and consideration of these issues has influenced the scope of the assessment for the individual VC.

6.2.3.3 Potential Environmental Effects, Pathways and Measurable Parameters

Potential environmental effects arising from interactions between the Project and each selected VC are identified in their respective subsections in Section 7. For each individual VC, potential environmental effects are identified and one or more measurable parameters are selected to facilitate quantitative or qualitative assessment of those effects. Measurable parameters for biophysical VCs include measures of ecosystem health and integrity. Where applicable, measurable parameters also reference regional, provincial and/or national objectives, standards or guidelines.

6.2.3.4 Environmental Assessment Boundaries

Environmental effects are evaluated within spatial and temporal boundaries. The spatial and temporal boundaries may vary among VCs, depending on the nature of potential environmental effects. The spatial boundaries must reflect the geographic range over which the Project's potential environmental effects may occur, recognizing that some environmental effects will extend beyond the Project Area. Temporal boundaries identify when an environmental effect may occur. The temporal boundaries are based on the timing and duration of Project activities and the nature of the interactions with each individual VC. Spatial and temporal boundaries are developed for each VC in consideration of:

- timing/scheduling of Project activities for all Project phases;
- known natural variations of each VC;
- information gathered on current and traditional land and resource use;
- the time required for recovery from an environmental effect; and
- potential for cumulative environmental effects.

The temporal boundaries for the Project to be assessed encompass all Project phases, including well drilling, testing and abandonment. Up to seven exploration wells will be drilled over the term of the ELs, with Project activities at each well taking approximately 120 days to drill. It is assumed that Project activities could occur year-round.

The spatial boundaries for the Project to be assessed are defined below with respect to Project activities and components.

Project Area: The Project Area encompasses the immediate area in which Project activities and components may occur and includes the area within which direct physical disturbance to the marine benthic environment may occur. Well locations have not yet been identified, but will occur within the Project Area and represent the actual Project footprint. As a subset of the Project Area, the wellsite is referenced in the assessment discussion, where relevant, to more appropriately characterize the associated effects. The Project Area is consistent for all VCs and includes ELs 2431, 2432, 2433, and 2434 as depicted on Figure 2.2.1.

Local Assessment Area (LAA): The LAA is the maximum area within which environmental effects from routine Project activities and components can be predicted or measured with a reasonable degree of accuracy and confidence. It consists of the Project Area and adjacent areas where Project-related environmental effects are reasonably expected to occur based on available information including effects thresholds, predictive modelling and professional judgement. The LAA has also been defined to include PSV routes to and from the Project Area. A figure depicting the applicable LAA for each VC is provided in its respective subsection of Section 7.

Regional Assessment Area (RAA): The RAA is the area within which residual environmental effects from Project activities and components may interact cumulatively with the residual environmental effects of other past, present, and future (*i.e.*, certain or reasonably foreseeable) physical activities. The RAA is restricted to the 200 nautical mile limit of Canada's EEZ, including offshore marine waters of the Scotian Shelf and Slope within Canadian jurisdiction. The western extent of the RAA encompasses the Georges Bank Oil and Gas Moratorium Area and terminates at the international maritime boundary between Canada and the United States. The eastern extent of the RAA extends into the Laurentian Channel to the NAFO division 4S boundary and approaches the Nova Scotia coastline along the boundary of NAFO Unit Area 4VSb. The RAA extends along the Nova Scotia coastline from North Fourchu, Richmond County to Comeaus Hill, Yarmouth County. The RAA is consistent for all VCs and is depicted on Figure 2.2.1. Although the RAA is intended to be much broader than the LAA which focuses on the extent of potential effects associated with routine Project activities for each VC, it is possible that effects from larger scale unplanned events (*e.g.*, blowout) could extend beyond the RAA.

6.2.3.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance

In consideration of the Operational Policy Statement, *Determining Whether a Designated Project is Likely to Cause Significant Environmental Effects under the Canadian Environmental Assessment Act, 2012* (CEA Agency 2015b), criteria or established thresholds for determining the significance of residual adverse environmental effects are identified for each VC and are included in the corresponding sections in the impact assessment chapter (Section 7). These criteria or thresholds are defined using:

- available information on the status and characteristics of each VC;
- scientific literature to assess and qualify significance of an impact (*e.g.*, Southall *et al.* 2007; French-McCay 2009);
- applicable regulatory documents, environmental standards, guidelines, or objectives where available; and
- the professional judgment of the EA Study Team.

These criteria or thresholds establish a level beyond which a residual environmental effect would be considered significant (*i.e.*, an unacceptable change). Where pre-established standards or thresholds do not exist, significance criteria have been defined qualitatively and justifications for the criteria provided.

Additional criteria (*i.e.*, magnitude, geographic extent, duration, frequency, reversibility, and context) are also identified and defined for each VC to support characterization of the nature and extent of residual environmental effects (refer to Section 6.2.5).

6.2.4 Existing Conditions

Existing conditions of the marine physical environment, marine biological environment, and socio-economic environment are described in Section 5 to characterize the setting for the Project, support an understanding of the receiving environment, and provide sufficient context for the effects assessment. A brief overview of existing conditions is also provided for each VC in Section 7, highlighting key information to support the assessment. Inclusion of information on existing conditions is limited to that which is necessary to assess the environmental effects of the Project and support recommendations for mitigation, monitoring and follow-up, as applicable.

6.2.5 Assessment of Project-Related Environmental Effects

The assessment of Project-related environmental effects follows a sequential process whereby potential interactions between each VC and the Project are first identified, and where such interactions may exist, a more detailed assessment of those effects is completed to further characterize the potential effects.

For each VC, a table is used to list Project activities and components, and to identify potential interactions from those Project activities and components with the VC. Interactions are indicated by checkmarks and are discussed in the context of effects pathways, standard and Project-specific mitigation, and residual effects.

- The assessment of potential environmental effects includes: identification of environmental effects pathways (*i.e.*, identification of the means by which the Project could result in an environmental effect on the VC);
- description of the mitigation measures proposed to reduce or eliminate potential environmental effects, including industry standards, best management practices and environmental protection measures that BP will implement;
- identification and characterization of the nature and extent of potential residual environmental effects (*i.e.*, those environmental effects that remain after the proposed mitigation measures have been applied) through application of specific criteria (*i.e.*, magnitude, geographic extent, duration, frequency, reversibility, and context); and
- determination of significance of the residual effects. Where a residual significant effect is predicted, a determination of likelihood based on consideration of probability and uncertainty is given.

The following criteria are used to characterize residual environmental effects on each VC.

- Direction: pertains to whether the effect is predicted to be positive, adverse, or neutral.
- Magnitude: refers to the amount of change in a measurable parameter relative to baseline conditions or other standards, guidelines or objectives. This predicted change may be expressed quantitatively or qualitatively (*i.e.*, negligible, low, moderate, high).
- Geographic Extent: refers to the geographic area or spatial scale over which the residual effect is expected to occur (*i.e.*, within the Project Area, LAA, or RAA).
- Duration: refers to the length of time the residual effect will occur (*i.e.*, short-term, medium-term, long-term, permanent).
- Frequency: refers to how often the residual effect occurs (*i.e.*, single event, multiple irregular events, multiple regular events, continuous).
- Reversibility: pertains to whether or not the residual effect on the VC can be returned to its previous condition once the activity or component causing the disturbance ceases (*i.e.*, reversible or irreversible).
- Context: refers to the current degree of anthropogenic disturbance and/or ecological sensitivity in the area in which the residual effect may occur.

Table 6.2.2 provides an example of generic criteria used to describe residual effects. Refer to Section 7 for VC-specific criteria.

Table 6.2.2 Generic Characterization of Residual Environmental Effects

Characterization	Description	Quantitative Measure of Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	**Positive** – an effect that moves measurable parameters in a direction beneficial relative to baseline. **Adverse** – an effect that moves measurable parameters in a detrimental direction relative to baseline. **Neutral** – no net change in measureable parameters relative to baseline.
Magnitude	The amount of change in measurable parameters or the VC relative to existing conditions	**Negligible** – no measurable change in species populations, habitat quality or quantity **Low** – a measurable change but within the range of natural variability; will not affect population viability **Moderate** – measurable change but not posing a risk to population viability **High** – measurable change that exceeds the limits of natural variability and may affect long-term population viability
Geographic Extent	The geographic area in which an environmental effect occurs	**Project Area** – effects are restricted to the Project Area **Local Assessment Area** – effects are restricted to the LAA **Regional Assessment Area** – effects are restricted to the RAA
Frequency	Identifies how often the residual effect occurs	**Single Event** – effect occurs once **Multiple Irregular Event** – occurs at not set schedule **Multiple Regular Event** – occurs at regular intervals **Continuous** – occurs continuously
Duration	The period of time required until the measurable parameter of the VC returns to its existing condition, or the effect can no longer be measured or otherwise perceived	**Short-term** – effect extends for a portion of the duration of Project activities **Medium-term** – effect extends through the entire duration of Project activities **Long-term** – effects extend beyond the duration of Project activities and continue after well abandonment
Reversibility	Pertains to whether a measurable parameter or the VC can return to its existing condition after the project activity ceases	**Reversible** – will recover to baseline conditions before or after Project completion (well abandonment) **Irreversible** – permanent
Ecological and Socio-economic Context	Existing condition and trends in the area where environmental effects occur	**Undisturbed** – area is relatively undisturbed or not adversely affected by human activity **Disturbed** – area has been substantially disturbed by previous human development or human development is still present

Following a characterization of the residual effects, a determination of the significance is provided.

The level of confidence is provided for each determination of significance, which is typically based on professional judgment, prior experience, and scope and quality of available information. Where a significant effect is predicted to occur, the likelihood of this significant effect is discussed in the context of probability and certainty.

Following the determination of significance, follow-up and monitoring measures are recommended, where required, to verify environmental effects predictions or to assess the effectiveness of proposed mitigation measures.

6.2.6 Assessment of Accidental Events

Environmental effects associated with potential accidental events are assessed in Section 8. The focus of the assessment is on credible worst-case accidental event scenarios that could result in significant environmental effects. Interactions with VCs are identified for these scenarios, and potential environmental effects are assessed. A description of the planned mitigation and contingency measures is provided, and a conclusion regarding the significance of potential residual environmental effects and their likelihood of occurrence is given. Section 8 provides further details regarding approach to the assessment for the potential accidental events.

6.2.7 Effects of the Environment on the Project

Effects of the environment on the Project are assessed in Section 9. This section considers how local environmental conditions and natural hazards (*e.g.*, extreme weather) could adversely affect the Project and thus result in potential effects on the environment (*e.g*., accidental events). Section 9.3 defines criteria for what would be considered to be a significant effect on the Project. Potential adverse effects of the environment on a project are typically a function of project design and environmental conditions that could affect the project. These effects are generally mitigated through engineering and environmental design criteria, industry standards, and environmental monitoring.

6.2.8 Assessment of Cumulative Environmental Effects

Cumulative environmental effects are assessed in Section 10 of this EIS in accordance with the CEA Agency's (2013a) Operational Policy Statement (OPS), *Assessing Cumulative Environmental Effects Under the Canadian Environmental Assessment Act, 2012*. Potential cumulative environmental effects are identified in consideration of potential interactions with other physical activities that have been or will be carried out in the vicinity of the Project. These other physical activities include certain or reasonably foreseeable future undertakings. The assessment of cumulative environmental effects is carried out with respect to any Project-related residual environmental effect that is considered likely to overlap with the residual environmental effect of another past, present, or future physical activity.

Where there is potential for cumulative interaction, the residual environmental effects of the Project are assessed in combination with those of other physical activities. The contribution of the Project to the cumulative environmental effects is evaluated, and the significance of residual cumulative environmental effects is determined. Section 10 provides further details regarding the approach to the assessment of cumulative environmental effects.

7.0 ENVIRONMENTAL EFFECTS ASSESSMENT

This section of the EIS identifies and evaluates environmental effects that are likely to result from interactions between Project activities and components and the receiving environment, focusing on the VCs selected in Section 6.

Section 7.1 presents an overview of existing knowledge of potential interactions and effects from past environmental assessment reports (including the Shelburne Basin Venture Exploration Drilling Project EIS [Stantec 2014a], the Environmental Assessment of BP Exploration (Canada) Limited's Tangier 3D Seismic Survey [LGL 2014], and the Environmental Assessment of Exploration Drilling of the Cabot Licence EL 2403 [BP 2003]), SEAs, monitoring programs, and scientific literature with respect to the individual Project activities and components. This information is designed to improve understanding of the potential interactions and resulting environmental effects in order to help facilitate the VC-based analysis of environmental effects that follows in Sections 7.2 to 7.7.

7.1 OVERVIEW OF POTENTIAL INTERACTIONS

This section of the EIS focuses on existing knowledge regarding potential interactions between Project activities and environmental components. Key Project activities and components are addressed within the scope of the EIS, and are summarized from the information presented in Section 2. The selection of VCs is scoped in Section 6. There are several potential interactions between the key Project activities and the VCs that require evaluation for environmental effects. Each of these interactions is noted in Table 7.1.1 and discussed below, in the context of existing scientific knowledge and standard mitigation/best management practices, to facilitate the VC analyses that follow in Sections 7.2 to 7.7.

An overview of the underwater sound propagation and cuttings dispersion assessments carried out in support of this EIS, including modelling work, is also described in this section.

Table 7.1.1 Potential Interactions between the Project and Valued Components

Project Activities and Components	VC					
	Fish and Fish Habitat	Marine Mammals and Sea Turtles	Migratory Birds	Special Areas	Commercial Fisheries	Current Aboriginal use of Lands and Resources for Traditional Purposes
Presence and Operation of the MODU (including well drilling and testing operations and associated lights, safety [exclusion] zone and underwater sound)	✓	✓	✓	✓	✓	✓
Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)	✓	✓	✓	✓	✓	✓
Vertical Seismic Profiling	✓	✓	✓	✓	✓	✓
Supply and Servicing Operations (including helicopter transportation and PSV operations)	✓	✓	✓	✓	✓	✓
Well Abandonment	✓	✓		✓	✓	✓

7.1.1 Presence and Operation of the MODU

As explained in Section 2.3.1, the MODU used to support the Project will be either a semi-submersible rig or drillship. The chosen MODU will be stationed in the Project Area during drilling, testing and abandonment activities and will stay on-site using a dynamic positioning (DP) system, which will result in negligible interaction with the sea floor associated with the anchoring of bottom transponders.

It is anticipated that the presence and operation of the MODU will interact with each of the VCs identified in Section 6, as illustrated in Table 7.1.1. This is a result of:

- the 500-m safety (exclusion) zone required by the *Nova Scotia Offshore Drilling and Production Regulations;*
- underwater sounds generated by the DP system, MODU vibration and the drillstring; and
- light generated by deck lighting (continuous) and well test flaring (short term, intermittent when required).

Further detail of existing knowledge of the environmental effects of MODU presence and operation is provided below.

7.1.1.1 Safety (Exclusion) Zone

In accordance with the *Nova Scotia Offshore Drilling and Production Regulations*, a 500-m safety (exclusion) zone will be established around the MODU within which non-Project vessels (*e.g.*, fishing vessels) will be prohibited entry. As explained in Section 2.4.1, the safety (exclusion) zone is designed to prevent collisions between the MODU and other vessels operating in the area. The safety (exclusion) zone will be monitored by the standby vessel at the MODU at all times. No persons other than Project or CNSOPB personnel will be allowed within the safety (exclusion) zone without the permission of the Offshore Installation Manager. The Offshore Installation Manager has the authority, granted by the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act*, to enforce exclusion and safety (exclusion) zones. Under the *Nova Scotia Offshore Drilling and Production Regulations*, reasonable measures will be taken to warn persons who are in charge of vessels and aircraft of the safety (exclusion) zone boundaries, of the facilities within the safety (exclusion) zone, and of any related potential hazards. BP will provide details of the safety (exclusion) zone to the Marine Communication and Traffic Services for broadcasting and publishing in the Notices to Shipping and Notices to Mariners. Details of the safety (exclusion) zone will also be communicated during ongoing consultations with commercial and Aboriginal fishers. The MODU and standby vessel will be equipped with navigation and communication equipment as specified in regulations. The safety (exclusion) zone will create a relatively small, temporary exclusion area of approximately 0.8 km^2 for fishing on the Scotian Slope, potentially affecting commercial and Aboriginal fishers for the period that the MODU is on location.

7.1.1.2 Underwater Sound

The MODU will generate underwater sounds as a result of the DP system and drilling activities. Further information on these activities is provided in Section 2.8.5.1. The DP system will employ thrusters to keep the MODU on location. These thrusters will generate underwater sound through vibration, and through the creation of low pressure points and bubbles known as cavitation; this is the primary mechanism for sounds produced by propellers and thrusters under higher speeds and loads (Leggat *et al.* 1981). Underwater sound will also be generated in association with drilling activities through mechanical vibration of the MODU and associated machinery located on the vessel. During drilling, the drill string and bit will also emit sound into the marine environment.

Exposure to some anthropogenic sounds can result in adverse effects on marine life. There are two categories of potential effects from sound exposure to marine life:

- injury/mortality (including pathological and physiological effects); and
- behavioural effects.

Each of these categories of potential effects is discussed as applicable in the discussion of Fish and Fish Habitat (Section 7.2), Marine Mammals and Sea Turtles (Section 7.3), and Migratory Birds (Section 7.4). A description of how underwater sound is generated and measured is presented below to help inform these VC-specific analyses of effects of underwater sound. Underwater sound associated with other Project activities (*e.g.*, VSP and PSV operations) are discussed in Sections 7.1.3 and 7.1.4.

Fundamentals of Underwater Acoustics

The basic form of sound is the sound wave, which consists of the alternating compression and rarefactions of molecules within a medium (air, earth, water). This wave can be detected by a receiver as changes in pressure. Structures in the ears of marine mammals, fish, turtles, and marine birds, as well as structures sensitive to vibration (*i.e.*, lateral lines and swim bladders in certain species) are sensitive to these changes in pressure (WDCS 2004). The speed of a sound wave is the rate at which vibrations propagate through an elastic medium, and is characteristic of that medium. In water, the speed of sound is a function of the density of the water, which is dependent on temperature, depth (pressure), and salinity. The frequency of the sound wave is measured in Hertz (Hz), which represents the number of compression / rarefaction cycles per second. The perceived pitch of a sound (*e.g.*, low to high notes on a piano) is how the ear and brain subjectively interpret a sound's frequency (low to high respectively). Sounds that have frequencies within an animal's hearing range are audible if they have higher received amplitudes and/or different characteristics as compared to background (ambient) sound levels.

Underwater sound can be characterized as either impulsive (*e.g.*, from a seismic sound source) or non-impulsive (*e.g*., from drilling, or transiting vessels). Sound levels can also be described using a variety of metrics such as sound pressure levels (SPLs), which represent only the pressure component of sound, and sound exposure levels (SELs), which is a measure of energy (pressure squared) that also takes into account the duration of the signal. SPLs can further be measured by either their root-mean-square (RMS) pressure, which indicates an average SPL over a given amount of time, or by their peak pressure (*i.e*., maximum wave amplitude) or peak-to-peak pressure (*i.e*., maximum negative to maximum positive wave amplitude). There can be large differences between these three ways of characterizing SPLs. While there are numerous factors to consider in selecting a metric, RMS calculations are generally more appropriate for measuring non-impulsive signals, as they are highly dependent on the time window that is applied. Peak SPLs are commonly used for impulsive sounds, as they provide information related to the instantaneous intensity of a sound; however, they do not account for the bandwith or duration of the sound, and are therefore a poor indicator for perceived loudness. Historically, RMS SPLs have also been used to characterize pulsed signals.

Sound level (magnitude) is typically measured on the decibel (dB) scale, with RMS SPLS denoted by dB RMS and peak SPLs denoted by dB Peak. The decibel scale is a logarithmic ratio scale of intensity, and is relative and therefore only meaningful if a reference level is included. In underwater acoustics, a reference pressure of 1 µPa is commonly used to describe SPLs (Richardson *et al.* 1995), whereas a reference pressure of 20 µPa is used for sound in air. The logarithmic nature of the decibel scale means that every 10 dB increase in SPL is a ten-fold increase in acoustic power. However, the way an animal (including humans) perceives the "loudness" of a signal, is not the same as the measured signal strength. While 6 dB represents a doubling of signal strength or intensity, humans perceive a10 dB increase as a doubling of sound "loudness". Unlike SPLs, SELs are a measure of the total energy of one or multiple acoustic events over the duration of the event. Since energy is proportional to squared pressure and the reference time for SELs has been set to one second, SELs are presented in dB re 1 $\mu Pa^2 s$. SELs can also be measured cumulatively, measuring the total sound energy at a receiver location over a period of time. Cumulative SELs (SEL_{cum}) capture the overall sound levels experienced by sound receivers as a result of multiple sound events over a period of time (Southall *et al*. 2007).

Terms referred to in underwater acoustics include both source and received levels. The source level usually represents the SPL at a distance of 1 m from the source, referenced to 1 μPa (*e.g.*, 200 dB re 1μPa @ 1m). Source levels are usually derived from received levels obtained during field measurements at some distance from the source, and back-propagated to a distance of 1 m using an acoustic propagation model. This method can overestimate actual near-field source levels for complex sound sources such as seismic arrays, which are made up of multiple source elements; however, these considerations are incorporated into acoustic modelling when predicting sound propagation and transmission loss (see Appendix D). Received levels are usually measured at the receiver's position or predicted through modelling based on estimated source levels, environmental conditions, distance to the receiver, and transmission loss over that distance.

The intensity of sound weakens as it travels through water as a result of spreading and attenuation; this is known as transmission loss. Transmission loss due to spreading can occur in one of two simplistic forms: spherical or geometric spreading loss; or cylindrical spreading loss (Richardson *et al.* 1995). Spherical spreading loss assumes a uniform environment, which is typically found in deep waters (typically >200 m). Cylindrical spreading loss occurs when a water body is non-homogenous such as in shallow coastal waters (<200 m) or in stratified water bodies. Under cylindrical spreading loss, sound is reflected or refracted off the sea surface, seabed, or off water layers of differing densities. As a result, if there are density gradients in the water column, sound can travel much farther than when the water column is mixed and homogeneous (WDCS 2004). In reality, transmission loss falls somewhere between these various forms (see Appendix D for further details of calculations used in the acoustic modelling).

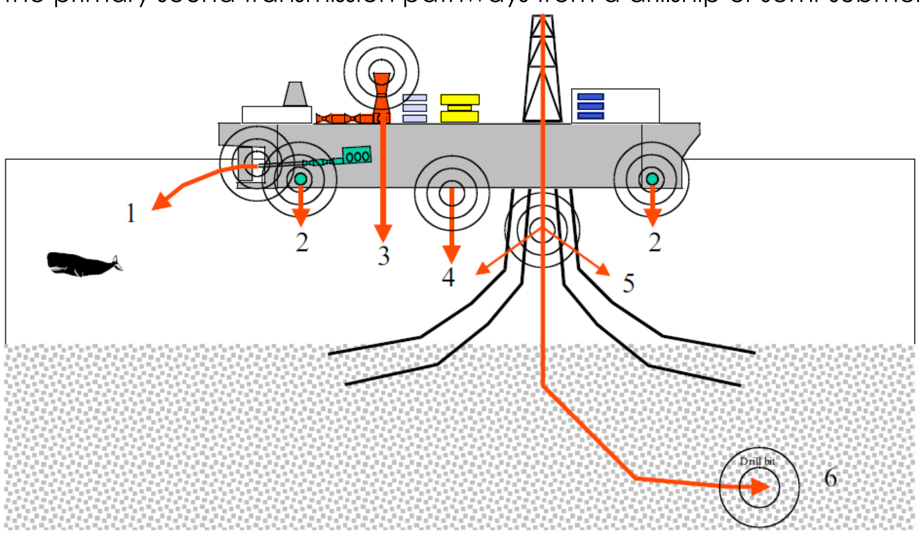
Underwater Acoustic Modelling of Project Activities

JASCO Applied Sciences was engaged to perform acoustic modelling to predict underwater sound levels associated with the MODU, PSV, and VSP (Zykov 2016; Appendix D). As some exact Project details were not available at the time of modelling, two representative wellsites were selected for modelling purposes, and multiple scenarios were modelled at each site to cover different configurations of the acoustic sources (MODU type with/without PSV), as well as potential seasonal variations (winter versus summer). The two representative wellsites were selected within the viable drilling area and included the deepest and shallowest potential locations within the drilling area to demonstrate the potential effect of water depth on the propagation of sound.

MODU source levels were modelled assuming all thrusters operating at their highest operating load (*i.e.*, the highest sustainable revolutions per minute [rpm]) and it was assumed that sound levels from cavitation processes on the thruster propellers dominate all other sources of vessel sound output, including drilling operations. This assumption was validated through comparison of modelled MODU source levels with source levels of similar vessels obtained from direct measurements. Estimated broadband source levels from acoustic modelling and literature values are summarized in the following section. Further details on the acoustic modelling are available in Appendix D. Sound emissions associated with VSP and PSV operations are discussed in Sections 7.1.3 and 7.1.4, respectively.

Sound Levels Associated with the Presence and Operation of the MODU

MODUs vary in form, shape, and size. The MODU design, in combination with the local oceanographic conditions, will affect how much sound is transferred into the water. The presence and operation of the MODU will introduce underwater sound via three primary pathways: mechanical and vibrational sounds from the MODU itself, propeller and thruster cavitation from the DP system, and direct drilling sounds from the drill string and drill bit. Figure 7.1.1 depicts the primary sound transmission pathways from a drillship or semi-submersible drill rig.



Source: WDCS 2004

(1) Cavitation associated with the propeller, (2) Cavitation associated with thrusters, (3) Exhaust ports, (4) Hull vibration associated with machinery, (5) Vibration through drill string casing or risers, and (6) Vibration of the drill bit.

Figure 7.1.1 Sound Transmission Pathways and Sources of Sound Associated with a Drillship or Semi-submersible Drilling Vessel

Mechanical vibration created by the operation of the MODU will result in underwater sounds transferred to the sea via either the ship hull (*i.e.*, in the case of a drillship) or drilling floats. Within the machinery itself, sound and vibrations are created by propulsion equipment, including diesel engines, thrusters, main motors, and reduction gears. Sound can also be created from auxiliary machinery onboard the MODU, including generators, pumps, and HVAC equipment (WDCS 2004).

During operations, the DP thruster system will run continuously, keeping the MODU on station. Each well is estimated to take up to 120 days to drill, with drilling operations occurring 24-hours a day. It is expected that all sources of sound (thrusters, vessel machinery and vibration, drill string) will be operated continuously during drilling. Sound emissions during testing and abandonment activities may be reduced slightly as a result of the removal of the drill string and associated drilling sounds, but the anticipated sound emissions from the operation of the MODU will be similar throughout all Project activities. Under higher propulsion system load (*e.g.*, when thrusters are positioning the vessel) and at higher speeds, the acoustic output from the cavitation processes is expected to dominate over all other sources of sound on the vessel (Leggat *et al.* 1981).

A drillship or a semi-submersible drilling vessel could be used in the Project; therefore, sound levels from both of these scenarios were modelled, along with the presence of a PSV operating alongside the MODU (Appendix D). The estimated broadband source levels for the drillship and semi-submersible drilling vessel were both approximately 197 dB re 1 µPa @ 1 m RMS SPL. Previously reported SPLs produced by operating MODUs range from 130 to 190 dB re 1 µPa @ 1 m RMS SPL (peak frequency 10 to10,000 Hz) (Richardson *et al.* 1995; Hildebrand 2005; OSPAR 2009). Drilling sounds from a rig used in the Beaufort Sea were recorded at approximately 150 dB re 1 µPa @ 1 m RMS SPL at 30 to 40 Hz (OSPAR 2009). Measurements from the drillship *Stena Forth* operating in Baffin Bay in 2010 recorded source levels of 184 dB re 1 µPa @ 1 m RMS SPL (NERI 2011). These example RMS SPLs take into account the combination of all sound sources emitted from the MODU. Based on these previously reported field values, source levels estimated and used in the acoustic modelling (with all thrusters operating at nominal speeds) are higher than those that have been measured and therefore considered conservative for the assessment of potential acoustic effects. Refer to Sections 7.2 Fish and Fish Habitat, and Section 7.3 Marine Mammals and Sea Turtles for a discussion of modelling results and predicted effects on marine life.

7.1.1.3 Lights and Flares

The MODU will emit light. The effects of these light emissions will be strongest above the surface of the water, although some deck lighting is likely to affect areas of the water column down to a certain depth which will be dependent on the strength of the light as well as the various properties of the water itself (factors such as the quality and concentration of suspended particulate matter that affect light attenuation and scattering). Flaring during well testing, if required, will also generate light emissions. However, it is currently anticipated that well testing will not be carried out on the first two wells drilled as part of the Project. If flaring is required, these light emissions will be temporary, short-term and intermittent (*e.g.*, from a few hours up to three days).

Artificial lighting on ships, offshore drilling and production structures, coastal communities, and oceanic island communities regularly attract nocturnally-active seabirds and nocturnally migrating land and waters birds, sometimes in large numbers (Imber 1975; Montevecchi *et al.* 1999; Wiese *et al.* 2001; Gauthreaux and Belser 2006; Montevecchi 2006; Bruinzeel *et al.* 2009; Bruinzeel and van Belle 2010; Ronconi *et al.* 2015), resulting in sublethal and lethal effects. More information on potential interactions between lights and flares and migratory birds is provided in Section 7.4.

Light emitted from the MODU can also affect the light and dark cycle for aquatic species inhabiting the upper layers of the water column, potentially attracting species to the light source and/or interrupting circadian rhythms.

Lighting on the MODU and PSVs will be reduced to the extent that worker safety and safe operations is not compromised. Reduction of light may include avoiding use of unnecessary lighting, shading, and directing lights towards the deck.

7.1.2 Waste Management

As explained in Section 2.8, a number of liquid discharges and solid wastes could be generated from the MODU and associated drilling equipment, and on the PSVs, thereby potentially affecting water, sediment and/or air quality and directly or indirectly affecting the VCs as illustrated in Table 7.1.1. Offshore waste discharges and emissions associated with the Project (*i.e.*, operational discharges and emissions from the MODU and PSVs) will be managed in accordance with relevant regulations and municipal bylaws as applicable, including the Offshore Waste Treatment Guidelines (OWTG) (NEB *et al.*, 2010) and the International Convention for the Prevention of Pollution from Ships (MARPOL), of which Canada has incorporated provisions under various sections of the *Canada Shipping Act*. Waste discharges not meeting legal requirements will not be discharged to the ocean and will be brought to shore for disposal. . Section 2.8 discusses waste discharges and emissions and how they will be managed during Project activities.

Waste management, specifically the discharge of drill muds and cuttings and other drilling and testing emissions is anticipated to have an interaction with each of the six VCs identified in Section 6, as illustrated in Table 7.1.1.

Key waste streams that will be generated by the Project include:

- drilling waste discharges, including cuttings and drilling fluids and cement returns;
- atmospheric emissions from fuel combustion and well test flaring; and
- liquid discharges from the MODU and PSVs, such as produced water, bilge water, ballast water, BOP testing fluids.

Solid waste which will be removed from the MODU and PSVs and sent to shore for disposal in line with regulations and consequently are unlikely to interact with the VCs. Further detail of existing knowledge of the environmental effects of wastes and discharges is provided below.

7.1.2.1 Drill Waste Discharges

As discussed in Section 2.3.2, the drilling of each offshore well is expected to consist of two phases, starting with riserless drilling (*i.e.*, an open system with no direct drill fluid return connection to the MODU) and continuing drilling with a riser (*i.e.*, closed loop system with direct drill fluid return connection to the MODU). During riserless drilling, there is no closed loop (riser) system in place to return drilling fluid back to the MODU; therefore, the drilling fluid (seawater and WBM) will be released directly to the seafloor. During riserless drilling, only WBM will be used. Excess cement from the cementing of the conductor and surface casing string will also be discharged directly to the seafloor during the riserless phase. Once the riser (and BOP) have been installed, the drilling fluids (also referred to as drilling muds) and cuttings generated from the wellbore, as well as any excess cement can be transported back to the MODU for treatment. During this phase of drilling, either WBM or SBM may be used as the drilling fluid.

As explained in Section 2.8.2, once on the MODU, cuttings are separated from the drilling fluid for management and disposal. The recovered drilling mud is reconditioned and reused to the extent practicable. SBM cuttings will only be discharged once the performance targets in OWTG of 6.9 g/100 g retained "synthetic on cuttings" on wet solids can be satisfied. The concentration of SBM on cuttings will be monitored on the MODU for compliance with the OWTG. It is expected that this SBM treatment will be done using a cuttings dryer, equipment which uses high speed centrifuge technology to separate drilling fluid from the solids. In accordance with OWTG, no excess or spent SBM will be discharged to the sea. Spent or excess SBM that cannot be re-used during drilling operations will be brought back to shore for disposal. More information on drill muds and cuttings, including typical components and predicted discharge volumes is presented in Section 2.8.2. Appendix C presents drill waste dispersion modelling conducted for the Project based on predicted mud types and volumes; results are summarized below.

Drilling Waste Discharges Environmental Stressors

There are several environmental stressors related to drilling discharges including those in the water column (toxic components and suspended particles), and those in the sediment (toxic compounds, change in grain size, oxygen depletion and burial of organisms) (Smit *et al.* 2006). The duration of water column exposure to drill waste can range from minutes to several days. Sediment exposure to drill waste is considered more chronic and can persist for months or years (Smit *et al.* 2006). Studies on the environmental effects of drill waste have primarily focused on effects on the marine benthic environment. Several laboratory studies have focused on the toxicity of drill muds and the sublethal effects of exposure (*e.g.*, Neff *et al.* 1989; Cranford and Gordon 1992; Cranford *et al.* 1999). These studies have linked prolonged exposure of bentonite and barite (found in both WBM and SBM) to sublethal effects affecting shellfish (*e.g.*, scallop) growth and reproduction (Cranford and Gordon 1992; Cranford *et al.* 1999, 2005). However, in many cases, exposure levels were higher than what would be expected in field conditions where WBM and SBM discharges are diluted and dispersed. Field studies have primarily focused on delineating the extent of benthic faunal disturbance through evidence of smothering, elevated contaminants in sediment sampling, and benthic community diversity. Field studies have also examined recovery times for benthic communities.

As reviewed by Neff (2010), most field study experiments and EEM results have shown the following:

- no evidence of ecologically significant bioaccumulation of metals and petroleum hydrocarbons by marine organisms;
- no evidence of toxicity effects associated with WBM constituents;
- no or minimal short-term effects on zooplankton communities; and
- limited effects on benthic macro- and mega-faunal communities restricted to approximately 100-m radius from the well.

These findings are consistent with what has been reported in EEM studies conducted for SOEP and Deep Panuke on the Scotian Shelf (CNSOPB 2011a; McGregor Geoscience Limited 2012).

Measurable adverse environmental effects on the marine benthos from exploration drilling are primarily related to the physical disturbance of the water column and benthic environment, particularly when large amounts of solids accumulate on the seafloor, causing burial and suffocation of benthic species (Neff *et al.* 2004; Neff 2010).

The severity of adverse effects related to burial on species is determined by the following factors: depth of burial; rate of burial; tolerance of species; nature of material (*i.e.*, grain size different from native sediment); and temperature (mortality rate by burial is higher in the summer than the winter) (Smit *et al.* 2006a). In spite of these variables, average burial thresholds have been proposed for consideration in risk assessment studies, ranging from 6.5 mm to 9.6 mm (Neff *et al.* 2004; Smit *et al.* 2006b). It is recognized that drill waste modelling predicts thickness of the deposited layer, which is not necessarily equivalent to depth of burial (*e.g.*, for epifauna attached to the seafloor) (refer to Section 7.2.8 and Appendix C).

Reviews of the environmental effects of offshore drilling in the Norwegian Sea have found that while project-related environmental changes (*i.e.*, chemical footprint, benthic invertebrate effects, metals, total organic carbon) are detectable during the earlier phases of drilling and production, the spatial effects are very localized (*e.g.*, within a 500-m radius of the wellsite) and subside with time (Gates and Jones 2012; Bakke *et al.* 2013). Long-term population and ecosystem effects to benthic communities from drill mud (WBM and SBM) and cuttings discharges are generally low, although recovery time varies with a number of factors including the local environmental conditions (*e.g.*, water depth, currents, temperature) and change in sediment particle size (Gates and Jones 2012).

There has been extensive environmental monitoring in both the Norwegian and UK oil producing regions of the North Sea, with up to 40 years of research. Recovery of sites previously affected by drill cuttings (which included diesel-based muds, as well as WBM and SBM) has been shown to occur in as little as four years (Schaanning and Bakke 1997; Bakke *et al.* 2011) although other studies have shown recovery of deepwater megafaunal assemblages taking longer than this. Jones *et al*. (2012) studied deepwater megafaunal density and diversity in the Faroe-Shetland Channel following deepwater drilling and reported partial megabenthic recovery occurring between three and ten years post-disturbance, with drill cuttings and impacts on epibenthic megafaunal assemblages still evident after a decade. However, these effects were observed only within 10 m of the disturbed area, with the megafaunal community at 10 m distance not readily distinguishable from that found over 100 m from the drilling location (Jones *et al.* 2012).

Bakke *et al.* (1986) capped sediments with 10 mm of WBM and found that fauna recolonization on sediment cuttings differed little in diversity from natural sediment after as little as one year. The results indicated that the recolonizing species were different, which was hypothesized to be related to the fact that the WBM provides a finer sediment type than the natural sediments in the area.

In a review of existing literature and EEM data from exploratory drilling in Canada, Hurley and Ellis (2004) determined that changes in the diversity and abundance of benthic organisms were most common within 50 to 500 m of drill sites and that benthic communities typically returned to baseline conditions within one year after drilling operations ceased. They also found that results of laboratory and field studies reviewed during their assessment suggested a low potential for toxicity or health effects. On the Grand Banks, major indices of benthic community structure (total abundance, total biomass, richness, and diversity) have been largely unaffected by project activity at production fields monitoring such endpoints (Husky Energy 2011; Suncor Energy 2011).

Drill Waste Modelling

Drill waste dispersion modelling has been carried out to demonstrate the expected deposition of cuttings. As with the sound modelling, some Project details were not available at the time of modelling. Consequently, the same two representative wellsites used in the sound modelling were selected for dispersion modelling purposes to illustrate effects at different water depths within the ELs. These wells are referred to as NS1 and NS3.

Table 7.1.2 Drill Waste Dispersion Modelling Locations

Well Reference	Water Depth	Location
NS1	2,104 m	43.046428 N, 60.434610 W
NS3	2,790 m	42.847114 N, 60.297611 W

Appendix C presents the drill waste dispersion modelling report.

The provisional well design illustrated in Section 2.4.2 was used as basis for the modelling work (*i.e.*, a seven-string configuration). It was assumed that SBM would be used once the riser is installed. The modelling accounted for likely discharges from the entire well drilled over a 120 day period, including WBM discharges at seafloor for the initial hole sections [pre-riser], bulk WBM discharges, and treated SBM associated cuttings discharges from the MODU post-riser installation.

Table 7.1.3 summarizes the predicted distances (maximum extent) from the discharge point for various deposition thicknesses associated with sedimentation from drilling discharges for wells at NS1 and NS3. Table 7.1.3 summarizes the predicted areal coverage of sedimentation. These data can be used to predict potential environmental effects on the benthic environment, particularly as it pertains to burial and smothering.

Table 7.1.3 Predicted Maximum Extent of Deposition from the Discharge Point

Deposition Thickness (mm)	Maximum Extent from Discharge Point (m)	
	Well Location NS1	Well Location NS3
0.001	11,213	7,446
0.01	3,684	3,547
0.1	1,367	1,309
1	563	358
2.5	150	251
5	102	167
10	78	116
20	71	93
50	33	62
100	21	30
500	7	15

Table 7.1.4 Predicted Area Extent of Sedimentation from Drilling Discharges

Deposition Thickness (mm)	Well Location NS-1		Well Location NS-3	
	Hectares	m^2	Hectares	m^2
0.001	4,872.7305	48,727,305	5,352.8105	53,528,105
0.01	703.7430	7,037,430	796.2614	7,962,614
0.1	104.7752	1,047,752	116.2959	1,162,959
0.2	58.2847	582,847	66.8110	668,110
0.5	28.1940	281,940	18.7219	187,219
1	9.9089	99,089	4.1702	41,702

Table 7.1.4 Predicted Area Extent of Sedimentation from Drilling Discharges

Deposition Thickness (mm)	Well Location NS-1		Well Location NS-3	
	Hectares	m^2	Hectares	m^2
2	2.5045	25,045	2.3199	23,199
5	0.9891	9,891	1.0889	10,889
10	0.5388	5,388	0.5356	5,356
20	0.2960	2,960	0.2970	2,970
50	0.1164	1,164	0.1320	1,320
100	0.0658	658	0.0685	685
200	0.0354	354	0.0381	381
500	0.0177	177	0.0102	102

Using a threshold of 9.6 mm (Neff *et al*. 2004) to assume burial of benthic species, it is predicted that these sediment thicknesses could extend up to 116 m from the discharge point, or cover an area of approximately 0.54 ha per well. Refer to Appendix C for more information on modelling methods and results. For more information on the effects of drill waste discharges on the marine environment (focusing on the marine benthos), refer to Section 7.2.8.

7.1.2.2 Other Discharges and Emissions

Section 2.8.1 discusses Project-related air emissions, which are expected to be low and will comply with applicable regulatory requirements. Given the distance of the Project offshore, there will be no predicted effect on air quality of Nova Scotia or public health.

Section 2.8.3 discusses liquid waste and how it will be managed in accordance with applicable regulatory requirements. All liquid wastes generated by the PSVs and MODU will be discharged in accordance with the OWTG and MARPOL. Drilling will require the use of seawater for cooling. The volume of cooling water used will be low and therefore the area of thermal effects will be negligible. Other discharges such as drilling fluids, deck drainage, and bilge waters may have residual hydrocarbon presence, although this would be at allowable levels stated by the OWTG with no measureable adverse effects predicted for marine animals.

Section 2.8.4 discusses solid wastes that may be generated by the Project activities, such as food and domestic waste and packaging. As mentioned in Section 2.8.4, sanitary and food wastes will be macerated to a particle size of 6 mm or less and then discharged overboard. Organic matter will be quickly dispersed by ocean currents and wave activity and will be degraded by bacterial communities. Some birds (*e.g.*, Procellariiforms, such as petrels) use olfactory cues to navigate and may be attracted to the domestic and sanitary waste emissions (Weise *et al.* 2001; Nevitt and Bonadonna 2005). Some fish and marine mammals may also be attracted to emissions, although during active drilling, any attraction would likely be limited due to underwater sound emissions. Further information about potential effects is provided in Section 7.2 for Fish and Fish Habitat and, Section 7.3 for Marine Mammals and Sea Turtles.

7.1.3 Vertical Seismic Profiling (VSP)

As explained in Section 2.4.3.2, VSP may be carried out as part of the well evaluation processes to provide further subsurface information. Where it occurs, VSP would be carried out after drilling has been completed, but before well abandonment and is used to correlate the surface seismic data to well data.

As a result of the sound generated by VSP, potential interaction with each of the six VCs identified in Section 6 is anticipated.

Sound Profiles Associated with VSP

The source of underwater sound during VSP operation is similar to that used in seismic operations (*i.e.*, a seismic sound source array made up of individual source elements), the associated size and overall volume of the source array are much smaller than in a traditional offshore surface seismic survey, and thus VSP operation produce less energy. Exploratory seismic surveys typically produce sound in the frequency range of 5 to 300 Hz and at SPLs of approximately 245 to 260 dB peak re 1 µPa @ 1m in their primary radiation direction (calculated through back-propagation methods that likely typically overestimates actual sound levels in the near-field) (Lee *et al.* 2011). Acoustic modelling for the Project of a representative VSP used by BP in previous Gulf of Mexico surveys produced a broadside source level of 248 dB re 1 µPa @ 1m Peak SPL (SEL of 225 dB re 1 μPa^2s @ 1m), with most energy produced at frequencies below 250 Hz (Zykov 2016; Appendix D).

In addition to utilizing a smaller source array than traditional seismic surveys, VSP operation occurs over substantially shorter time frames (*e.g.*, days instead of months) and is conducted over a much smaller spatial scale (*i.e.*, limited to the wellsite). The VSP that BP is proposing to use for this Project will typically take no more than a day per well to complete and will be located directly above the wellsite. Further description of VSP is provided in Section 2.4.3.

An interpretation of the modelling results relative to potential environmental effects on marine fish, marine mammals and sea turtles is provided in Sections 7.2 and 7.3. Indirect effects on Special Areas, commercial fisheries, and Aboriginal use of lands and resources for traditional purposes are assessed in Sections 7.5, 7.6, and 7.7. Effects of VSP on migratory birds would be limited to diving birds; these interactions are assessed in Section 7.4.

7.1.4 Supply and Servicing Operations

Offshore drilling operations will be supported by logistics arrangements for supply and servicing activity. Such arrangements will allow the movement of equipment and personnel between the MODU and land, and will allow sufficient stocks of equipment and supplies to be maintained for reliable, ongoing drilling operations. Supply and servicing operations will include:

- Helicopter transportation between the MODU and Stanfield International Airport; and
- PSV transit between the MODU and Halifax Harbour.

It is anticipated that supply and servicing operations will interact with each of the VCs as illustrated in Table 7.1.1. Further information is provided below.

7.1.4.1 Helicopter Transportation

As discussed in Section 2.4.5, Project activities will require helicopter support for transfer of crew and light supply. Helicopters transiting to and from the MODU will fly at altitudes greater than 300 m and at a lateral distance of 2 km around active bird colonies when possible. Helicopters will also avoid flying over Sable Island (a 2-km buffer will be recognized) except as needed in the case of an emergency.

The key potential environmental effects associated with helicopter support involve sensory disturbance from helicopter sound. This sensory disturbance can be realized by marine mammals and migratory birds, and can also affect the habitat quality of Special Areas designated as being important for these groups. Helicopter operations can also potentially result in injury or mortality risks to migratory birds through collision during flight. Further information is provided in Section 7.2 and 7.3, for fish and marine mammals and sea turtles. Information about potential effects on migratory birds is provided in Section 7.4.

7.1.4.2 PSV Operations

PSVs will be used for the transport of supplies from the supply base to the MODU and returning waste material for appropriate disposal onshore, as well as providing standby assistance during drilling activities. It is anticipated that two to three PSVs will be required to support the Project with two to three round trips per week being made for transport purposes. One vessel will be required to be on standby (within 20 minutes of the MODU) at all times during drilling operations.

Although the exact routes for the PSVs have not yet been determined, routes are expected to be consistent with existing shipping traffic routes/lanes commonly used by other vessels approaching/leaving Halifax Harbour. Once out in the open sea, the support vessel will select the most direct route for reaching the destination. The PSVs may transit through fishing areas, although this would result in a slight incremental increase over similar effects currently associated with existing high levels of marine traffic and shipping activity throughout the RAA.

Key potential interactions between PSV operations and biological VCs are related to routine emissions, underwater sound, and the risk of collision with marine mammals and sea turtles (refer to Section 7.3). Effects of PSV lights would be similar to those associated with the presence of the MODU (refer to Section 7.1.1) and therefore could have an interaction with migratory birds (refer to Section 7.4 for further information).

7.1.4.3 Underwater Sound

Underwater acoustic modelling for the Project assumed PSV source levels of 188.6 dB re 1 µPa @ 1 m RMS SPL (refer to Zykov 2016; Appendix D). Effects of underwater sound from PSV operation are considered alongside MODU operation, since the highest sound levels are predicted during times when the MODU and PSV are operating simultaneously.

7.1.4.4 Vessel Strikes

The presence and operation of PSVs will result in an increase in marine traffic within the LAA. It is likely that two to three PSVs will be required to support the Project, with one vessel on stand-by at the MODU at all times. It is estimated that the PSVs will make two to three round trips per week between the MODU and the supply base. The increase in vessel traffic from the Project could potentially increase the risk of mortality of marine mammals and sea turtles due to vessel strikes. While there is limited information with respect to the effects of vessel collisions on sea turtles, vessel strikes have been identified as a leading cause of marine mammal injury and mortality (*e.g.,* Vanderlaan and Taggart 2007). Most injuries resulting from animal-vessel interactions are the result of either impact trauma or contact with the propellers (Laist *et al.* 2001). Vessel speed has been positively correlated with the likelihood of a strike, and the likelihood and degree of injury for both marine mammals and sea turtles (Kite-Powell *et al.* 2007; Laist *et al.* 2001; Hazel *et al.* 2007; Vanderlaan and Taggart 2007; Work *et al.* 2010). PSVs will travel at a speed of approximately 12 knots in transit to and from the Project Area, except as needed in the case of an emergency.

7.1.5 Well Abandonment

As discussed in Section 2.4.4, all wells drilled as part of the Project will be abandoned. Once wells have been drilled to TD and well evaluation programs completed (if applicable), the well will be plugged and abandoned in line with applicable BP practices and CNSOPB requirements.

The final well abandonment program has not yet been finalized; however these details will be confirmed to the CNSOPB as planning for the Project continues.

It is possible that the subsea infrastructure could be removed. If this is the case, casing will be cut below the seabed and the wellhead removed. The wellhead will be lifted to the surface and brought to shore using a PSV. No infrastructure will be left on the seafloor after the wellhead has been removed. These details will be confirmed as planning for the Project continues. There will be some underwater noise associated with well abandonment which could be detected by marine fish, marine mammals and sea turtles.

Alternatively, approval may be sought to leave the wellhead in place. Depending on the final details of the abandonment program, there could be some ongoing interaction with the benthic environment, which is evaluated as part of the Fish and Fish Habitat VC (see Section 7.2 for more information).

Both abandonment scenarios (*i.e.*, wellhead removal and wellhead left in place) have been assessed in the EIS.

Regardless of whether the wellhead is removed or kept in place, effects on the benthic environment are expected to be reversible (through colonization) or positive. If the wellhead is not removed, once abandoned it will provide benthic organisms with hard surfaces to colonize and promote benthic biodiversity and productivity, similar to an "artificial reef". Offshore EEM studies from the Deep Panuke Project on the Scotian Shelf report evidence of a "reef effect" with colonization of subsea production structures, including wellheads. Wellhead protection structures associated with the Deep Panuke Project have been colonized by blue mussels, sea cucumbers, sea anemones, and frequented by comb jellies (likely *Pleurobrachia* sp.), cod, Pollock, and cunner (McGregor Geoscience Limited 2012).

Prior to well abandonment, a survey will be completed to confirm the location of the well and details will be submitted to the CNSOPB. The well location will be marked on nautical charts as applicable.

7.2 FISH AND FISH HABITAT

Fish and Fish Habitat was selected as a VC in consideration of the ecological value provided to marine ecosystems, the socio-economic importance of fisheries resources (*i.e.*, target fish species), the EIS Guidelines, and the potential for interactions with Project activities and components. Fish and fish habitat are also regulated under the federal *Fisheries Act*, which includes provisions to protect the productivity of commercial, recreational and Aboriginal (CRA) fisheries. For the purposes of this assessment, Fish and Fish Habitat is assessed according to the following definitions under the *Fisheries Act:*

> "Fish" is defined under section 2 of the *Fisheries Act* and includes: fish, shellfish, crustaceans, and marine animals; any parts of fish, shellfish, crustaceans, and marine animals; and the eggs, sperm, spawn, larvae, spat, and juvenile stages of fish, shellfish, crustaceans, and marine animals.
>
> "Fish habitat" is defined in the *Fisheries Act* as including spawning, rearing, nursery, food supply, overwintering, migration corridors, and any other area on which fish depend directly or indirectly in order to carry out their life processes.

As indicated in Table 6.2.1 in Section 6, fish habitat includes all aspects of the physical marine environment, including the benthic environment and water quality. Marine plants are not located in the Project Area (given water depth) and routine Project activities are not predicted to interact with marine plants which occur in the nearshore.

Although "fish", as defined under the *Fisheries Act*, is inclusive of marine mammals and sea turtles as marine animals, environmental effects on marine mammals and sea turtles are considered separately in the Marine Mammals and Sea Turtles VC (Section 7.3) due to differences in the nature and extent of potential Project interactions.

Environmental effects on designated Special Areas, including those that provide important habitat for fish species and the prey upon which fish species depend, are assessed with respect to the Special Areas VC (Section 7.5).

Although the assessment in relation to this VC considers potential environmental effects on fisheries resources, potential environmental effects on commercial and Aboriginal fish harvesting are assessed separately in the context of the closely related Fisheries VC (Section 7.6) and Current Aboriginal Use of Lands and Resources for Traditional Purposes VC (Section 7.7), respectively.

7.2.1 Regulatory and Policy Setting

The *Fisheries Act* focuses on protecting the productivity of CRA fisheries including a prohibition against causing serious harm to fish (*i.e.*, the death of fish or any permanent alteration to, or destruction of, fish habitat) that are part of or support a CRA fishery (section 35) (DFO 2013y). Proponents of projects that cause serious harm to fish are required to offset that harm to maintain and enhance the productivity of the fishery (DFO 2013z). Section 36(3) of the *Fisheries Act* prohibits the deposition of a deleterious substance in waters frequented by fish.

Fish Species at Risk (SAR) are protected under the federal *Species at Risk Act* (SARA), which focuses on protecting species and associated habitat whose populations are not secure. For the purposes of this assessment, sections 32, 33 and 58 of SARA are the most relevant sections of the Act that contain provisions to protect species listed on Schedule 1 of SARA and their critical habitat. Critical habitat is defined by SARA 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 the recovery strategy or in an action plan for the species" (section 2[1]). Critical habitat has not yet been defined for any listed fish species.

Ministerial notification is required under section 79 of SARA if a project is likely to affect a listed wildlife species or its critical habitat. The person required to notify the minister must identify the adverse effects of the project on the listed wildlife species and its critical habitat and, if the project is carried out, must ensure that measures are taken to avoid or lessen those effects and to monitor them.

The *Canadian Environmental Protection Act*, 1999 (CEPA), and specifically the Disposal at Sea Regulations, also protect marine fish and fish habitat. These regulations (*i.e.*, the Disposal at Sea provisions of Part 7, Division 3 of CEPA, under the authority of Environment Canada; CEPA 1999), stipulate that disposal in the marine environment requires a permit and that sediment or cuttings be screened for potential chemical contaminants.

7.2.2 The Influence of Engagement on the Assessment

Key issues raised during stakeholder and Aboriginal engagement for the Project to date include general concerns related to potential Project effects (and cumulative effects) on the marine environment including fish species at risk, commercial fish species, and/or fish species that have been identified as having significance to Mi'kmaq and/or Wolastoqiyik (Maliseet) culture. Questions and concerns were raised with respect to effects of routine discharges and spills on fish populations and migration, feeding, and spawning activities that could be occurring in the affected area.

7.2.3 Potential Environmental Effects, Pathways and Measurable Parameters

Routine Project activities and components have the potential to interact with fish and fish habitat, primarily due to underwater sound emissions from MODU operation, PSV traffic, and VSP surveys. Operational solid and liquid discharges from the MODU and PSVs (*e.g.*, drill muds and cuttings, cooling water, ballast water, bilge and deck water, grey/black water and process water) can interact with fish and fish habitat.

As a result of these considerations, and the policies put in place to protect fish and their habitat outlined in the *Fisheries Act,* SARA, and CEPA, the assessment of Project-related environmental effects on Fish and Fish Habitat is focused on the following potential environmental effects:

- Change in Risk of Mortality or Physical Injury; and
- Change in Habitat Quality and Use.

These effects capture *Fisheries Act* prohibitions against causing serious harm to fish (*i.e.*, "the death of fish) or any permanent alteration to, or destruction of, fish habitat") that are part of or support a CRA fishery and also allow for consideration of effects on fish SAR. The measurable parameters used for the assessment of the potential environmental effects identified above, and the rationale for their selection, are provided in Table 7.2.1. Effects of accidental events are assessed separately in Section 8.5.1.

Table 7.2.1 Potential Environmental Effects, Effects Pathways and Measurable Parameters for Fish and Fish Habitat

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in Risk of Mortality or Physical Injury	Direct project effects on fish mortality, injury or health due to direct interactions with individuals (*e.g.*, smothering as a result of deposition of cuttings/drill muds) or indirectly through a change in habitat quality (degradation of habitat quality affecting fish health)	• Mortality,(may be either direct measurement or qualitative) focused on population level changes

Table 7.2.1 Potential Environmental Effects, Effects Pathways and Measurable Parameters for Fish and Fish Habitat

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in Habitat Quality and Use	Change in fish habitat use due to physical disturbance, destruction of benthic habitats or deposition of cuttings/drill muds	• Areal extent of alteration or destruction of fish habitat (ha)
	Change in fish habitat quality due to a change in the chemical composition of sediment and water	• Areal extent (ha) of fish habitat affected by changes in water quality and/or sediment quality
	Increased risk of exposure to underwater sound at levels capable of causing sensory disturbance	• Area of potential behavioural or physiological effects on fish from underwater sound emissions and reported thresholds

7.2.4 Environmental Assessment Boundaries

7.2.4.1 Spatial Boundaries

The spatial boundaries for the environmental effects assessment for Fish and Fish Habitat are defined below and depicted on Figure 7.2.1.

Project Area: The Project Area encompasses the immediate area in which Project activities and components may occur and as such represents the area within which direct physical disturbance to the marine benthic environment may occur. Well locations have not yet been identified, but will occur within the Project Area and represent the actual Project footprint. The Project Area includes ELs 2431, 2432, 2433, and 2434.

Local Assessment Area (LAA): The LAA is the maximum area within which potential environmental effects from Project activities and components can be predicted or measured with a reasonable degree of accuracy and confidence. It consists of the Project Area and adjacent areas where Project-related environmental effects on Fish and Fish Habitat are reasonably expected to occur. Based on predicted propagation of sound pressure levels (SPLs) from Project activities and reported thresholds for behavioural effects on fish, a buffer of 30 km around the Project Area boundaries has been established to represent the LAA. The LAA has also been defined to include PSV routes to and from the Project Area.

Regional Assessment Area (RAA): The RAA is the area within which residual environmental effects from Project activities and components may interact cumulatively with the residual environmental effects of other past, present, and future (*i.e.*, certain or reasonably foreseeable) physical activities and to provide regional context for the effects assessment. The RAA is restricted to the 200 nautical mile limit of Canada's EEZ, including offshore marine waters of the Scotian Shelf and Slope within Canadian jurisdiction.

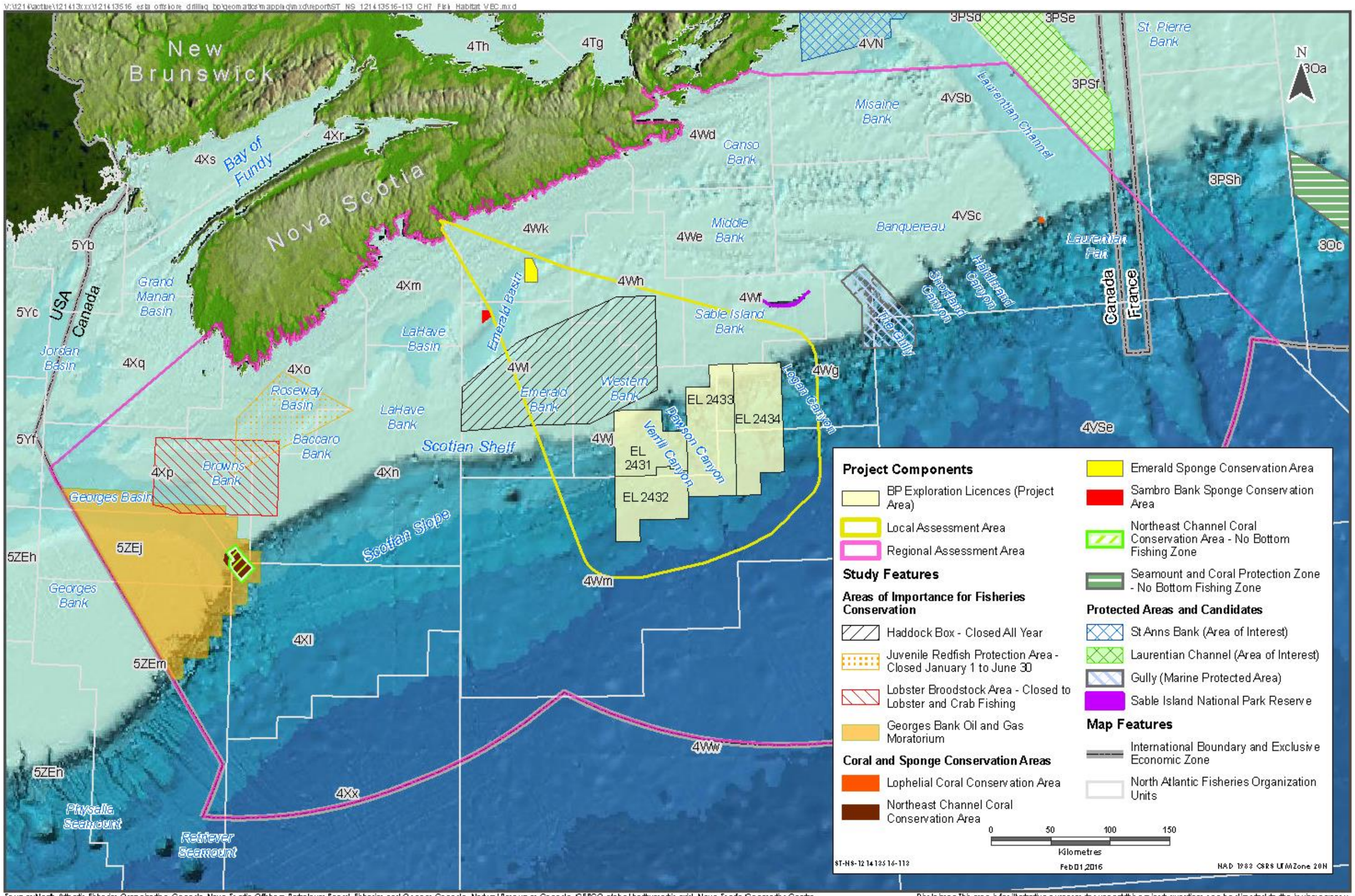


Figure 7.2.1 Assessment Boundaries for Fish and Fish Habitat

7.2.4.2 Temporal Boundaries

The temporal boundaries for the assessment of potential Project-related environmental effects on Fish and Fish Habitat encompass all Project phases, including well drilling, testing and abandonment. Up to seven exploration wells will be drilled over the term of the ELs, with Project activities at each well taking approximately 120 days to drill. It is assumed that Project activities could occur year-round; however, VSP operation (and pulsed sound associated with VSP) is expected to take no more than a day per well.

Fish can be found year-round in and around the Project Area carrying out various life cycle processes. Refer to Section 5.2.5 for specific details regarding specific marine fish species (*i.e.*, SAR and Species of Conservation Concern (SOCC) and species of importance to CRA fisheries) known to occur in the RAA, including their sensitive life stages and their relation to the Project Area.

7.2.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance

Table 7.2.2 defines the descriptors used to characterize residual environmental effects on Fish and Fish Habitat.

Table 7.2.2 Characterization of Residual Environmental Effects on Fish and Fish Habitat

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	**Positive** – an effect that moves measurable parameters in a direction beneficial to Fish and Fish Habitat relative to baseline **Adverse** – an effect that moves measurable parameters in a direction detrimental to Fish and Fish Habitat relative to baseline **Neutral** – no net change in measureable parameters for the Fish and Fish Habitat relative to baseline
Magnitude	The amount of change in measurable parameters of the VC relative to existing conditions	**Negligible** – no measurable change in marine species populations, habitat quality or quantity **Low** – a measurable change but within the range of natural variability; will not affect population viability **Moderate** – measurable change but not posing a risk to population viability **High** – measurable change that exceeds the limits of natural variability and may affect long-term population viability
Geographic Extent	The geographic area in which an environmental effect occurs	**Project Area** – effects are restricted to the Project Area **Local Assessment Area** – effects are restricted to the

Table 7.2.2 Characterization of Residual Environmental Effects on Fish and Fish Habitat

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
		LAA **Regional Assessment Area** – effects are restricted to the RAA
Frequency	Identifies how often the residual effect occurs	**Single Event** – effect occurs once **Multiple Irregular Event** – occurs more than once at not set schedule **Multiple Regular Event** – occurs more than once at regular intervals **Continuous** – occurs continuously
Duration	The period of time required until the measurable parameter of the VC returns to its existing condition, or the effect can no longer be measured or otherwise perceived	**Short-term** – effect extends for a portion of the duration of Project activities **Medium-term** – effect extends through the entire duration of Project activities **Long-term** – effects extend beyond the duration of Project activities and continue after well abandonment
Reversibility	Pertains to whether a measurable parameter or the VC can return to its existing condition after the project activity ceases	**Reversible** – will recover to baseline conditions before or after Project completion (well abandonment) **Irreversible** – permanent
Ecological and Socio-economic Context	Existing condition and trends in the area where environmental effects occur	**Undisturbed** – area is relatively undisturbed or not adversely affected by human activity **Disturbed** – area has been substantially disturbed by previous human development or human development is still present

In consideration of the descriptors listed above, as well as consideration of requirements under SARA and associated regulations and recovery plans, the following threshold has been established to define a significant adverse residual environmental effect on Fish and Fish Habitat.

For the purposes of this effects assessment, a **significant adverse residual environmental effect** on Fish and Fish Habitat is defined as a Project-related environmental effect that:

- causes a significant decline in abundance or change in distribution of fish populations within the RAA, such that natural recruitment may not re-establish the population(s) to its original level within one generation;
- jeopardizes the achievement of self-sustaining population objectives or recovery goals for listed species;
- results in permanent and irreversible loss of critical habitat as defined in a recovery plan or an action strategy; or

- results in serious harm to fish as defined by the *Fisheries Act* that is unauthorized, unmitigated, or not compensated through offsetting measures in accordance with DFO's Fisheries Protection Policy Statement (DFO 2013z).

7.2.6 Existing Conditions

The Project Area is located to the south of the Sable Island and Western Banks in an area partly on the Scotian Shelf but primarily on the Scotian Slope. Water depths in the Project Area range from approximately 100 m to over 3,000 m. At water depths of 2,000 to 3,000 m, the slope is more gradual and known as the Continental Rise. Figure 5.1.14 (Section 5.1) illustrates a bathymetric overview of the Project Area and the Scotian Slope. Notable bathymetric features present within or adjacent to the Project Area include the Verrill Canyon, which extends into the Project Area, and Dawson and Logan Canyons that are immediately adjacent to the Project Area (Figure 5.1.14). The eastern Scotian Shelf (east of the Project Area) hosts a series of deepwater canyons, including the Gully and Shortland and Haldimand canyons, which originate on the outer edge of the Scotian Shelf and continue down the slope (Figure 5.1.14).

Several deepsea benthic surveys have been undertaken along the Scotian Slope in 2001 and 2002 in former licence blocks near and overlapping the Scotian Basin Project Area (refer to Section 5.2.2). The areas previously surveyed are within the depth range of the Project Area and the habitat among the adjacent blocks is consistent and provides supporting evidence to suggest that similar habitat is likely to occur within the Project Area (Figure 5.2.4).

Overall, the benthic fauna across the two blocks (former ELs 2381 and 2382) was low in abundance and diversity, and no regions contained substantial coral development (JWEL 2003). BP will conduct an imagery based seabed survey in the vicinity of wellsites to ground-truth the findings of the GBR. This includes confirming the absence of habitat-forming corals or species at risk. Refer to Section 5.2.2 for additional information on the habitat of the previously surveyed blocks within and adjacent to the Project Area.

There are 24 fish SAR and SOCC that may be present on the Scotian Shelf or Slope at various times of the year. A complete list of species, their status and presence near the Project is presented in Table 7.2.3. Details on life history characteristics (*i.e.*, mating, spawning and potential times and locations of species' larvae and eggs) are provided in Section 5.2, Table 5.2.3.

Table 7.2.3 Fish Species at Risk and/or of Conservation Concern Potentially Occurring on the Scotian Shelf and Slope

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation[1]	Potential for Occurrence in the Project Area[2]	Timing of Presence
Acadian redfish (Atlantic population)	*Sebastes fasciatus*	Not Listed	Threatened	Low	Year-round
American eel	*Anguilla rostrata*	Not Listed	Threatened	Transient	November -Silver eel out migration from NS March to July - Larvae and glass eels on the Slope and Shelf
American plaice (Maritime population)	*Hippoglossus platessoides*	Not Listed	Threatened	Low	Year-round
Atlantic bluefin tuna	*Thunnus thynnus*	Not Listed	Endangered	High	June to October
Atlantic cod (Laurentian South population)	*Gadus morhua*	Not Listed	Endangered	Low	Year-round
Atlantic cod (Southern population)		Not Listed	Endangered	Low	Winter – Deep water of Browns and LaHave Banks Summer- Southern Northwest Channel, shallow waters of Browns and LaHave Banks
Atlantic salmon (Outer Bay of Fundy population)	*Salmo salar*	Not Listed	Endangered	Transient	March to November
Atlantic salmon (Inner Bay of Fundy population)		Endangered	Endangered	Transient	March to November

Table 7.2.3 Fish Species at Risk and/or of Conservation Concern Potentially Occurring on the Scotian Shelf and Slope

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation[1]	Potential for Occurrence in the Project Area[2]	Timing of Presence
Atlantic salmon (Eastern Cape Breton population)		Not Listed	Endangered	Transient	March to November
Atlantic salmon (Nova Scotia Southern Upland population)		Not Listed	Endangered	Transient	March to November
Atlantic sturgeon (Maritimes population)	*Ancipenser oxyrinchus*	Not Listed	Threatened	Low	Year-round
Atlantic wolffish	*Anarhichas lupus*	Special Concern	Special Concern	Low	Year-round
Basking shark (Atlantic population)	*Cetorhinus maximus*	Not Listed	Special Concern	Low to Moderate	Year-round
Blue shark (Atlantic population)	*Priomace glauca*	Not Listed	Special Concern	Moderate to High	June to October
Cusk	*Brosme brosme*	Not Listed	Endangered	Low to Moderate	Year-round
Deepwater redfish (Northern population)	*Sebastes mentalla*	Not Listed	Threatened	Low	Year-round
Northern wolffish	*Anarhichas denticulatus*	Threatened	Threatened	Low	Year-round
Porbeagle shark	*Lamna nasus*	Not Listed	Endangered	High	Year-round
Roughhead grenadier	*Macrourus berglax*	Not Listed	Special Concern	Moderate	Year-round
Roundnose grenadier	*Coryphaenoides rupestris*	Not Listed	Endangered	Moderate to High	Year-round
Shortfin mako	*Isurus oxyrinchus*	Not Listed	Threatened	Moderate	July to October
Smooth skate (Laurentian-Scotian population)	*Malacoraja senta*	Not Listed	Special Concern	Moderate	Year-round
Spiny dogfish (Atlantic population)	*Squalus acanthias*	Not Listed	Special Concern	High	Year-round

Table 7.2.3 Fish Species at Risk and/or of Conservation Concern Potentially Occurring on the Scotian Shelf and Slope

<table>
<tr><th>Common Name</th><th>Scientific Name</th><th>SARA Schedule 1 Status</th><th>COSEWIC Designation[1]</th><th>Potential for Occurrence in the Project Area[2]</th><th>Timing of Presence</th></tr>
<tr><td>Spotted wolffish</td><td>Anarhichas minor</td><td>Threatened</td><td>Threatened</td><td>Low</td><td>Year-round</td></tr>
<tr><td>Striped bass (Southern Gulf of St. Lawrence population)</td><td rowspan="2">Morone saxatilis</td><td>Not Listed</td><td>Special Concern</td><td>Low</td><td rowspan="2">June to October</td></tr>
<tr><td>Striped bass
(Bay of Fundy population)</td><td>Not Listed</td><td>Endangered</td><td>Low</td></tr>
<tr><td>Thorny skate</td><td>Amblyraja radiate</td><td>Not Listed</td><td>Special Concern</td><td>Low to Moderate</td><td>Year-round</td></tr>
<tr><td>White shark</td><td>Carcharodon Carcharias</td><td>Endangered</td><td>Endangered</td><td>Low</td><td>June to November</td></tr>
<tr><td>White hake</td><td>Urophycis tenuis</td><td>Not Listed</td><td>Special</td><td>Moderate</td><td>Year-round</td></tr>
<tr><td colspan="6">Note:
[1]Species of conservation concern (SOCC) listed as endangered, threatened, or of special concern by COSEWIC and not listed on Schedule 1 of SARA.
[2]This is based on the analysis of habitat preferences during various life-history stages, distribution mapping, and catch data for each species within the Project Area.</td></tr>
</table>

Source: BIO 2013a; Campana *et al.* 2013; COSWEIC 2006a, 2006b, 2007a, 2008a, 2009b, 2009c, 2010a, 2010b, 2010c, 2010d, 2011b, 2012a, 2012b, 2012c, 2012d, 2012e, DFO 2013e, 2013l, 2013j, 2013k, 2013w; Horseman and Shackell 2009; Maguire and Lester 2012; NOAA2013e; SARA 2015

As noted in Table 7.2.3, five fish species are listed under Schedule 1 and formally protected under SARA. These species include:

- Atlantic salmon (Inner Bay of Fundy population);
- Atlantic wolffish;
- Northern wolffish;
- Spotted wolffish; and
- White shark.

Atlantic salmon are expected to be transient, and individuals from the Inner Bay of Fundy population are not expected to occur in the Project Area. Unlike all other salmon in North America, evidence suggests that inner Bay of Fundy Atlantic Salmon have very limited migration, staying within the Bay of Fundy and the Gulf of Maine for extended periods (SARA 2015).

Atlantic wolffish are typically found inhabiting the seafloor in water depths of 150 to 350 m and have been found as deep as 918 m (COSEWIC 2012b). An examination of wolffish landings in NAFO Division 4X revealed that Atlantic wolffish were concentrated on the western peak of Browns Bank, west of German Bank and in three isolated areas inshore of the 100-m isobath contour line (LGL 2014). Northern wolffish are found in deep water up to 1,500 m and prefer a narrow temperature range of 3 to 5°C; it is believed that temperature is a limiting factor in their distribution (COSEWIC 2012d). Spotted wolffish prefer a broader water temperature range of 2 to 8°C and are often found in shallower water than their Northern counterparts. Both benthic fish species could be found in low numbers on the Scotian Shelf and prefer sand or a mix of sand and shell habitat; the potential occurrence of any of these wolffish species in the Project Area is deemed low based on habitat preferences (COSEWIC 2012d, COSEWIC 2012e).

The white shark is rare in the northwest Atlantic (32 records in 132 years), as it is the northern edge of their range. Recorded sightings near the Project include the Bay of Fundy, Laurentian Channel, and Sable Island Bank. They are predominantly pelagic and can range in water depth from the surface to 1,300 m. These fish are highly mobile and migrate seasonally (COSEWIC 2006b).

Table 5.2.20 summarizes Special Areas in the RAA. Special Areas are often designated to protect SAR and SOCC including fish species. Special Areas of particular relevance to Fish and Fish Habitat include the following:

- Sambro Bank and Emerald Basin *Vazella* Closure Areas - Approximately 130 and 126 km northwest of the Project Area, respectively are habitat for the glass sponge *Vazella pourtalesi* which is known to exist in only three locations worldwide – the Gulf of Mexico, the Azores, and in Canada. The locations on the Scotian Shelf are the only instances where large aggregations have been found and thus are regarded as being globally-unique aggregations.

- Georges Bank – Approximately 300 km southwest from the Project Area, Georges Bank is at the northern edge of southern assemblages of plankton and fish and at the southern edge of northern assemblages. Therefore, biodiversity is very high in this area (of both subpolar and subtropical assemblages), with the Northeast Peak being the most productive part of Georges Bank (NRCan and NSPD 1999).

- Northeast Channel Coral Conservation Area – Approximately 306 km southwest from the Project Area. This conservation area was primarily selected on the basis of having the highest density of large, branching octocorals (gorgonian), *Paragorgia arborea* and *Primnoa resdaeformis* in the Maritimes. These corals provide various ecosystem functions, and coral biomass has been shown to be closely correlated to fish biodiversity (Campbell and Simms 2009).

- Emerald Bank, Western Bank and Sable Bank Complex Ecologically and Biologically Significant Area (EBSA) – Located north of the Project Area. The Emerald Bank, Western Bank and Sable Bank Complex is an area with the highest larval fish density along the Scotian Shelf due to seasonal congregations of spawning fish. This bank complex provides a juvenile nursery area for haddock, cod, monkfish, skates and flounder.

- Haddock Nursery Closure, Emerald and Western Banks (Haddock Box) – Located north of the Project Area in the Emerald Bank, Western Bank and Sable Bank Complex EBSA. The Haddock Box is an important nursery area for juvenile haddock, and is closed year-round by DFO to the commercial groundfish fishery. Scallop fishing continues to occur on the eastern-most part of the closed area (O'Boyle 2011).

Further information about Special Areas is presented in Section 7.5.

As noted above, fish and fish habitat are regulated under the federal *Fisheries Act*, which includes provisions to protect the productivity of CRA fisheries. Within and surrounding the Project Area, the socio-economic setting is dominated by commercial and Aboriginal fisheries activity. Groundfish, pelagic, and invertebrate fisheries occur on the Scotian Shelf and Slope, with large pelagics (*e.g.*, swordfish, tuna, and shark) being the most commonly harvested fish in the Project Area. Following the collapse of the traditional groundfish stocks (*e.g*., cod, flatfish and pollock), shellfish stocks have grown significantly in their contribution to revenue and profitability of the Scotian Shelf fishery. CRA fish species with the potential to occur in the Project Area are listed in Table 7.2.4. The corresponding fisheries data are presented in Section 5.3.5, with the assessment of the interaction of the Project with commercial and Aboriginal fisheries presented in Sections 7.6 and 7.7, respectively.

Table 7.2.4 Fish Species of Commercial, Recreational or Aboriginal Value Found in the RAA

Common Name	Scientific Name	Potential for Occurrence in the Project Area[1]	Timing of Presence
Groundfish Species			
Acadian redfish[2]	*Sebastes fasciatus*	Low	Year-Round
American plaice[2]	*Hippoglossoides platessoides*	Low	Year-Round
Atlantic cod[2]	*Gadus morhua*	Low	Year-Round
Atlantic halibut	*Hippoglossus hippoglossus*	Moderate	Year-Round
Deepwater redfish[2]	*Sebastes mentalla*	Low	Year-Round
Haddock	*Melanogrammus aeglefinus*	Low	Year-Round
Hagfish	*Myxine glutinosa*	Moderate	Year-Round
Monkfish	*Lophius americanus*	Low	Year-Round
Pollock	*Pollachius virens*	Low	Year-Round
Red hake	*Urophycis chuss*	Low	Year-Round
Sand lance	*Ammodytes dubius*	Low	Year-Round
Silver hake	*Merluccius bilinearis*	Low	Year-Round
Turbot – Greenland flounder	*Reinhardtius hippoglossoides*	Moderate to High	Year-Round
White hake[2]	Urophycis tenuis	Moderate	Year-Round
Witch flounder	*Glyptocephalus cynoglossus*	Low	Year-Round
Yellowtail founder	*Limanda ferruginea*	Low	Year-Round
Pelagic Species			
Albacore tuna	*Thunnys alalunga*	Low	July to November
Alewife	*Alosa pseudolarengus and A. aestivalis*	Low	July to February
Atlantic herring	*Clupea harengus*	Low	Year-round
Atlantic mackerel	*Scomber scombrus*	Low	Winter – deep water on the Shelf Spring/Summer – Migrate to shallower coastal zones
Bigeye tuna	*Thunnus obesis*	Low	July to November
Black dogfish	*Centroscyllium fabricii*	Low	Year-round
Bluefin tuna[2]	*Thunnus thynnus*	Low	June to October
Blue shark[2]	*Prionace glauce*	Moderate	June to October
Capelin	*Mallotus villosus*	Low	Year-round
Porbeagle shark[2]	*Lamna nasus*	Moderate	Year-round

Table 7.2.4 Fish Species of Commercial, Recreational or Aboriginal Value Found in the RAA

Common Name	Scientific Name	Potential for Occurrence in the Project Area[1]	Timing of Presence
Shortfin mako shark[2]	*Leurus oxyringus*	Moderate	July to October
Swordfish	*Xiphias gladuis*	Moderate	July to October
White marlin	*Tetrapturus albidus*	Moderate	July to October
Yellowfin tuna	*Thunnus albacares*	Low	July to October
Invertebrates			
American lobster	*Homarus americanus*	Low	Year-round
Jonah crab	*Cancer borealis*	Low	Year-round
Atlantic sea scallop	*Placopecten magellanicus*	Low	Year-round
Clams (Atlantic Surf, Soft-shelled, quahaugs)	*Spisula solidissima, Mya areniaria, Mercenaria mercenaria.*	Low	Year-round
Green sea urchin	*Strongylocentrotus droebachiensis*	Low	Year-round
Northern shrimp	*Pandalus borealis*	Low	October - April – Nearshore May - September-Offshore
Shortfin squid	*Illex illecebrosus*	High	April – November[3]
Snow crab	*Chionoecetes opilio*	Low	Year-round
Red crab	*Chaceon quinquedens*	Low	Year-round

Note:
[1] Based on the analysis of habitat preferences during various life-history stages, distribution mapping, and catch data for each species within the Project Area.
[2] Species at Risk or Species of Conservation Concern.
[3] Based on assumed spawning times.

For more information on baseline conditions for Fish and Fish Habitat, refer to Sections 5.1 (Marine Physical Environment), 5.2 (Marine Biological Environment) and 5.3 (Socioeconomic Environment).

7.2.7 Potential Project-VC Interactions

Table 7.2.5 identifies the physical Project activities that can interact with the Fish and Fish Habitat VC to result in the identified environmental effects. These interactions are indicated by checkmarks and are discussed in Section 7.2.8 in the context of effects pathways, mitigation, and residual effects. A justification is provided below for non-interactions where applicable.

Table 7.2.5 Potential Project-Environment Interactions and Effects on Fish and Fish Habitat

Project Components and Physical Activities	Potential Environmental Effects	
	Change in Risk of Mortality or Physical Injury	Change in Habitat Quality and Use
Presence and Operation of MODU (including well drilling and testing operations and associated lights, safety [exclusion] zone and underwater sound)	✓	✓
Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)	✓	✓
Vertical Seismic Profiling	✓	✓
Supply and Servicing Operations (including helicopter transportation and PSV operations)	-	✓
Well Abandonment	-	✓

Note:
✓ = Potential interactions that might cause an effect.
– = Interaction between the Project and the VC are not expected.

Supply and Servicing Operations

Helicopter transportation is not predicted to interact with Fish and Fish Habitat to cause a Change in Risk of Mortality or Physical Injury or Change in Habitat Quality and Use due to a lack or very limited interaction with the marine environment (*i.e.*, very weak to no underwater sound transmission and no marine discharges) and associated fish and fish habitat.

The operation of the PSVs (including transit and transfer activities) is not predicted to interact with Fish and Fish Habitat resulting in a Change in Risk of Mortality or Physical Injury because the underwater sound levels associated with PSV traffic is not expected to be at levels that would cause injury or mortality to marine fish species. Fish are anticipated to temporarily avoid the immediate areas subject to PSV traffic, thereby reducing the risk of fish mortality due to vessel strikes or contact with propeller blades. Change in Habitat Quality and Use for fish species has been identified as having potential interactions with PSVs that might cause an environmental effect on Fish and Fish Habitat and is therefore discussed in Section 7.2.8.

Well Abandonment

All wells drilled in the drilling campaign will likely be permanently plugged and abandoned. Wells will be abandoned using a series of cement and mechanical plugs within the wellbore, and will have no interaction with fish and fish habitat outside of the wellsite. Whether the wellhead is removed or kept in place, well abandonment activities are not anticipated to produce underwater sound or discharges that would pose a risk of physical injury or mortality to fish. Well abandonment activities are therefore not predicted to interact with Fish and Fish Habitat resulting in a Change in Risk of Mortality or Physical Injury. Well abandonment may interact with Fish and Fish Habitat potentially resulting in a Change in Habitat Quality and Use; this effect is therefore discussed in Section 7.2.8.

7.2.8 Assessment of Project-Related Environmental Effects

The following section assesses the environmental effects on Fish and Fish Habitat arising from potential interactions identified in Table 7.2.5. Given the similarities in Project description, proximity of activities on the Scotian Slope, and relevancy of recent data, the Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) and the Environmental Assessment of BP Exploration (Canada) Limited's Tangier 3D Seismic Survey (LGL 2014) have been referenced extensively for this analysis, with updates incorporated as applicable due to Project and geographic differences (*e.g*., expansion of geographic scope), scientific updates, and refined EA methods.

7.2.8.1 Project Pathways for Effects

Change in Risk of Mortality or Physical Injury

A Change in Risk of Mortality or Physical Injury for individual marine fish may result from underwater sound associated with the presence and operation of the MODU and VSP. Drilling operations and station-keeping (*i.e.*, use of dynamic positioning thrusters) during MODU operations will generate underwater sound while the MODU is on station, affecting the quality of the underwater acoustic environment for fish species in the Project Area. VSP operation will also result in temporarily (no more than a day per well) increased sounds levels in the marine environment. Sound levels in very close proximity to the VSP sound array may result in physical injury or mortality from acute changes in pressure.

Mortality or physical injury may also occur to benthic species (*e.g*., fish, shellfish, sponges and corals) from smothering or crushing as a result of waste management activities (particularly the discharging of drill muds and cuttings). Routine liquid discharges (cooling water, ballast water, bilge and deck water, grey/black water and small amounts of process water during well testing) will be in accordance with the OWTG, Transport Canada's *Ballast Water Control and Management Regulations* and/or MARPOL as applicable, which are designed to be protective of the marine environment and will not be at levels that would cause mortality or physical injury to fish species.

Change in Habitat Quality and Use

A Change in Habitat Quality and Use for marine fish may occur as a result of Project activities affecting the marine environment including the presence and operation of the MODU (light and sound emissions into the water column), waste management (discharge of drill muds and cuttings affecting water and sediment quality), VSP (underwater sound), supply and servicing operations (PSV operations and underwater sound associated with vessel movement), and well abandonment (potential underwater sound associated with removal of wellhead infrastructure and/or a change in benthic habitat associated with leaving the wellhead in place).

7.2.8.2 Mitigation of Project-Related Environmental Effects

In consideration of the environmental effect pathways outlined above, the following mitigation measures and standard practices will be employed to reduce the potential environmental effects of the Project on Fish and Fish Habitat. Refer to Table 13.2.1 for a complete list of Project mitigation measures.

Presence and Operation of MODU

- BP will conduct an imagery based seabed survey in the vicinity of wellsites to ground-truth the findings of the GBR. This includes confirming the absence of shipwrecks, debris on the seafloor, unexploded ordnance and sensitive environmental features, such as habitat-forming corals or species at risk. The survey will be carried out prior to drilling. If any environmental or anthropogenic sensitivities are identified during the survey, BP will move the wellsite to avoid affecting them if it is feasible to do so. If it is not feasible, BP will consult with the CNSOPB to determine an appropriate course of action.
- No Project well locations will be located within the Haddock Box.
- Lighting will be reduced to the extent that worker safety and safe operations is not compromised. Reduction of light may include avoiding use of unnecessary lighting, shading, and directing lights towards the deck.

Waste Management

- As described in Section 2.8, offshore waste discharges and emissions associated with the Project (*i.e.*, operational discharges and emissions from the MODU and PSVs) will be managed in accordance with relevant regulations and municipal bylaws as applicable, including the *Offshore Waste Treatment Guidelines* (OWTG) and the *International Convention for the Prevention of Pollution from Ships* (MARPOL), of which Canada has incorporated provisions under various sections of the *Canada Shipping Act*. Waste discharges not meeting legal requirements will not be discharged to the ocean and will be brought to shore for disposal.
- Selection of drilling chemicals will be in accordance with the OCSG that provides a framework for chemical selection to reduce potential for environmental effects. During planning of drilling activities, where feasible, lower toxicity drilling muds and biodegradable and environmentally friendly additives within muds and cements will be preferentially used. Where feasible, the chemical components of the drilling fluids will be those that have been rated as being least hazardous under the OCNS scheme and as PLONOR by OSPAR.

- Discharges of SBM mud and cuttings will be managed in accordance with the OWTG. SBM cuttings will only be discharged once the performance targets in OWTG of 6.9 g/100 g retained "synthetic on cuttings" on wet solids can be satisfied. The concentration of SBM on cuttings will be monitored on the MODU for compliance with the OWTG. In accordance with OWTG, no excess or spent SBM will be discharged to the sea. Spent or excess SBM that cannot be re-used during drilling operations will be brought back to shore for disposal.

- Excess cement may be discharged to the seabed during the initial phases of the well, which will be drilled without a riser. Once the riser has been installed, all cement waste will be returned to the MODU. Cement waste will then be transported to shore for disposal in an approved facility.

- Small amounts of produced water may be flared. If volumes of produced water are large, some produced water may be brought onto the MODU for treatment so that it can be discharged in line with the OWTG.

- Deck drainage and bilge water will be discharged according to the OWTG, which state that deck drainage and bilge water can only be discharged if the residual oil concentration of the water does not exceed 15 mg/L.

- Ballast water will be discharged according to IMO *Ballast Water Management Regulations* and Transport Canada's *Ballast Water Control and Management Regulations.* The MODU will carry out ballast tank flushing prior to arriving in Canadian waters.

- Sewage will be macerated prior to discharge. In line with the OWTG and International Convention for the Prevention of Pollution from Ships (MARPOL) requirements, sewage will be macerated so that particles are less than 6 mm in size prior to discharge.

- Cooling water will be discharged in line with the OWTG*, which* states that any biocides used in cooling water are selected in line with a chemical management system developed in line with the OCSG. Cooling water is likely to be warmer than the ambient water temperature upon discharge but will be rapidly dispersed, reaching ambient temperatures.

- BOP fluids and any other discharges from the subsea control equipment will be discharged according to OWTG and OCSG.

- Any hydrocarbons, such as gas, oil or formation water that are brought to surface as part of well test activity will be flared to enable their safe disposal. All flaring will be via one of two horizontal burner booms, to either a high efficiency burner head for liquids, or simple open ended gas flare tips for gases to minimize fall out of un-combusted hydrocarbons. Flaring will be optimized to the amount necessary to characterize the well potential and as necessary for the safety of the operation.

- Liquid wastes, not approved for discharge in OWTG such as waste chemicals, cooking oils or lubricating oils, will be transported onshore for transfer to an approved disposal facility.

- Waste management plans and procedures will be developed and implemented to prevent unauthorized waste discharges and transfers.
- Putrescible solid waste, specifically food waste generated offshore on the MODU and PSVs, will be disposed of according to OWTG and MARPOL requirements. In particular, food waste will be macerated so that particles are less than 6 mm in diameter and then discharged. There will be no discharge of macerated food waste within 3 nm from land. Biomedical waste will be collected onboard by the doctor and stored in special containers before being sent to land for incineration.
- Transfer of hazardous wastes will be conducted according to the *Transportation of Dangerous Goods Act*. Any applicable approvals for the transportation, handling and temporary storage, of these hazardous wastes will be obtained as required.

Vertical Seismic Profiling

- VSP activity will be planned and conducted in consideration of the *Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment* (SOCP; DFO 2007b).
- A ramp-up procedure (*i.e.*, gradually increasing seismic source elements over a period of approximately 30 minutes until the operating level is achieved) will be implemented before any VSP operation begins.
- BP will use the minimum amount of energy necessary to achieve operational objectives; reduce the energy at frequencies above those necessary for the purpose of the survey; and will reduce the proportion of energy that propagates horizontally.

Well Abandonment

- Once wells have been drilled to TD and well evaluation programs completed (if applicable), the well will be plugged and abandoned in line with applicable BP practices and CNSOPB requirements. The final well abandonment program has not yet been finalized; however, these details will be confirmed to the CNSOPB as planning for the Project continues.

7.2.8.3 Characterization of Residual Project-Related Environmental Effects

Change in Risk of Mortality or Physical Injury

Presence and Operation of MODU

Underwater sound levels from the MODU were modelled to predict sound level propagation and inform the effects assessment (refer to Appendix D for the acoustic modelling report). It is generally recognized that establishing a single sound exposure criteria for marine fish to predict physical or behavioural changes is very challenging given the variation in sound characteristics from different types of sound sources and interspecific differences in how sound affects different species (generally due to diversity in body type and physiology)(*e.g.,* Popper *et al.* 2014). Most research on sound exposure criteria for marine fish has focused on percussive sounds such as those produced during pile driving activity or seismic surveys.

Although intended as criteria for the onset of effects of impulsive sounds (*e.g.*, pile driving, air guns), in terms of injuries to fish, the US Fisheries Hydroacoustic Working Group proposes the dual criteria of a peak sound pressure level of 206 dB re 1 μPa (peak) and cumulative SEL of 187 dB re 1 $μPa^2s$ for fish 2 grams or heavier (Fisheries Hydroacoustic Working Group 2008). In consideration of this general criteria and the acoustic modelling conducted for the Project, physical injury effects to individual fish as a result of MODU operation would be very localized. It should also be noted that exposure at these levels would be transient as mobile fish would be expected to react behaviourally at lower thresholds, moving away from these sound levels before injury could occur.

The source levels for the MODU used in the acoustic modelling are 208.7 dB re 1 μPa @1m peak SPL (Zykov 2016), thus just slightly above the 206 dB re 1 μPa peak SPL threshold and therefore have potential to cause physical injury or mortality at very close range (*i.e.,* within 1 to 2 m) to individual fish (refer to Section 4.2.3.2 in Appendix D). Whilst physical effect on small fish may occur if they are in the immediate vicinity of the MODU, mobile fish will likely be startled by vessel movement and activation of the thrusters and are predicted to avoid the area immediately around the thrusters before injury can occur. Aggregations of fish surrounding the thrusters are unlikely as a result of the turbulence generated by the thruster propellers. Given that the majority of mobile fish species are generally expected to avoid underwater sound at lower levels than those at which injury or mortality may occur, physical harm associated with peak SPLs is unlikely to occur therefore any potential impact on fish populations is highly unlikely.

The US Fisheries Hydroacoustic Working Group guidelines also suggest a second threshold criteria of 187 dB re 1 μPa cumulative SEL for fish 2 grams or heavier. Sound modelling of the MODU with PSV suggests a 24-hour cumulative SEL will decrease to below 190 dB re 1 $μPa^2s$ beyond a maximum distance of 2 km (assuming maximum $R_{95\%}$ value across all seasons and sites). This predicted distance is based on ocean conditions during winter when sound propagation is greater (during summer this distance is reduced to 1 km). These maximum values are based on cumulative sound exposure levels over a period of 24 hours; within this period avoidance behaviour by fish is likely to result by increasing their distance from the source, and therefore an associated exposure to decreased cumulative SELs. Based on the motility of the fish species and their anticipated avoidance behaviour, the risk of mortality or injury from cumulative SELs is expected to be low. Studies by Popper *et al*. (2014) and Normandeau Associates (2012) also indicate that the cumulative SEL criteria established by the Hydroacoustic Working Group may be lower than the actual level of effect for hearing in non-specialist fish. This is substantiated with results by Halvorsen *et al*. (2011a, b) and Casper *et al*. (2011) on hearing generalists.

The Change in Risk of Mortality or Physical Injury as a result of the presence and operation of the MODU is predicted to be adverse, low in magnitude, restricted to the Project Area, continuous throughout the Project, medium-term in duration and reversible.

Waste Management

As discussed in Section 7.1.2, adverse environmental effects on the marine benthos from exploration drilling are primarily related to the physical disturbance of the water column and benthic environment as a result of the discharge of drill muds and cuttings. In particular, an accumulation of drill solids on the seafloor can cause burial and suffocation of benthic species (Neff *et al.* 2004; Neff 2010).

Effects of smothering can include mortality, reduced growth of some species, reduced larval settlement, and a change in fauna composition (Neff *et al.* 2004). Some organisms may die from the mass of the discharges crushing them, while others may perish because they cannot penetrate through the deposited layer burying them. This effect is localized and short-term and will occur in close proximity to the discharge site and is unlikely to have an effect at the population level.

An average burial depth of 9.6 mm has been calculated to which there will likely be no net adverse effects to benthic organisms attributable to sedimentation (Neff *et al.* 2004). This is an average value and is species-dependent; some species may experience adverse effects at shallower depths (*e.g.*, Smit *et al.* (2006b) references a threshold of 6.5 mm). At thicknesses of approximately 10 mm or more, benthic communities comprised of sedentary or slow moving species may be smothered and the sediment quality will be altered in terms of nutrient enrichment and oxygen depletion (Neff *et al.* 2000; Neff *et al.* 2004).

Drill waste dispersion modelling conducted for this Project considered the extent of various thicknesses of the deposition of drill cuttings on the seafloor in a radius from the discharge site (refer to Appendix C). The modelling predicts that the thickest drill cuttings deposition (>500 mm) will be confined to an area within 15 m of the discharge point. Considering both the shallowest (NS1) and deepest (NS3) wellsite locations, sediment thicknesses at or above 1 mm will extend up to 563 m from the discharge site and occupy a maximum areal extent of 9.91 ha per well; sediment thicknesses greater than 10 mm will extend up to 116 m, with a maximum footprint of 0.53 ha per well; and sediment thicknesses at or above 100 mm will be confined to a distance of 30 m from the discharge point, with a maximum footprint of 0.07 ha per well.

Environmental changes associated with the discharge of drill muds and cuttings are detectable during the earlier phases of drilling within a localized area (*e.g.*, within 500-m radius) but these effects subside with time (one to four years) (Bakke *et al.* 1986; Hurley and Ellis 2004; Renaud *et al.* 2008; Bakke *et al.* 2011).

In consideration of the predictive drill waste modelling results and mitigation described in Section 7.2.8.2, the Change in Risk of Mortality or Physical Injury as a result of waste management is predicted to be adverse, low in magnitude, restricted to the Project Area, occurring more than once at regular intervals, medium-term in duration and reversible (*i.e.*, low benthic mortality rates are not predicted to result in irreversible changes to local populations).

Vertical Seismic Profiling

Vertical seismic profiling is expected to generate the most intensive underwater sound associated with the Project, although it will be over a relatively short period of time (no more than one day per well). Acoustic modelling conducted for the Project (refer to Appendix D) suggests the maximum sound source level of the VSP array will be 248 dB re 1 μPa @ 1 m peak SPL (broadside).

As discussed for the MODU operation, a threshold of 206 dB re 1 μPa peak and cumulative SELs of 187 dB re 1 μPa^2s has been suggested as a threshold to avoid potential injury to fish species 2 grams or heavier (Fisheries Hydroacoustic Working Group 2008). The results of the acoustic modelling conducted for the Scotian Basin Exploration Drilling Project (Zykov 2016; Appendix H), predicted that sound levels will decrease to below 202 dB re 1 μPa peak SPL at distances greater than 140 m from the VSP source (at wellsite) during VSP surveys (maximum $R_{95\%}$ value across all seasons and sites). This suggests that injury or mortality to fish if they were present (caused by exposure to SPLs ≥ 206 dB re 1 μPa peak) would be restricted to less than 140 m from the VSP sound source.

The results of the modelling were also compared to the Fisheries Hydroacoustic Working Group (2008) cumulative SEL criteria. The modelled cumulative SEL for a 24-hour period was predicted to decrease to below 190 dB re 1 μPa^2s at distances greater than 1.7 km from the VSP source (maximum $R_{95\%}$ value across all seasons and sites). As previously mentioned, application of this criteria is considered to be conservative as more recent studies indicate effects to hearing generalists could occur at sound levels greater than 187 dB re 1 μPa^2s SEL.

Received sound levels are unlikely to result in physical effects to the majority of mobile fish species due to the expectation that they would respond to avoid underwater sound at lower levels than those at which injury or mortality may occur. A ramp-up period for the VSP source will be initiated to further deter mobile fish from the area, thereby reducing their risk of being exposed to harmful levels of sound.

Underwater sound emissions from a seismic source array such as that used in VSP may cause mortality of fish eggs, larvae or fry in very close proximity (*i.e.* <5 m) (Kostyuchenko 1973; Booman *et al.* 1996). Potential mortality associated with sound from the VSP source is not considered to have an effect on recruitment to fish populations (Dalen *et al*. 1996). Sound exposure guidelines for eggs and larvae by Popper *et al*. (2014) were established using dual-criteria similar to those established by the Hydroacoustic Working Group. The sound exposure guidelines suggest that potential mortality or injury to eggs and larvae from seismic sources may result from a cumulative SEL greater than 210 dB re 1 μPa^2s or peak SPLs greater than 207 dB re 1 μPa. Using this dual criteria, potential injury to fish eggs and larvae may occur within 160 m of the source.

The diversity and abundance of fish eggs and larvae in the Project Area and surrounding LAA, with the exception of the Haddock Box, is generally expected to be low. Based on the likely wellsite locations within the Project Area (no Project well locations will be located within the

Haddock Box) and predicted sound propagation, the low likelihood of marine fish eggs and larvae located within a few hundred metres of the sound source while VSP is occurring, and the temporary nature of VSP surveys (no more than one day per well), it is anticipated that the amount of eggs and larvae with the potential to be exposed to sound levels causing physical injury or mortality (even in consideration of proximity to the Haddock Box) would be negligible. Eggs and larvae are only present in the water column during certain periods, thereby reducing temporal opportunities for potential interactions with Project activities and components. The distribution of these species' eggs or larvae extends well beyond the LAA to include most or all of the RAA. Saetre and Ona (1996) concluded that the mortality rates from exposure to a seismic sound source is insignificant as compared to natural mortality. This conclusion is consistent with findings reported in the Environmental Assessment of BP's Tangier 3D Seismic Survey (LGL 2014).

The Change in Risk of Mortality or Physical Injury as a result of VSP operation is predicted to be adverse, low in magnitude, occur within the LAA, occurring more than once at irregular intervals, short-term in duration, and reversible.

Change in Habitat Quality and Use

Presence and Operation of MODU

Drilling operations as well as dynamic positioning activity of the MODU (*i.e.*, use of thrusters) will generate underwater sound, which may affect the quality of the underwater acoustic environment for marine fish. This activity could occur at any time of the year and would be continuous during the time it takes to drill each well (approximately 120 days per well).

As indicated above, predicting behavioural changes in fish is challenging given the variation in sound characteristics from different types of sources and interspecific differences in how sound is perceived by and may affect different species. Numerous studies have demonstrated avoidance behaviour (*e.g.*, diving, horizontal movements) of fish to approaching vessels, although reactions can vary depending on species, environmental conditions, and the physiological state of the fish (De Robertis and Handegard 2013). Behavioural responses of fish can also vary depending on the context (*e.g.*, the same fish may react differently when exposed to the same sound level while aggregated for spawning versus during foraging or feeding activities) (Hawkins and Popper 2014). Although underwater sound is believed to be the primary stimuli, other factors, including visual stimuli, may also influence behaviour.

During the initial period of drilling, avoidance of some fish species may occur, and startle responses may be elicited in close proximity to the sound source (*e.g.*, DP thrusters) at start-up (Mueller-Blenkle *et al.* 2008; Fewtrel and McCauley 2012). A general behavioral response was noted by McCauley *et al.* (2000a) at sound levels of 156 to 161 dB re 1µPa SPL RMS. Over the course of drilling, it is expected that fish will become habituated to the sound and avoidance and startle responses will cease (Chapman and Hawkins 1969; McCauley *et al.* 2000a, 2000b; Fewtrel and McCauley 2012). Acoustic modelling for the Project (Zykov 2016) predicts sound levels will decrease to below ≤ 150 dB re 1 µPa peak SPL greater than 0.4 km from the MODU and PSV (maximum $R_{95\%}$ value across all seasons and sites, Figure 29, Table 14 in Appendix D).

Lights from the MODU could potentially result in physiological stress in marine fish within the area of influence as artificial light is introduced to the water column. A common reaction of fish groups to the presence of artificial lighting is to school and move towards the light source. Sharp light contrasts created by over-water structures due to shading during the day and artificial lighting at night have the potential to alter the feeding, schooling, predator avoidance, and migratory behaviours of fish (Nightingale and Simenstad 2001; Hanson *et al.* 2003). Fish, especially juveniles and larvae, rely on visual cues for feeding. Shadows can create a light-dark interface, which may increase predation by ambush predators and increase starvation through limited feeding ability (NOAA 2008). The migratory behaviour of some species may favour deeper waters away from shaded areas during the day and lighted areas could affect migratory movements at night, contributing to increased risk of predation.

The Change in Habitat Quality and Use as a result of the presence and operation of the MODU is predicted to be adverse, low in magnitude, occur within the LAA, continuous throughout the Project, medium-term in duration and reversible.

Waste Management

The discharge of drill muds and cuttings could give rise to a change in sediment quality within a localized area, which may be altered in terms of nutrient enrichment and oxygen depletion which could potentially result in changes in the composition of the benthic macrofauna community. However, few fish species are expected to inhabit the individual wellsites within the Project Area given the depths at which the operations will take place. BP will conduct an imagery based seabed survey in the vicinity of wellsites to ground-truth the findings of the GBR. This includes confirming the absence of sensitive environmental features, such as habitat-forming corals or species at risk. The survey will be carried out prior to drilling. If any environmental or anthropogenic sensitivities are identified during the survey, BP will move the wellsite to avoid affecting them if it is feasible to do so. If it is not feasible, BP will consult with the CNSOPB to determine an appropriate course of action.

Waste and emission discharges with potential for toxicity effects to the marine environment are regulated for compliance under the OWTG. Discharges from the MODU will meet OWTG requirements, which are established to protect the marine environment.

Discharges are expected to be temporary, non-bio-accumulating, non-toxic, and will be subject to high dilution in the open ocean; organic matter will be quickly dispersed and degraded by bacteria. If residual hydrocarbons are present in discharges (*e.g.*, deck drainage, bilge water) they would be at such low volumes and concentrations as they will comply with OWTG and MARPOL requirements.

The Change in Habitat Quality and Use as a result of waste management is predicted to be adverse, low in magnitude, restricted to the Project Area, occurring more than once at regular intervals, medium-term in duration and reversible.

Vertical Seismic Profiling

As noted above for a Change in Risk of Mortality or Physical Injury, this activity is expected to generate the most intense sounds associated with Project activities, with the energy level from a single VSP shot expected to have a frequency of 5 to 2,000 Hz and a SPL of 248.7 dB re 1 µPa @ 1 m (*i.e.*, at source) (Zykov 2016; Appendix D). As noted above, thresholds for behavioural effects can vary, where avoidance behaviour can potentially occur at sound levels of 151 dB re 1 µPa peak SPL (McCauley *et al*. 2000a). Acoustic modelling for the Project (Zykov 2016) predicts sound levels will decrease to below 160 dB re 1 µPa peak SPL at distances greater than 20 km from the VSP sound source (maximum $R_{95\%}$ value across all seasons and sites (Figure 45, Table 26 in Appendix D)).

The Change in Habitat Quality and Use as a result of VSP operation is predicted to be adverse, low in magnitude, occur within the LAA, occurring more than once at irregular intervals, short-term in duration, and reversible.

Supply and Servicing Operations

Supply and servicing operations will increase vessel traffic within the Project Area and LAA (two to three PSVs making two to three round trips per week between the MODU and the supply base) and may therefore locally affect Fish Habitat Quality and Use around the PSV due to increased vessel sound. At an estimated sound source level of 188 dB re 1 µPa @ 1 m RMS SPL (Zykov 2016; Appendix D), underwater sound associated with PSV traffic will introduce additional underwater sound to the acoustic environment, although given the relatively small increment in vessel traffic as a result of the Project, this increase will be very low. Reactions of fish to vessels can vary by species and can also be influenced by environmental conditions and physiological state of the fish at the time of the interaction (De Robertis and Handegard 2013). However, the likely reaction to vessel sound is either temporary displacement or avoidance of the area in which the disturbing sound level is occurring. Any change to habitat quality would represent a small increment over similar effects currently associated with existing high levels of marine traffic and shipping activity throughout the RAA.

The Change in Habitat Quality and Use as a result of supply and servicing operations is predicted to be adverse, low in magnitude, occur within the LAA, continuous throughout the Project, medium-term in duration and reversible.

Well Abandonment

Well abandonment is likely only to give rise to a localized disturbance, and therefore it is expected that fish would avoid the immediate area where the mechanical separation activities are taking place. Following abandonment of the drill site, it is anticipated that the wellhead (if left in place), will provide hard substrate suitable for recolonization by benthic communities.

The Change in Habitat Quality and Use as a result of well abandonment is predicted to be adverse, low in magnitude, restricted to the Project Area, occurring more than once at irregular intervals, short-term in duration, and reversible.

Summary of Residual Effects

In summary, the Project may result in adverse effects that cause a Change in Risk of Mortality or Physical Injury and a Change in Habitat Quality and Use for Fish and Fish Habitat. In consideration of the implementation of applicable mitigation measures, best practices, and adherence to industry standards (*e.g*., compliance with OWTG, *Canadian Practice with Respect to the Mitigation of Sound in the Marine Environment*), the residual effect of a Change in Risk of Mortality or Physical Injury for various Project components and activities is considered to be low in magnitude. Residual project environmental effects for a Change in Risk of Mortality or Physical Injury will be restricted primarily to the Project Area but could extend into parts of the LAA during VSP surveys. The duration of effects will vary from short-term events (*i.e.,* no more than one day per well for VSP) to medium-term, continuous or regular events such as the presence and operation of the MODU and waste management. These environmental effects may occur within a disturbed ecological and socio-economic context (associated with ongoing harvesting of fish species and underwater sound and waste discharge associated with marine shipping in the RAA). Similarly, changes to Habitat Quality and Use for Fish and Fish Habitat are predicted to be low in magnitude, occur within the Project Area or parts of the LAA, be short to medium-term in duration, be reversible at the completion of the Project, and occur within a relatively undisturbed ecological and socio-economic context. No permanent alteration to, or destruction of, fish habitat is predicted to occur as a result of Project activities.

Table 7.2.6 summarizes the environmental effects assessment and prediction of residual environmental effects resulting from those interactions between the Project and Fish and Fish Habitat that were identified in Table 7.2.6.

Table 7.2.6 Summary of Project Residual Environmental Effects on Fish and Fish Habitat

Residual Effect	Residual Environmental Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in Risk of Mortality or Physical Injury							
Presence and Operation of MODU (including well drilling and testing operations and associated lights, safety [exclusion] zone and underwater sound)	A	L	PA	MT	C	R	D
Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)	A	L	PA	MT	R	R	D
Vertical Seismic Profiling	A	L	LAA	ST	IR	R	D
Change in Habitat Quality and Use							
Presence and Operation of MODU (including well drilling and testing operations and associated lights, safety [exclusion] zone and underwater sounds)	A	L	LAA	MT	C	R	D
Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)	A	L	PA	MT	R	R	D
Vertical Seismic Profiling	A	L	LAA	ST	IR	R	D
Supply and Servicing Operations (including helicopter transportation and PSV operations)	A	L	LAA	MT	R	R	D
Well Abandonment	A	L	PA	ST	IR	R	D

KEY:
See Table 7.2.2 for detailed definitions
N/A: Not Applicable

Direction:
P: Positive
A: Adverse
N: Neutral

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PA: Project Area
LAA: Local Assessment Area
RAA: Regional Assessment Area

Duration:
ST: Short-term
MT: Medium-term
LT: Long-term

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socio-Economic Context:
D: Disturbed
U: Undisturbed

7.2.9 Determination of Significance

With the application of proposed mitigation and environmental protection measures, the residual environmental effects of a Change in Risk of Mortality of Physical Injury and Change in Habitat Quality on Fish and Fish Habitat from Project activities and components are predicted to be not significant. This conclusion has been determined with a moderate to high level of confidence based on a good understanding of the general effects of exploration drilling and VSP operation on Fish and Fish Habitat and the effectiveness of mitigation measures discussed in Section 7.2.8.2. Taking a conservative approach, the confidence level has been reduced to moderate in some cases to account for the dearth of research around appropriate effects thresholds for continuous sounds on marine fish.

7.2.10 Follow-up and Monitoring

BP will conduct a visual survey (using an ROV) of the seafloor during and after drilling activities to assess the extent of sediment dispersion.

BP will assess in consultation with the appropriate authorities the potential for undertaking an acoustic monitoring program during the drilling program to collect field measurements of underwater sound in order to verify predicted underwater sound levels. The objectives of such a program will be identified in collaboration with DFO and the CNSOPB and in consideration of lessons learned from the underwater sound monitoring program to be undertaken by Shell as part of the Shelburne Basin Venture Exploration Drilling Project in 2016.

7.3 MARINE MAMMALS AND SEA TURTLES

Marine Mammals and Sea Turtles was selected as a VC in recognition of the ecological value they provide to marine ecosystems, specific regulatory requirements of the *Fisheries Act* and SARA, requirements of the EIS Guidelines, and potential interactions with the Project. This VC considers secure species as well as species of marine mammals and sea turtles listed under SARA (*i.e.*, SAR) or considered at risk by COSEWIC (*i.e.*, SOCC). The marine mammals component includes consideration of baleen whales (mysticetes), toothed whales (odontocetes), and seals (phocids). Due to similarities in habitat use and the nature of interactions with the Project, sea turtles are assessed together with marine mammals, with differences noted as applicable.

The Project Area is located within the Scotian Slope offshore region, which is known to support a diversity of marine mammals and sea turtles and to contain important foraging areas and migratory routes for these species (refer to Section 5.2). This VC is related to the Special Areas VC, considered separately in Section 7.5, as Special Areas are often designated to protect SAR and SOCC, including applicable species of marine mammals and sea turtles.

7.3.1 Regulatory and Policy Setting

Marine mammals and sea turtles are "marine animals" and therefore included within the definition of "fish" under the *Fisheries Act*. As noted in Section 7.2, the federal *Fisheries Act* includes provisions that prohibit serious harm to fish (*i.e.*, the death of fish or any permanent alteration to, or destruction of, fish habitat) that are part of a commercial, recreational, or Aboriginal (CRA) fishery. It also prohibits the deposition of a deleterious substance in waters frequented by fish.

The federal SARA focuses on protecting species and their associated habitat whose populations are not secure. SARA seeks to prevent species from being extirpated (*i.e*., locally extinct) or becoming extinct; to provide for the recovery of species that are extirpated, endangered or threatened as a result of human activity; and to manage species of special concern to prevent them from becoming endangered or threatened. For the purposes of this assessment, sections 32, 33 and 58 of SARA are the most relevant sections of the Act and contain provisions to protect species listed on Schedule 1 of SARA and their critical habitat. Critical habitat is defined under SARA 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]). Critical habitat has not yet been defined for all listed species.

Under section 79 of SARA, Ministerial notification is required if a project "is likely to affect a listed wildlife species or its critical habitat". This notification must identify the adverse effects of the project on the listed wildlife species and its critical habitat and, if the project is carried out, measures that will be taken to avoid or lessen those effects, along with monitoring commitments.

DFO has not yet set regulatory thresholds for levels of underwater sound to be avoided to reduce potential for injury or behavioural disturbance effects to marine mammals. In the absence of formal Canadian thresholds, published literature reviews and US regulatory and draft regulatory thresholds for reducing risk of potential impacts to marine mammals and fish have been used to inform this assessment of potential physical injury in the form of permanent threshold shifts (PTS). Various thresholds have been established using peak sound pressure level (SPL), root-mean-square (RMS) SPL, and sound exposure (energy) level (SEL) metrics.

Threshold criteria are commonly used to assess potential PTS; however, behavioural responses of marine mammals to underwater sound are generally more variable, context-dependent and less predictable than potential physical effects (Southall *et al*. 2007). Therefore, use of available sound thresholds to predict behavioural response are considered as a guide to informing the assessment of potential effects of sound on marine mammals rather than as an absolute measure of such effects occurring.

The determination of threshold criteria for sound levels believed to have the potential to injure or disturb marine mammals is currently an active and complex research topic. Since 2007, several expert groups have investigated various assessment approaches and a number of key studies and papers have been undertaken on the topic. In the US, NOAA has recently released for public comment, a third version (NOAA 2016a) of their draft guidelines - *Draft Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing* (NOAA 2015b). While the most recent 2016 version updates were not available for review and incorporation at the time acoustic modelling was undertaken for this Project, the 2015 draft guidelines were considered and predictions based on those thresholds are presented in this report. The draft NOAA guidelines provide the most current guidance on the threshold levels of underwater sound that are thought to cause temporary or permanent changes in marine mammal hearing sensitivity (*i.e.,* temporary threshold shifts (TTS) and PTS). It is important to recognize that these draft guidelines remain under review by the scientific community and are subject to change. Much of the basis for these guidelines comes from the recommendations previously put forward by Southall *et al*. (2007), whose criteria have and continue to be commonly used for assessing potential effects from sounds associated with offshore activities around the world. NOAA's new guidelines also incorporate more recent auditory data acquired since 2007. Since the NOAA 2015b thresholds remain in draft form, have already undergone and will continue to be subject to further revision, and have not yet been formally accepted by either NOAA or the scientific community, the thresholds put forward by Southall *et al.* (2007) have been used as the primary source of acoustic criteria for this assessment with additional context provided by exploring the draft 2015 NOAA Guidelines. Thresholds for onset of PTS in marine mammals proposed by NOAA (2015) and Southall *et al.* (2007) are summarized in Table 1 of Appendix D and are discussed as applicable in the subsections below. NOAA (2015b) and Southall *et al.* (2007) both present dual metrics (*i.e.,* they provide threshold values in both peak and cumulative sound exposure level (SEL) decibel levels), and recommend that proponents draw conclusions based on whichever metric is exceeded first. It is noted that disagreement persists in the scientific community with respect to many aspects of the establishment of appropriate exposure criteria for marine mammals (see for example Wright 2015, Tougaard *et al.* 2015, Finneran 2015).

Both the NOAA (2015b) and Southall *et al.* (2007) criteria were developed specifically for use with marine mammals. NOAA has stated that they intend to establish similar acoustic injury thresholds for other species of conservation concern, such as sea turtles and marine fish, as soon as more data become available (NOAA 2015b). Under the ANSI-Accredited Standards Committee S3/SC 1, a Working Group (WG) on Animal Bioacoustics has established sound exposure guidelines for sea turtles that adopt some of Southall *et al.* (2007)'s approaches for marine mammals. However, the WG acknowledges that it is very difficult to establish guidelines for sea turtles because very little is known about their hearing and the role of sound in their lives (Popper *et al.* 2014). The WG has therefore only developed numeric thresholds for potential sea turtle mortality and mortal injury in relation to explosions, seismic airguns, and pile driving, at this time. The recommended thresholds for seismic airguns are considered in the assessment of potential effects on sea turtles from VSP.

NOAA's interim guidelines (NOAA n.d.) for marine mammals provide threshold levels for broadband underwater RMS SPLs to avoid risk of behavioural disruption. NOAA's most recent 2015 draft guidelines do not address behavioural disruption or update the interim guidelines, which is widely recognized as being a complex and challenging subject which is an area of ongoing investigation and analysis. Until this updated guidance is developed, and in the absence of formal Canadian thresholds, NOAA's interim root mean square (RMS) SPLs (NOAA n.d.) sound level thresholds have been used to inform the assessment of potential behavioural effects of sound on marine mammals with additional context provided based on outcomes of various available research study and review publications . These sound level threshold values, which have been historically applied generically to both cetaceans and pinnipeds, are 120 dB RMS re 1 µPa for continuous sounds (*e.g*., shipping and drilling) and 160 dB RMS re 1 µPa for pulse sounds (*e.g*., seismic surveys and VSP). These sound levels have commonly been used in environmental assessments of seismic programs in Atlantic Canada (as well as Pacific Canada, Arctic Canada, and the US) for assessing behavioural effects of anthropogenic underwater sound on marine mammals. See for example: BP Exploration (Canada) Limited's Tangier 3D Seismic Survey (LGL 2014); the Shelburne Basin Venture Exploration Drilling Project (Stantec 2014a; the Strategic Environmental Assessment for Offshore Petroleum Exploration Activities - Western Scotian Slope (Phase 3B) (Stantec 2014b); the SEA for Offshore Petroleum Activities - Eastern Scotian Slope (Phase 1B) (Stantec 2012b). This approach is also consistent with that taken in the acoustic assessment framework put forward by DFO in which an SPL of 120 dB re 1 µPa RMS is applied as the received threshold sound levels at which negative responses by cetaceans to underwater continuous sound are "presumed to begin" (Lawson and Lesage 2013). However, similar to criteria developed for auditory injury, it is noted that there exists much scientific disagreement and debate concerning the validity and relevance of assigning singular value sensory disturbance thresholds across species, particularly considering evidence highlighting the importance of context at the time of exposure. While there has been suggestion that the 120 and 160 dB values over-extrapolate results from too few studies and species (Green 1994), recent studies have also shown responses at lower levels (*e.g*., bowhead whales showed decreases in call rates in response to a received seismic pulse SPL of 116 dB RMS re 1 µPa [Blackwell *et al.* 2013]).

7.3.2 The Influence of Engagement on the Assessment

Key issues raised during stakeholder and Aboriginal engagement for the Project to date include concerns about potential effects of drilling sounds on marine mammals, and the proximity of Project activities to important habitat for marine mammals and sea turtles, including the endangered North Atlantic right whale, northern bottlenose whale, and leatherback sea turtle. Whales were also identified as being spiritually important to the Mi'kmaq.

7.3.3 Potential Environmental Effects, Pathways and Measurable Parameters

Routine Project activities and components have the potential to interact with marine mammals and sea turtles as well as their habitat. These interactions could result from underwater sound emissions produced by operation of the MODU, PSV, and helicopter, as well as during VSP surveys. PSV traffic presents a risk of collision with marine mammals and seas turtles, potentially resulting in physical injury or mortality to individuals. The Project could also result in changes in availability, distribution, or quality of prey items and habitat for marine mammals and sea turtles as a result of underwater sound or operation discharges (refer to Section 7.2. for an assessment of effects on prey species).

In consideration of these potential interactions, the assessment of Project-related environmental effects on Marine Mammals and Sea Turtles is focused on the following potential environmental effects:

- Change in Risk of Mortality or Physical Injury; and
- Change in Habitat Quality and Use.

The measurable parameters used for the assessment of these environmental effects, and the rationale for selection, are provided in Table 7.3.1. Effects of accidental events are assessed separately in Section 8.5.2.

Table 7.3.1 Potential Environmental Effects, Effects Pathways and Measurable Parameters for Marine Mammals and Sea Turtles

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in Risk of Mortality or Physical Injury	• Increased risk of exposure to underwater sound at levels capable of causing auditory injury (*i.e.*, PTS) • Increased risk of vessel collision	• Species injury or mortality (qualitative likelihood of species injury or mortality) • Extent (km from sound source) of underwater sound potentially injuring marine mammals and sea turtles
Change in Habitat Quality and Use	• Increased risk of exposure to marine contaminants • Increased risk of exposure to underwater sound at levels capable of causing sensory disturbance	• Change in chemical composition of water (unit depends on the contaminant) • Extent (km from sound source) of underwater sound potentially affecting marine mammal and sea turtle behaviour

Determining if and at what distance an animal can hear a sound is important in assessing effects from introduced underwater sound (Richardson *et al.* 1995; Popper 2003). This EIS uses expected species presence in the study area along with the results of acoustic modelling (Section 7.1.1.2 and Appendix D) to compare predicted Project-related sound levels to commonly used sound level thresholds to assess the ranges from the source at which potential injury or behavioural disturbance may occur. Distances of threshold exceedance presented in this EIS are the $R_{95\%}$ values, which are based on the predicted range that encompasses at least 95% of the area (in the horizontal plane) that would be exposed to sound at or above that threshold level.

7.3.4 Environmental Assessment Boundaries

7.3.4.1 Spatial Boundaries

The spatial boundaries for the environmental effects assessment for Marine Mammals and Sea Turtles are defined below and depicted on Figure 7.3.1.

Project Area: The Project Area encompasses the immediate area in which Project activities and components may occur and represents the area within which direct physical disturbance to the marine benthic environment may occur. Well locations have not yet been identified, but will occur within the Project Area and represent the actual Project footprint. The Project Area includes ELs 2431, 2432, 2433, and 2434.

Local Assessment Area (LAA): The LAA is the maximum area within which environmental effects from Project activities and components can be predicted or measured with a reasonable degree of accuracy and confidence. It consists of the Project Area and adjacent areas where Project-related environmental effects on Marine Mammals and Sea Turtles are reasonably expected to occur if they are present within this area. Based on predicted propagation of sound from Project Activities and reported thresholds for behavioural and physical effects on cetaceans, the recognition of critical habitat for SAR in the RAA and migratory activity of marine mammals and sea turtles in the RAA, and the PSV routes to and from the Project Area, the LAA has been extended to include the entire RAA.

Regional Assessment Area (RAA): The RAA is the area within which residual environmental effects from Project activities and components may interact cumulatively with the residual environmental effects of other past, present, and future (*i.e.*, certain or reasonably foreseeable) physical activities and to provide regional context for the effects assessment. The RAA is restricted to the 200 nautical mile limit of Canada's EEZ, including offshore marine waters of the Scotian Shelf and Slope within Canadian jurisdiction.

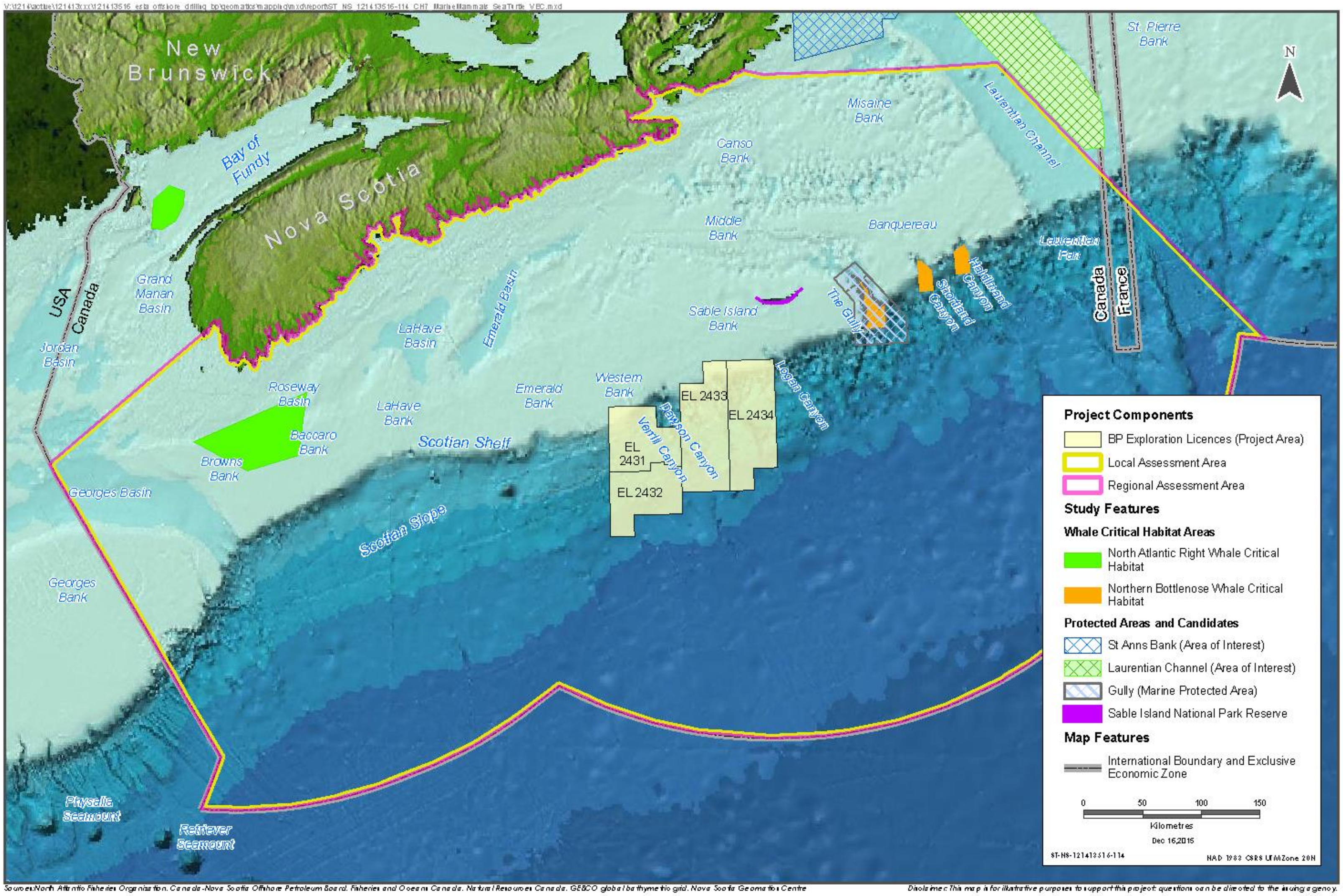


Figure 7.3.1 Assessment Boundaries for Marine Mammals and Sea Turtles

7.3.4.2 Temporal Boundaries

The temporal boundaries for the assessment of potential Project-related environmental effects on Marine Mammals and Sea Turtles encompass all Project phases, including well drilling, testing and abandonment. Up to seven exploration wells will be drilled over the term of the ELs, with Project activities at each well taking up to a maximum of 120 days to drill. VSP operations are typically short duration, normally taking no more than a day per well to complete the profiling. It is assumed that Project activities could occur year-round.

Marine mammals and sea turtles can be found year-round in and around the Project Area carrying out various life cycle processes. Refer to Section 5.2 for details regarding the specific marine mammal and sea turtle species known to occur in the RAA, including their sensitive life stages in relation to the Project Area.

7.3.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance

Table 7.3.2 defines the descriptors that are used to characterize residual environmental effects on Marine Mammals and Sea Turtles.

Table 7.3.2 Characterization of Residual Environmental Effects on Marine Mammals and Sea Turtles

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	**Positive** – an effect that moves measurable parameters in a direction beneficial to Marine Mammals and Sea Turtles relative to baseline **Adverse** – an effect that moves measurable parameters in a direction detrimental to Marine Mammals and Sea Turtles relative to baseline **Neutral** – no net change in measureable parameters for the Marine Mammals and Sea Turtles relative to baseline
Magnitude	The amount of change in measurable parameters of the VC relative to existing conditions	**Negligible** – no measurable change in marine species populations, habitat quality or quantity **Low** – a measurable change but within the range of natural variability; will not affect population viability **Moderate** – measurable change outside the range of natural variability but not posing a risk to population viability

Table 7.3.2 Characterization of Residual Environmental Effects on Marine Mammals and Sea Turtles

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
		High – measurable change that exceeds the limits of natural variability and may affect long-term population viability
Geographic Extent	The geographic area in which an environmental effect occurs	**Project Area** – effects are restricted to the Project Area **Local Assessment Area** – effects are restricted to a portion of the LAA/RAA **Regional Assessment Area** – effects could extend widely throughout the LAA/RAA
Frequency	Identifies when the residual effect occurs and how often during the Project or in a specific phase	**Single Event** – effect occurs once **Multiple Irregular Event** – occurs more than once with no set schedule **Multiple Regular Event** – occurs more than once at regular intervals **Continuous** – occurs continuously
Duration	The period of time required until the measurable parameter of the VC returns to its existing condition, or the effect can no longer be measured or otherwise perceived	**Short-term** – effect extends for a portion of the duration of Project activities **Medium-term** – effect extends through the entire duration of Project activities **Long-term** – effects extend beyond the duration of Project activities and continues after well abandonment
Reversibility	Pertains to whether a measurable parameter or the VC can return to its existing condition after the project activity ceases	**Reversible** – will recover to baseline conditions before or after Project completion (well abandonment) **Irreversible** – permanent
Ecological and Socio-economic Context	Existing condition and trends in the area where environmental effects occur	**Undisturbed** – area is relatively undisturbed or not adversely affected by human activity **Disturbed** – area has been substantially disturbed by previous human development or human development is still present

In consideration of the descriptors listed above, the following threshold has been established to define a significant adverse residual environmental effect on Marine Mammals and Sea Turtles.

For the purposes of this effects assessment, a **significant adverse residual environmental effect** on Marine Mammals and Sea Turtles is defined as a Project-related environmental effect that:

- causes a decline in abundance or change in distribution of marine mammal or sea turtle populations within the RAA, such that natural recruitment may not re-establish the population(s) to its original level within one generation;
- jeopardizes the achievement of self-sustaining population objectives or recovery goals for listed SARA species; or
- results in permanent and irreversible loss of critical habitat as defined in a recovery plan or an action strategy.

7.3.6 Existing Conditions

7.3.6.1 Overview of Marine Mammal and Sea Turtle Species Presence

Marine mammals and sea turtles found on the Scotian Shelf and Slope include six species of mysticetes (baleen whales), eleven species of odontocetes (toothed whales), five species of phocids (seals), and four species of sea turtles (see Tables 5.2.9 and 5.2.12). Of these, ten species are designated at risk by SARA or COSEWIC (three species of mysticetes, four species of odontocetes, and two species of sea turtles; see Table 7.3.3). No phocid populations on the Scotian Shelf are listed as SOCC.

Most species of baleen whale are migratory, and are present on the Scotian Shelf and Slope from late spring through fall. Only the fin whale is present year-round. While odontocetes are also present in greatest diversity during the spring through fall months, their timing is more variable, with multiple species present in the winter or year-round. Table 5.2.10 presents information on presence and timing of marine mammals known to occur in the vicinity of the Project Area based on a review of existing literature incorporated within the SEA for the Scotian Slope (Phase 1B and 3B) (Stantec 2012b, 2014b). Critical habitat for the endangered North Atlantic right whale has been identified in Roseway Basin on the Scotian Shelf within the RAA (Brown *et al.* 2009). Critical habitat for the endangered northern bottlenose whale has been designated in the Gully and in the Shortland and Haldimand Canyons on the east of the Scotian Shelf and Slope (DFO 2010b).

In the waters off Nova Scotia, seals are most commonly found over the Scotian Shelf, particularly north of the Project Area, in the nearshore waters around Sable Island. They are less common in the open waters over the Scotian Slope, where the Project Area is located. For example, during the 2014 Tangier 3D Seismic Survey, only three harbour seals were observed in the Project Area (see Table 5.2.11; LGL 2014). Sable Island is an important area for phocids as it hosts breeding populations of harbour seals (*Phoca vitulina*), and the world's largest breeding colony of grey seals (*Halichoerus grypus*; DFO 2011a; Freedman 2014). Smaller breeding colonies have also been found on coastal islands along southwestern Nova Scotia at Flat, Mud, Noddy, and Round Islands (Bowen *et al.* 2011). Grey seals pup from mid-December to late January, while harbour seals are year-round residents that pup from mid-May to mid-June. Other species of phocids known to forage on the Scotian Shelf include harp (*Pagophilus groenlandica*), hooded (*Cystophora cristata*) and ringed (*Pusa hipsida*) seals. Generally, these species have only occasionally been observed foraging offshore Nova Scotia and are considered to be infrequent visitors to these waters; however, for a few hours or days during the winter and early spring, hundreds of harp and hooded seals and one or two ringed seals come ashore on Sable Island (DFO 2011a). Seal observations recorded on the Scotian Shelf and Slope between 1911 and 2013 are presented in Figure 5.2.18.

Four species of sea turtle can be found migrating and foraging on the Scotian Shelf and Slope waters. Of these, the leatherback (*Dermochelys coriacea*) and loggerhead (*Caretta caretta*) sea turtles are the most likely to occur, and both species are listed as endangered by COSEWIC (only the leatherback sea turtle is currently designated under SARA). Leatherback and loggerhead sea turtles, and a few green sea turtles (*Chelonia mydas*) were observed over the course of BP's 2014 Tangier 3D Seismic Survey (RPS 2014), and Shell's 2013 Shelburne Basin 3D Seismic Survey (see Figures 5.2.19-5.2.20 for reported sea turtle sightings). The presence of Kemp's ridley sea turtle (*Lepidochelys kempii*) in the Project Area is considered unlikely.

Critical habitat was not identified in the 2006 Recovery Strategy for the leatherback sea turtle; however, DFO has been using satellite tracking data to define important habitat for leatherback turtles in Atlantic Canada for the purpose of identifying critical habitat for designation under SARA (DFO 2011b). Research has identified three important areas for leatherback turtle foraging in Atlantic Canadian water (DFO 2013c) and it is expected that these areas will be included as critical habitat in an amended Recovery Strategy, once finalized.

Table 7.3.3 Marine Mammal and Sea Turtle Species at Risk and Species of Conservation Concern Found in the RAA

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation	Potential for Occurrence in the Project Area[1]	Timing of Presence
Mysticetes (Toothless or Baleen Whales)					
Blue whale (Atlantic population)	*Balaenoptera musculus*	Endangered	Endangered	Moderate	Summer to Fall
Fin whale (Atlantic Population)	*Balaenoptera physalus*	Special Concern	Special Concern	High	Year- round (highest concentrations in Summer)
North Atlantic right whale	*Eubalaena glacialis*	Endangered	Endangered	Low	Summer
Odontocetes (Toothed Whales)					
Harbour porpoise (Northwest Atlantic population)	*Phocoena phocoena*	Not Listed	Special Concern	Low	Summer to Fall
Killer whale	*Orcinus orca*	Not Listed	Special Concern	Low to Moderate	Summer

Table 7.3.3 Marine Mammal and Sea Turtle Species at Risk and Species of Conservation Concern Found in the RAA

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation	Potential for Occurrence in the Project Area[1]	Timing of Presence
Northern bottlenose whale (Scotian Shelf Population)	*Hyperoodon ampullatus*	Endangered	Endangered	Low	Year-round
Sowerby's beaked whale	*Mesoplodon bidens*	Special Concern	Special Concern	Low	Year-round
Sea Turtles					
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	Endangered	High	April to December
Loggerhead sea turtle	*Caretta caretta*	Not Listed	Endangered	High	April to December
Note: [1]This is based on the analysis of habitat preferences during various life history stages, distribution mapping, and sightings data for each species within the Project Area.					

Source: Modified from Stantec 2012b and 2014bb

7.3.6.2 Marine Mammals and Underwater Sounds

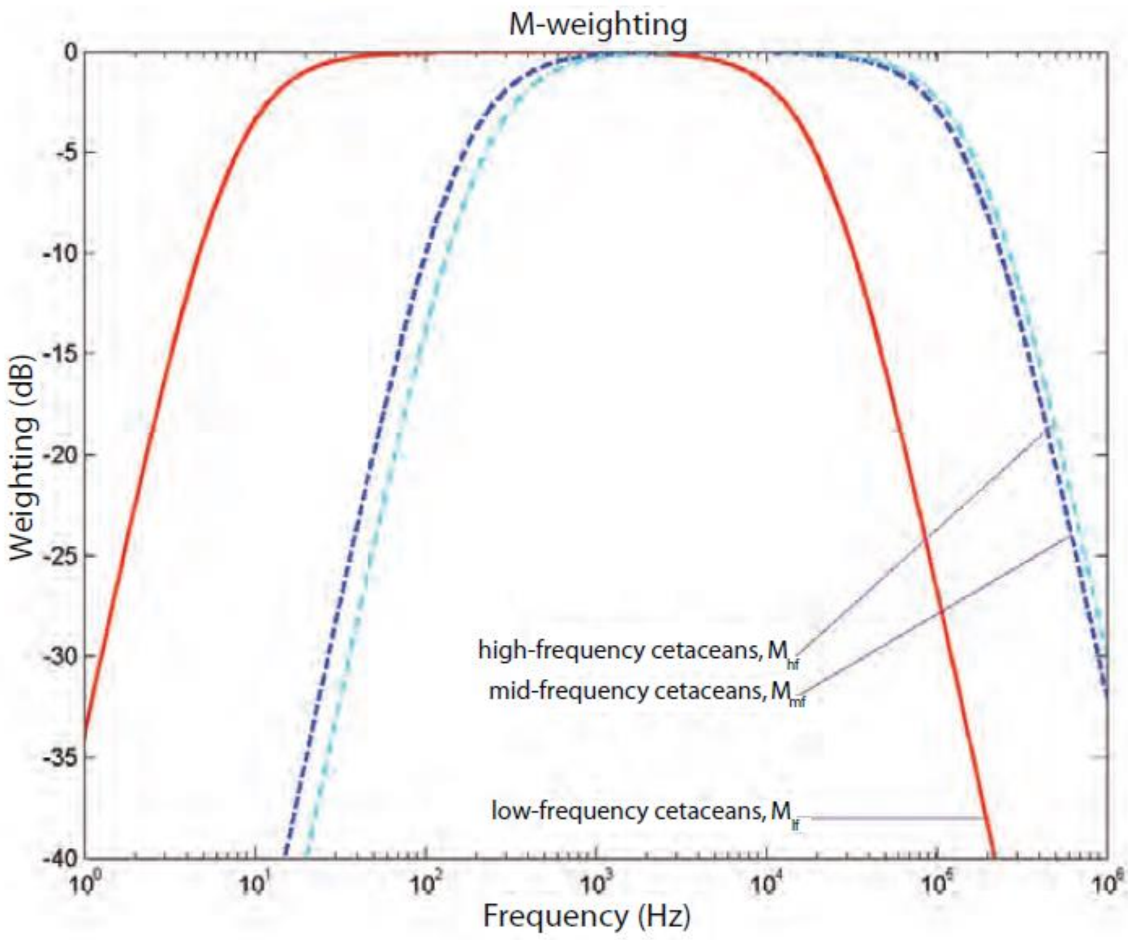
Marine mammals rely heavily on their ability to hear and use underwater sounds to communicate, locate prey, avoid predators, and gather other information about their surroundings (Richardson *et al.* 1995; Gordon *et al.* 2004; Nowacek *et al.* 2007; Tyack 2008). Research to date (based on both direct measurements and predictions resulting from morphology, behaviour, vocalizations, and taxonomy) indicates that not all marine mammal individuals or species have equal hearing capabilities in terms of absolute hearing sensitivity or the frequency at which they are able to detect sound (Southall 2007; NOAA 2015b). The hearing abilities of some marine mammals species have been directly measured (*i.e.*, some odontocetes, pinnipeds), while for other species (*i.e.*, mysticetes) hearing abilities have been determined from behavioural and anatomical evidence alone, as limitations exist to make such measurements (*e.g.*, it is difficult to keep baleen whales in captivity) (Houser *et al.* 2001; Parks *et al.* 2007; Dahlheim and Ljungbald 1990; Reichmuth 2007). The ability to hear sounds varies across a species' functional hearing range, with most marine mammal audiograms depicting a "U-shape", where frequencies at the bottom of the "U" are those to which the animal is the most sensitive and for which they have the best hearing ability (Southall 2007; NOAA 2015b). To reflect this higher sensitivity to particular frequencies, received sound levels are often weighted using species-specific (or functional hearing group-specific) audiograms. Weighting functions have been proposed for marine mammals, specifically when associated with TTS and PTS acoustic threshold levels expressed as cSEL. The functional hearing ranges of marine mammals (according to Southall *et al.* 2007) are listed in Table 7.3.4.

Table 7.3.4 Functional Hearing Range of Marine Mammals.

Functional Hearing Group	Functional Hearing Range	Frequency- Weighting Network
Low-Frequency (LF) Cetaceans[1] (Mysticetes)	7 Hz to 22 kHz	M_{lf} (lf: low-frequency cetacean)
Mid-Frequency (MF) Cetaceans (Most Odontocetes)	150 Hz to 160 kHz	M_{mf} (mf:mid-frequency cetacean)
High- Frequency (HF) Cetaceans (*e.g.*, Harbour Porpoise)	200 Hz to 180 kHz	M_{hf} (hf:high-frequency cetacean)
Pinnipeds in Water	75 Hz to 75 kHz	M_{pw} (pw:pinnipeds in water)
Pinnipeds in Air	75 Hz to 30 kHz	M_{pa} (pa:pinnipeds in air)
[1]Estimated hearing and frequency range for low-frequency cetaceans is based on behavioural studies, recorded vocalizations, and inner ear morphology measurements. No direct measurements of hearing ability have been successfully completed.		

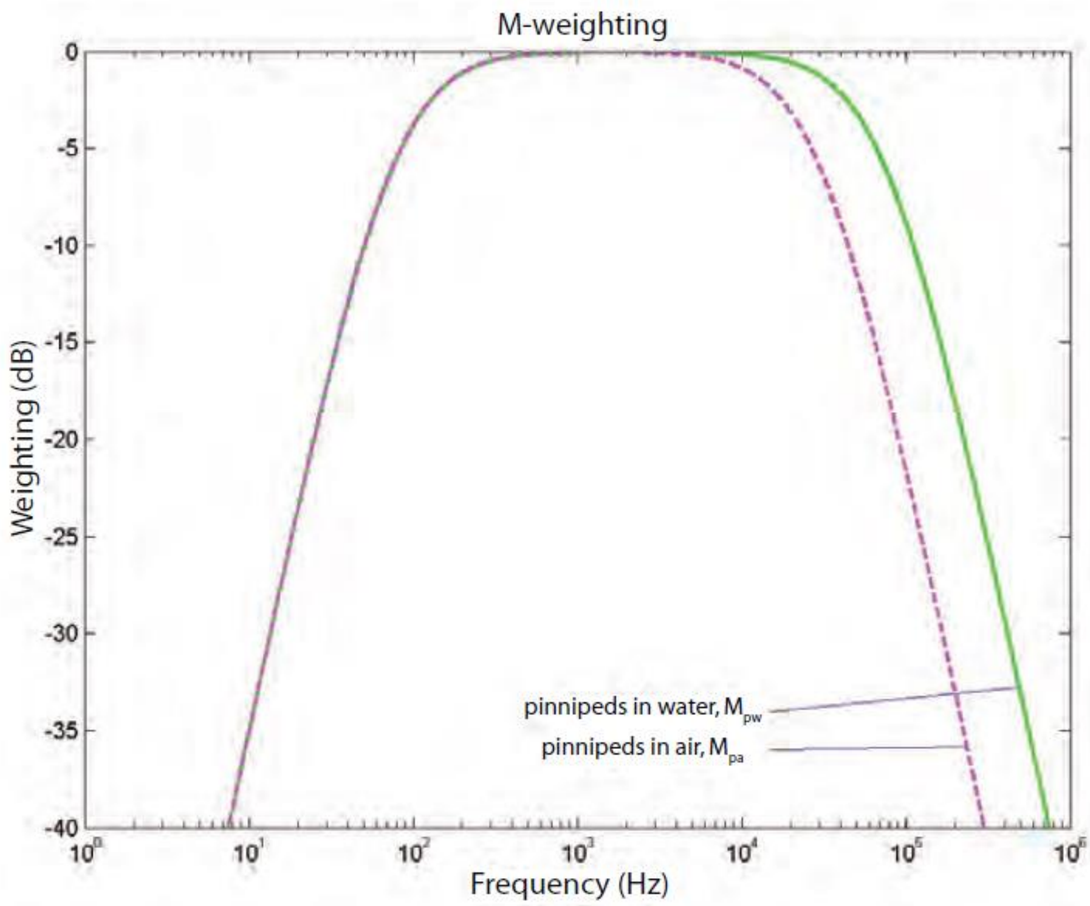
Source: Southall *et al.* 2007

Southall *et al.* (2007) proposed standard frequency weighted functions (referred to as M-weighted functions) for marine mammals. These functions can be viewed in Figures 7.3.2 and 7.3.3 (taken from Southall *et al.* 2007). The weighted function accounts for a "discount" to sound frequencies outside of the peak hearing frequency for a mammal. An animal's ability to hear or detect sound levels outside the range of a functional hearing group's prime hearing sensitivity (*i.e*., where the weighted function amplitude is equal to 0) is reduced. The farther a sound source's frequency is away from the range of best sensitivity, the lower the animal's ability to detect or hear that sound.



Source: Southall *et al.* 2007

Figure 7.3.2 High-frequency, Mid-frequency, and Low-frequency Cetacean Auditory Weighting Functions



Source: Southall *et al.* 2007

Figure 7.3.3 Pinniped Auditory Weighting Function

The addition of anthropogenic underwater sounds to the marine environment has the potential to result in adverse effects on marine life. Potential effects are highly variable and may include injury/mortality (both pathological and physiological effects), behavioural effects, and effects on habitat (*e.g*., communication masking). The actual reactions of marine mammals are difficult to predict and depend on many variables including the type, magnitude and duration of the sound, the species and its distance from the source, and the activity state of the animal at the time (Popper and Hawkins 2012; Richardson *et al.* 1995).

7.3.6.2.1 Physiological Effects

One of the more common potential physiological effects of increased anthropogenic sound levels is a threshold shift caused by hair cell fatigue or damage within the ear, or nerve degeneration resulting in a loss of hearing sensitivity. The result of a threshold shift is a reduction in hearing sensitivity and an upward shift in the auditory threshold (*i.e.,* reduction in the ability to hear certain sound levels). The auditory threshold is the level of the quietest sound audible, and is estimated by either behavioural or electrophysiological responses over a specified percent of trials (Southall *et al.* 2007). A threshold shift may occur due to exposure to a sound level, which is species-dependent; once this occurs, the threshold of hearing increases, resulting in decreased sensitivity to sound. If marine animals are exposed to sounds of sufficient intensity, they may experience a noise-induced threshold shift – an increased hearing threshold (decrease in hearing sensitivity)(Southall *et al.* 2007). These shifts can either be temporary (TTS) for some duration following exposure or, in the event of prolonged exposure and/or sufficiently intense sound levels, permanent (PTS).

Southall *et al.* (2007) have suggested that marine mammals below the surface can likely tolerate (before the onset of permanent hearing damage) exposure to about 17 dB higher received acoustic energy level if the sound is non-impulsive as opposed to impulsive. Thresholds for onset of PTS in marine mammals proposed by Southall *et al*. (2007) and NOAA (2015) are summarized in Table 1 of Appendix D.

7.3.6.2.2 Behavioural Effects

Potential behavioural disturbance effects can be difficult to measure and depend on a wide variety of factors such as the physical characteristics of the sound source, the behavioural and motivational state of the receiver, its age, sex, social status, *etc.* (OSPAR 2009). Behavioural reactions can range from very subtle changes in behaviour to overt avoidance reactions. Increased levels of underwater sound have been shown to cause stress (Wright and Kuczaj 2007; Wysocki *et al*. 2006; Hastings and Popper 2005; Rolland *et al.* 2012), which could theoretically lead to lowered immune response and diminished reproductive effort (Southall *et al.* 2007; Wright *et al.* 2007a, 2007b, 2009, 2011). Behavioural effects can also take the form of changes in vocal activity (Clark *et al.* 2009; Popper and Hawkins 2012; Richardson *et al.* 1995; Risch *et al.* 2012; Southall *et al.* 2007; Williams *et al.* 2013) or through the triggering of avoidance behaviours, with potential effects on migration (*e.g*., van Opzeeland and Slabbekoorn 2012) and foraging patterns (*e.g.*, Slotte *et al.* 2004; Sundermeyer *et al.* 2012; Tougaard *et al.* 2012). Information on the reactions of marine mammals to anthropogenic sound is available through a number of studies (see for example the Behavioural Response of Australian Humpback whales to Seismic Surveys [BRAHSS] program), although this information is limited in terms of species and situations (Richardson *et al.*1995; Gordon *et al.* 2004; Nowacek *et al.* 2007; Southall *et al.* 2007; BRAHSS 2015). The majority of this research has focused on the response to seismic sound, and not specifically on drilling sounds.

Examples of observed behavioural responses from mysticetes in relation to seismic activity include deviation from their migration routes, altered feeding patterns, and avoidance behaviour (Malme *et al.*1984, 1985, 1988; Richardson *et al.* 1986, 1995; Richardson and Malme 1993; Ljungbald and Miller 1988; McCauley *et al.* 1998, 2000a, 2000b; Gordon *et al.* 2004; Miller *et al.* 2005; Moulton and Miller 2005; Stone and Tasker 2006; Johnson *et al.* 2007; Nowacek *et al.* 2007; Weir 2008). Other examples of mysticete responses to sound are changes in respiration and dive patterns, breaching, and tail slapping (Nowacek *et al.* 2007; Southall *et al.* 2007). There is less information regarding odontocete responses to increased underwater sound, as much research has focused on mysticetes; however, some odontocetes such as harbour porpoises have been shown to move away from areas of intense sound. Due to the lower magnitude of sound emitted during drilling, effects are expected to be considerably less than those observed in response to seismic source.

7.3.6.2.3 Masking

Masking is considered to occur when a sound interferes with the way in which an animal receives an acoustic signal. The occurrence and degree of masking depend on a large number of factors, including the source level and spectral characteristics of the signal, the distance between the source and receiver, habitat characteristics affecting sound absorption, reflection, refraction, scattering and spreading loss, and ambient sound levels (biotic, abiotic, and anthropogenic). Some marine animals have been shown to alter their communications (*i.e*., frequency, duration, or intensity) in response to the presence of a masking sound (*e.g*., Clark *et al*. 2009; Popper and Hawkins 2012; Risch *et al*. 2012; Williams *et al*. 2013). Masking is of potential concern when it interferes with an animal's ability to detect biologically important signals, including communication sounds, echolocation clicks, social calls and songs during mating and reproduction, and passive detection cues that are used to navigate and find prey (OSPAR 2009; Clark 1990; Erbe 2002; Southall *et al*. 2007; Wright 2008; Erbe *et al*. 2016). Some species use areas of thousands of square kilometres to communicate and masking may shrink the distance over which these communications can be detected (OSPAR 2009). A recent study on the west coast of Canada conducted by Williams *et al.* (2013) has illustrated that the presence of anthropogenic sounds can heavily reduce the possible range of cetacean communication. The largest effects were observed for low- and mid-frequency communications. Under natural, ambient ocean conditions (*i.e.,* from natural sound sources including wind and surf), fin whales lose less than 1% of their communication space. In contrast, under the "noisiest conditions" humpback whales can lose 80 to 94% of their communication space within the 71 to 708 Hz communication range; under "typical" (median) conditions, they lose 35 to 52% (Williams *et al.* 2013). In another study, killer whales in British Columbia were shown to lose up to 97% of their communication space in the mid-frequency range (1.5 to 3.5 kHz), compared to the quietest natural conditions.

7.3.6.3 Sea Turtles and Underwater Sounds

Available information indicates that turtles hear at low frequency ranges (*e.g.*, 100 to 900 Hz), with measureable age and species variations in response to underwater sound (Office of Naval Research 2002; Environment Australia 2003; Ketten and Bartol 2005). Ketten and Bartol (2005) observed a size/age difference in hearing range for loggerhead and green sea turtles, with smaller, younger individuals having a greater hearing range than larger, older individuals. Martin *et al.* (2012) demonstrated that loggerhead sea turtles have low frequency hearing, with the best sensitivity between 100 and 400 Hz. Juvenile green sea turtles responded to underwater stimuli between 50 to 1,600 Hz and have optimal hearing below 1,000 Hz (Dow Piniak *et al.* 2012a). Dow Piniak *et al.* (2012b) determined that leatherback sea turtle hearing sensitivity overlaps with frequencies and source levels that are produced by low-frequency anthropogenic sources including seismic source arrays, offshore drilling, and vessel traffic. There remains a lack of research on the acoustic sensitivity of sea turtles and on the relative importance of their acoustic environment. There is little evidence to suggest that sea turtles would be more sensitive to drilling sounds than cetaceans or fish. In the absence of established hearing impairment thresholds for sea turtles, the thresholds for PTS or TTS onset in cetaceans have frequently been applied to sea turtles (LGL 2013), based on the fact that sea turtles and mysticetes both have best sensitivity to low frequencies. To date, however, there are no known studies demonstrating sea turtle TTS or PTS (Finneran and Jenkins 2012) and the sea turtle WG has concluded that comparing sea turtles to fish has higher merit than the comparison to marine mammals, based on hearing ranges and ear anatomy (Popper *et al.* 2014). Numeric underwater sound thresholds for sea turtles do not exist for activities associated with the Project.

7.3.7 Potential Project-VC Interactions

Table 7.3.5 identifies the physical Project activities that might interact with the VC to result in the identified environmental effects. These interactions are indicated by checkmarks, and are discussed in Section 7.3.8 in the context of effects pathways, mitigation, and residual effects. A justification is also provided below for non-interactions (no checkmarks).

Table 7.3.5 Potential Project-Environment Interactions and Effects on Marine Mammals and Sea Turtles

Project Components and Physical Activities	Potential Environmental Effects	
	Change in Risk of Mortality or Physical Injury	Change in Habitat Quality and Use
Presence and Operation of MODU (including well drilling and testing operations and associated lights, safety [exclusion] zone and underwater sound)	✓	✓
Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)	-	✓
Vertical Seismic Profiling	✓	✓
Supply and Servicing Operations (including helicopter transportation and PSV operations)	✓	✓
Well Abandonment	-	✓
Note: ✓ = Potential interactions that might cause an effect. – = Interaction between the Project and the VC are not expected.		

Waste Management

Discharge of drill muds and cuttings as well as other routine discharges are not predicted to interact with Marine Mammals and Sea Turtles to cause a Change in Risk of Mortality or Physical Injury; these discharges will be in accordance with the OWTG, which are designed to mitigate potential effects from discharges. Wastes that do not meet OWTG requirements will not be discharged to the ocean, but brought to shore for disposal. Discharges made in accordance with OWTG requirements will result in a temporary and localized reduction in water and sediment quality; however, they are highly unlikely to cause mortality or physical injury to marine mammals or sea turtles. Potential effects of these discharges on marine mammal and sea turtle food sources (*e.g.*, plankton, fish) are discussed in Section 7.3.8 in the context of Change in Habitat Quality and Use.

Supply and Servicing (Helicopter Transportation)

Helicopter transportation is not predicted to interact with Marine Mammals and Sea Turtles to cause a Change in Risk of Mortality or Physical Injury. While helicopter presence, and associated in-air and underwater sound levels may result in localized behavioural disturbance, sound levels will not reach thresholds predicted to cause injury or mortality to marine mammals and sea turtles. The potential for helicopter transportation to result in a Change in Habitat Quality and Use for Marine Mammals and Sea Turtles is discussed in Section 7.3.8.

Well Abandonment

Well abandonment is not predicted to interact with Marine Mammals and Sea Turtles to cause a Change in Risk of Mortality or Physical Injury. All wells drilled in the drilling campaign will be permanently plugged and abandoned (P&A), which involves setting a series of cement and mechanical plugs within the wellbore. If the wellhead is removed, it will be accomplished by using mechanical means; explosives will not be used. This activity will have no interaction with marine mammals and sea turtles outside of the wellsite. Well abandonment activities are not anticipated to produce sound or discharges that would pose a risk of physical injury or mortality to marine mammals or sea turtles. Well abandonment activities that could potentially result in a Change in Habitat Quality and Use are discussed in Section 7.3.8.

7.3.8 Assessment of Project-Related Environmental Effects

The following section assesses the potential environmental effects on Marine Mammals and Sea Turtles identified as arising from interactions in Table 7.3.5. Given the similarities in Project description, proximity of activities on the Scotian Slope, and relevancy of recent data, the Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) and the Environmental Assessment of BP Exploration (Canada) Limited's Tangier 3D Seismic Survey (LGL 2014) have been referenced extensively for this analysis, with updates incorporated as applicable due to Project and geographic differences (*e.g.*, expansion of geographic scope), scientific updates, and refined EA methods.

7.3.8.1 Project Pathways for Effects

Change in Risk of Mortality or Physical Injury

A Change in Risk of Mortality or Physical Injury as a result of underwater sound levels may occur for Marine mammals and Sea Turtles in close proximity during VSP operations, or for individuals that remained in close proximity to the MODU and PSV (*i.e.*, during the use of dynamic positioning thrusters during station keeping and drilling). Exposure to underwater sound of sufficient intensity may result in hearing loss, whether temporary or permanent (*i.e.,* TTS or PTS)

(Richardson *et al.* 1995; Nowacek *et al.* 2007; Southall *et al.* 2007). There is also the potential for vessel collisions with marine mammals and sea turtles during PSV operations.

Change in Habitat Quality and Use

Underwater sounds introduced by the presence and operation of the MODU and VSP, helicopter transportation, and PSV traffic activities may affect the quality of the underwater acoustic environment for marine mammals and sea turtles. Biological effects on marine organisms may occur when introduced anthropogenic sounds overlap in sound signal characteristics and frequency with the hearing range of species present in the area of sound exposure. A sound is considered audible if the receiver is able to detect it over background sound (existing ambient sounds on the Scotian Shelf and Slope are discussed in Section 5.1.3.6). Possible marine mammal or sea turtle responses to increased underwater sound levels include: avoidance, communication masking, discomfort, and behavioural disturbance (*e.g*., changes in diving/breathing rate or foraging efficiency).

Potential changes in the chemical composition of water may also result from the discharge of drill muds and cuttings and other discharges and emissions. Change in Habitat Quality and Use as a result of physical disturbance may also occur during well abandonment.

7.3.8.2 Mitigation of Project-Related Environmental Effects

In consideration of the environmental effect pathways outlined above, the following mitigation measures and standard practices will be used to reduce the potential environmental effects of the Project on Marine Mammals and Sea Turtles.

MODU

- PSV and MODU contractors will have a Maintenance Management System designed to ensure that the vessels and MODU, and all equipment, are well maintained and operated efficiently. This will reduce the possibility of generating excess noise, for example from vessel engines or propellers.

Waste Management

- Refer to the waste management mitigation measures identified in the Fish and Fish Habitat VC (Section 7.2.8.2).

Vertical Seismic Profiling

In March 2014, the Canadian Science Advisory Secretariat (CSAS) held a national peer review process to examine mitigation and monitoring measures for seismic survey activities in and near habitat for cetacean species at risk (*e.g.*, northern bottlenose whale, North Atlantic right whale, Atlantic blue whale), using the Maritimes Region as a case study (DFO 2015a). The CSAS review focused on sound exposure criteria and additional mitigation and monitoring measures that should be considered to avoid or reduce adverse effects on cetacean species at risk.

- BP will consult with DFO regarding relevant findings from the 2014 CSAS review (DFO 2015a), including additional recommended mitigation that would be appropriate for implementation during VSP prior to Project commencement.
- VSP activity will be planned and conducted in consideration of the *Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment* (SOCP; DFO 2007b).

The following mitigation measures, recommended in the SOCP (DFO 2007b), will be implemented during Project VSP activities:

- Marine Mammal Observers (MMOs) will be used to monitor and report on marine mammal and sea turtle sightings during VSP surveys to enable shutdown or delay actions to be implemented in the presence of a marine mammal or sea turtle species listed on Schedule 1 of SARA, as well as all other baleen whales and sea turtles (see also Section 7.3.10).
- A ramp-up procedure (*i.e.*, gradually increasing seismic source elements over a period of approximately 30 minutes until the operating level is achieved) will be implemented before any VSP activity begins. This measure is aimed at reducing the potential for auditory injury to marine animals in close proximity to the source at the onset of the activity. It is based on the assumption that the gradual increase in emitted sound levels will provide an opportunity for marine animals to move away from the sound source before potentially injurious sound levels are achieved close to the source.
- Shutdown procedures (*i.e.*, shutdown of source array) will be implemented if a marine mammal or sea turtle species listed on Schedule 1 of SARA, as well as all other baleen whales (*i.e.*, mysticetes) and sea turtles are observed within 650 m of the wellsite. This is larger than the minimum distance (500 m) specified in the SOCP in recognition of the potential for SARA and SOCC to be foraging or migrating through the RAA and in consideration of species sensitivities to operating frequencies of the VSP sound source as well as acoustic modelling completed for this Project (Appendix D).
- Passive acoustic monitoring (PAM) will be used to detect vocalizing marine mammals during conditions of low visibility (*e.g.*, fog and darkness). The technical specifications and operational deployment configuration of the PAM system will be optimized within the bounds of operational and safety constraints in order to maximize the likelihood of detecting cetacean species anticipated in the area.

Supply and Servicing

- Helicopters transiting to and from the MODU will fly at altitudes greater than 300 m (with the exception of approach and landing activities). Helicopters will also avoid flying over Sable Island (a 2 km buffer will be recognized) except as needed in the case of an emergency.

- To reduce the risk of marine mammal vessel strikes, Project PSVs will avoid currently-identified critical habitat for the North Atlantic right whale (Roseway Basin) and northern bottlenose whale (the Gully, and Shortland and Haldimand canyons), during transiting activities within the LAA and outside the Project Area, except as needed in the case of an emergency.

- PSVs travelling from mainland Nova Scotia will follow established shipping lanes in proximity to shore. During transit to/from the Project Area, PSVs will travel at vessel speeds not exceeding 22 km/hour (12 knots), except as needed in the case of an emergency. In order to reduce the potential for vessel collisions during transiting activities outside the Project Area, vessels will reduce speed in the event that a marine mammal or sea turtle is noted in proximity to the vessel.

- Should critical habitat be formally designated for leatherback sea turtle or other SAR within the RAA over the term of the exploration licences, BP will comply with applicable restrictions or mitigations developed for the marine shipping industry to reduce the risks of vessel strikes in these areas.

Well Abandonment

- Once wells have been drilled to TD and well evaluation programs completed (if applicable), the well will be plugged and abandoned in line with applicable BP practices and CNSOPB requirements. The final well abandonment program has not yet been finalized; however, details will be confirmed to the CNSOPB as planning for the Project continues.

7.3.8.3 Characterization of Residual Project-Related Environmental Effects

Change in Risk of Mortality or Physical Injury

Presence and Operation of the MODU

Underwater sounds from the presence and operation of the MODU may result in a Change in Risk of Mortality or Physical Injury to Marine Mammals and Sea Turtles in the Project Area if they are in and remain within close proximity of the operation. Underwater acoustic modelling (Zykov 2016) results for the operation of the MODU with PSV, suggest cumulative SELs over 24 hours will decrease to below threshold values associated with potential injury for cetaceans at distances between less than 100 m and 470 m from the operation, (depending on species group and scenario) using both the Southall *et al.* (2007) and NOAA (2015b) criteria (Appendix D). Calculation of these values assumes that all of the thrusters of the vessels (MODU and PSV as applicable) are performing at nominal output power (*i.e.*, the highest sustainable revolutions per minute [rpm]), and that the receiver (*i.e.,* marine mammal or sea turtle) is exposed to this level continuously over a 24-hour period. This scenario is precautionary and highly unlikely to manifest, as marine mammals are not expected to remain within 470 m of the MODU and PSV over the course of 24 hours. Peak SPLs based on both the Southall *et al.* (2007) and NOAA (2015b) criteria are predicted to decrease to below threshold values associated with potential auditory injury at distances beyond 10 m from the source. All values presented are maximum $R_{95\%}$ values across seasons and sites modelled.

Although responses of marine mammals to increased sound levels are highly variable and depend on several internal and external factors (NRC 2005), some studies have documented avoidance of intense sound sources by marine mammals (Stone and Tasker 2006; Moulton and Holst 2010), particularly if the marine mammals are exposed to multiple simultaneous sound sources (Richardson *et al.* 1995; Richardson and Wursig 1995). Based on the most conservative thresholds and modelled results, cumulative SEL over 24 hours, high-frequency cetaceans (*e.g.,* harbour porpoise) would have to remain within approximately 470 m of the MODU, seals would have to remain within 210 m, and low- and mid-frequency cetaceans (including blue, fin, North Atlantic right, and northern bottlenose whale, Sowerby's beaked whale, and killer whale) would have to remain within 140 m of the MODU and PSV for sound levels to be greater than threshold level associated with potential auditory injury. These are not likely to be credible scenarios.

Less is known about the responses of sea turtles to underwater sound; studies to date have focused on seismic sound sources that are far more intense than the sounds emitted from drilling activities. It is assumed that similar to marine mammals, sea turtles will tend to avoid intense sources of sound, and therefore may not approach close enough to the MODU, or remain in the vicinity long enough to be exposed to sound levels capable of causing auditory injury.

The Change in Risk of Mortality or Physical Injury as a result of the presence and operation of the MODU is predicted to be adverse, low in magnitude, restricted to the Project Area, continuous throughout the Project, medium-term in duration, and reversible.

Vertical Seismic Profiling

There have been no documented cases of marine mammal or sea turtle mortality stemming from exposure to sound from exploration seismic surveys. However, it has been suggested that the typical monitoring programs implemented for mitigation purposes during offshore activities may not detect sub-lethal or longer-term effects that could have occurred (DFO 2004). Underwater sounds emitted during VSP operation are expected to be the most intense sounds generated by the Project and therefore may result in a Change in Risk of Mortality or Physical Injury to Marine Mammals and Sea Turtles. Although VSP sound sources typically use similar equipment that is used in seismic operations (*i.e*., an array of compressed air source elements), VSPs typically use substantially smaller source array volumes than those used in exploration seismic surveys. A typical source array for VSP uses between three and six sound source elements, each with a volume size of 150 to 250 cubic inches; however, larger source arrays may be used depending on the geophysical objectives. These sound sources are generally positioned at 5 to 10 m water depth. For the purposes of acoustic modelling, a larger source array, the Schlumberger Dual Magnum 2,400 in^3 airgun, which has been used by BP in other geographic regions, was modelled as the VSP sound source for the Project at an assumed depth of 4.5 m (Appendix D). Literature values suggest that the energy level from a single VSP pulse is expected to produce a source level of 220 to 245 dB re 1 μPa @ 1 m, at frequencies of 5 to 300 Hz (Lee *et al*. 2011). Source level specifications for the airgun source array used in the acoustic modelling were 248 dB re 1 μPa @ 1 m (peak SPL) in the broadside firing direction (Appendix D).

Based on the results of underwater acoustic modelling (Zykov 2016) (Appendix D) sound levels are expected to decrease to below peak SPL threshold values associated with potential permanent auditory injury (*i.e.,* 230 dB, 218 dB, and 202 dB re 1 μPa) at distances greater than 40 m for mid- and low-frequency cetaceans and pinnipeds (Southall *et al.* 2007 and NOAA 2015b), and >140 m for high-frequency cetaceans (NOAA 2015b).

Sound levels (maximum $R_{95\%}$ values across all seasons and sites) are expected to be below cumulative SEL levels associated with permanent auditory injury (198 dB re 1 μPa^{2}s for cetaceans and 186 dB re 1 μPa^{2}s for pinnipeds) (Southall *et al*. 2007) beyond maximum distances of approximately 620 m, 240 m 170 m, and 1.6 km for low, mid and high-frequency cetacean hearing groups and pinnipeds, respectively. Calculation of cumulative SEL values assumes that the VSP source array is activated 2,040 times in a 24-hour period during the VSP survey and that the receiver (*i.e.,* marine mammal or sea turtle) is exposed to this level continuously over this period. VSP surveys are expected to take up to one day at each well; therefore, based on the most conservative distance estimate considered, a marine mammal would have to remain within 1.6 km of the VSP sound source over the duration of the survey for cumulative sound levels to be greater than threshold values associated with potential auditory injury. This scenario is considered unlikely. Sound levels are expected to be below the NOAA 2015b cumulative SEL threshold levels for all cetacean hearing groups and pinnipeds at shorter distances from the sound source than those predicted using the Southall *et al.* (2007) thresholds. For example, for low-frequency cetaceans (including fin and blue whales) and mid-frequency cetaceans (including the northern bottlenose whale, Sowerby's beaked whale, and killer whale) this distance is expected to be less than 240 m and 20 m, respectively, from the sound source (compared to 620 m and 240 m, Southall *et al.* [2007]). For seals, this distance is predicted to be approximately 370 m compared to 1.6 km. Likewise, peak SPLs are expected to decrease below the Southall *et al.* 2007 and NOAA 2005 thresholds for all cetacean hearing groups and pinnipeds at shorter distances from the sound source than those discussed above.

Although less is known about sound levels that may cause auditory injury to sea turtles, it is assumed that these values would not exceed those for cetaceans (LGL 2014). While they acknowledge that few data exist on the effects of seismic airguns on sea turtles, Popper *et al.* (2014) proposed guidelines for threshold levels capable of causing mortality and potential mortal injury from seismic airguns of 210 dB cumulative SEL and 207 dB peak SPL. These values are consistent with those proposed for fish species whose swim bladder is not involved in hearing (Popper *et al.* 2014). Based on acoustic modelling (Zykov 2016), sound levels from VSP operations are predicted to be below these levels at distances greater than approximately 160 m and

100 m respectively. It is also possible that sea turtles are highly protected from potential effects from impulsive sound by their rigid external anatomy (Popper *et al.* 2014). Thresholds for non-mortal injury of sea turtles have not been identified, but the relative risk has been described as 'high' in the 'near' field (*i.e.,* in the tens of metres from the source), and 'low' at both intermediate (*i.e.,* hundreds of metres) and far (*i.e.,* thousands of metres) distances (Popper *et al.* 2014).

Marine mammals and sea turtles are generally expected to temporarily avoid localized areas subject to sound from seismic sources (LGL 2014) and are therefore considered unlikely to approach (or remain) close enough to the VSP sound source to be exposed to sound levels capable of causing auditory injury. A number of mitigation measures will also be implemented to further reduce the effects to marine mammals and sea turtles from VSP operation (see Section 7.3.8.2 above).

The Change in Risk of Mortality or Physical Injury as a result of VSP operation is predicted to be adverse, low in magnitude, restricted to the Project Area, occurring more than once at irregular intervals, short-term in duration, and reversible.

PSV Operations

The presence and operation of PSVs will increase marine traffic within the LAA (two to three PSVs making two to three round trips per week between the MODU and the supply base). This represents a very small increase over existing shipping levels in the RAA (refer to Figure 5.3.4 for a visualization of shipping traffic in the RAA). PSVs are not expected to produce sound levels above those associated with potential permanent auditory injury; however, the Project could produce a Change in Risk of Mortality or Physical Injury due to potential for PSV collision with marine mammals and sea turtles during transit. In general, odontocetes and pinnipeds are less likely to be struck by vessels, while mysticetes (*e.g.*, North Atlantic right whales) are known to be more vulnerable (Laist *et al.* 2001; Jensen and Silber 2003; Vanderlaan and Taggart 2007). Vanderlaan and Taggart (2007) examined historical vessel strike data from 1885 to 2002 and determined that the species of whales most frequently affected by vessel strikes are North Atlantic right whales, fin whales, humpback whales, and grey whales. The North Atlantic right whale is the species most affected by vessel strikes, with mortalities two orders of magnitude more frequent than any other whale species on a per capita basis (Vanderlaan and Taggart 2007). Right whales tend to be easily injured because they are slow moving and have a low profile in the water. Results have shown that reducing vessel speed reduces the number of deaths and severe injuries by vessel impact (Vanderlaan and Taggart 2007; Vanderlaan *et al.* 2008, 2009; van der Hoop *et al.* 2012). Lethal strikes to whales have been noted to be infrequent at vessel speeds less than 25.9 km/hour (14 knots) and rare at speeds less than 18.5 km/hour (10 knots) (Laist *et al.* 2001). As discussed in Section 7.3.8.2, during transit between Halifax Harbour and the Project Area, PSVs will travel at vessel speeds not exceeding 22 km/hour (12 knots) except as needed in the case of an emergency.

There is limited information with respect to the frequency of vessel collisions and sea turtles. Sea turtles have been observed avoiding vessels (Hazel *et al.* 2007), but speed plays a key role in this as turtles can only swim at certain speeds. In an Australian field study examining behavioural effects of vessel speed on green sea turtles, Hazel *et al.* (2007) demonstrated that the proportion of turtles that moved away to avoid the vessel decreased significantly as vessel speed increased. Turtles that moved away from "moderate" (11 km/hour; 6 knots) and "fast" approaches (19 km/hour; 10 knots) did so at significantly shorter distances from the vessel compared to "slow" (4 km/hour; 2 knots) approaches. This research suggests that vessel operators cannot rely on green sea turtles to actively avoid being struck by the vessel if speeds exceed 4 km/hour (2 knots) (Hazel *et al.* 2007). However, reduced (mitigated) speeds within the Project Area are still considered of benefit in reducing the overall likelihood of vessel strikes. Animals are likely to be more susceptible to strikes while foraging. Should critical habitat be formally designated for leatherback sea turtle or other SAR over the term of the exploration licences, BP will comply with applicable restrictions or mitigations developed for the marine shipping industry to reduce the risks of vessel strikes in these areas.

The Change in Risk of Mortality or Physical Injury as a result of PSV operation is predicted to be adverse, low in magnitude, occur within the LAA, occurring more than once at regular intervals, medium-term in duration, and reversible.

Change in Habitat Quality and Use

Presence and Operation of the MODU

As indicated in Section 5.1.3.6, the Scotian Shelf is an active economic area with anthropogenic sound stemming from a number of sources (*i.e.,* shipping, commercial fishing, oil and gas, defence, construction, marine research, and tourism)(Walmsley and Theriault 2011), though shipping is considered to be the major and consistent contributor to low-frequency ambient sound. Effects of underwater sound generated by the presence and operation of the MODU may result in a Change in Habitat Quality and Use for Marine Mammals and Sea Turtles. The operation of the MODU, and in particular, the dynamic positioning activity (*i.e.*, use of DP thrusters), will generate underwater sound, thereby affecting the quality of the underwater acoustic environment for marine mammals and sea turtles. This activity could occur at any time of the year and would be continuous during the time it takes to drill each well (*i.e.,* approximately 120 days per well).

Threshold criteria are commonly used to assess potential PTS; however, behavioural responses of marine mammals to underwater sound are generally more variable, context-dependent and less predictable than potential physical effects (Southall *et al*. 2007). Therefore, use of available sound thresholds to predict behavioural response are considered as a guide to informing the assessment of potential effects of sound on marine mammals rather than as an absolute measure of such effects occurring.

In the US, NOAA (n.d.) has used 120 dB re 1 µPa RMS SPL as a behavioural threshold value for marine mammals exposed to continuous sounds (*e.g.*, shipping and drilling). At received sound levels above this, marine mammals may exhibit a variety of behavioural responses. These may include, for example, changes in vocalizations and call length, diving rates, foraging or travelling patterns, breeding and/or migration routes, and in some cases of intense source levels, avoidance of the area of increased sound (refer to Section 7.3.6.2 for additional information on potential behavioural effects of introduced underwater sound).

Based on the results of underwater acoustic modelling (Zykov 2016), sound levels are predicted to decrease to below 120 dB re 1 µPa RMS SPL at distances >150 km from the MODU during operations in winter (*i.e.,* when sound propagates furthest due to environment conditions). For the most conservative summer scenario (*i.e*., drillship with PSV at Site A), the distance is predicted to be one-third of the winter distance, approximately 50 km. This large variation in distance is due to the strong surface channel produced by the sound speed profile in February, which was selected as an average worst case scenario to represent the winter period, although in reality the temperature and salinity varies on a daily basis. The predicted February surface channel acts to trap acoustic energy at the surface, reducing potential transmission loss (see Appendix D). Sound attenuates rapidly with distance, particularly in deepwater environments, and sound levels greater than 120 dB re 1 µPa RMS SPL are predicted to occur at much closer distances to the source. While onset of marine mammal behavioural responses to continuous sound may occur at SPLs of 120 dB re 1 µPa RMS (NOAA n.d.), the potential magnitude and ecological relevance of a response is expected to vary dependent on a number of factors, such as the intensity of underwater sound, degree of overlap in frequency between a sound and the marine mammal species' hearing sensitivity, as well as the animal's activity state at the time of exposure. More extreme behavioural responses (*e.g.*, long-term displacement from an area) may become generally more likely at received sound levels higher than 120 dB re 1 µPa RMS SPL. Therefore, the distances over which such overt responses may occur will also be less than those predicted for the 120 dB re 1 µPa isopleth. Thompson *et al.* (2016) observed short-term avoidance movements (10 km) and decreased densities of harbour porpoise in response to underwater noise from commercial two-dimensional seismic surveys in the North Sea (peak-to-peak source SPLs of 242 to 253 dB re 1 µPa at 1 m), but most harbour porpoise returned to the area within a few hours following seismic activity (Thompson *et al.* 2013). Some species of marine mammals, such as fin and right whales, have been found to be less responsive to stationary sources of sound than moving sources (Watkins 1986).

The greatest potential for masking exists for marine mammals that produce and perceive sounds within the range of frequencies produced by vessels. Baleen whales vocalize primarily in the lower frequencies (7 Hz to 22 kHz) and are therefore likely to be the most susceptible species (Clark 1990; Erbe 2002) to potential masking associated with the increased ambient sound levels as a result of the MODU or PSV traffic, especially over greater distances. In contrast, odontocete communication frequency ranges from 2 to over 100 kHz (Au and Hastings 2008), which would only partially be overlapped by the low frequency range of drilling sounds (10 Hz to 10 kHz). This suggests that effects of masking may be of lesser concern than for baleen whales, though recent studies suggest odontocetes may still react to low levels of the high frequency components of vessel noise (*e.g.*, Dyndo *et al.* 2015; Veirs *et al.* 2016). Studies on North Atlantic right whales indicate that this species will adjust its vocalizations in the presence of vessel sound; however, as noted by Wright 2008, such alterations "can be presumed to be costly to survival and/or reproductive success" (Wright 2008). Most species of baleen whales known to occur in the RAA are present primarily in the summer months; thus individuals that frequent the area are less likely to be present at the time of year when sound levels will extend to the greater distances due to the sound propagation characteristics in winter. Some species of toothed whale are present in the RAA year-round (see Table 5.2.9). Most of these species are mid-frequency cetaceans, and thus communicate at frequency ranges that only partially overlap with the low-frequency range of MODU operation sounds; however, at ranges less than 3 km, sound levels received from ships also extends to frequencies used by odontocetes (*i.e*., 10 to 96 kHz)(Veirs *et al.* 2016). The marine mammal SAR and SOCC that are most likely to be in the RAA during the winter months are fin whale (SAR Special Concern), northern bottlenose whale (SAR Endangered), and Sowerby's beaked whale (SAR Special Concern). During the winter months, when the strong surface channel propagates sound from the MODU and PSV over the greatest distances, sound levels above 120 dB re 1 µPa RMS SPL may extend to portions of northern bottlenose whale critical habitat: the Gully, Shortland Canyon, and Haldimand Canyon approximately 81 km, 139 km and 171 km respectively from the Project Area. Uncertainty around acoustic disturbances and the effect on species using the Gully remains in spite of numerous scientific reviews undertaken to address this issue (*e.g.,* Lawson *et al*. 2000; Lee *et al*. 2005) (see Section 7.5 – Special Areas).

At this time, there are no data on the effects of shipping sounds (or other continuous sources such as drilling or dynamic positioning) on sea turtles, and no numeric thresholds have been proposed for which to compare to acoustic modelling results (Popper *et al.* 2014). None of the four species of sea turtles known to occur in the vicinity of the Project Area are expected to be present in February, when underwater sounds from MODU operations are expected to extend the furthest. Leatherback and loggerhead sea turtles may still be in the area in December, but Kemp's ridley and green sea turtles are expected only during the summer months. Studies have suggested that sea turtles (including these four species) have greatest hearing sensitivity to low-frequency sounds (Office of Naval Research 2002; Environment Australia 2003; Ketten and Bartol 2005). While there is a general lack of research or scientific data on the effects of sound on sea turtles or the relative importance of their acoustic environment, there is also little to suggest that they would be more sensitive to underwater sounds than marine mammals (Popper *et al.* 2014). The same categories of potential effects discussed above for marine mammals (*i.e.,* behavioural effects and communication masking) are generally expected to encompass the range of potential effects on sea turtles.

The Change in Habitat Quality and Use as a result of the presence and operation of the MODU is predicted to be adverse, moderate in magnitude, occur within the RAA, continuous throughout the Project, short-term in duration, and reversible.

Waste Management

The routine discharge of wastes and emissions (including drill waste discharges) could potentially result in a Change in Habitat Quality and Use for Marine Mammals and Sea Turtles. Routine discharges from the MODU will meet OWTG requirements, which have been established to protect the marine environment. The routine discharge of wastes and emissions is regulated for compliance against these requirements; these discharges therefore have a low potential for toxicity effects to the marine environment and low risk of affecting any marine species. Discharges will not be bio-accumulating or toxic, and will be subject to high dilution in the open ocean. Organic matter associated with any discharge will be quickly degraded by bacteria.

Discharges of mud and cuttings will be in accordance with the OWTG, which allows discharge of WBM cuttings without treatment and SBM cuttings treated prior to release to achieve 6.9% or less synthetic oil on cuttings. Screening of chemicals will be done in accordance with the OCSG to assess the viability of using lower toxicity chemicals. Localized smothering and mortality of sedentary or slow moving benthic species is expected to occur due to the deposition of discharged drill muds and cuttings at thicknesses of ≥10 mm; this is predicted to extend up to 116 m from the wellsite (refer to Appendix C). Benthic species do not represent primary prey for marine mammals and sea turtles. Baleen whales feed primarily on plankton and small schooling fish from the water column. Toothed whales and dolphins feed primarily on fish and squid, some of which may be demersal species. Sea turtles feed primarily on pelagic invertebrates such as jellyfish. Although some of these prey species may be exposed to drill cuttings and other discharges in the water column and in localized areas around the wellsites within the Project Area, they will not be affected to an extent that would result in a change in the quantity or quality of the food source of marine mammals and sea turtles.

The Change in Habitat Quality and Use as a result of waste management is predicted to be adverse, low in magnitude, restricted to the Project Area, occurring more than once at irregular intervals, medium-term in duration, and reversible.

VSP

Acoustic modelling conducted for the Project (Zykov 2016) predicts that sound from the VSP source will decrease to below 160 dB re 1 µPa RMS SPL (NOAA's interim threshold for sensory disturbance from an impulsive source) at distances greater than approximately 3.2 km from the sound source.

Mysticetes generally avoid active air source arrays, although the radius of avoidance can vary (Richardson *et al.*1995; Gordon *et al.* 2004). Numerous studies have been conducted and mysticetes exposed to strong pulses from air source arrays typically respond by avoiding the sound source, which can result in deviation from their normal migration route and/or disruption to feeding (Malme *et al.* 1984, 1985, 1988; Richardson *et al.* 1986, 1995; Ljungbald *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). Avoidance responses may occur at distances beyond the monitoring range of vessel-based observers and as a result, behavioural observations from vessels can be biased (LGL 2014).

Studies of migrating grey, bowhead, and humpback whales have shown that received SPLs of pulses in the 160 to 170 dB re 1 µPa RMS range elicit avoidance behaviour in a substantial number of animals exposed to the sound (Richardson *et al.* 1995). Migrating bowhead whales have shown avoidance behaviour to sound levels as low as 120 to 130 dB re 1 µPa RMS (over pulse duration) (Miller *et al.* 1999; Manly *et al.* 2007). At the same time, some mysticetes have shown limited response to sound from full-air source arrays with only localized avoidance and minor changes in behaviour (LGL 2014). Additionally, grey whales have continued to migrate annually along the west coast of North America regardless of seismic exploration or shipping traffic in the area (Malme *et al.* 1984; Richardson *et al.* 1995). As a result of these varying findings, it is not known to what extent impulsive sounds affect the distribution and habitat use of cetaceans. The overall trend seems to show that over the history of seismic surveys co-existing with mysticetes, brief exposure to pulsed sounds from a single seismic survey are not likely to result in prolonged disturbance (LGL 2014).

The overall response of odontocetes to seismic pulsed sound is variable (LGL 2014). Data suggest that some odontocete species such as belugas and harbour porpoises are more responsive to low-frequency sound than once thought (LGL 2014). Reactions at larger distances may occur when environmental sound propagation conditions are conducive to transmission of the higher-frequency components of the pulsed sound (DeRuiter *et al*. 2006; Tyack *et al.* 2006; Potter *et al.* 2007). There is a lack of specific data on responses of beaked whales to seismic surveys, but it is believed that they would exhibit strong avoidance patterns. Most beaked whales avoid approaching vessels in general (Würsig *et al.* 1998) and may also dive for extended periods of time when approached by a vessel (Kasuya 1986). As a result, it is likely that beaked whales would show avoidance to seismic vessels and activity, although this behaviour has not been specifically studied or documented to date.

For some odontocetes such as delphinids, data suggest that a sound level of >170 dB re 1 µPa RMS may result in avoidance behaviour (LGL 2014). Seismic operators and marine mammal observers on seismic vessels regularly observe dolphins and other small toothed whales in close proximity to operating air source arrays, but there is a general tendency for most delphinids to show some avoidance to operating seismic air source arrays (Stone and Tasker 2006; Weir 2008; Richardson *et al.* 2009; Moulton and Holst 2010). Harbour porpoises have been shown to exhibit behavioural responses to operating seismic air source arrays at levels <145 dB re 1 µPa RMS (Bain and Williams 2006). Lee *et al.* (2005) reported that northern bottlenose whales in the Gully were not displaced by received sound levels of 145 dB re 1 µPa RMS SPL generated by a seismic survey >20 km away that had been operating for a number of weeks. For VSP surveys, sound levels are expected to dissipate below 150 dB re 1 µPa RMS approximately >20 km from the source, and potential for exposure would be limited to a single day for each well.

Visual monitoring from seismic vessels has shown little to no avoidance of air source arrays by pinnipeds, with only a few observed changes in behaviour. Studies have shown that pinnipeds do not avoid the area within a few hundred metres around the air source array (Harris *et al.* 2001; Moulton and Lawson 2002; Miller *et al.* 2005); however, the opposite has been shown with larger sample sizes and observations from a separate observation vessel (LGL 2014). Southall *et al.* 2007 found that, though limited data exist for pinnipeds exposed to multiple pulses (primarily ringed seals), received levels of greater than 190 dB re 1 µPa RMS are likely to elicit a response.

Masking could potentially occur during VSP, although the sound emitted during the survey would be of very short duration (*i.e.*, one day), with periods of silence between pulses, resulting in a limited masking effect.

Studies to date indicate that seismic surveys can have short-term effects on sea turtles such as a change in hearing sensitivity and behavioural effects (*e.g.*, increased and erratic swimming behaviour; McCauley *et al.* 2000a), and physiological responses. Certain levels of exposure to low-frequency sound may cause temporary displacement from areas near the sound source and increased surfacing behaviour. This exposure could potentially lead to displacement from preferred foraging areas (Atlantic Leatherback Turtle Recovery Team 2006). Weir (2007) reported a decrease in the number of sea turtles (of several species) during periods when seismic sources were active, although sea turtles at the surface exhibited no obvious behavioural avoidance, and it is not possible to distinguish whether the decrease in numbers was in relation to the presence of the ship and towing equipment, or to the airgun sounds themselves. DeRuiter and Doukara (2012) also reported avoidance responses (diving behaviour) by loggerhead sea turtles at ranges of up to 839 m, in response to active seismic sources at estimated exposure levels between 175 and 191 dB re 1 µPa peak SPL. In studies of penned animals, McCauley *et al.* (2000) reported behavioural responses (including surfacing and changes in swim patterns) in sea turtles exposed to received levels of 166 dB re 1 µPa RMS SPL, and Moein *et al.* (1994) (cited in Popper *et al.* 2014) reported avoidance of penned loggerhead turtles exposed to active airguns at source levels of 175 to 179 dB re 1 µPa at 1 m (though this behaviour occurred only upon first exposure). Sea turtle dive probability has been shown to decline with increasing minimum range to a seismic source array (DeRuiter and Doukara 2012). No critical habitat for any species of sea turtle in the Atlantic Ocean has yet been defined under SARA; however, a draft Recovery Strategy for the Leatherback Sea Turtle Atlantic population identified three areas of critical habitat (DFO 2015o). The closest of these areas to the Project Area is located south and southeast of Georges Bank and extending to the southwest boundary of the Canadian EEZ on the southwestern Scotian Slope (DFO 2015o); this area is well beyond (more than 200 km) the extent over which behavioural responses to sound from VSP operation may be expected, and any potential disturbance effects in the near field would be short-lived.

The Change in Habitat Quality and Use as a result of VSP operation is predicted to be adverse, low in magnitude, restricted to the Project Area, continuous throughout the Project, short-term in duration, and reversible.

Supply and Servicing

Helicopter transportation has the potential to interact with marine mammals or sea turtles via sensory disturbance resulting from visual cues and helicopter sounds (while the animal is either at the surface or submerged). For aircraft with propellers, sound is primarily related to rotor and propeller blade revolutions per minute, with frequencies concentrated below 500 Hz (Richardson *et al.* 1995). The amount of helicopter sound that enters the marine environment depends primarily on the aircraft's altitude as well as the sea surface conditions (Richardson *et al.* 1995), but sounds will be strongest just below the surface and directly underneath the aircraft. Underwater sound from a passing aircraft is generally brief in duration and will become undetectable underwater far faster than it would in air (Richardson *et al.* 1995).

The most common response of cetaceans to aircraft sounds is diving; however, other reactions include breaching, short surfacing, and changes in behavioural state (Luksenburg and Parsons 2009). Cetaceans have shown varying degrees of sensitivity to aircraft sounds; this may depend on their activity and behavioural state at the time of exposure (*e.g*., resting, socializing, foraging or travelling), with individuals in a resting state appearing to be the most sensitive to disturbance (Würsig *et al*. 1998; Luksenburg and Parsons 2009). In a study in the Beaufort Sea, observers recorded beluga and bowhead whale reactions to a Bell 212 helicopter, and reported that the majority of responses occurred when the helicopter was flying at altitudes less than 150 m, and at lateral distances of less than 250 m (Patenaude *et al.* 2002).

Flights to and from the MODU will be short-term and regular. Except as needed in the case of an emergency, helicopters will also avoid flying over Sable Island, which will reduce the likelihood of effects on seals; this is the standard protocol for other oil and gas operators working offshore Nova Scotia. Helicopter transportation is therefore not predicted to affect seals that could be feeding, breeding or pupping on Sable Island. Any behavioural responses of cetaceans near the surface during a helicopter overflight are expected to be infrequent and temporary.

Underwater sound associated with PSV traffic (*i.e.*, during transiting and operations) has the potential to adversely affect the quality of the acoustic environment and therefore result in a Change in Habitat Quality and Use by marine mammals and sea turtles. The combined effects of underwater sound levels produced by the PSV while alongside the operating MODU are addressed above; however, PSVs will also produce sound during transit to and from the MODU. PSVs are predicted to have nominal operating source sound levels of 170 to 180 dB re 1 µPa @ 1 m RMS SPL (Hurley and Ellis 2004). Sound levels produced by PSVs are not expected to be high enough to cause direct physical harm; however, similar to any other vessels, they could result in changes to swimming, foraging, or vocal behaviours and contribute to masking, as previously discussed (Richardson *et al.* 1995; Clark *et al.* 2009; Nowacek *et al.* 2007; Sundermeyer *et al.* 2012; Tougaard *et al.* 2012; Parks *et al.* 2012). Studies have shown that at frequencies dominated by shipping sound (10 to 100 Hz), ambient spectral sound levels in the RAA are up to 40 dB re 1 µPa higher than sound levels generated by high winds (Walmsley and Theriault 2011).

The Change in Habitat Quality and Use as a result of supply and servicing operations is predicted to be adverse, low in magnitude, occur within the LAA, occurring more than once at regular intervals, medium-term in duration, and reversible.

Well Abandonment

The well abandonment program has not yet been finalized. If approval is sought and granted to keep the wellhead in place, benthic communities may begin to colonize the hard surface of the wellhead; however, this change in habitat is expected to have a negligible effect on marine mammal and sea turtle populations. If the wellhead is removed, it will be done via mechanical separation, which will also result in limited interaction with marine mammals and sea turtles. The mechanical separation of the wellhead from the seabed will not produce excess sound or discharge, but it is likely that this physical disturbance may result in marine mammals and sea turtles temporarily avoiding the immediate area around the wellhead during this activity (which may take 7 to 10 days per well).

The Change in Habitat Quality and Use as a result of well abandonment is predicted to be adverse, low in magnitude, restricted to the Project Area, occurring more than once at irregular intervals, short-term in duration, and reversible.

Summary of Residual Effects

In summary, the Project may result in adverse effects that cause a Change in Risk of Mortality or Physical Injury and a Change in Habitat Quality and Use for Marine Mammals and Sea Turtles. In consideration of the implementation of applicable mitigation measures, best practices, and adherence to industry standards (*e.g.*, compliance with OWTG), the residual effect of a Change in Risk of Mortality or Physical Injury for various Project components and activities is considered to be low in magnitude. Effects will be restricted primarily to the Project Area but will extend into the LAA for Supply and Servicing, and will be short- to medium-term in duration, continuous or irregular, reversible, and occur within a disturbed ecological and socio-economic context (stemming from current sources of ambient noise (primarily shipping) in the RAA). Similarly, Changes to Habitat Quality and Use for Marine Mammals and Sea Turtles are predicted to be low to moderate in magnitude, occur within the Project Area or RAA, be short- to medium-term in duration, continuous or irregular, reversible, and occur within a disturbed context.

Summary of Residual Effects

Table 7.3.6 summarizes the environmental effects assessment and prediction of residual environmental effects resulting from interactions between the Project and Marine Mammals and Sea Turtles that were identified in Table 7.3.5.

Table 7.3.6 Summary of Project Residual Environmental Effects on Marine Mammals and Sea Turtles

Residual Effect	Residual Environmental Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in Risk of Mortality or Physical Injury							
Presence and Operation of MODU (including well drilling and testing operations and associated lights, safety [exclusion] zone and underwater sound)	A	L	PA	MT	C	R	D
Vertical Seismic Profiling	A	L	PA	ST	IR	R	D
Supply and Servicing (PSV Operations)	A	L	LAA	MT	R	R	D
Change in Habitat Quality and Use							
Presence and Operation of MODU (including well drilling and testing operations and associated lights, safety [exclusion] zone and underwater sound)	A	M	RAA	MT	C	R	D
Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)	A	L	PA	MT	IR	R	D
Vertical Seismic Profiling	A	L	PA	ST	IR	R	D
Supply and Servicing (including helicopter transportation and PSV operations)	A	L	LAA	MT	R	R	D
Well Abandonment	A	L	PA	ST	IR	R	D

KEY:
See Table 7.3.2 for detailed definitions
N/A: Not Applicable

Direction:
P: Positive
A: Adverse
N: Neutral

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PA: Project Area
LAA: Local Assessment Area
RAA: Regional Assessment Area

Duration:
ST: Short-term
MT: Medium-term
LT: Long-term

N/A: Not Applicable

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socio-Economic Context:
D: Disturbed
U: Undisturbed

7.3.9 Determination of Significance

With the application of proposed mitigation and environmental protection measures, the residual environmental effects of a Change in Risk of Mortality or Physical Injury and Change in Habitat Quality and Use on Marine Mammals and Sea Turtles from Project activities and components are predicted to be not significant. This conclusion has been determined with a moderate level of confidence based on the low likelihood of animals being present and remaining within close proximity of the operations and the duration of the Project activities. Confidence is reduced from high due to scientific uncertainty of potential effects of introduced underwater sound on sea turtles and marine mammals (particularly with respect to species-specific behavioural effects). There are also inherent uncertainties in the acoustic model, as well as scientific disagreement about the appropriateness of the various thresholds. There is, however a reasonable understanding of the general effects of exploration drilling and VSP operation on marine mammals and the effectiveness of mitigation measures, including those discussed in Section 7.3.8.2.

7.3.10 Follow-up and Monitoring

BP will assess in consultation with the appropriate authorities the potential for undertaking an acoustic monitoring program during the first phase of the drilling program to collect field measurements to verify predicted underwater sound levels. The objectives of such a program will be identified in collaboration with DFO and CNSOPB and in consideration of lessons learned from the underwater sound monitoring program to be undertaken by Shell as part of the Shelburne Basin Venture Exploration Drilling Project in 2016.

MMOs will be employed to monitor and report on sightings of marine mammals and sea turtles during VSP surveys (see Section 7.3.8.2). Monitoring will include visual observations and the use of PAM to inform decisions related to mitigation actions required during VSP operations when baleen whales, sea turtles, or any marine mammal listed on Schedule 1 of SARA are detected within a minimum 650 m predetermined exclusion zone.

MMO duties will include watching for and identifying marine mammals and sea turtles; recording their numbers, distances and behaviour relative to the VSP survey; initiating mitigation measures when appropriate (*e.g.*, shutdown); and reporting results. Following the program, copies of the marine mammal and sea turtle observer reports will be provided to DFO and the CNSOPB.

PAM will be used to detect marine mammals during periods of low visibility (*e.g.*, fog and darkness) for the VSP surveys. The technical specifications and operational deployment configuration of the PAM system will be optimized within the bounds of operational and safety constraints in order to maximize the likelihood of detecting cetacean species anticipated to be in the area.

Following the program, recorded PAM data will be provided to DFO so that this information can be used to help inform understanding of marine mammals in the area.

BP will also consult with DFO regarding relevant findings from the 2014 CSAS review that examined mitigation and monitoring measures for seismic survey activities in and near habitat for cetacean species at risk (DFO 2015a).

In the event that a vessel collision with a marine mammal or sea turtle occurs, BP will contact the Marine Animal Response Society or the Canadian Coast Guard to relay incident information.

7.4 MIGRATORY BIRDS

Migratory Birds was selected as a VC due to their ecological value to marine and coastal ecosystems, potential interaction with Project activities and components, regulatory considerations, and requirements in the EIS Guidelines. The Migratory Birds VC includes pelagic (*i.e.*, offshore) and neritic (*i.e.*, inshore) seabirds, waterfowl, and shorebirds that are protected under the *Migratory Birds Convention Act* (MBCA) and additional marine-related birds not protected under the Act (*e.g.*, cormorants). This VC also considers all migratory birds listed under Schedule 1 of SARA, COSEWIC, and/or the NS ESA.

This VC is related to the Fish and Fish Habitat VC (Section 7.2) in recognition of prey species on which migratory birds may rely. This VC is also related to the Special Areas VC (Section 7.5), as Special Areas are often designated to protect SAR and SOCC, including applicable species of migratory birds. As defined in Section 5.2, SAR include all species listed under Schedule 1 of the federal SARA as *endangered*, *threatened*, or of *special concern*; or listed under the Nova Scotia *Endangered Species Act* (NS ESA) as *endangered*, *threatened*, or *vulnerable*. SOCC include those that are listed as *endangered*, *threatened*, or of *special concern* by COSEWIC, but not yet listed in Schedule 1 of SARA.

7.4.1 Regulatory and Policy Setting

Migratory birds are protected federally under the MBCA, which is administered by Environment Canada. The MBCA and associated regulations provide protection to all birds listed in the Canadian Wildlife Service (CWS) *Occasional Paper No. 1, Birds Protected in Canada* under the MBCA. Migratory birds protected by the Act generally include all seabirds, except cormorants and pelicans, all waterfowl, all shorebirds, and most landbirds (birds with principally terrestrial life cycles). The Act and associated regulations state that no person may disturb, destroy, or take/have in their possession a migratory bird (alive or dead), or its nest or eggs, except under authority of a permit. Section 5.1 of the MBCA describes prohibitions related to depositing substances harmful to migratory birds: "No person or vessel shall deposit a substance that is harmful to migratory birds, or permit such a substance to be deposited, in waters or an area frequented by migratory birds or in a place from which the substance may enter such waters or such an area". Other bird species (and other wildlife) not protected under the federal act, such as cormorants, are protected under the provincial *Wildlife Act*.

Both federal and provincial legislation protect SAR and SOCC, including migratory birds. SARA and the NS ESA generally protect species listed as being *extirpated*, *endangered*, *threatened*, or *vulnerable*, as well as important habitat for these species.

Wildlife species that are protected federally under SARA are listed in Schedule 1 of the Act. SARA seeks to prevent species from being extirpated or becoming extinct; to provide for the recovery of species that are *extirpated*, *endangered* or *threatened* as a result of human activity; and to manage species of *special concern* to prevent them from becoming *endangered* or *threatened*. Sections 32, 33 and 58 of SARA contain provisions to protect species listed on Schedule 1 of SARA, and their critical habitat. Under section 79 of SARA, Ministerial notification is required if a project is likely to affect a listed wildlife species or its critical habitat. This notification must identify the adverse effects of the project on the listed wildlife species and its critical habitat and, if the project is carried out, measures that will be taken to avoid or lessen those effects, along with monitoring commitments.

The NS ESA provides protection to species listed as *endangered*, *threatened*, or *vulnerable* under the Act, as well as their core habitat. The conservation and recovery of species assessed and listed under the NS ESA is coordinated by the Wildlife Division of the NSDNR.

7.4.2 The Influence of Engagement on the Assessment

Birds have traditionally played and continue to play an important role in Mi'kmaq culture, providing cues for traditional harvesting activities along the coast and also providing a food source. Accordingly, potential effects on migratory birds (primarily as a result of a spill) have been raised as an issue during Aboriginal engagement.

7.4.3 Potential Environmental Effects, Pathways and Measurable Parameters

Routine Project activities and components have potential to interact with migratory birds and their associated habitat due to attraction to the lights and flares of the MODU, operational discharges during well drilling and testing operations, underwater sound emissions from VSP operations, and interactions with PSV and helicopter activities during supply and servicing.

As a result of these considerations, the assessment of Project-related environmental effects on Migratory Birds is focused on the following potential environmental effects:

- Change in Risk of Mortality or Physical Injury; and
- Change in Habitat Quality and Use.

The measurable parameters used for the assessment of the environmental effects presented above, and the rationale for their selection, are provided in Table 7.4.1. Effects of accidental events are assessed separately in Section 8.5.3.

Table 7.4.1 Potential Environmental Effects, Effects Pathways and Measurable Parameters for Migratory Birds

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in Risk of Mortality or Physical Injury	Interactions between the extent, duration, or timing of Project activities and the environment that result in direct (*e.g.*, collisions, oiling) effects to the health or condition of migratory birds	• Species injury or mortality (qualitative likelihood of species injury or mortality) • Increase in predator species (qualitative likelihood of predator species attraction)
Change in Habitat Quality and Use	Interactions between the extent, duration, or timing of Project activities and the environment that result in chemical, physical, or sensory changes to migratory bird habitat	• Change in area of habitat (qualitative) used for feeding, breeding, resting, or travelling

7.4.4 Environmental Assessment Boundaries

7.4.4.1 Spatial Boundaries

The spatial boundaries for the environmental effects assessment for Migratory Birds are defined below and depicted on Figure 7.4.1.

Project Area: The Project Area encompasses the immediate area in which Project activities and components may occur and as such represents the area within which direct physical disturbance to the marine benthic environment may occur as a result of the Project. Well locations have not yet been identified, but will occur within the Project Area and represent the actual Project footprint. The Project Area includes ELs 2431, 2432, 2433, and 2434.

Local Assessment Area (LAA): The LAA is the maximum area within which environmental effects from routine Project activities and components can be predicted or measured with a reasonable degree of accuracy and confidence. It consists of the Project Area and adjacent areas where Project-related environmental effects on Migratory Birds are reasonably expected to occur. In consideration of potential effects on prey (fish), an approximate 30 km buffer around the Project Area boundaries has been established to represent the LAA. The LAA has also been defined to include PSV routes to and from the Project Area.

Regional Assessment Area (RAA): The RAA is the area within which residual environmental effects from Project activities and components may interact cumulatively with the residual environmental effects of other past, present, and future (*i.e.*, certain or reasonably foreseeable) physical activities and to provide regional context for the effects assessment. The RAA is restricted to the 200 nautical mile limit of Canada's EEZ, including offshore marine waters of the Scotian Shelf and Slope within Canadian jurisdiction.

7.4.4.2 Temporal Boundaries

The temporal boundaries for the assessment of potential Project-related environmental effects on Migratory Birds encompass all Project phases, including well drilling, testing and abandonment. Up to seven exploration wells will be drilled over the term of the ELs, with Project activities at each well taking approximately 120 days to drill. It is assumed that Project activities could occur year-round.

Migratory birds can be found in and around the Project Area year-round carrying out various life cycle processes. Refer to Section 5.2.7 for details regarding the specific migratory bird SAR and SOCC known to occur in the RAA, including their sensitive periods and relation to the Project Area. An overview is also provided below in Section 7.4.6.

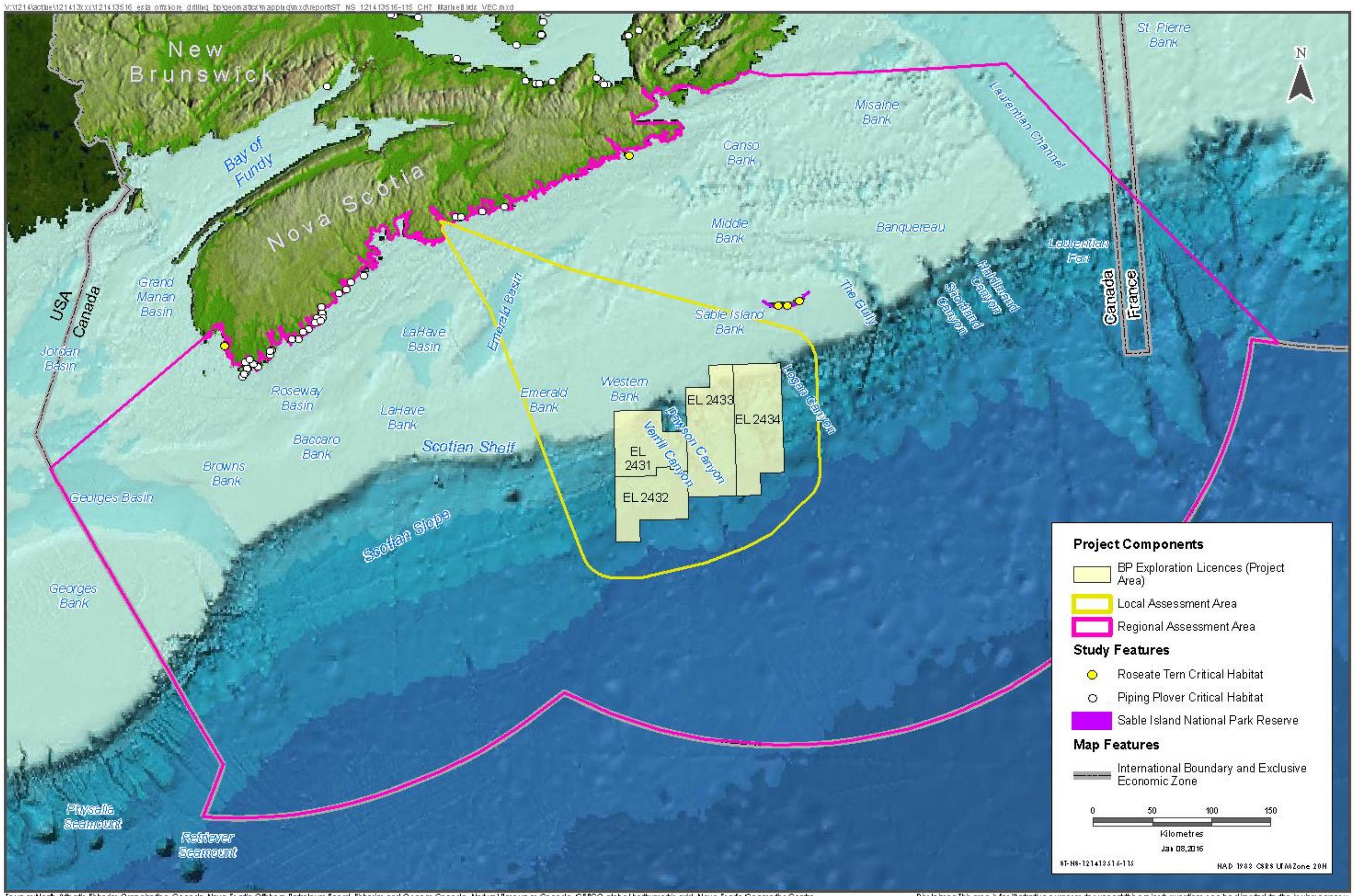


Figure 7.4.1 Spatial Assessment Boundaries for Migratory Birds

7.4.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance

Table 7.4.2 defines the descriptors used to characterize residual environmental effects on Migratory Birds.

Table 7.4.2 Characterization of Residual Environmental Effects on Migratory Birds

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	**Positive** – a residual effect that moves measurable parameters in a direction beneficial to Migratory Birds relative to baseline **Adverse** – a residual effect that moves measurable parameters in a direction detrimental to Migratory Birds relative to baseline **Neutral** – no net change in measureable parameters for the Migratory Birds relative to baseline
Magnitude	The amount of change in measurable parameters of the VC relative to existing conditions	**Negligible** – no measurable change in migratory species populations, habitat quality or quantity **Low** – a measurable change but within the range of natural variability (change in population levels consistent with baseline levels); will not affect population viability **Moderate** – measurable change outside the range of natural variability but not posing a risk to population viability **High** – measurable change that exceeds the limits of natural variability and may affect long-term population viability
Geographic Extent	The geographic area in which an environmental effect occurs	**Project Area** –effects are restricted to the Project Area **Local Assessment Area** –effects are restricted to the LAA **Regional Assessment Area** –effects are restricted to the RAA
Frequency	Identifies how often the effect occurs	**Single Event** – effect occurs once **Multiple Irregular Event** – occurs more than once at no set schedule **Multiple Regular Event** – occurs more than once at regular intervals **Continuous** – occurs continuously

Table 7.4.2 Characterization of Residual Environmental Effects on Migratory Birds

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Duration	The period of time required until the measurable parameter returns to its existing condition, or the effect can no longer be measured or otherwise perceived	**Short-term** – effect extends for a portion of the duration of Project activities **Medium-term** – effect extends through the entire duration of Project activities **Long-term** – effects extend beyond the duration of Project activities and continue after well abandonment
Reversibility	Pertains to whether a measurable parameter of the VC can return to its existing condition after the Project activity ceases	**Reversible** – will recover to baseline conditions before or after Project completion (well abandonment) **Irreversible** – permanent
Ecological and Socio-economic Context	Existing condition and trends in the area where environmental effects occur	**Undisturbed** – area is relatively undisturbed or not adversely affected by human activity **Disturbed** – area has been substantially disturbed by previous human development or human development is still present

In consideration of the descriptors listed above, as well as consideration of requirements under SARA and associated regulations and recovery plans, the following threshold has been established to define a significant adverse residual environmental effect on Migratory Birds.

For the purposes of this effects assessment, a **significant adverse residual environmental effect** on Migratory Birds is defined as a Project-related environmental effect that:

- causes a decline in abundance or change in distribution of migratory birds within the RAA, such that natural recruitment may not re-establish the population(s) to its original level within one generation;
- jeopardizes the achievement of self-sustaining population objectives or recovery goals for listed (SAR) species; or
- results in permanent and irreversible loss of critical habitat as defined in a recovery plan or an action strategy for a listed (SAR) species.

7.4.6 Existing Conditions

Waters off the Scotian Shelf are nutrient rich and highly productive due to the complex oceanographic conditions of the area with an estimated 30 million seabirds using the eastern Canadian waters each year (Fifield *et al.* 2009). Large numbers of breeding marine birds and millions of migrating birds from the southern hemisphere and northeastern Atlantic can be found using the area throughout the year (Gjerdrum *et al*. 2008, 2012). Species diversity peaks during the summer months, when northern hemisphere breeders have returned to their breeding grounds and southern hemisphere breeders have returned from their winter breeding season to spend the summer in more northern waters (Fifield *et al.* 2009). The combination of northern hemisphere birds and southern hemisphere migrating birds results in a diversity peak during spring months (Fifield *et al.* 2009). Significant numbers of overwintering alcids, gulls, and northern fulmars can be found in Atlantic Canadian waters during the fall and winter (Brown 1986), whereas species assemblages are dominated by shearwaters, storm-petrels, northern fulmars, and gulls in summer (Fifield *et al.* 2009).

The waters of the RAA are known to support approximately 19 species of pelagic seabirds, 14 species of neritic seabirds, 18 species of waterfowl and loons, and 22 shorebird species (Table 7.4.3), with more occurring in the area as rare vagrants or incidentals. However, many of these species have a coastal affinity and would therefore not be expected to regularly occur in waters of the Project Area. Seven migratory bird SAR/SOCC are known to occur in waters of the Scotian Shelf and Slope and could occur within the RAA: Ivory Gull, Piping Plover, Roseate Tern, Red Knot, Harlequin Duck, Red-necked Phalarope, and Barrow's Goldeneye. A number of breeding, migrant, and vagrant landbirds also occur in association with the RAA, including two SAR/SOCC that have coastal affinities: Peregrine Falcon and Savannah Sparrow (*Ipswich* subspecies).

Table 7.4.3 Migratory Birds Found in the RAA[1]

Common Name	Species Name
Pelagic Seabirds	
Northern Fulmar	*Fulmarus glacialis*
Cory's Shearwater	*Calonectris diomedea borealis*
Great Shearwater	*Puffinus gravis*
Sooty Shearwater	*Puffinus griseus*
Manx Shearwater	*Puffinus puffinus*
Wilson's Storm-Petrel	*Oceanites oceanicus*
Leach's Storm-Petrel	*Oceanodroma leucorhoa*
Northern Gannet	*Morus bassanus*
Pomarine Jaeger	*Stercorarius pomarinus*
Parasitic Jaeger	*Stercorarius parasiticus*
Long-tailed Jaeger	*Stercorarius longicaudus*
Great Skua	*Stercorarius skua*
South Polar Skua	*Stercorarius maccormicki*
Black-legged Kittiwake	*Rissa tridactyla*
Dovekie	*Alle alle*
Common Murre	*Uria aalge*
Thick-Billed Murre	*Uria lomvia*
Razorbill	*Alca torda*
Atlantic Puffin	*Fratercula arctica*

Table 7.4.3 Migratory Birds Found in the RAA[1]

Common Name	Species Name
Neritic Seabirds	
Great Cormorant	*Phalacrocorax carbo*
Double-Crested Cormorant	*Phalacrocorax auritus*
Black-headed Gull	*Larus ridibundus*
Bonaparte's Gull	*Larus philadelphia*
Ring-billed Gull	*Larus delawarensis*
Herring Gull	*Larus argentatus*
Iceland Gull	*Larus glaucoides*
Glaucous Gull	*Larus hyperboreus*
Great Black-backed Gull	*Larus marinus*
Ivory Gull[2]	*Pagophila eburnea*
Roseate Tern[3]	*Sterna dougallii*
Common Tern	*Sterna hirundo*
Arctic Tern	*Sterna paradisaea*
Black Guillemot	*Cepphus grylle*
Waterfowl and Loons	
Red-throated Loon	*Gavia stellata*
Common Loon	*Gavia immer*
Canada Goose	*Branta Canadensis*
American Green-winged Teal	*Anas crecca*
American Black Duck	*Anas rubripes*
Mallard	*Anas platyrhynchos*
Greater Scaup	*Aythya marila*
Lesser Scaup	*Aythya affinis*
Common Eider	*Somateria mollissima*
Harlequin Duck[4]	*Histrionicus histrionicus*
Long-tailed Duck	*Clangula hyemalis*
Black Scoter	*Melanitta nigra*
Surf Scoter	*Melanitta perspicillata*
White-winged Scoter	*Melanitta fusca*
Common Goldeneye	*Bucephala clangula*
Barrows Goldeneye[5]	*Bucephala islandica*
Bufflehead	*Bucephala albeola*
Red-breasted Merganser	*Mergus serrator*
Shorebirds	
Black-bellied Plover	*Pluvialis squatarola*

Table 7.4.3 Migratory Birds Found in the RAA[1]

Common Name	Species Name
American Golden-Plover	*Pluvialis dominica*
Semipalmated Plover	*Charadrius semipalmatus*
Piping Plover (melodus subspecies)[6]	*Charadrius melodus melodus*
Killdeer	*Charadrius vociferus*
Greater Yellowlegs	*Tringa melanoleuca*
Lesser Yellowlegs	*Tringa flavipes*
Willet	*Tringa semipalmata*
Spotted Sandpiper	*Actitis macularius*
Whimbrel	*Numenius phaeopus*
Ruddy Turnstone	*Arenaria interpres*
Red Knot rufa ssp[7]	*Calidris canutus rufa*
Sanderling	*Calidris alba*
Semipalmated Sandpiper	*Calidris pusilla*
Least Sandpiper	*Calidris minutilla*
White-rumped Sandpiper	*Calidris fuscicollis*
Pectoral Sandpiper	*Calidris melanotos*
Purple Sandpiper	*Calidris maritima*
Dunlin	*Calidris alpina*
Short-billed Dowitcher	*Limnodromus griseus*
Red-necked Phalarope[8]	*Phalaropus lobatus*
Red Phalarope	*Phalaropus fulicarius*
Terrestrial (Land) Birds	
Peregrine Falcon[9]	*Falco perigrinus anatum/tundrius*
Savannah Sparrow (*princeps* subspecies)[10]	*Passerculus sandwichensis*

Note:
[1]Excludes rare transients / vagrants, except for species at risk which are known to occasionally occur (*e.g.*, Ivory Gull).
[2]Ivory Gull is designated as *endangered* under SARA (Schedule 1) and by COSEWIC.
[3]Roseate Tern is designated as *endangered* under SARA (Schedule 1), the NS ESA, and by COSEWIC.
[4]Harlequin Duck is designated as a species of *special concern* under SARA (Schedule 1) and by COSEWIC; and is listed as *endangered* under the NS ESA.
[5]Barrows Goldeneye is designated as a species of *special concern* under SARA (Schedule 1) and by COSEWIC.
[6]Piping Plover (melodus subspecies) is designated as *endangered* under SARA (Schedule 1), the NS ESA, and by COSEWIC.
[7]Red Knot rufa ssp is designated as *endangered* under SARA (Schedule 1), the NS ESA, and by COSEWIC.
[8]Red-necked Phalarope is designated as a species of *special concern* by COSEWIC.
[9]Peregrine Falcon is designated as a species of *special concern* under SARA (Schedule 1) and by COSEWIC; and is listed as *vulnerable* under the NS ESA.
[10]Savannah Sparrow (*princeps* subspecies) is designated as a species of *special concern* under SARA (Schedule 1) and by COSEWIC.

Source: Modified from Stantec 2014a

During summer months, the coastline of the RAA supports over two hundred colonies of nesting migratory birds, ranging in size from a few individuals to thousands of breeding pairs. In general, nesting colonies are distributed all along the coast of Nova Scotia. Areas of dense aggregation include the area between Cape Sable and Yarmouth, the Eastern Shore islands along the southeast coast, and near Country Harbour and Tor Bay. These colonies are known to support Atlantic Puffins, Black-legged Kittiwakes, Common Eiders, Cormorants, Leach's Storm-petrels, Great Black-backed Gulls, Herring Gulls, Razorbills, and terns. Leach's Storm-petrel is the most numerous breeding seabird in the RAA, the vast majority of breeding birds being found on Bon Portage Island near Cape Sable Island. Sable Island is also an important breeding area for colonial marine birds, including gulls, terns, cormorants, as well as other migratory birds.

Fourteen coastal Important Bird Areas (IBAs), including Sable Island, are present within the RAA, as shown in Figures 5.2.25 and 5.2.26. The IBAs are scattered throughout the RAA but many are located in the southeastern portion of Nova Scotia, between Halifax and Cape Breton Island. These areas have been designated as IBAs for a variety of reasons including the presence of breeding habitat for SAR, important shorebird migration habitat, important coastal waterfowl habitat, and/or the occurrence of regionally significant colonial water bird colonies.

7.4.7 Potential Project-VC Interactions

Table 7.4.4 identifies the physical Project activities that might interact with the VC to result in the identified environmental effects. These interactions are indicated by checkmarks, and are discussed in Section 7.4.8 in the context of effects pathways, mitigation, and residual effects. A justification is also provided below for non-interactions (no checkmarks).

Table 7.4.4 Potential Project-Environment Interactions and Effects on Migratory Birds

Project Components and Physical Activities	Potential Environmental Effects	
	Change in Risk of Mortality or Physical Injury	Change in Habitat Quality and Use
Presence and Operation of MODU (including well drilling and testing operations and associated lights, safety [exclusion] zone and underwater sound)	✓	✓
Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)	✓	✓
Vertical Seismic Profiling	✓	✓
Supply and Servicing Operations (including helicopter transportation and PSV operations)	✓	✓
Well Abandonment	-	-
Note: ✓ = Potential interactions that might cause an effect. – = Interaction between the Project and the VC are not expected.		

Well Abandonment

Well abandonment will occur underwater at sufficient depths to prevent interaction with migratory birds, including diving species. Of the migratory birds which are likely to occur in the vicinity of the Project regularly, alcids would spend the most amount of time underwater and are among the deepest divers. The maximum diving depth has been estimated to be approximately 50 m for black guillemots and 60 m for Atlantic puffins; razorbills are known to dive to depths of at least 120 m, and common murres to 180 m or deeper (Piatt and Nettleship 1985). Water depths range from 100 to more than 3,000 m in the Project Area but drilling and well abandonment will take place beyond the depth of diving seabirds (*e.g.*, 180 m or shallower) found in the area and is therefore not predicted to interact with Migratory Birds, including diving seabirds.

7.4.8 Assessment of Project-Related Environmental Effects

The following section assesses the environmental effects on Migratory Birds identified as arising from potential interactions in Table 7.4.4. Given the similarities in Project description, proximity of activities on the Scotian Slope, and currency of data, the EA for the Tangier 3D Seismic Survey (LGL 2014) and the Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) have been drawn on for this analysis, with updates incorporated as applicable due to Project and geographic differences, scientific updates, and refined EA methods.

7.4.8.1 Project Pathways for Effects

Change in Risk of Mortality or Physical Injury

The presence and operation of the MODU and PSVs has the greatest potential to result in Changes to Risk of Mortality or Physical Injury for Migratory Birds because they are known to aggregate around drilling features as a result of night lighting, food, and other visual cues, potentially making them subject to increased risk of mortality due to physical impacts with structures, predation by other marine bird species, and incineration from flares (Wiese *et al.* 2001; Ronconi *et al*. 2015). In addition to direct (*e.g*., collisions) and indirect interactions with the MODU and PSVs, the Project has potential to result in a Change in Risk of Mortality or Physical Injury of Migratory Birds through exposure to residual hydrocarbons associated with drill muds, cuttings, and other discharges and emissions through exposure to underwater sound caused by VSP operations and disturbance from and collisions with transiting helicopters.

Change in Habitat Quality and Use

A Change in Habitat Quality and Use for Migratory Birds could potentially occur as a result of Project activities; particularly the influence of sound, lights, and flaring from the MODU and PSVs on habitat conditions, the presence of hydrocarbons and TSS within the water column from the discharge of drill muds and cuttings; the release of other discharges and emissions (including cooling water, ballast water, bilge and deck water, grey/black water and small quantities of process water); through exposure of migratory birds to underwater sound from VSP operations; and disturbance from helicopter transportation.

7.4.8.2 Mitigation of Project-Related Environmental Effects

In consideration of the environmental effects pathways outlined above, the following mitigation measures and standard practices will be employed to reduce the potential environmental effects of the Project on Migratory Birds. Refer to Table 13.2.1 for a complete list of Project mitigation measures.

Presence and Operation of MODU

- Lighting will be reduced to the extent that worker safety and safe operations is not compromised. Reduction of light may include avoiding use of unnecessary lighting, shading, and directing lights towards the deck.

- Routine checks for stranded birds will be conducted on the MODU and appropriate procedures for release will be implemented. If stranded birds are found during routine inspections, they will be handled using the protocol outlined in *The Leach's Storm Petrel: General Information and Handling Instructions* (Williams and Chardine 1999), including obtaining the associated permit from CWS. Activities will comply with the requirements for documenting and reporting any stranded birds (or bird mortalities) to CWS during the drilling program.

Waste Management

- Refer to the waste management mitigation measures identified in the Fish and Fish Habitat VC (Section 7.2.8.2).

Vertical Seismic Profiling

- A ramp-up procedure (*i.e.*, gradually increasing seismic source elements over a period of approximately 30 minutes until the operating level is achieved) will be implemented before any VSP activity begins.

Supply and Servicing Operations

- Helicopters transiting to and from the MODU will fly at altitudes greater than 300 m (with the exception of approach and landing activities) and at a lateral distance of 2 km around active colonies when possible. Helicopters will avoid flying over Sable Island (a 2 km buffer will be recognized) except as needed in the case of an emergency.

- Lighting on PSVs will be reduced to the extent that worker safety and safe operations is not compromised. Reduction of light may include avoiding use of unnecessary lighting, shading, and directing lights towards the deck.

- PSVs travelling from mainland Nova Scotia will follow established shipping lanes in proximity to shore. During transit to/from the Project Area, PSVs will travel at vessel speeds not exceeding 22 km/hour (12 knots), except as needed in the case of an emergency. PSVs will maintain a 2 km avoidance buffer around Sable Island and associated bird colonies in that area except as needed in the case of an emergency.

- Routine checks for stranded birds will be conducted on the PSVs and appropriate procedures for release will be implemented. If stranded birds are found during routine inspections, they will be handled using the protocol outlined in *The Leach's Storm Petrel: General Information and Handling Instructions* (Williams and Chardine 1999), including obtaining the associated permit from CWS. Activities will comply with the requirements for documenting and reporting any stranded birds (or bird mortalities) to CWS during the drilling program.

7.4.8.3 Characterization of Residual Project-Related Environmental Effects

Change in Risk of Mortality or Physical Injury

Presence and Operation of the MODU

Many migratory birds navigate by sight, and lights can be a visual cue (Wiese *et al.* 2001). Artificial lighting in the offshore and coastal environments regularly attract nocturnally-active seabirds and migrating land and waters birds, sometimes in large numbers (Imber 1975; Montevecchi *et al*. 1999; Wiese *et al.* 2001; Gauthreaux and Belser 2006; Montevecchi 2006; Bruinzeel *et al*. 2009; Bruinzeel and van Belle 2010; Ronconi *et al*. 2015). Attraction to artificial lighting is widespread among procellariiform sea birds (*e.g*., shearwaters and storm-petrels), because they feed on bioluminescent prey and are naturally attracted to light (Imber 1975). During migration, small songbirds are also commonly attracted to artificial lighting on offshore ships and installations (Gauthreaux and Belser 2006; Poot *et al.* 2008). Artificial lighting associated with the MODU and PSVs has potential to result in strandings, collisions, increased opportunities for predation, and exposure to other vessel-based threats.

Migratory birds that are attracted to offshore installations may experience mortality through direct collision with the MODU or may become disoriented by lights and become stranded. Short-duration flaring by the MODU during testing may attract migratory birds and result in increased mortality risk. In addition to incineration, seabirds have been observed to circle flares for days, eventually dying of starvation (Bourne 1979). However, studies have shown most bird mortality on offshore platforms or lighthouses to be related to collision injuries rather than energy reserve depletion (Bruinzeel and van Belle 2010). Storm petrels are the most common species to be stranded on vessels in Atlantic Canada (Environment Canada 2015), but Greater Shearwater and Sooty Shearwater have also been observed to commonly strand themselves in Nova Scotia (LGL 2014). Predation is an additional potential problem for certain species such as storm petrels. For example, during shipboard studies conducted in 1999, Leach's Storm-petrels were observed being attacked by Great Black-backed Gulls after they became confused by the lights of vessels and platforms (Wiese and Montevecchi 2000). Additionally, birds that spend the nighttime circling the platform may need to prolong their migratory journeys during the day, potentially increasing predation risks (Bruinzeel and van Belle 2010).

A number of factors influence the potential severity of marine bird interactions with flares, including the time of year, location, height, light and cross-sectional areas of the obstacle and weather conditions (Weir 1976; Wiese *et al.* 2001). The extent of attraction from artificial lights on drilling vessels and flares can vary based on meteorological conditions (rain, visibility), season, age of the birds, the lunar phase, and light composition (*e.g*., wavelength, intensity). Assuming a typical offshore platform scenario of 30 kW of artificial lighting, birds may be attracted from distances up to 5 km from the source (Poot *et al.* 2008). Bruinzeel and van Belle (2010) calculate that the threshold for disorientation ranges from 200 m (dense fog), 1000 m (fog) 1,250 m (mist), 1,400 m light rain, and 1,650 m (heavy rain), with the most dramatic scenario being one with perfect ground visibility (*e.g*., 10,000 m) with no celestial cues due to overhead clouds, where disorientation can occur up to 4,500 m from the illuminated platform. During conditions of drizzle and fog, moisture droplets in the air refract light and greatly increase the illuminated area, thus enhancing attraction. Mortality can also increase during migration when large numbers of birds fly relatively low as a result of unfavorable weather conditions (Wiese *et al.* 2001). Mortality risk with flares and other lighted structures may also be higher in the latter part of the night as most nocturnal migrants climb to their migrating height soon after takeoff and then undertake a gradual descent shortly after midnight (Weir 1976).

Recent studies have examined the effects of lighting composition (*e.g*., wavelength, intensity), with most studies showing that longer wavelengths are more likely to cause disorientation to migrating birds. Steady burning red-coloured lights were shown to result in the majority of bird casualties (Gautreaux and Belser 2006; Gehring *et al*. 2009; Marquenie *et al*. 2014). A 2000 field experiment at an offshore oil platform in the North Sea demonstrated a high correlation between lighting intensity and bird attraction (Marquenie and van der Laar 2004). When platform lighting was reduced from full illumination to only beacon and obstruction lights, the number of birds observed circling the platform was significantly reduced (Marquenie and van der Laar 2004). The type and intensity of lighting are therefore expected to be important factors in determining the magnitude of adverse effects on migratory birds.

Seabird monitoring conducted as part of the SOEP and Deep Panuke EEM programs has shown little to no effect of flaring on birds transiting to and from Sable Island or the Scotian Slope (CNSOPB 2011; McGregor Geoscience Limited 2012). In 2012, only a single stranding (Leach's Storm-petrel) was recorded during the Deep Panuke bird monitoring program, with the bird released unharmed (McGregor Geoscience Limited 2012).

While conducting daily vessel searches during BP's Tangier 3D seismic survey, the MMOs and vessel crews on the six seismic vessels encountered 19 stranded birds and 26 dead birds over the course of the survey (May to September 2014). Stranded birds consisted of 18 storm petrel species and one warbler species; the majority of dead birds were passerines (RPS 2014).

In general, bird morality rates recorded from offshore platforms are believed to be underreported most likely due to the birds falling into the sea and/or being consumed by scavengers before being detected by observers (Bruinzeel *et al.* 2009). As such, it is likely that some unknown proportion of individuals entering into contact with flares or otherwise negatively affected by flaring would not be recovered during monitoring.

In consideration of mitigation, including efforts to reduce flaring and exposure to artificial lighting, the Change in Risk of Mortality or Physical Injury as a result of the presence and operation of the MODU is predicted to be adverse, low to moderate in magnitude, restricted to the Project Area, continuous throughout the Project, medium-term in duration, and reversible.

Waste Management

Although there are several types of discharges that migratory birds may interact with during drilling of the well and operation of the PSVs, all will be in compliance with the OWTG and in adherence to MARPOL, both of which have been established to protect the marine environment. As well, discharges and emissions are expected to be temporary, localized, non-toxic, and subject to high dilution in the open ocean.

Drill cuttings associated with SBM use will be discharged via a caisson below the sea surface, potentially affecting water quality within a localized area as the discharges migrate through the water column (refer to Appendix C for drill waste dispersion modelling). The discharge of cuttings has potential to result in small sheens to form under certain conditions (*i.e.*, calm winds and small waves) during routine operation, which could affect migratory birds. Although data on the relationship between sheen thickness and lethality to marine birds are lacking (Hartung 1995), a laboratory study demonstrated that it only requires a small amount of oil (*e.g.*, 10 ml) to affect the feather structure of Common Murre (*Uria aalge*) and Dovekie (*Alle alle*) (O'Hara and Morandin 2010). However, there are no data on threshold number of affected feathers before an individual bird would begin to be affected by exposure to oil sheen (O'Hara and Morandin 2010).

The potential for sheen formation as a result of the discharge of cuttings and SBM use is low because activity will be carried out in adherence to the OWTG and drill muds will be selected in accordance with OCSG. The SBM itself has a fraction of oil or synthetic oil as a component and the cuttings are cleaned and have only a very small fraction of the SBM adhered to them when discharged. The amount of SBM on cuttings would be in the single percentages of the total volume. Discharging the cuttings at depth further mitigates the potential for sheen formation. Furthermore, if the wind and wave conditions were such that a sheen formed in association with an SBM cuttings discharge for this Project, the sheen would be temporary and limited in size, such that only birds in the immediate area of the spill would likely be affected. While the risk of mortality for individual birds that came in contact with the sheen would be increased, the limited nature of this sheen and the likely number of birds affected are such that potential effects are minor. Additionally, WBM and cuttings released at the seafloor will not interact with surface waters such that migratory birds or their prey would be affected.

Deck drainage and bilge waters have potential to negatively affect marine bird health because of the presence of residual hydrocarbons. However, residual hydrocarbons in discharges are generally not associated with the formation of a slick and are therefore unlikely to have a measurable effect on migratory birds. Sea water used for cooling purposes aboard the MODU will be treated through an oil-water separator before being disposed of at sea. Discharges of sanitary and domestic waste may attract birds and/or prey to the MODU and PSVs, but food and sewage waste will be macerated to maximum particle size (6 mm) prior to disposal. This waste is expected to be quickly degraded by bacteria and other biological activity after release. However, even if discharges are non-toxic, gray water discharge will attract gulls and other species to the vicinity of the MODU and PSVs, which may slightly increase Risk of Mortality or Physical Injury of marine bird species, particularly if they interact with a flare or become stranded on the MODU. No food or sewage waste will be discharged within 3 nm of the coast consistent with MARPOL.

The Change in Risk of Mortality or Physical Injury as a result of waste management is predicted to be adverse, negligible in magnitude, restricted to the Project Area, occurring more than once at regular intervals, medium-term in duration, and reversible.

Vertical Seismic Profiling

There is a scarcity of data on the effects of underwater sound on marine birds and the few studies that have been done regarding seismic testing have observed little behavioural effect (Stemp 1985; Turnpenny and Nedwell 1994; Lacroix *et al.* 2003). For example, shearwaters have been observed with their heads underwater within 30 m of seismic vessels and no response was noted (Stemp 1985). Environmental observers found the same lack of response by guillemots, fulmars, and kittiwakes during seismic testing in the North Sea (Turnpenny and Nedwell 1994). A study of Long-tailed Ducks in the Beaufort Sea also found no effects from seismic testing (Lacroix *et al*. 2003).

Although birds are generally considered to have good hearing abilities, information on their underwater hearing abilities is largely lacking (Wiese *et al.* 2001; OSPAR 2009; Dooling and Therrien 2012). Audiograms of over 50 species of birds indicate that they hear best, on average, between 2 and 5 kHz in air (Dooling and Therrien 2012). The effects of anthropogenic sound in air include auditory system damage, and behavioural responses. For birds in air, continuous sound exposure levels above 110 dB(A) SPL or blast noise above 140 dB SPL can result in PTS (Dooling and Therrien 2012). Continuous sound exposure levels above 90 to 95 dB SPL, has been shown to cause TTS (in air). Taking into consideration changes in human hearing underwater and the protective effect against acoustic overexposure in birds from changes in middle ear pressure, it has been suggested that diving birds may not hear well underwater. It is also thought that the frequency for optimal hearing may shift below 2 to 4 kHz (Dooling and Therrien 2012).

In consideration of the short term nature of VSP operation (lasting for no more than one day per well), the lack of documented behavioral and physiological effects of seismic testing on diving birds, and use of a ramp-up procedure, the Change in Risk of Mortality or Physical Injury as a result of VSP operation is predicted to be adverse, negligible in magnitude, restricted to the Project Area, occurring more than once at irregular intervals, short-term in duration, and reversible.

Supply and Servicing Operations

Studies have shown that marine birds react mostly to low-level helicopter flights and the effects of these responses are short in duration (Stantec 2013b). Helicopter flights at 300 m failed to elicit responses in moulting sea ducks in the North Sea, while flights occurring at 100 m created a short-term avoidance response (Ward and Sharp 1974). Marine birds tend to habituate to helicopter transportation over time. One of the greatest effects due to helicopter transportation can occur over large nesting colonies. Aircraft passing over nesting colonies can cause birds to panic, leaving eggs and young-of-the-year unprotected from predators and inclement weather, and also result in the use of valuable energy reserves for defence instead of caring for their young (Environment Canada 2013f).

As outlined in Section 7.4.8.2, helicopters transiting to and from the MODU will fly at altitudes greater than 300 m (with the exception of approach and landing activities) and at a lateral distance of 2 km around active colonies when possible; thus reducing disturbance to migratory birds and potential for collisions.

Residual effects of PSV operations are expected to be similar to that described above in the context of lighting effects from the MODU, although the lighting will not be stationary and the extent of residual effects could extend beyond the Project and into the LAA to account for PSV transit to and from the supply base.

In consideration of proposed mitigation, the Change in Risk of Mortality or Physical Injury as a result of supply and servicing is predicted to be adverse, low in magnitude, occur within the LAA, occurring more than once at regular intervals, medium-term in duration, and reversible.

Change in Habitat Quality and Use

Presence and Operation of the MODU

Underwater and atmospheric sound from the MODU may result in sensory disturbance to migratory birds, leading to behavioural responses such as temporary habitat avoidance or changes in activity state (*e.g.*, feeding, resting, or travelling). However, because the MODU will remain on-site at the drilling location during Project activities, the spatial extent of changes to habitat quality for migratory birds as a result of the presence and operation of the MODU would be minimal. Furthermore, mitigation measures to limit flaring and exposure of migratory birds to artificial lighting will reduce potential effects.

The Change in Habitat Quality and Use as a result of the presence and operation of the MODU is predicted to be adverse, low in magnitude, restricted to the Project Area, continuous throughout the Project, medium-term in duration, and reversible.

Waste Management

There are several types of discharges during drilling of the well and from PSV operations that may interact with migratory bird habitat and use (Section 2.8). However, all of these discharges will be in compliance with the OWTG and in adherence to MARPOL. As well, discharges and emissions are expected to be temporary, localized, non-toxic, and subject to high dilution in the open ocean. Residual hydrocarbons in discharges are generally not associated with the formation of a slick and are therefore unlikely to have a measurable effect on the quality of migratory bird habitat.

The discharge of mud and cuttings could potentially result in a Change in Habitat Quality for Migratory Birds. However, WBM and cuttings released at the seafloor will not interact with surface waters such that migratory birds or their prey would be affected. Furthermore, drill cuttings associated with SBM use will be treated in accordance with the OWTG prior to discharged via a caisson below the sea surface. Discharged drill cuttings will settle rapidly to the seabed and have a negligible interaction with migratory birds. Extremely small volumes and fine particle sizes of SBM adhered to treated drill cuttings will remain suspended in the upper water column, contributing to increased levels of TSS before dispersing (refer to Appendix C for drill waste dispersion modelling). As such, temporary elevated TSS levels in the water column could result in temporary avoidance of a localized area of the Project Area by migratory birds during discharge of SBM cuttings at the surface.

As outlined in Section 7.4.8.2, seawater used for cooling purposes aboard the MODU will be treated through an oil-water separator before being disposed of at sea. Discharges of sanitary and domestic waste may attract birds and/or prey to the MODU and PSVs, but food and sewage waste will be macerated to maximum particle size (6 mm) prior to discharge. This waste is expected to be quickly degraded by bacteria and other biological activity after release.

The Change in Habitat Quality and Use as a result of waste management is predicted to be adverse, negligible in magnitude, restricted to the Project Area, occurring more than once at regular intervals, medium-term in duration, and reversible.

Vertical Seismic Profiling

Sound from VSP operations is expected to be the most intense sound generated by the Project. However, the VSP operations is only expected to be generated for approximately one day per well and studies have failed to document a strong response of migratory birds to seismic testing (Stemp 1985; Turnpenny and Nedwell 1994; Lacroix *et al*. 2003). Furthermore, many species of seabirds that may be present in the Project Area spend less than one minute underwater during a foraging dive, resulting in a short temporal overlap with VSP operations. Of the migratory birds that may be found within the Project Area, alcids (*e.g.*, Dovekie, Common Murre, Thick-billed Murre, Atlantic Puffin) spend relatively high amounts of time underwater during forage dives. However, it is unlikely that these birds will feed underwater when the seismic source is activated as a ramp-up period will be initiated which would deter migratory birds from the area and reduce their exposure to harmful underwater sound waves.

The Change in Habitat Quality and Use as a result of VSP operations is predicted to be adverse, low in magnitude, restricted to the Project Area, occurring more than once at irregular intervals, short-term in duration and reversible.

Supply and Servicing Operations

Migratory birds can react to low-level helicopter flights although their reactions are often temporary in nature. However, as outlined in Section 7.4.8.2, helicopters transiting to and from the MODU will fly at altitudes greater than 300 m and at a lateral distance of 2 km around active colonies when possible. Helicopters will also avoid flying over Sable Island (a 2 km buffer will be recognized) except as needed in the case of an emergency, as is the standard protocol for other oil and gas operators working offshore Nova Scotia (see Section 7.5). Although migratory birds near the MODU may be disturbed during take-off and landing, they are likely to become habituated to the activity.

The presence of an approaching PSV may alert birds and flush some species from the area. The potential for PSVs to disturb bird colonies will be minor as the only colonies in the vicinity of the travel routes are in Halifax Harbour, where nesting birds are currently habituated to relatively high shipping activity. PSVs will not come in close proximity to any critical habitat for marine birds (*i.e.*, piping plover or roseate tern), or IBAs. Additionally, PSV activities are expected to be minimal compared to ongoing ship activity within the LAA; two or three PSVs will be required for the transport of materials and equipment to the MODU and will make between two to three round trips per week. One PSV must also be present on-site at all times as a standby vessel, as required by BP's operating standards and under the CNSOPB regulations. PSVs travelling from mainland Nova Scotia will follow established shipping lanes in proximity to shore and travel at approximately 22 km/hour (12 knots), except as needed in the case of an emergency.

The Change in Habitat Quality and Use as a result of supply and servicing operations is predicted to be adverse, low in magnitude, occur within the LAA, occurring more than once at regular intervals, medium-term in duration and reversible.

Summary of Residual Effects

In summary, the Project will result in adverse effects to a Change in Risk of Mortality or Physical Injury and a change in Habitat Quality and Use for Migratory Birds. In consideration of the implementation of applicable mitigation measures, best practices, and adherence to industry standards (*e.g.*, compliance with OWTG), the residual effect on a Change in Risk or Mortality or Physical Injury is considered to vary from negligible to moderate in magnitude for various Project components and activities; primarily restricted to the Project Area but extend into the LAA for PSV operations and helicopter traffic; are short to medium-term in duration, reversible, and primarily occur within an undisturbed ecological and socio-economic context (with the exception of helicopter and PSV activity in the nearshore environment). Similarly, changes to Habitat Quality and Use for Migratory Birds are predicted to be negligible to low in magnitude, restricted to the Project Area or LAA, short to medium-term in duration, reversible, and to primarily occur within an undisturbed context. Table 7.4.5 summarizes the environmental effects assessment and prediction of residual environmental effects resulting from those interactions between the Project and Migratory Birds that were identified in Table 7.4.4.

Table 7.4.5 Summary of Project Residual Environmental Effects on Migratory Birds

Residual Effect	Residual Environmental Effects Characterization						
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Ecological and Socio-economic Content**
Change in Risk of Mortality or Physical Injury							
Presence and Operation of MODU (including drilling and testing operations and associated lights, safety [exclusion] zone and underwater sound)	A	L-M	PA	MT	C	R	U
Waste Management	A	N	PA	MT	R	R	U
Vertical Seismic Profiling	A	N	PA	ST	IR	R	U
Supply and Servicing Operations	A	L	LAA	MT	R	R	U-D
Change in Habitat and Use							
Presence and Operation of MODU (including drilling and testing operations and associated lights, safety (exclusion) zone and underwater sound)	A	L	PA	MT	C	R	U
Waste Management	A	N	PA	MT	R	R	U
Vertical Seismic Profiling	A	L	PA	ST	IR	R	U
Supply and Servicing Operations (including helicopter transportation PSV operations)	A	N-L	LAA	MT	R	R	U-D

KEY:
See Table 7.4.2 for detailed definitions
N/A: Not Applicable

Geographic Extent:
PA: Project Area
LAA: Local Assessment Area
RAA: Regional Assessment Area

Frequency:
S: Single event
IR: Irregular event
R: Regular event

Table 7.4.5 Summary of Project Residual Environmental Effects on Migratory Birds

Residual Effect	Residual Environmental Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Content

Direction:
P: Positive
A: Adverse
N: Neutral

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Duration:
ST: Short-term
MT: Medium-term
LT: Long-term

C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socio-Economic Context:
D: Disturbed
U: Undisturbed

7.4.9 Determination of Significance

With the application of proposed mitigation and environmental protection measures, the residual environmental effect of a Change in Risk of Mortality or Physical Injury and Change in Habitat Quality and Use on Migratory Birds during routine Project activities is predicted to be not significant. This conclusion has been determined with a high level of confidence based on an understanding of the general effects of routine exploration drilling and the effectiveness of mitigation measures. The greatest risk to migratory birds from routine Project activities and components was identified as a potential Change in Risk of Mortality or Physical Injury as a result of the presence of the MODU and the transiting PSVs (See Table 7.4.5).

7.4.10 Follow-up and Monitoring

Follow-up and monitoring will include routine checks for stranded birds on the MODU and PSVs (with handling as per the Williams and Chardine 1999 protocol) and compliance with the requirements for documenting and reporting any stranded birds (or bird mortalities) to the CWS during the drilling program. To differentiate between Wilson's storm-petrel (*Oceanites oceanicus*) and Leach's storm-petrel, photographs depicting their differences will be provided to crew members trained to check for and handle stranded birds.

7.5 SPECIAL AREAS

Special Areas has been selected as a VC due to ecological and/or socio-economic importance, stakeholder and regulatory interests, and potential Project interactions. Special Areas provide important habitat that may be relatively more vulnerable to Project-related effects than other areas. Adverse environmental effects on Special Areas could degrade the ecological integrity of a Special Area such that it is not capable of providing the same biological or ecological function for which it was designated (*e.g.*, protection of sensitive or commercially important species). Special Areas are often designated to protect SAR and SOCC; therefore the assessment of Special Areas is closely linked to the other VCs (including associated SAR and SOCC) considered in this assessment including Fish and Fish Habitat (Section 7.2), Marine Mammals and Sea Turtles (Section 7.3) and Migratory Birds (Section 7.4).

Special Areas includes consideration of areas noted for their biological and ecological significance including, but not limited to, protected areas and Ecologically and Biologically Significant Areas (EBSAs). Although EBSAs do not have the same regulatory status as protected areas, they have been recognized by DFO as warranting consideration for conservation given their ecological and biological significance. In many cases, EBSAs overlap with other designated Special Areas that may already receive regulatory protection under federal legislation (*e.g.*, Emerald-Western-Sable Island Bank Complex EBSA and the Haddock Box). In these circumstances, the VC analysis focuses on the designated protected area, rather than the EBSA itself. The Scotian Slope EBSA extends through the Project Area. Therefore, this VC focuses on designated protected areas and the Scotian Slope EBSA.

7.5.1 Regulatory and Policy Setting

Many of the Special Areas (shown in Figure 7.5.1) considered in this assessment are under regulatory protection to protect the biological and ecological integrity of the Special Area and associated resources.

Petroleum exploration is prohibited on Sable Island National Park Reserve (approximately 48 km northeast of the Project Area) and in the Gully MPA (approximately 71 km northeast of the Project Area). Sable Island became officially designated as a National Park Reserve under the *Canada National Parks Act* in 2013. In response to this designation, the *Canada–Nova Scotia Offshore Petroleum Resources Accord Implementation Act* was amended to prohibit drilling for petroleum on Sable Island and within a one-nautical-mile exclusion zone around it. As an MPA under the *Oceans Act*, the Gully is protected from any activity within or near the MPA that disturbs, damages, destroys or removes any living marine organism or any part of its habitat within the MPA as per the *Gully Marine Protected Area Regulations*.

Closures have been established in accordance with the *Fisheries Act* and *Oceans Act*, restricting bottom fisheries activities on the eastern Scotian Shelf (Sambro Bank and Emerald Basin) to protect *Vazella Pourtalesi* (Russian hat glass sponges). Although petroleum exploration is not specifically prohibited, the designations protect high densities of intact octocorals and glass sponges from benthic disturbance which effectively negates drilling activity in these areas.

DFO has designated a Whale Sanctuary for the northern bottlenose whales. The Recovery Strategy for northern bottlenose whale identifies the entirety of Zone 1 of the Gully MPA and areas with water depths of more than 500 m in Haldimand Canyon and Shortland Canyon as Critical Habitat under SARA for the Scotian Shelf population (DFO 2009j). The Gully, Shortland Canyon and Haldimand Canyon are approximately 81 km, 139 km and 171 km respectively from the Project Area.

Critical habitat has also been designated under SARA for the endangered North Atlantic right whale, in the Roseway Basin (refer to Section 7.3.1 for further information on SARA). This area is also recognized by Transport Canada (TC) and IMO as a seasonal area to be avoided by ships 300 gross tonnage and above in transit during the period of June 1 to December 31. The Roseway Basin Critical Habitat/Area to be Avoided is located approximately 264 km northwest of the Project Area.

The federal *Species at Risk Act* (SARA) focuses on protecting species and their associated habitat whose populations are not secure. Sections 32, 33 and 58 of SARA contain provisions to protect species listed on Schedule 1 of SARA and their critical habitat. Critical habitat is defined under SARA 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]).

Under section 79 of SARA, Ministerial notification is required if a project "is likely to affect a listed wildlife species or its critical habitat". This notification must identify the adverse effects of the project on the listed wildlife species and its critical habitat and, if the project is carried out, measures that will be taken to avoid or lessen those effects, along with monitoring commitments.

Other than the Scotian Slope EBSA, which extends across the RAA, including through the Project Area, the Special Areas located in closest proximity to the Project Area are fisheries closure areas that have been designated under the *Fisheries Act* to protect spawning and nursery areas and/or juvenile species. Although there are no specific regulatory considerations relevant to exploration drilling, these designations are relevant from a biological, ecological and socio-economic perspective. The closest closure area for the Project is the Haddock Box of which approximately 153 ha is located within the Project Area.

7.5.2 The Influence of Engagement on the Assessment

Key issues raised during stakeholder and Aboriginal engagement for the Project to date include concerns about possible effects on species at risk and their habitat such as the potential effects of underwater sound on marine life. Concerns were raised regarding the proximity of the Project to Sable Island, the Gully and northern bottlenose whale critical habitat. Through Aboriginal engagement, concern for sensitive and protected areas was noted and additional information regarding potential effects on these areas was requested.

7.5.3 Potential Environmental Effects, Pathways and Measurable Parameters

Routine Project activities and components could potentially interact with Special Areas, which could affect the ability of the Special Area to continue to provide important biological and ecological functions on which marine species and/or fisheries depend. These potential interactions most closely relate to concerns with the changes to the existing quality and use of natural habitats within these Special Areas.

As a result of these considerations, the assessment of Project-related environmental effects on Special Areas is focused on the following potential environmental effect:

- Change in Habitat Quality.

The effect pathway and measurable parameters used for the assessment of the environmental effect presented is provided in Table 7.5.1. Effects of accidental events are assessed separately in Section 8.5.4.

Table 7.5.1 Potential Environmental Effects, Effects Pathways and Measurable Parameters for Special Areas

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in Habitat Quality	Interactions between the extent, duration, or timing of Project activities that result in direct loss or alteration of habitat	• Area of habitat permanently affected (m^2) • Change in chemical composition of sediment and water (unit depends on the contaminant) • Sound level (dB) and extent (km from sound source) of underwater sound affecting marine fish, marine mammals, and/or sea turtles

7.5.4 Environmental Assessment Boundaries

7.5.4.1 Spatial Boundaries

The spatial boundaries for the environmental effects assessment for Special Areas are defined below and depicted on Figure 7.5.1.

Project Area: The Project Area encompasses the immediate area in which Project activities and components may occur and represents the area within which direct physical disturbance to the marine benthic environment may occur. Well locations have not yet been identified, but will occur within the Project Area and represent the actual Project footprint. The Project Area includes ELs 2431, 2432, 2433, and 2434.

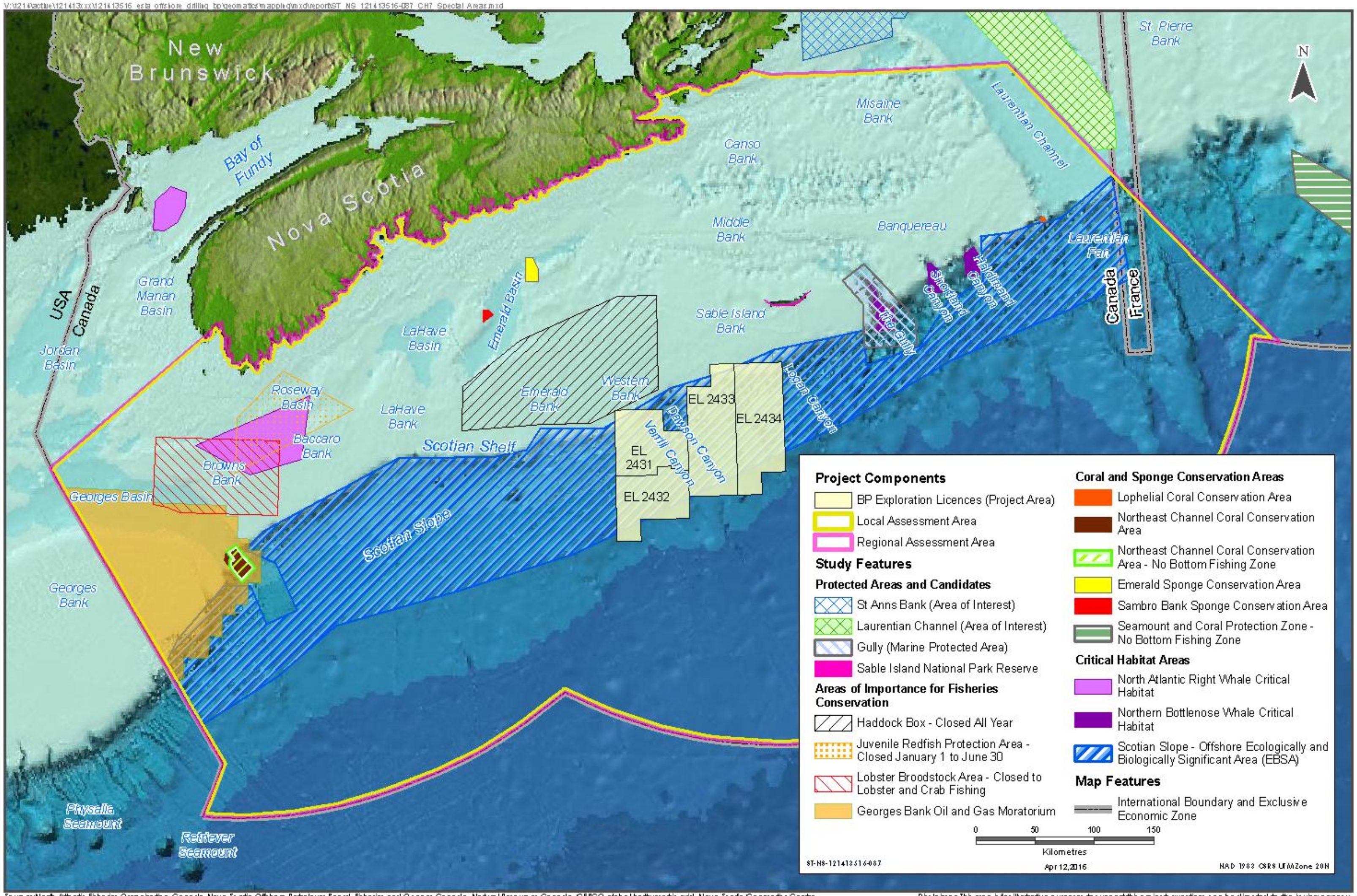
Local Assessment Area (LAA): The LAA is the maximum area within which environmental effects from routine Project activities and components can be predicted or measured with a reasonable degree of accuracy and confidence. It consists of the Project Area and adjacent areas where Project-related environmental effects on Special Areas are reasonably expected to occur and considers LAAs defined for other marine wildlife VCs. In recognition of the broad LAA delineation for Marine Mammals and Sea Turtles extending to include the RAA, the LAA for Special Areas has also been defined to reflect the RAA including PSV routes to and from the Project Area.

Regional Assessment Area (RAA): The RAA is the area within which residual environmental effects from Project activities and components may interact cumulatively with the residual environmental effects of other past, present, and future (*i.e*., certain or reasonably foreseeable) physical activities, and to provide regional context for the effects assessment. The RAA is restricted to the 200 nautical mile limit of Canada's EEZ, including offshore marine waters of the Scotian Shelf and Slope within Canadian jurisdiction.

7.5.4.2 Temporal Boundaries

The temporal boundaries for the assessment of potential Project-related environmental effects on Special Areas encompass all Project phases, including well drilling, testing and abandonment. Up to seven exploration wells will be drilled over the term of the ELs, with Project activities at each well taking approximately 120 days to drill. VSP operations are typically short duration, normally taking no more than a day to complete the profiling. It is assumed that Project activities could occur year-round.

Special Areas provide important habitat year-round, although some areas are more sensitive or commonly used by species during specific times of the year (*e.g.*, adult haddock aggregate to spawn in the Haddock Box from March to June). The Scotian Slope EBSA, which transects the Project Area, provides various functions for a diversity of species at different times of the year (*e.g.*, migratory route and foraging area for leatherback turtles in the spring, summer and fall; overwintering area for several fish (including benthic invertebrates) and bird species; and year-round habitat for several marine species). Refer to Section 5.2.10 for information on species use of Special Areas.



Sources: North Atlantic Fisheries Organization. Canada-Nova Scotia Offshore Petroleum Board. Fisheries and Oceans Canada. Natural Resources Canada. GEBCO global bathymetric grid. Nova Scotia Geomatics Centre

Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.

Figure 7.5.1 Assessment Boundaries for Special Areas

7.5.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance

Table 7.5.2 defines descriptors that are used to characterize residual environmental effects on Special Areas.

Table 7.5.2 Characterization of Residual Environmental Effects on Special Areas

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	**Positive** – a residual effect that moves measurable parameters in a direction beneficial to Special Areas relative to baseline **Adverse** – a residual effect that moves measurable parameters in a direction detrimental to Special Areas relative to baseline **Neutral** – no net change in measureable parameters for the Special Areas relative to baseline
Magnitude	The amount of change in measurable parameters of the VC relative to existing conditions	**Negligible** – no measurable change in marine species populations, habitat quality or quantity **Low** – a measurable change but within the range of natural variability (change in population levels consistent with baseline levels); will not affect population viability **Moderate** – measurable change outside the range of natural variability but not posing a risk to population viability **High** – measurable change that exceeds the limits of natural variability and may affect long-term population viability
Geographic Extent	The geographic area in which an environmental effect occurs	**Project Area** – effects are restricted to the Project Area **Local Assessment Area** – effects are restricted to a portion of the LAA/RAA **Regional Assessment Area** – effects extend throughout the LAA/RAA
Frequency	Identifies when the residual effect occurs	**Single Event** – effect occurs once **Multiple Irregular Event** – occurs more than once at no set schedule **Multiple Regular Event** – occurs more than once at regular intervals **Continuous** – occurs continuously
Duration	The period of time required until the measurable parameter of the VC returns to its	**Short-term** – effect extends for a portion of the duration of Project activities **Medium-term** – effect extends through the entire duration of Project activities

Table 7.5.2 Characterization of Residual Environmental Effects on Special Areas

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
	existing condition, or the effect can no longer be measured or otherwise perceived	**Long-term** – effects extend beyond the duration of Project activities and continue after well abandonment
Reversibility	Pertains to whether a measurable parameter of the VC can return to its existing condition after the project activity ceases	**Reversible** – will recover to baseline conditions before or after Project completion (well abandonment) **Irreversible** – permanent
Ecological and Socio-economic Context	Existing condition and trends in the area where environmental effects occur	**Undisturbed** – area is relatively undisturbed or not adversely affected by human activity **Disturbed** – area has been substantially disturbed by previous human development or human development is still present

In consideration of the descriptors listed above, the following threshold has been established to define a significant adverse residual environmental effect on Special Areas.

A **significant adverse residual environmental effect** on Special Areas is defined as a Project-related environmental effect that:

- alters the valued habitat physically, chemically or biologically, in quality or extent, to such a degree that there is a decline in abundance lasting more than one generation of key species (for which the Special Area was designated) or a change in community structure, beyond which natural recruitment (reproduction and immigration from unaffected areas) would not sustain the population or community in the Special Area and would not return to its original level within one generation; or
- results in permanent and irreversible loss of critical habitat as defined in a recovery plan or an action strategy.

7.5.6 Existing Conditions

Section 5.2.9 describes the Special Areas in the RAA. Both the Scotian Slope EBSA and Haddock Box are partially located within the Project Area. The Scotian Slope EBSA is recognized for: high primary productivity; species diversity and richness; unique and sensitive benthic communities; migratory routes; overwintering habitat; foraging area for leatherback sea turtles; and habitat for Greenland sharks (Doherty and Horsman 2007; DFO 2014b). Approximately 87% of the Project Area falls within the Scotian Slope EBSA. However, the EBSA is very large (approximately 72,568 km^2); the Project Area constitutes only about 17% of the total area of the EBSA.

The Haddock Box is an important nursery area for the protection of juvenile haddock, and is closed year-round by DFO to the commercial groundfish fishery. Scallop fishing continues to occur on the eastern-most part of the closed area (O'Boyle 2011). Approximately 153 ha of the Haddock Box is within the Project Area (representing 0.01% of the Haddock Box area). The LAA for the PSV route crosses through the Haddock Box and encompasses the Sambro Bank Sponge Conservation Area and Emerald Sponge Conservation Area located 130 km and 126 km, respectively, from the Project Area.

Table 7.5.3 lists the Special Areas in the RAA and the approximate distance (in order of proximity) to the Project Area at the closest point.

Table 7.5.3 Proximity of Special Areas to the Project Area

Special Area	Distance from Project Area
Scotian Slope EBSA	0 km
Haddock Nursery Closure, Emerald/Western Bank (Haddock Box)	0 km
Sable Island National Park Reserve	48 km
The Gully Marine Protected Area	71 km
Northern Bottlenose Whale Critical Habitat (Sanctuaries): the Gully, Shortland Canyon, Haldimand Canyon	81 km, 139 km, 171 km
Sambro Bank and Emerald Basin Sponge Conservation Areas	130 km, 126 km
Redfish Nursery Closure Area (Bowtie)	221 km
Lophelia Conservation Area (LCA)	248 km
North Atlantic Right Whale Critical "Habitat/Area to be Avoided"	264 km
Lobster Fishing Area 40 (Georges Bank)	284 km
Georges Bank Oil and Gas Moratorium Area	300 km
Northeast Channel Coral Conservation Area	306 km
Hell Hole (Northeast Channel)	336 km

Given the relative distance of most of the identified Special Areas from the Project Area, the consideration of potential Project-VC interactions (and resulting environmental effects) focuses primarily on the Scotian Slope EBSA, the Haddock Box, and the Gully MPA. PSV transit activities could potentially cross the Emerald Basin Sponge Conservation Area, and to a lesser likely extent, the Sambro Bank Sponge Conservation Area. Although Sable Island National Park Reserve is closer than some Special Areas, the extent of potential effects from routine Project activities are not predicted to interact with this Special Area. Effects on migratory birds using Sable Island are assessed in Section 7.4.

7.5.7 Potential Project-VC Interactions

Table 7.5.4 identifies the physical Project activities that might interact with the Special Areas VC to result in the identified environmental effect. These interactions are indicated by checkmarks, and are discussed in Section 7.5.8 in the context of effects pathways, mitigation, and residual effects.

Table 7.5.4 Potential Project-Environment Interactions and Effects on Special Areas

Project Components and Physical Activities	Potential Environmental Effects
	Change in Habitat Quality
Presence and Operation of MODU (including well drilling and testing operations and associated lights, safety [exclusion] zone and underwater sound)	✓
Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)	✓
Vertical Seismic Profiling	✓
Supply and Servicing Operations (including helicopter transportation and PSV operations)	✓
Well Abandonment	✓
Note: ✓ = Potential interactions that might cause an effect. – = Interaction between the Project and the VC are not expected.	

7.5.8 Assessment of Project-Related Environmental Effects

The following section assesses the environmental effects on Special Areas arising from potential interactions in Table 7.5.4. Effects on species that could occur within the Special Areas are assessed within their respective VCs including: Section 7.2 (Fish and Fish Habitat); Section 7.3 (Marine Mammals and Sea Turtles); and Section 7.4 (Migratory Birds). Given the similarities in Project description, proximity of activities on the Scotian Slope, and relevancy of recent data, the Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) and the Environmental Assessment of BP Exploration (Canada) Limited's Tangier 3D Seismic Survey (LGL 2014) have been referenced extensively for this analysis, with updates incorporated as applicable due to Project and geographic differences (*e.g.*, expansion of geographic scope), scientific updates, and refined EA methods.

7.5.8.1 Project Pathways for Effects

Change in Habitat Quality

A Change in Habitat Quality for Special Areas could potentially occur as a result of Project activities affecting the marine environment including the presence and operation of the MODU (light and sound emissions affecting underwater environment), discharge of drill muds and cuttings (reduction of water and sediment quality), other emissions and discharges (effects on water quality), VSP (underwater sound), helicopter transportation (sound emissions), PSV operations (underwater sound associated with vessel movement), and well abandonment (potential underwater sound associated with removal of wellhead infrastructure and/or a change in benthic habitat associated with leaving the wellhead in place).

7.5.8.2 Mitigation of Project-Related Environmental Effects

In consideration of the environmental effects pathways outlined above, the following mitigation measures and standard practices, in addition to mitigation measures identified for the Fish and Fish Habitat, Marine Mammals and Sea Turtles, and Migratory Birds VCs, will be employed to reduce the potential environmental effects of the Project on special areas. Refer to Table 13.2.1 for a complete list of Project mitigation measures.

Presence and Operation of MODU

- BP will conduct an imagery based seabed survey in the vicinity of wellsites to ground-truth the findings of the GBR. This includes confirming the absence of shipwrecks, debris on the seafloor, unexploded ordnance and sensitive environmental features, such as habitat-forming corals or species at risk. The survey will be carried out prior to drilling. If any environmental or anthropogenic sensitivities are identified during the survey, BP will move the wellsite to avoid affecting them if it is feasible to do so. If it is not feasible, BP will consult with the CNSOPB to determine an appropriate course of action.
- No Project well locations will be located within the Haddock Box.

Waste Management

- Refer to the waste management mitigation measures identified in the Fish and Fish Habitat VC (Section 7.2.8.2).

Vertical Seismic Profiling

- Refer to the VSP mitigation measures identified in the Marine Mammals and Sea Turtles VC (Section 7.3.8.2).

Supply and Servicing Operations

- To reduce the risk of marine mammal vessel strikes, Project PSVs will avoid currently-identified critical habitat for the North Atlantic right whale (Roseway Basin) and northern bottlenose whale (the Gully, and Shortland and Haldimand canyons), during transiting activities within the LAA and outside the Project Area, except as needed in the case of an emergency.
- Helicopters transiting to and from the MODU will fly at altitudes greater than 300 m (with the exception of approach and landing activities) and at a lateral distance of 2 km around active colonies when possible. Helicopters will avoid flying over Sable Island (a 2 km buffer

will be recognized) except as needed in the case of an emergency. These restrictions will also apply to other active coastal colonies (refer to Figures 5.2.25 and 5.2.26).

Well Abandonment

- Once wells have been drilled to TD and well evaluation programs completed (if applicable), the well will be plugged and abandoned in line with applicable BP practices and CNSOPB requirements. The final well abandonment program has not yet been finalized; however, details will be confirmed to the CNSOPB as planning for the Project continues.

7.5.8.3 Characterization of Residual Project-Related Environmental Effects

Change in Habitat Quality

Presence and Operation of the MODU

The Scotian Slope EBSA, Haddock Box, the Gully, and Shortland Canyon could potentially experience effects from the presence and operation of the MODU. Drilling operations and dynamic positioning of the MODU will generate underwater sound, which may affect the quality of the underwater acoustic environment and potentially result in temporary avoidance of habitat by marine fish, marine mammals and sea turtles. Sections 7.2 and 7.3 assess the effects of MODU underwater sound on fish and fish habitat, and marine mammals and sea turtles, respectively. Sections 7.2.7 and 7.3.8 discuss the results of the acoustic modelling and predicted effects on marine fish, and marine mammals and sea turtles, respectively. Based on predicted propagation of MODU and PSV underwater sound emissions, a Change in Habitat Quality for marine fish could potentially occur in areas of the Scotian Slope EBSA and Haddock Box that are situated closer to the Project Area.

While threshold criteria are commonly used to assess potential permanent auditory injury, behavioural responses of marine mammals to underwater sound are generally more variable, context dependent and less predictable than potential physical impacts (Southall *et al*. 2007). Therefore, the use of sound thresholds to predict behavioural response is limited and considered as a guide to informing the assessment of potential effects of sound on marine mammals rather than an absolute measure. In the US, NOAA (n.d.) has used 120 dB re 1 μPa RMS SPL in some offshore regions as a behavioural threshold value for marine mammals and continuous sounds (*e.g.*, shipping and drilling). However, as noted in Section 7.3, there exists much scientific disagreement and debate concerning the validity and relevance of assigning singular value sensory disturbance thresholds across species, particularly considering evidence highlighting the importance of context at the time of exposure. Based on acoustic modelling conducted for the Project (refer to Appendix D), these sound levels may extend into the Gully MPA, and Shortland Canyon under certain environmental conditions (winter season). These canyons, along with the Haldimand Canyon, provide important habitat for many marine species including primary year-round habitat for all life stages of the endangered northern bottlenose whale (Whitehead and Wimmer 2002; DFO 2009j).

Uncertainty around acoustic disturbances and the effect on species using the Gully remains in spite of numerous scientific reviews undertaken to address this issue (e.g., Lawson *et al.* 2000; Hooker and Whitehead 2002; Lee *et al.* 2005). However, to be conservative, it is assumed that a Change in Habitat Quality could therefore potentially occur in the Gully MPA and Shorland Canyon during the winter season when sound propagates furthest due to environmental conditions. However, this change would be temporary and is not predicted to result in permanent or irreversible loss of critical habitat.

Lights from the MODU will affect a portion of the visual environment of the EBSA and Haddock Box within the LAA and may attract fish and migratory birds; however, these effects are expected to be of negligible to low magnitude, continuous, medium-term and reversible. These effects are not likely to affect viability of populations using the EBSA and Haddock Box. At a distance of 48 km, the MODU will not affect the night-time light levels of Sable Island National Park Reserve; therefore the presence and operation of the MODU is not predicted to result in a Change in Habitat Quality of Sable Island.

Given the large extent of the EBSA relative to the area potentially affected by elevated SPLs from MODU presence and operation, a predicted Change in Habitat Quality of the Haddock Box and Scotian Slope EBSA are expected to be adverse, low in magnitude, continuous throughout the Project, medium-term in duration, and reversible. Effects on Habitat Quality in the Gully and Shortland and Haldimand Canyons are predicted to be adverse, moderate in magnitude, regular (potentially occurring in the winter season), short-term in duration (effect is predicted only during a seasonal portion of the drilling program), and reversible (baseline conditions are expected to return once the drilling program is complete).

Waste Management

The discharge of drill muds and cuttings as well as other discharges and emissions from the MODU and PSVs has the potential to cause a change in water and sediment quality within the portion of the Scotian Slope EBSA that falls within the Project Area. As discussed in Section 7.1.2, benthic communities comprised of sedentary or slow moving species may be smothered in the immediate vicinity of the wellsite by drill waste and the sediment quality will be altered in terms of nutrient enrichment and oxygen depletion (Neff *et al.* 2000; Neff *et al.* 2004). These effects could potentially result in changes in the composition of the benthic macrofauna community, although studies have shown recorded effects on benthic macrofauna are most often confined to within a 250-m radius and seldom detected beyond 500 m (Bakke *et al.* 2013). Drill waste modelling conducted for this Project considered the extent of various thicknesses of the deposition of drill cuttings on the seafloor in a radius from the discharge site (refer to Appendix C).Using a threshold of 9.6 mm to assume burial of benthic species, it is predicted that these sediment thicknesses could extend approximately 116 m from the discharge point, or cover an area of approximately 0.54 ha per well.

Available benthic habitat mapping in the vicinity of the Project Area (refer to Figure 5.2.4) suggests the presence of a low-energy, Holocene mud and clay benthos with ophuroids, burrowing anemones and sea urchins as typical benthic fauna likely to be encountered with some corals also potentially present. BP will conduct an imagery based seabed survey in the vicinity of wellsites to ground-truth the findings of the GBR. This confirms confirming the absence of shipwrecks, debris on the seafloor, unexploded ordnance and sensitive environmental features, such as habitat-forming corals or species at risk. The survey will be carried out prior to drilling.

Other discharges and emissions will be released on a regular basis during the drilling program, potentially affecting water quality within the LAA. Marine fish and birds could be attracted to certain discharges from the MODU and PSVs (*e.g.*, sanitary and organic wastes). These discharges will have a negligible effect on water quality and species use of the EBSA or Haddock Box will not be affected at a population level. No other Special Areas are predicted to be affected by waste management.

The Change in Habitat Quality as a result of waste management is predicted to be adverse, low in magnitude, restricted to the Project Area, occurring more than once at regular intervals, medium-term in duration, and reversible.

Vertical Seismic Profiling

Physiological and biological effects of underwater sound from VSP operation on marine fish and marine mammals and sea turtles are discussed in Section 7.2.8 and 7.3.8 respectively.

As discussed in Section 7.2.8, thresholds for behavioral effects of marine fish can vary, with avoidance behavior potentially occurring at sound levels of 151 dB re 1 μPa peak SPL (McCauley *et al.* 2000a). Acoustic modelling for the Project predicts sound levels will decrease to below ≤160 dB re 1 μPa peak SPL up to 20 km from the VSP sound source (Zykov 2016; Table 26 in Appendix D). Depending on the proximity of the wellsite to the Haddock Box (there will be no drilling within the Haddock Box), there could potentially be elevated SPLs within the Haddock Box that could result in a temporary Change in Habitat Quality for marine fish species. VSP operation will occur over a relatively short period of time (up to one day per well) and there is a low likelihood of a VSP survey occurring within 20 km of the Haddock Box, and/or coinciding with spawning activities in the Haddock Box. VSP operation will be carried out in consideration of the mitigation commitments stated in Section 7.5.8.2.

As discussed in Section 7.3.8.3, acoustic modelling conducted for the Project predicts that sound from the VSP source will decrease to below 160 dB re 1 μPa RMS SPL (NOAA's interim threshold for sensory disturbance from an impulsive sound source) at distances greater than approximately 3 km from the sound source (details presented in Appendix D). Higher SPLs occur only in close proximity to the source, with 180 dB re 1 μPa RMS SPL expected within 280 m of the source. Based on the extent of these predicted effects on marine mammals, and the distance of the Project Area to other Special Areas, it is assumed that a Change in Habitat Quality as a result of VSP operation would be restricted to the Scotian Slope EBSA. No other Special Areas are expected to be affected by VSP operation.

The Change in Habitat Quality as a result of VSP operations is predicted to be adverse, low in magnitude, occur within the LAA, occurring more than once at irregular intervals, short-term in duration, and reversible.

Supply and Servicing Operations

Although PSVs may transit through or in close proximity to the Sambro Bank and Emerald Bank Sponge Closure Areas, this interaction is not predicted to result in any change that would affect the biological or ecological integrity of these Special Areas.

Helicopter transportation and PSV traffic could affect habitat quality of Special Areas as a result of sound disturbance, particularly in the vicinity of migratory bird colonies. As noted in Section 7.4.8.2 and 7.5.8.2, helicopters will avoid flying at altitudes less than 300 m (with the exception of approach and landing activities) and a lateral distance of 2 km around active bird colonies when possible. Helicopters will avoid flying over Sable Island (a 2 km buffer will be recognized) except as needed in the case of an emergency. These restrictions will also apply to other active coastal colonies (refer to Figures 5.2.25 and 5.2.26).

Sound disturbance effects on marine mammals and sea turtles are discussed in Section 7.3 and above in the context of MODU presence and operation. Collision risk associated with PSV transit, which will be mitigated in part by avoidance of the Roseway Basin, the Gully and Shortland and Haldimand Canyons, is discussed with respect to a Change in Risk of Mortality or Physical Injury for Marine Mammals and Sea Turtles in Section 7.3 and is not considered in the context of this VC.

The Change in Habitat Quality as a result of supply and servicing operations are predicted to be adverse, low in magnitude, occur within the LAA, occurring more than once at regular intervals, medium-term in duration, and reversible.

Well Abandonment

As discussed in Section 2.4.4, all wells drilled as part of the Project will be abandoned. Once wells have been drilled to TD and well evaluation programs completed (if applicable), the well will be plugged and abandoned in line with applicable BP practices and CNSOPB requirements.

The final well abandonment program has not yet been finalized; however, these details will be confirmed to CNSOPB as planning for the Project continues. It is possible that the subsea infrastructure could be removed after the cement plugs are set within the well. If this is the case, casing would be cut below the seabed and the wellhead removed. The wellhead would be lifted to the surface and brought to shore using a PSV. No infrastructure would be left on the seafloor after the wellhead has been removed. These details will be confirmed as planning for the Project continues. If the wellhead is removed mechanically, well abandonment is expected to have little interaction with the Scotian Slope EBSA and the Haddock Box outside the immediate vicinity of the wellhead. This activity will not produce excess sound or discharge.

Alternatively, approval may be sought to leave the wellhead in place. If this is the case, there will be a hard substrate suitable for recolonization by benthic communities.

The Change in Habitat Quality as a result of well abandonment are predicted to be adverse, low in magnitude, restricted to the Project Area, occurring more than once at irregular intervals, short-term in duration, and reversible.

Summary of Residual Effects

In summary, the Project is expected to result in adverse effects to a Change in Habitat Quality for Special Areas including the Scotian Slope EBSA, the Haddock Box, the Gully, and the Shortland and Haldimand Canyons (critical habitat for the northern bottlenose whale). In consideration of the implementation of applicable mitigation measures, best practices, and adherence to industry standards (*e.g.*, compliance with OWTG), the residual effect on a Change in Habitat Quality is considered to be low in magnitude for most Project components and activities; are short- to medium-term in duration; reversible; and primarily occur within an undisturbed ecological and socio-economic context (with the exception of helicopter and PSV activity in the nearshore environment). Underwater sound associated with MODU presence and operation could result in a moderate magnitude effect based on predicted sound propagation to the Gully and other designated critical habitat for the northern bottlenose whale in the winter season (refer to Section 7.3.8). This effect is predicted to be short-term in duration and reversible and will not result in permanent and irreversible loss of critical habitat. Table 7.5.5 summarizes the environmental effects assessment and prediction of residual environmental effects resulting from those interactions between the Project and Special Areas that were identified in Table 7.5.4.

Table 7.5.5 Summary of Project Residual Environmental Effects on Special Areas

Residual Effect	Residual Environmental Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in Habitat Quality							
Presence and Operation of MODU (including well drilling and testing operations and associated lights, safety [exclusion] zone and underwater sound)	A	L-M	LAA	ST-MT	C	R	D
Waste Management	A	L	PA	MT	R	R	U
Vertical Seismic Profiling	A	L	LAA	ST	IR	R	D
Supply and Servicing Operations (including helicopter transportation and PSV operations)	A	L	LAA	MT	R	R	D
Well Abandonment	A	L	PA	ST	IR	R	U

KEY:
See Table 7.5.2 for detailed definitions
N/A: Not Applicable

Direction:
P: Positive
A: Adverse
N: Neutral

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PA: Project Area
LAA: Local Assessment Area
RAA: Regional Assessment Area

Duration:
ST: Short-term
MT: Medium-term
LT: Long-term

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socio-Economic Context:
D: Disturbed
U: Undisturbed

7.5.9 Determination of Significance

With the application of proposed mitigation and environmental protection measures, the residual environmental effects of a Change in Habitat Quality of Special Areas from Project activities and components are predicted to be not significant. This conclusion has been determined with a moderate level of confidence based on the conservative assumptions used in underwater sound modelling and application of a conservative threshold to predict potential change in behavior for marine mammals. The level of confidence is reduced from high due to uncertainties regarding the scientific information on behavioural changes for cetaceans to underwater sound in the Gully and Haldimand and Shortland Canyons regarding potential Change in Habitat Quality.

7.5.10 Follow-up and Monitoring

BP will assess in consultation with the appropriate authorities the potential for undertaking an acoustic monitoring program during the first phase of the drilling program to collect field measurements to verify predicted underwater sound levels. The objectives of such a program will be identified in collaboration with DFO and CNSOPB and in consideration of lessons learned from the underwater sound monitoring program to be undertaken by Shell as part of the Shelburne Basin Venture Exploration Drilling Project in 2016.

7.6 COMMERCIAL FISHERIES

Commercial Fisheries is included as a VC because of the commercial and cultural importance of commercial fisheries to the region, regulatory protection of fish and fish habitat under the *Fisheries Act*, requirements of the EIS Guidelines, and the potential for Project activities and components to interact with fisheries. This VC addresses potential effects on non-Aboriginal commercial fisheries, focusing on those interactions that could have an effect on the success of commercial fisheries.

Effects on Aboriginal fisheries (including Aboriginal commercial fisheries) are discussed in Section 7.7 (Current Aboriginal Use of Lands and Resources for Traditional Purposes). Effects on targeted fishery species could potentially affect the success of commercial fisheries; therefore, this VC is also closely related to the Fish and Fish Habitat VC (Section 7.2). The Commercial Fisheries VC is also related to the Special Areas VC (Section 7.5) as some Special Areas are designated for the protection of important spawning areas (*i.e*., the Haddock Box).

7.6.1 Regulatory and Policy Setting

The Project Area is located within NAFO Unit Areas 4Wm, 4Wj, 4Wg and 4Wf, Scallop Fishing Area (SFA) 25 and CFA 24 (refer to Figure 5.3.1). The *Fisheries Act* focuses on protecting the productivity of CRA fisheries including a prohibition against causing serious harm to fish that are part of or support a CRA fishery without authorization (Section 35).

The *Maritime Provinces Fishery Regulations* (MPFR) governs fishing activity in inland and adjacent tidal waters of the provinces of Nova Scotia, New Brunswick and Prince Edward Island. The *Atlantic Fishery Regulations, 1985* provide for the management and allocation of fishery resources off the Atlantic coast of Canada. MPFR prohibits any person from fishing, including catching and retaining fish, unless: (a) the person is authorized to do so under the authority of a MPFR issued licence, the *Fishery (General) Regulations,* or the *Aboriginal Communal Fishing Licences Regulations;* (b) holds a fisher's registration card; or (c) where a vessel is used in fishing, a vessel registration card has been issued in respect of the vessel. The administration of aquaculture, sea plant harvesting, seafood processing and recreational fisheries in the province is provided by the provincial *Fisheries and Coastal Resources Act*.

Fishery resources are protected from uncontrolled fishing activity through various measures such as area closures, fishing quotas, fishing seasons, and gear and vessel restrictions. Closures have been established in accordance with the *Fisheries Act* and *Oceans Act*, restricting bottom fisheries activities on the eastern Scotian Shelf (Sambro Bank and Emerald Basin) to protect *Vazella Pourtalesi* (Russian hat glass sponges). Other broad mechanisms for the protection of marine resources are provided in the federal *Oceans Act* (*e.g.*, authority to establish MPAs).

7.6.2 The Influence of Engagement on the Assessment

Key issues raised during stakeholder and Aboriginal engagement for the Project to date consists of concerns related to potential Project effects on the marine environment including commercially fished species and the possible effects to the fishing industry. Aboriginal engagement identified concern of possible obstruction of Mi'kmaq and Wolastoqiyik (Maliseet) fishing areas as a result of the Project as well as potential effects on nearshore and inshore resources as a result of a spill (refer to Section 7.7 for an assessment of effects on Aboriginal fishing). Questions and concerns were raised with respect to effects of routine discharges and spills on fish populations and migration, feeding, and spawning activities that could be occurring in the affected area.

7.6.3 Potential Environmental Effects, Pathways and Measurable Parameters

Routine Project activities and components have potential to interact with fisheries resources by direct or indirect effects on commercially fished species and/or effects on fishing activity from displacement from fishing areas, gear loss or damage that may result in a demonstrated financial loss to commercial fishing interests.

As a result of these considerations, the assessment of Project-related environmental effects on Commercial Fisheries is focused on the following potential environmental effect:

- Change in Availability of Fisheries Resources.

The measurable parameters used for the assessment of the environmental effect presented above, and the rationale for selection, are provided in Table 7.6.1. Effects of accidental events are assessed separately in Section 8.5.5.

Table 7.6.1 Potential Environmental Effects, Effects Pathways and Measurable Parameters for Commercial Fisheries

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in Availability of Fisheries Resources	Interactions between the extent, duration, or timing of Project activities that result in direct or indirect loss in availability of fisheries resources	• Change in access to area used for commercial fisheries (ha) • Change in catch rates (qualitative) • Area of fish habitat permanently affected (m^2) • Mortality of commercially important species • (qualitative) • Damage to fishing gear

7.6.4 Environmental Assessment Boundaries

7.6.4.1 Spatial Boundaries

The spatial boundaries for the environmental effects assessment for Commercial Fisheries are defined below and depicted on Figure 7.6.1.

Project Area: The Project Area encompasses the immediate area in which Project activities and components may occur, and represents the area within which direct physical disturbance to the marine benthic environment may occur. Well locations have not yet been identified, but will occur within the Project Area and represent the actual Project footprint. The Project Area includes ELs 2431, 2432, 2433, and 2434.

Local Assessment Area (LAA): The LAA is the maximum area within which environmental effects from routine Project activities and components can be predicted or measured with a reasonable degree of accuracy and confidence. It consists of the Project Area and adjacent areas where Project-related environmental effects on Commercial Fisheries are reasonably expected to occur. Based on predicted propagation of SPLs from drilling and VSP, a buffer of 30 km around the Project Area boundaries has been established to represent the LAA. The LAA has also been defined to include PSV routes to and from the Project Area. In the context of Commercial Fisheries, the LAA, (including the PSV route) falls within NAFO Unit Areas 4Wk, 4Wl, 4Wh, 4Wf, 4Wg, 4Wj, and 4Wm.

Regional Assessment Area (RAA): The RAA is the area within which residual environmental effects from Project activities and components may interact cumulatively with the residual environmental effects of other past, present, and future (*i.e.*, certain or reasonably foreseeable) physical activities and to provide regional context for the effects assessment. The RAA is restricted to the 200 nautical mile limit of Canada's EEZ, including offshore marine waters of the Scotian Shelf and Slope within Canadian jurisdiction.

7.6.4.2 Temporal Boundaries

The temporal boundaries for the assessment of potential Project-related environmental effects on Commercial Fisheries encompass all Project phases, including well drilling, testing and abandonment. Up to seven exploration wells will be drilled over the term of the ELs, with Project activities at each well taking approximately 120 days to drill. It is assumed that Project activities could occur year-round.

Commercial fisheries could interact with the Project year-round although it is understood that the majority of fishing near the Project Area occurs between February and October with peak fishing efforts for pelagic and groundfish species occurring from July to September. Refer to Section 5.3.5 for a description of the fisheries conducted in 4W.

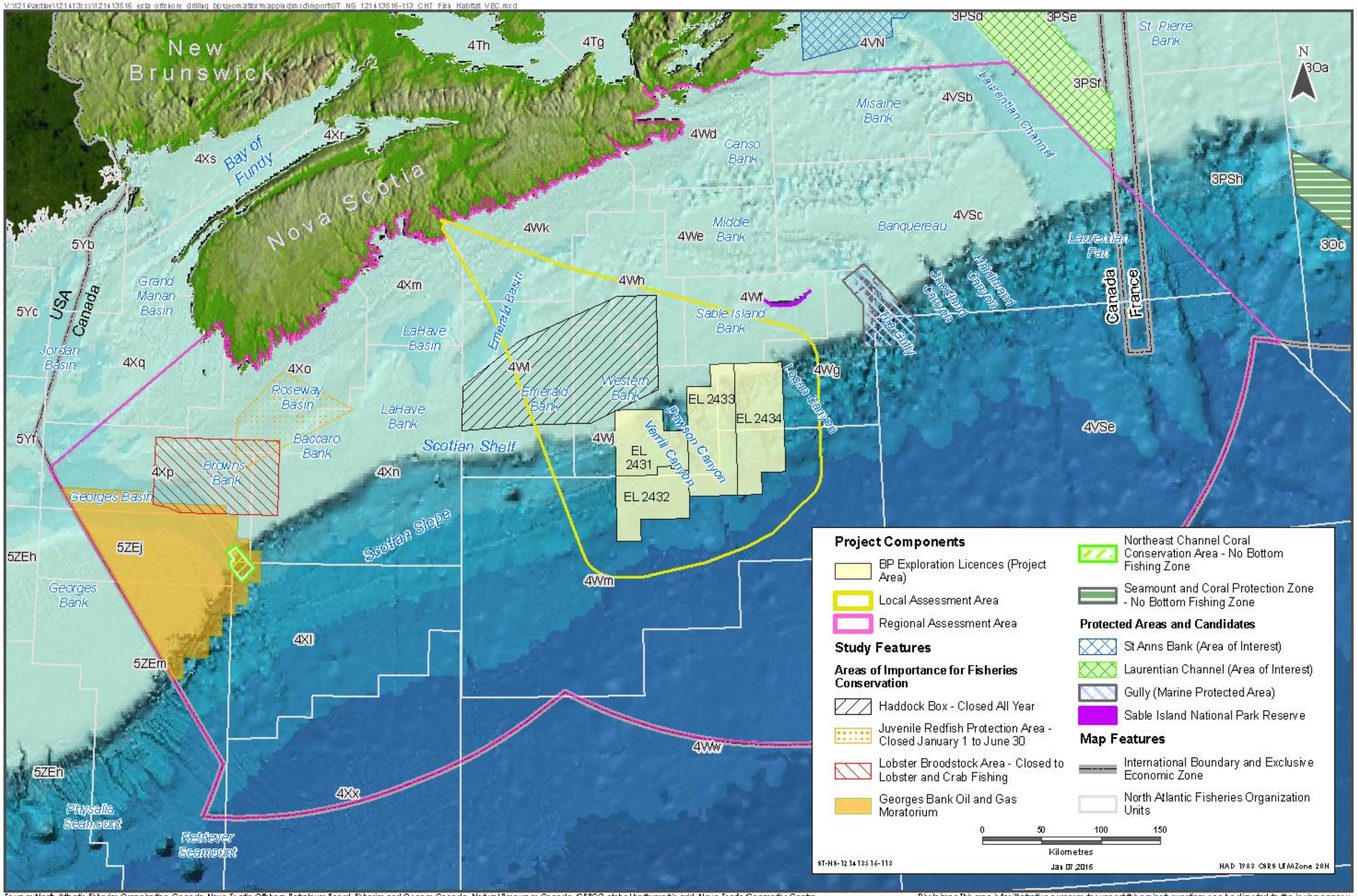


Figure 7.6.1 Assessment Boundaries for Commercial Fisheries

7.6.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance

Table 7.6.2 defines the descriptors used to characterize residual environmental effects on Commercial Fisheries.

Table 7.6.2 Characterization of Residual Environmental Effects on Commercial Fisheries

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	**Positive** – a residual effect that moves measurable parameters in a direction beneficial to Commercial Fisheries relative to baseline **Adverse** – a residual effect that moves measurable parameters in a direction detrimental to Commercial Fisheries relative to baseline **Neutral** – no net change in measureable parameters for the Commercial Fisheries relative to baseline
Magnitude	The amount of change in measurable parameters of the VC relative to existing conditions	**Negligible** – no measurable change to commercial fisheries **Low** – very small detectable change to commercial fisheries in low-use areas **Moderate** – measurable change to commercial fisheries in moderate-use areas **High** – measurable change to commercial fisheries in high-use areas
Geographic Extent	The geographic area in which an environmental effect occurs	**Project Area** – effects are restricted to the Project Area **Local Assessment Area** – effects are restricted to the LAA **Regional Assessment Area** – effects are restricted to the RAA
Frequency	Identifies how often the residual effect occurs	**Single Event** – effect occurs once **Multiple Irregular Event** – occurs more than once at not set schedule **Multiple Regular Event** – occurs more than once at regular intervals **Continuous** – occurs continuously
Duration	The period of time required until the measurable parameter of the VC returns to its existing condition, or the effect can no longer be measured or otherwise perceived	**Short-term** – effect extends for a portion of the duration of Project activities **Medium-term** – effect extends through the entire duration of Project activities **Long-term** – effects extend beyond the duration of Project activities and continue after well abandonment

Table 7.6.2 Characterization of Residual Environmental Effects on Commercial Fisheries

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Reversibility	Pertains to whether a measurable parameter or the VC can return to its existing condition after the project activity ceases	**Reversible** – will recover to baseline conditions before or after Project completion (well abandonment) **Irreversible** – permanent
Ecological and Socio-economic Context	Existing condition and trends in the area where environmental effects occur	**Undisturbed** – area is relatively undisturbed or not adversely affected by human activity **Disturbed** – area has been substantially disturbed by previous human development or human development is still present

In consideration of the residual effects descriptors listed in Table 7.6.2, the following threshold has been established to define a significant adverse residual environmental effect on Commercial Fisheries.

For the purposes of this effects assessment, a **significant adverse residual environmental effect** on Commercial Fisheries is defined as a Project-related environmental effect that results in one or more of the following outcomes:

- local fishers being displaced or unable to use substantial portions of the areas currently fished for all or most of a fishing season;
- local fishers experiencing a change in the availability of fisheries resources (*e.g.* fish mortality and/or dispersion of stocks) such that resources cannot continue to be used at current levels within the RAA for more than one fishing season; or
- unmitigated damage to fishing gear.

7.6.6 Existing Conditions

Within and surrounding the Project Area, the socio-economic setting is dominated by commercial fisheries activity. Groundfish, pelagic, and invertebrate fisheries occur on the Scotian Shelf and Slope, with large pelagics (*e.g.*, swordfish, tuna, and shark) as the most commonly harvested fish in the Project Area. The Project Area is located within Commercial Fisheries Management Areas for lobster, shrimp, scallop and crab (Figure 5.3.7), and within NAFO Unit Area 4Wm, 4Wj, 4Wg and 4Wf (Figure 7.6.1).

As evident in Figures 5.3.9 and 5.3.10, there is notable fishing effort within the northern portion of the Project Area along the Shelf break including the harvesting of Atlantic halibut, Greenland halibut, hagfish, swordfish, shark species, white hake, cusk, monkfish and redfish as well as some flatfish, bluefin tuna, herring, other tuna, red hake and silver hake. Based on previous data (*e.g.*, as presented in LGL 2014) it can be surmised that the primary commercial species likely harvested in the Project Area by landing weight include sea scallops (33%), swordfish (~20%), herring (~14%), Atlantic halibut (~10%), silver hake (~8%), cusk (~3%) and white hake (~3%) (LGL 2014). As presented in Table 5.3.4, in terms of catch value, large pelagics accounted for about 50% with swordfish accounting for about 45% of landings values and an average landings value of about $1.25 million (LGL 2014).

Based on Figure 5.3.9, productive groundfish harvesting occurs north of the Project Area near Western Bank and northwest of the Project Area near Emerald Basin. There is an active snow crab fishing area to the northeast of the Project Area, near Middle Bank.

Commercial fisheries can occur year-round for most species, although it is understood that the majority of fishing near the Project Area occurs between February and October with peak fishing efforts for pelagic and groundfish species occurring from July to September (refer to Table 5.3.5).

7.6.7 Potential Project-VC Interactions

Table 7.6.3 identifies the physical Project activities that might interact with the VC to result in the identified environmental effect. These interactions are indicated by checkmarks, and are discussed in Section 7.6.8 in the context of effects pathways, mitigation, and residual effects.

Table 7.6.3 Potential Project-Environment Interactions and Effects on Commercial Fisheries

Project Components and Physical Activities	Potential Environmental Effects
	Change in Availability of Fisheries Resources
Presence and Operation of MODU (including well drilling and testing operations and associated lights, safety [exclusion] zone and underwater sound)	✓
Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)	✓
Vertical Seismic Profiling	✓
Supply and Servicing Operations (including helicopter transportation and PSV operations)	✓
Well Abandonment	✓

Note:
✓ = Potential interactions that might cause an effect.
– = Interaction between the Project and the VC are not expected.

7.6.8 Assessment of Project-Related Environmental Effects

The following section assesses the environmental effects on fisheries resources arising from potential interactions in Table 7.6.3. Given the similarities in Project description, proximity of activities on the Scotian Slope, and currency of data, the Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a), and the Environmental Assessment of BP Exploration

(Canada) Limited's Tangier 3D Seismic Survey (LGL 2014) has been extensively referenced for this analysis. This information has been updated, as applicable, due to Project and geographic differences (*e.g.*, expansion of geographic scope), scientific updates, and refined EA methods.

7.6.8.1 Project Pathways for Effects

Change in Availability of Fisheries Resources

A Change in Availability of Fisheries Resources for commercial fisheries could potentially occur as a result of Project activities affecting the marine environment including the presence and operation of the MODU (fisheries exclusions and underwater sound effects on fisheries species), discharge of drill muds and cuttings (effects on water and sediment quality on fisheries species), other discharges and emissions (effects on water quality), VSP (underwater sound), PSV operations (underwater sound associated with vessel movement potentially causing behavioural effects on fisheries species), and well abandonment (potential underwater sound associated with removal of wellhead infrastructure and/or a change in benthic habitat associated with leaving the wellhead in place).

7.6.8.2 Mitigation of Project-Related Environmental Effects

In consideration of the environmental effects pathways outlined above, the following mitigation measures and standard practices, as well as mitigation measures identified for the Fish and Fish Habitat VC (refer to Section 7.2.8.2), will be employed to reduce the potential environmental effects of the Project on fisheries resources. Refer to Table 13.2.1 for a complete list of Project mitigation measures.

General

- BP will continue to engage commercial fishers to share Project details as applicable and facilitate coordination of information sharing. A Fisheries Communication Plan will be used to facilitate coordinated communication with fishers.

- BP will provide details of the safety (exclusion) zone to the Marine Communication and Traffic Services for broadcasting and publishing in the Notices to Shipping and Notices to Mariners. Details of the safety (exclusion) zone will also be communicated during ongoing consultations with commercial fishers.

- Project-related damage to fishing gear, if any, will be compensated in accordance with the *Compensation Guidelines with Respect to Damages Relating to Offshore Petroleum Activity* (C-NLOPB and CNSOPB 2002).

Supply and Servicing

- PSVs travelling from mainland Nova Scotia will follow established shipping lanes in proximity to shore. During transit to/from the Project Area, PSVs will travel at vessel speeds not exceeding 22 km/hour (12 knots), except as needed in the case of an emergency.
- To maintain navigational safety at all times during the Project, obstruction lights, navigation lights and foghorns will be kept in working condition on board the MODU and PSVs. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.

7.6.8.3 Characterization of Residual Project-Related Environmental Effects

Change in Availability of Fisheries Resources

Presence and Operation of MODU

There is potential for a disruption of commercial fishing activities if drilling activities displace fishing in the areas around drill sites. A 500-m radius safety (exclusion) zone will be established around the MODU, in accordance with the *Nova Scotia Offshore Petroleum Drilling and Production Regulations*, within which fisheries activities will be excluded while the MODU is in operation. This will result in localized fisheries exclusion within an area of approximately 0.8 km^2 (80 ha) for a maximum of 120 days for each well to be drilled. Although fishing effort may be disrupted within this safety (exclusion) zone, it is anticipated to be a temporary and localized fishing exclusion and is not likely to have a substantial effect on fishing activities and fisheries resources. The LAA does not include any unique fishing grounds or concentrated fishing effort that occurs exclusively within the LAA; similar alternative sites are readily available within the immediate area.

Fish can be affected by underwater sound emissions from the MODU. Sound generation from the MODU may cause fisheries species to avoid the area around the MODU, particularly during start-up of drilling. This avoidance behavior is expected to be temporary as fish become habituated to the continuous sound levels from the MODU and startle responses cease (Chapman and Hawkins 1969; McCauley *et al*. 2000a, 2000b; Fewtrel and McCauley 2012). Given the temporary and localized nature of this effect, it is not expected to affect commercial fisheries species so that fishers would be adversely affected. Refer to Section 7.2 for additional information on Project effects on Fish and Fish Habitat.

The Change in Availability of Fisheries Resources as a result of the presence and operation of the MODU is predicted to be adverse, low in magnitude, occur within the LAA, continuous throughout the Project, medium-term in duration, and reversible (*e.g*., avoidance behavior exhibited by fisheries species, as well as the establishment of the safety (exclusion) zone associated with the presence of the MODU will not have a permanent, irreversible effect on fisheries).

Waste Management

The discharge of drill muds and cuttings and other discharges and emissions from the MODU and PSVs can give rise to a change in sedimentation and water quality. As noted in Section 7.2, these effects are expected to be low in magnitude and localized to the Project Area. Adherence to the OCSG and OWTG, which have been developed to be protective of the marine environment, will reduce adverse effects on fisheries species.

Drill waste modelling conducted for this Project considered the extent of various thicknesses of the deposition of drill cuttings on the seafloor in a radius from the discharge site. As presented in Appendix C and discussed in Section 7.2.8, sediment thicknesses at or above 1 mm will extend up to 563 m from the discharge site and occupy a maximum areal extent of 9.91 ha per well; sediment thicknesses greater than 10 mm will extend up to 116 m, with a maximum footprint of 0.53 ha per well; and sediment thicknesses at or above 100 mm will be confined to a distance of 30 m from the discharge point, with a maximum footprint of 0.07 ha per well.

Results of environmental effects monitoring programs undertaken for various drilling programs in the Atlantic Canada (Hurley and Ellis 2004) concluded that there are negligible effects on fish health and fish habitat from these activities; therefore the availability of fisheries resources are not expected to be affected by waste management.

Other discharges and emissions such as drilling and testing emissions will result in temporary and localized effects on water quality. Discharges, however, will be in accordance with the OWTG, which is designed to mitigate potential effects from discharges and therefore they are not predicted to adversely affect fisheries species in the Project Area or the LAA. Discharges may include organic matter, substances containing minor amounts of chemicals or residual hydrocarbons. These discharges are expected to disperse quickly and will be degraded by bacterial communities.

Benthic prey species for commercially fished species are widespread within the LAA and available outside any localized areas at the wellsite that could be affected by drill mud and cuttings discharges and other discharges and emissions.

The Change in Availability of Fisheries Resources as a result of waste management are predicted to be adverse, low in magnitude, restricted to the Project Area, occurring more than once at regular intervals, medium-term in duration, and reversible.

Vertical Seismic Profiling

Section 7.2.8 discusses potential startle and alarm responses of marine fish as a result of VSP surveys and references acoustic modelling conducted for the Project. The Environmental Assessment of BP Exploration (Canada) Limited's Tangier 3D Seismic Survey (LGL 2014) provides a comprehensive literature review on the effects of seismic sound on fish and fisheries, concluding that behavioral effects (which can be quite variable between and within species) are localized and temporary but can result in short-term effects of catch rates. VSP operations are typically of short duration, normally taking no more than a day per well, which is much shorter than a typical 2D or 3D seismic exploration program. Therefore, any behavioral changes in fisheries species as a result of VSP surveys would be expected to be low.

The Change in Availability of Fisheries Resources as a result of VSP operation is predicted to be adverse, low in magnitude, occur within the LAA, occurring more than once at irregular intervals, short-term in duration, and reversible.

Supply and Servicing Operations

The operation of PSVs will increase vessel traffic within the Project Area and LAA. Two to three PSVs will be required for re-supply to the drilling vessel making two to three round trips per week between the MODU and the supply base. This increase in vessel traffic has the potential to interfere with fishing gear and may restrict fishing vessel navigation. PSVs will use existing shipping routes when travelling between the MODU and the supply base in Halifax Harbour, where applicable, and will adhere to standard navigation procedures, thereby reducing potential conflicts with commercial fisheries. Potential environmental effects on fish attributable to PSV traffic and operations would also represent only a small incremental increase over similar effects currently associated with existing high levels of marine traffic and shipping activity throughout the RAA.

Helicopter transportation is predicted to have negligible effect on fisheries given the limited frequency of trips associated with the exploration program and lack of interaction with the marine environment (including fish).

The Change in Availability of Fisheries Resources as a result of supply and servicing operations are predicted to be adverse, low in magnitude, occur within the LAA, occurring more than once at regular intervals, medium-term in duration, and reversible.

Well Abandonment

Once wells have been drilled to TD and well evaluation programs completed (if applicable), the well will be plugged and abandoned in line with applicable BP practices and CNSOPB requirements. The final well abandonment program has not yet been finalized; however, details will be confirmed to the CNSOPB as planning for the Project continues.

It is expected that plugging and abandonment activities would take approximately 7 to 10 days. It is likely that the casing will be cut below the seabed, and the wellhead removed which would mean that no infrastructure would be left on the seabed. In the event that the wellhead is left in place, there could potentially be an interaction with commercial fishing activity in the Project Area through a change in fish habitat (*i.e.*, small structure remaining above seabed). Prior to well abandonment, a survey will be completed to confirm the location of the well and details will be submitted to the CNSOPB. The well location will be marked on nautical charts as applicable.

Well abandonment is not expected to interact with commercial fishing activities given the temporary nature of the abandonment operation, the localized effects around the wellsite, and the water depths in the Project Area. Following abandonment of the drill site, it is anticipated that the wellhead (if kept in place) will provide hard substrate suitable for recolonization by benthic communities.

The Change in Availability of Fisheries Resources as a result of well abandonment is predicted to be adverse, low in magnitude, within the Project Area, occurring more than once at irregular intervals, short-term in duration, and reversible.

Summary of Residual Effects

In summary, the Project will result in adverse effects to a Change in Availability of Fisheries Resources for Commercial Fisheries. In consideration of the implementation of applicable mitigation measures, best practices, and adherence to industry standards (*e.g.*, compliance with OWTG), the residual effect on a Change in Availability of Fisheries Resources is considered low in magnitude for various Project components and activities; occur within the LAA; be of short to medium-term in duration, be reversible; and primarily occur within an undisturbed ecological and socio-economic context. Table 7.6.4 summarizes the environmental effects assessment and prediction of residual environmental effects resulting from those interactions between the Project and Commercial Fisheries that were identified in Table 7.6.3.

Table 7.6.4 Summary of Project Residual Environmental Effects on Commercial Fisheries

Residual Effect	Residual Environmental Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Content
Change in Availability of Fisheries Resources							
Presence and Operation of MODU (including well drilling and testing operations and associate lights, safety [exclusion] zone and underwater noise)	A	L	LAA	MT	C	R	U
Waste Management	A	L	PA	MT	R	R	U
Vertical Seismic Profiling	A	L	LAA	ST	IR	R	U

Table 7.6.4 Summary of Project Residual Environmental Effects on Commercial Fisheries

Residual Effect	Residual Environmental Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Content
Supply and Servicing Operations (including helicopter transportation and PSV operation)	A	L	LAA	MT	R	R	U
Well Abandonment	A	L	PA	ST	IR	R	U

KEY:
See Table 7.6.2 for detailed definitions
N/A: Not Applicable

Direction:
P: Positive
A: Adverse
N: Neutral

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PA: Project Area
LAA: Local Assessment Area
RAA: Regional Assessment Area

Duration:
ST: Short-term
MT: Medium-term
LT: Long-term

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socio-Economic Context:
D: Disturbed
U: Undisturbed

7.6.9 Determination of Significance

With the application of proposed mitigation and environmental protection measures, the residual environmental effects of a Change in Availability of Fisheries Resources on Commercial Fisheries from Project activities and components are predicted to be not significant. This conclusion has been determined with a high level of confidence based on a good understanding of the general effects on commercial species inhabiting the LAA and the effectiveness of mitigation measures including those discussed in Sections 7.6.8.2.

7.6.10 Follow-up and Monitoring

Given the high level of confidence around a prediction of no significant adverse environmental effects on Commercial Fisheries, and the implementation of standard mitigation, no follow-up and monitoring is proposed to be implemented for routine Project activities.

7.7 CURRENT ABORIGINAL USE OF LANDS AND RESOURCES FOR TRADITIONAL PURPOSES

Current Aboriginal Use of Lands and Resources for Traditional Purposes refers to communal commercial, as well as food, social and ceremonial (FSC) fishing activities by Aboriginal peoples that could potentially interact with the Project. It is included as a VC in recognition of the cultural and economic importance of marine life and fishing to Aboriginal peoples and in recognition of potential or established Aboriginal and Treaty rights. This VC is closely linked to the Fish and Fish Habitat VC (Section 7.2), the Special Areas VC (Section 7.5) and the Commercial Fisheries VC (Section 7.6). This VC is also closed linked to the Traditional Use Study (TUS) which has been conducted to obtain information about Aboriginal use of resources in the RAA (MGS and UINR 2016; refer to Appendix B).

7.7.1 Regulatory and Policy Setting

The Project Area is located within NAFO Unit Areas 4Wm, 4Wj, 4Wg and 4Wf. These boundaries include SFA 25 and CFA 24 (refer to Figure 5.3.8). The *Fisheries Act* focuses on protecting the productivity of commercial, recreational or Aboriginal (CRA) fisheries including a prohibition against causing serious harm to fish that are part of or support a CRA fishery without authorization. As indicated in Section 5.3.6, DFO manages Aboriginal fishing in accordance with the Aboriginal Fishing Strategy, which recognizes Aboriginal and Treaty rights and places priority on Aboriginal rights to fish for FSC purposes. Treaty rights in Nova Scotia to hunt, fish, and gather in pursuit of a moderate livelihood have been recognized through Supreme Court of Canada decisions. DFO also issues communal licences pursuant to the *Aboriginal Communal Fishing Licences Regulation* to provide for the harvest of fish for FSC purposes.

There are two key guidelines that have influenced the EA process including the scoping and assessment of this VC: *Proponent's Guide: The Role of Proponents in Crown Consultation with the Mi'kmaq of Nova Scotia* (NSOAA 2012) and the *Mi'kmaq Ecological Knowledge Study Protocol* (Assembly of Nova Scotia Mi'kmaq Chiefs 2007). Another relevant guideline with respect to Aboriginal engagement is the *Aboriginal Consultation and Accommodation – Updated Guidelines for Federal Officials to Fulfill the Duty to Consult* (AANDC 2011).

7.7.2 The Influence of Engagement on the Assessment

Aboriginal engagement identified concern of possible obstruction of Mi'kmaq and Wolastoqiyik (Maliseet) fishing areas as a result of the Project as well as potential effects on nearshore and inshore resources as a result of a spill. In particular, concerns were raised by Aboriginal organizations around potential adverse effects from planned Project activities or accidental events on fish identified as being traditionally or commercially significant to the Mi'kmaq and/or Wolastoqiyik (Maliseet) including American eel, Atlantic sturgeon, bluefin tuna, swordfish, herring, gaspereau (alewife), lobster, crab and shrimp. Concern was raised with regards to a potential spill affecting migration, spawning and/or feeding grounds of species of significance to

Mi'kmaq culture. Section 4 provides additional information on issues and concerns raised during Aboriginal engagement.

7.7.3 Potential Environmental Effects, Pathways and Measurable Parameters

The selection of environmental effects for this VC reflects the variations in fishing locations by Aboriginal Groups, which include nearshore areas and offshore areas. It also reflects the multiple purposes for the use of marine resources, which includes communal commercial fisheries and FSC fisheries and the economic or cultural aspects of each fishery. Similar to Commercial Fisheries (refer to Section 7.6), the Project could have an effect on fisheries resources by direct or indirect effects on fished species and/or effects on fishing activity from displacement from fishing areas, gear loss or damage.

The assessment of Project-related environmental effects on the Current Aboriginal Use of Lands and Resources for Traditional Purposes is therefore focused on the following potential environmental effect:

- Change in Traditional Use.

The effect pathway and measurable parameters used for the assessment of the environmental effect presented is provided in Table 7.7.1.

Table 7.7.1 Potential Environmental Effects, Effects Pathways and Measurable Parameters for Current Aboriginal Use of Lands and Resources for Traditional Purposes

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in Traditional Use	Direct or indirect loss in availability of fisheries resources arising from Project activities	• Change in access to area used for communal commercial or FSC fisheries (ha) • Change in catch rates (qualitative) • Area of fish habitat permanently affected (ha)

7.7.4 Environmental Assessment Boundaries

7.7.4.1 Spatial Boundaries

The spatial boundaries for the environmental effects assessment with respect to Current Aboriginal Use of Lands and Resources for Traditional Purposes are defined below and shown on Figure 7.7.1. Effects of accidental events are assessed separately in Section 8.5.1.

Project Area: The Project Area encompasses the immediate area in which Project activities and components may occur and as such represents the area within which direct physical disturbance to the marine benthic environment may occur as a result of the Project. Well locations have not yet been identified, but will occur within the Project Area and represent the actual Project footprint. The Project Area includes ELs 2431, 2432, 2433, and 2434.

Local Assessment Area (LAA): The LAA is the maximum area within which environmental effects from Project activities and components can be predicted or measured with a reasonable degree of accuracy and confidence. It consists of the Project Area and adjacent areas where Project-related environmental effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes are reasonably expected to occur. Based on predicted propagation of SPLs from drilling and VSP operation and minimum thresholds for behavioural effects on fish, a buffer of 30 km around the Project Area boundaries has been established to represent the LAA. Sound from VSP operation is expected to represent the maximum area within which environmental effects from Project activities and components would occur. The LAA has also been defined to include PSV routes to and from the Project Area.

Regional Assessment Area (RAA): The RAA is the area within which residual environmental effects from Project activities and components may interact cumulatively with the residual environmental effects of other past, present, and future (*i.e.*, certain or reasonably foreseeable) physical activities, and to provide regional context for the assessment. The RAA is restricted to the 200 nautical mile limit of Canada's EEZ, including offshore marine waters of the Scotian Shelf and Slope within Canadian jurisdiction.

7.7.4.2 Temporal Boundaries

The temporal boundaries for the assessment of potential Project-related environmental effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes encompass all Project phases, including well drilling, testing and abandonment. Up to seven exploration wells will be drilled over the term of the ELs, with Project activities at each well taking approximately 120 days to drill. It is assumed that Project activities could occur year-round.

As indicated in Section 4 of the TUS (refer to Appendix B), Aboriginal fishing activities can occur year-round.

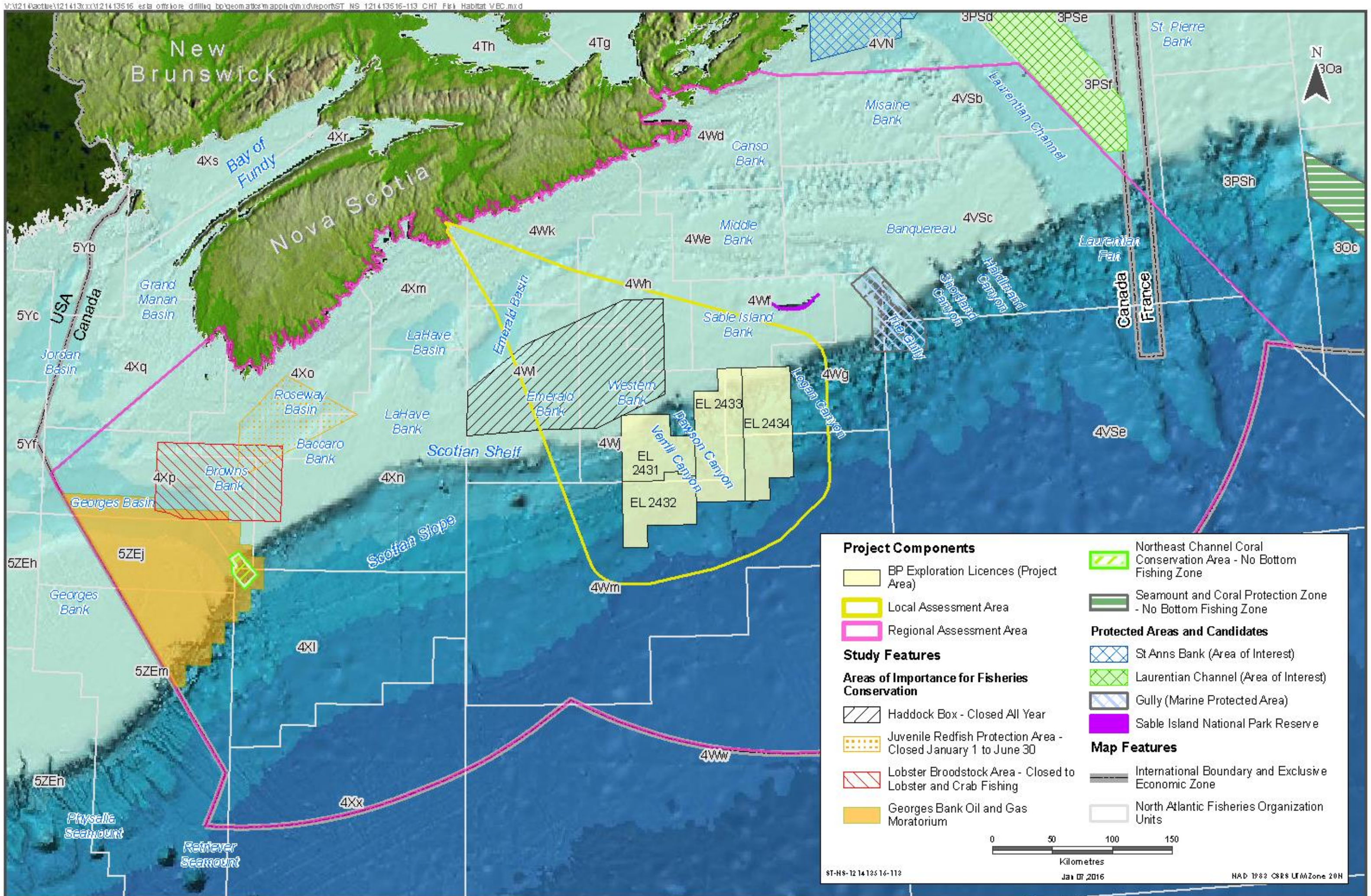


Figure 7.7.1 Assessment Boundaries for Current Aboriginal Use of Lands and Resources for Traditional Purposes

7.7.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance

Table 7.7.2 defines various descriptors that may be used to characterize residual environmental effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes.

Table 7.7.2 Characterization of Residual Environmental Effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	**Positive** – an effect that moves measurable parameters in a direction beneficial to Current Aboriginal Use of Lands and Resources for Traditional Purposes relative to baseline **Adverse** – an effect that moves measurable parameters in a direction detrimental Current Aboriginal Use of Lands and Resources for Traditional Purposes relative to baseline **Neutral** – no net change in measureable parameters for the Current Aboriginal Use of Lands and Resources for Traditional Purposes relative to baseline
Magnitude	The amount of change in measurable parameters of the VC relative to existing conditions	**Negligible** – no measurable change from baseline **Low** – very small detectable change from baseline **Moderate** – varies from baseline and may result in noticeable changes to traditional practices, traditional knowledge or community perceptions of traditional territory, practices or knowledge **High** – varies from baseline to a high degree, has serious implication for the continuance of traditional practices and traditional knowledge
Geographic Extent	The geographic area in which an environmental effect occurs	**Project Area** – effects are restricted to the Project Area **Local Assessment Area** – effects are restricted to the LAA **Regional Assessment Area** – effects are restricted to the RAA
Frequency	Identifies when the residual effect occurs	**Single Event** – effect occurs once **Multiple Irregular Event** – occurs more than once at not set schedule **Multiple Regular Event** – occurs more than once at regular intervals **Continuous** – occurs continuously
Duration	The period of time required until the measurable parameter of the VC returns to its	**Short-term** – effect extends for a portion of the duration of Project activities **Medium-term** – effect extends through the entire

Table 7.7.2 Characterization of Residual Environmental Effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
	existing condition, or the effect can no longer be measured or otherwise perceived	duration of Project activities **Long-term** – effects extend beyond the duration of Project activities, after well abandonment
Reversibility	Pertains to whether a measurable parameter of the VC can return to its existing condition after the project activity ceases	**Reversible** – will recover to baseline conditions before or after Project completion (well abandonment) **Irreversible** – permanent
Ecological and Socio-economic Context	Existing condition and trends in the area where environmental effects occur	**Undisturbed** – area is relatively undisturbed or not adversely affected by human activity **Disturbed** – area has been substantially previously disturbed by human development or human development is still present

In consideration of the descriptors listed above, the following threshold has been established to define a significant adverse residual environmental effect on Current Aboriginal Use of Lands and Resources for Traditional Purposes.

For the purposes of this effects assessment, a **significant adverse residual environmental effect** on Current Aboriginal Use of Lands and Resources for Traditional Purposes is defined as a residual Project-related environmental effect that results in one or more of the following outcomes:

- Aboriginal communal commercial fisheries or FSC fisheries being displaced or unable to use the areas traditionally or currently fished for all or most of a fishing season;
- a change in the availability of fisheries resources (*e.g.*, fish mortality and/or dispersion of stocks) such that resources cannot continue to be used at current levels within the RAA for more than one fishing season; and
- unmitigated damage to fishing gear.

7.7.6 Existing Conditions

Section 4.1 describes the Aboriginal groups in Nova Scotia and New Brunswick which could potentially be affected by the Project. In the DFO Maritimes Region, communal FSC licences are held by 16 First Nations and the Native Council of Nova Scotia (NCNS). Eleven of these communal FSC licences are held by groups in Nova Scotia while the remaining five are held by groups in New Brunswick. There are 22 Aboriginal organizations who hold licences issued by the DFO Maritimes Region and 12 Aboriginal organizations who hold licences issued by the DFO Gulf

Region that have communal commercial fishing access in the RAA including in or near the Project Area (refer to Section 5.3.6.1).

BP commissioned Membertou Geomatics Solutions (MGS) and Unama'ki Institute of Natural Resources (UINR) to undertake a TUS to obtain information from the Aboriginal fisheries occurring in and around the Project Area. The TUS scope of work included conducting a background review of commercial licences and FSC agreements, and interviews with elders, fishers and fisheries managers from a representative subset of First Nations in Nova Scotia and New Brunswick, and the NCNS. The TUS includes information on target species, general fishing areas, and fishing seasons, along with any additional information pertaining to fish or sensitive areas.

As reported in the TUS (Appendix B), all 13 Mi'kmaq First Nation communities in Nova Scotia currently have communal commercial fishing licences for various species that may be harvested from the RAA. There are 25 species being fished by Mi'kmaq First Nation communities under commercial communal fisheries access within the RAA and 15 species fished within the LAA. Many of these fisheries occur year-round. The following eight species are targeted within the Project Area: Atlantic cod, bluefin tuna, haddock, mahi-mahi, northern shrimp, shark, snow crab and swordfish. Cusk, halibut, and silver hake are harvested as by-catch within the Project Area.

The NCNS has a communal commercial licence granting access to 19 species (including by-catch species) within the RAA. Nine of these species may also be harvested by NCNS within the LAA. The following seven species may be harvested by NCNS within the Project Area: albacore tuna, bluefin tuna, bigeye tuna, halibut (by-catch), mahi-mahi (by-catch), swordfish, and yellowfin tuna (MGS and UINR 2016).

The TUS (Appendix B) includes tables identifying all of the species that are accessible within the RAA, LAA and Project Area under these communal commercial licences, as well as the timing of fishing activity for each species.

The TUS (Appendix B) indicates that Fort Folly Mi'kmaq First Nation and St. Mary's and Woodstock Wolastoqiyik (Maliseet) First Nations in New Brunswick hold communal commercial fishing licences for various species that may be harvested from the RAA. Under these licences, these communities report fishing 16 species within the RAA, ten of which may also be harvested within the LAA. Silver hake and swordfish are the only species that may also be harvested within the Project Area (MGS and UINR 2016). The TUS (Appendix B) includes a table identifying all of the species that that are accessible within the RAA, LAA and Project Area under these communal commercial licences, as well as the timing of fishing activity for each species.

According to the TUS, 44 species (34 fish species and 10 invertebrate species) were identified as being harvested for FSC purposes by Mi'kmaq First Nations throughout Nova Scotia. In particular, they reported harvesting seven fish species and three invertebrate species within the RAA, and one invertebrate species (lobster) within the LAA for FSC purposes. None of the species identified are known to be harvested for FSC purposes within the Project Area (MGS and UINR 2016).

Forty-three species (31 fish species and 12 invertebrate species) were identified as being harvested for FSC purposes by the NCNS. FSC fisheries for 22 of these species are known to occur in the RAA, FSC fisheries for five of these species are known to occur in the LAA (*i.e.*, Atlantic herring, Atlantic mackerel, Greenland halibut, redfish, and silver hake), and no FSC fisheries are known to occur in the Project Area (MGS and UINR 2016).

The TUS (Appendix B) includes tables identifying all of the species that may be harvested for FSC purposes within the RAA and LAA, as well as the timing of FSC fishing activity for each species.

Lobster is the only species identified as being harvested for FSC purposes by New Brunswick's Fort Folly and Woodstock First Nations, and it is harvested outside of the RAA, in the Bay of Fundy.

7.7.7 Potential Project-VC Interactions

Table 7.7.3 identifies the physical Project activities that might interact with the VC to result in the identified environmental effect. These interactions are indicated by checkmarks, and are discussed in Section 7.7.8 in the context of effects pathways, mitigation, and residual effects.

Table 7.7.3 Potential Project-Environment Interactions and Effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes

Project Components and Physical Activities	Potential Environmental Effects
	Change in Traditional Use
Presence and Operation of MODU (including well drilling and testing operations and associated lights, safety [exclusion] zone and underwater sound)	✓
Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)	✓
Vertical Seismic Profiling	✓
Supply and Servicing Operations (including helicopter transportation and PSV operations)	✓
Well Abandonment	✓

Note:
✓ = Potential interactions that might cause an effect.
– = Interaction between the Project and the VC are not expected.

7.7.8 Assessment of Project-Related Environmental Effects

The following section assesses the environmental effects on Aboriginal fisheries resources arising from potential interactions in Table 7.7.3. Given the similarities in Project description, proximity of activities on the Scotian Slope, and currency of data, the Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) and the Environmental Assessment of BP Exploration (Canada) Limited's Tangier 3D Seismic Survey (LGL 2014) have been referenced extensively for this analysis, with updates incorporated as applicable due to Project and geographic differences (*e.g.*, expansion of geographic scope), scientific updates, and refined EA methods.

7.7.8.1 Project Pathways for Effects

Change in Traditional Use

A Change in Traditional Use for Current Aboriginal Use of Lands and Resources for Traditional Purposes could potentially occur as a result of Project activities affecting the marine environment including the presence and operation of the MODU (fisheries exclusions and underwater sound effects on fisheries species), discharge of drill muds and cuttings (effects on water and sediment quality on fisheries species), other discharges and emissions (effects on water quality), VSP operations (underwater sound), PSV operations (underwater sound associated with vessel movement causing fisheries species to avoid the area), and well abandonment (potential underwater sound associated with removal of wellhead infrastructure and/or a change in benthic habitat associated with leaving the wellhead in place).

7.7.8.2 Mitigation of Project-Related Environmental Effects

In consideration of the environmental effects pathways outlined above, the following mitigation measures and standard practices, as well as mitigation measures identified for the Fish and Fish Habitat VC (refer to Section 7.2.8.2) will be employed to reduce the potential environmental effects of the Project on Aboriginal fisheries resources. These mitigation measures are consistent with measures proposed to reduce potential environmental effects on Commercial Fisheries (refer to Section 7.6.8.2). Refer to Table 13.2.1 for a complete list of Project mitigation measures.

General

- BP will continue to engage Aboriginal fishers to share Project details as applicable and facilitate coordination of information sharing. A Fisheries Communication Plan will be used to facilitate coordinated communication with fishers.

- BP will provide details of the safety (exclusion) zone to the Marine Communication and Traffic Services for broadcasting and publishing in the Notices to Shipping and Notices to Mariners. Details of the safety (exclusion) zone will also be communicated during ongoing consultations with Aboriginal commercial fishers.

- Project-related damage to fishing gear, if any, will be compensated in accordance with the *Compensation Guidelines with Respect to Damages Relating to Offshore Petroleum Activity* (C-NLOPB and CNSOPB 2002).

Supply and Servicing

- PSVs travelling from mainland Nova Scotia will follow established shipping lanes in proximity to shore. During transit to/from the Project Area, PSVs will travel at vessel speeds not exceeding 22 km/hour (12 knots), except as needed in the case of an emergency.

- To maintain navigational safety at all times during the Project, obstruction lights, navigation lights and foghorns will be kept in working condition on board the MODU and PSVs. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.

7.7.8.3 Characterization of Residual Project-Related Environmental Effects

Change in Traditional Use

Presence and Operation of MODU

There is potential for a disruption of Aboriginal fishing activities if drilling activities displace fishing in the areas around drill sites. A 500-m radius safety (exclusion) zone will be established around the MODU, in accordance with the *Nova Scotia Offshore Petroleum Drilling and Production Regulations*, within which Aboriginal fishing activities will be excluded while the MODU is in operation. This will result in localized Aboriginal fisheries exclusion within an area of approximately 0.8 km^2 (80 ha) for a maximum of 120 days for each well to be drilled. Although fishing effort may be disrupted within this safety (exclusion) zone, it is anticipated to be a temporary and localized fishing exclusion and is not likely to have a substantial effect on Aboriginal fishing activities and fisheries resources. The LAA does not include any unique fishing grounds or concentrated fishing effort that occurs exclusively within the LAA; similar alternative sites are readily available within the immediate area.

Fish can be affected by underwater sound emissions from the MODU. Sound generation from the MODU may cause fisheries species to avoid the area around the MODU, particularly during start-up of drilling. This avoidance behavior is expected to be temporary as fish become habituated to the continuous sound levels from the MODU and startle responses cease (Chapman and Hawkins 1969; McCauley *et al*. 2000a, 2000b; Fewtrel and McCauley 2012). Given the temporary and localized nature of this effect, it is not expected to affect fisheries species so that Aboriginal fishers would be adversely affected. Refer to Section 7.2 for additional information on Project effects on Fish and Fish Habitat.

The Change in Traditional Use as a result of the presence and operation of the MODU is predicted to be adverse, low in magnitude, within the LAA, continuous throughout the Project, medium-term in duration, and reversible (*e.g.*, avoidance behavior exhibited by fisheries species, as well as the establishment of the safety [exclusion] zone associated with the presence of the MODU will not have a permanent, irreversible effect on Traditional Use).

Waste Management

The discharge of drill muds and cuttings has the potential to interact with commercial and FSC fisheries species within a localized area from sedimentation and localized changes in water quality. As noted in Section 7.2, these effects are expected to be low in magnitude and localized to the Project Area. The Project will adhere to the OCSG and OWTG, which have been developed to protect the marine environment, will limit adverse effects on fisheries species.

Drill waste modelling conducted for this Project considered the extent of various thicknesses of the deposition of drill cuttings on the seafloor in a radius from the discharge site. As presented in Appendix C and discussed in Section 7.2.8, sediment thicknesses at or above 1 mm will extend up to 563 m from the discharge site and occupy a maximum areal extent of 9.91 ha per well; sediment thicknesses greater than 10 mm will extend up to 116 m, with a maximum footprint of 0.53 ha per well; and sediment thicknesses at or above 100 mm will be confined to a distance of 30 m from the discharge point, with a maximum footprint of 0.07 ha per well.

Results of environmental effects monitoring programs undertaken for various drilling programs in the Atlantic Canada (Hurley and Ellis 2004) concluded that there are negligible effects on fish health and fish habitat from these activities; therefore the availability of traditional fisheries resources are not expected to be affected by waste management.

Other discharges and emissions such as drilling and testing emissions will result in temporary and localized effects on water quality. Discharges, however, will be in accordance with the OWTG, which is designed to mitigate potential effects from discharges; therefore, Aboriginal fisheries species in the Project Area or the LAA are not expected to be adversely affected. Discharges may include organic matter, substances containing minor amounts of chemicals or residual hydrocarbons. These discharges are expected to disperse quickly and will be degraded by bacterial communities.

Benthic prey species for commercially or FSC fished species are widespread within the LAA and available outside any localized areas at the wellsite that could be affected by drill mud and cuttings discharges and other discharges and emissions.

The Change in Traditional Use as a result of waste management is predicted to be adverse, low in magnitude, restricted to the Project Area, occurring more than once at regular intervals, medium-term in duration, and reversible.

Vertical Seismic Profiling

Sound levels associated with VSP surveys can interact with commercially or FSC fished species. Section 7.2.8 discusses potential startle and alarm responses of marine fish resulting from VSP surveys. The Environmental Assessment of BP Exploration (Canada) Limited's Tangier 3D Seismic Survey (LGL 2014) provides a comprehensive literature review on the effects of seismic sound on fish and fisheries, concluding that behavioral effects (which can be quite variable between and within species) are localized and temporary but can result in short-term effects of catch rates. VSP operations are typically of short duration, and normally taking no more than a day, which is much shorter than a typical 2D or 3D seismic exploration program. Therefore, any behavioral changes in Aboriginal fisheries species resulting from VSP surveys would be expected to be low.

The Change in Traditional Use as a result of VSP operation is predicted to be adverse, low in magnitude, occur within the LAA, occurring more than once at irregular intervals, short-term in duration, and reversible.

Supply and Servicing Operations

The operation of PSVs will increase vessel traffic within the Project Area and LAA, and may therefore locally affect commercially or FSC fished species habitat quality and use around the PSV. Two to three PSVs will be required for re-supply to the drilling vessel making two to three round trips per week between the MODU and the supply base. The increase in vessel traffic has the potential to interfere with fishing gear and may restrict fishing vessel navigation. PSVs will use existing shipping routes when travelling between the MODU and the supply base in Halifax Harbour, where applicable, and will adhere to standard navigation procedures, thereby reducing potential conflicts with Aboriginal fisheries. Potential environmental effects on fish attributable to PSV traffic and operations would also represent only a small incremental increase over similar effects currently associated with existing high levels of marine traffic and shipping activity throughout the RAA.

Helicopter transportation is predicted to have a negligible effect on fisheries given the limited frequency of trips associated with the exploration program and lack of interaction with the marine environment (including fish). Except as needed in the case of an emergency, helicopters will also avoid flying over Sable Island, therefore helicopter transportation is not predicted to interact with seals (identified as a traditional FSC species) which could be feeding, breeding or pupping on the island (refer to Section 7.3 for an assessment of Project effects on marine mammals).

The Change in Traditional Use as a result of supply and servicing operations is predicted to be adverse, low in magnitude, occur within the LAA, occurring more than once at regular intervals, medium-term in duration, and reversible.

Well Abandonment

Once wells have been drilled to TD and well evaluation programs completed (if applicable), the well will be plugged and abandoned in line with applicable BP practices and CNSOPB requirements. The final well abandonment program has not yet been finalized; however, details will be confirmed to the CNSOPB as planning for the Project continues. It is expected that plugging and abandonment activities would take approximately 7 to 10 days. It is likely that the casing will be cut below the seabed, and the wellhead removed which would mean that no infrastructure would be left on the seabed. Should the wellhead be kept in place, the abandonment of wells could potentially interact with commercial or FSC fishing activity in the Project Area through a change in fish habitat (*i.e.*, small structure above the seabed). Prior to well abandonment, a survey will be completed to confirm the location of the well and details will be submitted to the CNSOPB. The well location will be marked on nautical charts as applicable.

Well abandonment is not expected to interact with Aboriginal fishing activities given the temporary nature of the abandonment operation, the localized effects around the wellsite, and the water depths in the Project Area. Following abandonment of the drill site, it is anticipated that the wellhead (if kept in place) will provide hard substrate suitable for recolonization by benthic communities.

The Change in Traditional Use as a result of well abandonment is predicted to be adverse, low in magnitude, restricted to the Project Area, occurring more than once at irregular intervals, short-term in duration, and reversible.

Summary of Residual Effects

In summary, the Project will result in adverse effects to a Change in Traditional Use for Current Aboriginal Use of Lands and Resources for Traditional Purposes. In consideration of the implementation of applicable mitigation measures, best practices, and adherence to industry standards (*e.g.*, compliance with OWTG), the residual effect on a Change in Traditional Use is considered low in magnitude for various Project components and activities; occur within the LAA; be of short to medium-term in duration, be reversible; and primarily occur within an undisturbed ecological and socio-economic context. Table 7.7.4 summarizes the environmental effects assessment and prediction of residual environmental effects resulting from those interactions between the Project and Current Aboriginal Use of Lands and Resources for Traditional Purposes that were identified in Table 7.7.3.

Table 7.7.4 Summary of Project Residual Environmental Effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes

Residual Effect	Residual Environmental Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Content
Change in Traditional Use							
Presence and Operation of MODU (including well drilling and testing operations and associate lights, safety [exclusion] zone and underwater sound)	A	L	LAA	MT	C	R	U
Waste Management	A	L	PA	MT	R	R	U
Vertical Seismic Profiling	A	L	LAA	ST	IR	R	U

Table 7.7.4 Summary of Project Residual Environmental Effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes

Residual Effect	Residual Environmental Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Content
Supply and Servicing Operations (including helicopter transportation and PSV operations)	A	L	LAA	MT	R	R	U
Well Abandonment	A	L	PA	ST	IR	R	U

KEY:
N/A: Not Applicable
See Table 7.7.2 for detailed definitions

Direction:
P: Positive
A: Adverse
N: Neutral

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PA: Project Area
LAA: Local Assessment Area
RAA: Regional Assessment Area

Duration:
ST: Short-term
MT: Medium-term
LT: Long-term

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socio-Economic Context:
D: Disturbed
U: Undisturbed

7.7.9 Determination of Significance

With the application of proposed mitigation and environmental protection measures, the residual environmental effects of a Change in Traditional Use on Current Aboriginal Use of Lands and Resources for Traditional Purposes from Project activities and components are predicted to be not significant. This conclusion has been determined with a high level of confidence based on a good understanding of the general effects on commercial species inhabiting the LAA and the effectiveness of mitigation measures including those discussed in Sections 7.7.8.2.

7.7.10 Follow-up and Monitoring

Given the high level of confidence around a prediction of no significant adverse environmental effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes, and the implementation of standard mitigation, no follow-up and monitoring is proposed to be implemented for routine Project activities.