6.0 Environmental Effects Assessment Scope and Methodology

6.1 SCOPE OF ASSESSMENT

6.1.1 Scope of the Project to be Assessed

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 portions of Shell's offshore ELs 2423, 2424, 2425, 2426, 2429 and 2430. This Project Area is located approximately 250 km offshore from Halifax in a geographical offshore area known as the Southwest Scotian Slope and a geological region known as the Shelburne Basin (see Figure 1.1.1).

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 (including lights, safety zone, and underwater noise)
- discharge of drill muds and cuttings
- other discharges and emissions (including drilling and testing emissions)
- VSP
- helicopter transportation
- OSV 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. 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 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.

6.1.3 Scope of the Factors to be Considered

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 Shell will require authorizations from CNSOPB under the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation 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. These considerations have included the selection of Valued Components and the

identification of spatial and temporal boundaries (refer to Section 6.2.2 and Section 6.2.4, respectively).

6.2 EA METHODS

6.2.1 Overview of Approach

The methodology 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 methodology used by Stantec for environmental assessments of other major projects assessed by the CEA Agency. The assessment methodology is structured to:

- focus on issues of greatest concern
- consider key issues raised by Aboriginal peoples, stakeholders, and the public
- integrate engineering design and programs for mitigation and follow-up into a comprehensive environmental planning process

This methodology is concentrated on the identification and assessment of potential adverse environmental effects of the Project on Valued Components (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, Shell, 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. As a result, VCs relate to ecological, social, and economic systems that comprise the environment (refer to Section 6.2.2).

Project-related environmental effects are assessed using a methodological framework as shown in Figure 6.2.1. The potential environmental effects of Project activities and components are assessed in Section 7 using a standard framework to facilitate individual assessment of each VC. Evaluation tables and matrices are utilized to document the assessment where effects have been identified for a more in-depth analysis. 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).

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).

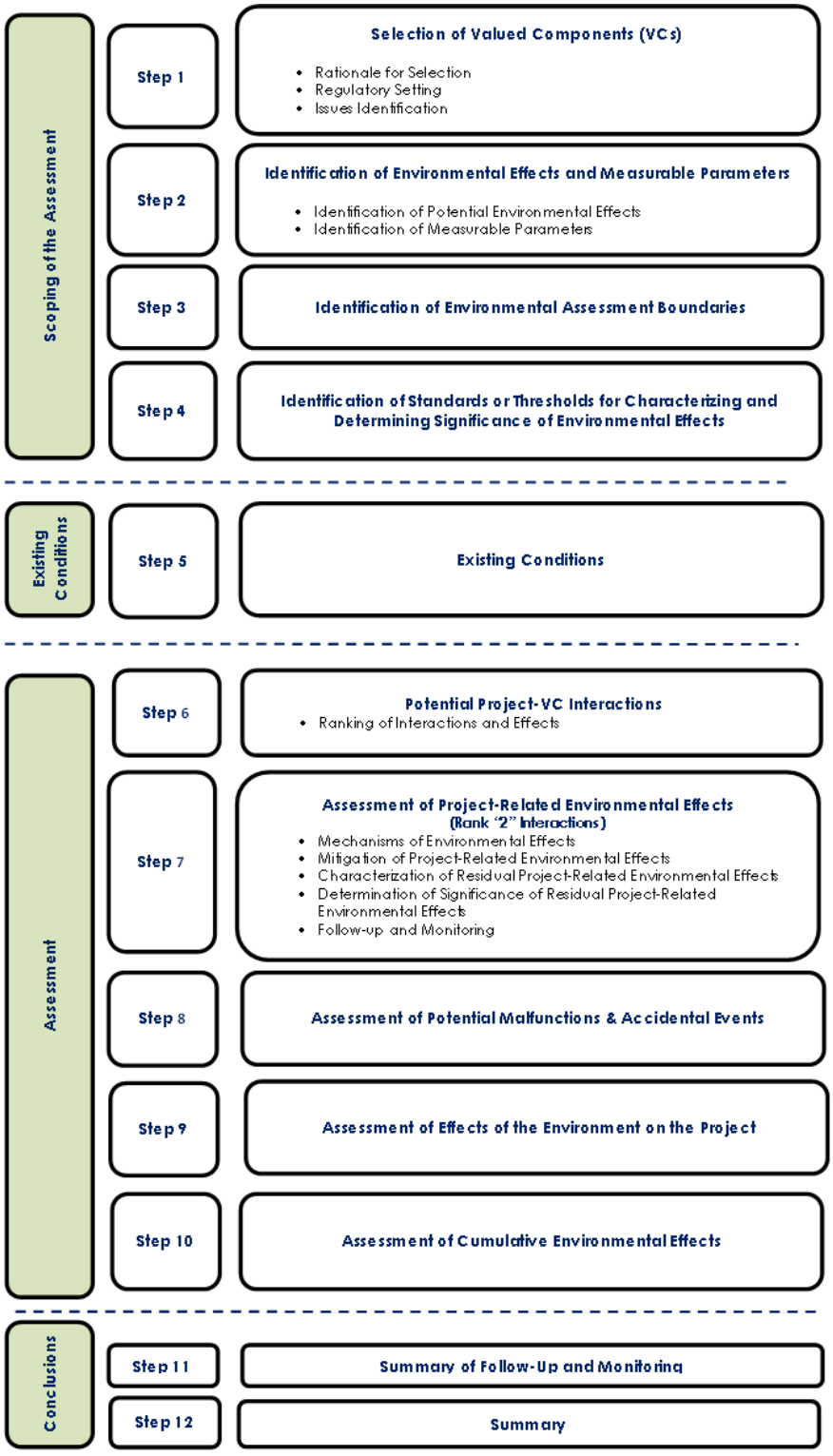


Figure 6.2.1 Overview of Approach

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.

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 2014)
- issues raised by regulatory agencies, key stakeholders, and the public (refer to Section 3, Section 4)
- issues raised by Aboriginal peoples, including traditional ecological knowledge obtained through completion of a Traditional Use Study (TUS) for the Project (refer to 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 as well as SEAs completed for the Scotian Shelf and Slope
- 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 6.1.3 of this EIS for a discussion of CEAA, 2012 section 5 requirements).

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
- Marine Birds
- Special Areas
- Commercial Fisheries
- Current Aboriginal Use of Lands and Resources for Traditional Purposes

Rationale for Selection

Table 6.2.1 presents the VCs assessed in this EIS and the rationale for their selection, and also provides the rationale for excluding certain environmental components that were identified in

the EIS Guidelines as potential VCs. Relevant sections of the EIS are referenced where applicable.

Table 6.2.1 Selected 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	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. Accordingly, this component has not been selected as a VC.	• All nearshore and offshore Project-related vessel operations will take place in Canada's portion of the North American Emission Control Area (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 2013b). • Given its distance offshore, the Project Area does not contain any receptors that would be sensitive to atmospheric emissions from Project activities and components or accidental events.	• Atmospheric emissions associated with the Project are described in Section 2.7.2. • Existing conditions regarding the atmospheric environment and climate are described in Section 5.1.2. • Effects of the environment on the Project (including the effects of climate change) are assessed in Section 9.
Fish and Fish Habitat	Environmental effects on fish (including applicable species of conservation interest (SOCI) 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	• Several species of fish (including SOCI) are known to occur in the vicinity of the Project Area and have potential to be affected (including habitat effects) by Project activities and components as well as accidental events associated with the Project. • Project effects on fish and fish habitat species has been identified as an issue of concern during Aboriginal engagement	• Existing conditions regarding fish and fish habitat are described in Sections 5.1 and 5.2. • Project-related environmental effects on fish and fish habitat are assessed in Section 7.2. • Environmental effects of potential accidental events on all VCs are assessed in Section 8.5.

Table 6.2.1 Selected Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
	protection of fish and fish habitat and applicable SOCI, and the nature of potential Project-VC interactions.	(refer to Section 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*).	• Cumulative environmental effects are assessed for all VCs in Section 10.2.
Marine Mammals	Environmental effects on marine mammals (including applicable SOCI) 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 SOCI, 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 SOCI) 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).	• Existing conditions regarding marine mammals are described in Section 5.2.4. • Project-related environmental effects on marine mammals are assessed in Section 7.3. • Environmental effects of potential accidental events on all VCs are assessed in Section 8.5. • Cumulative environmental effects are assessed for all VCs in Section 10.2.
Marine Turtles	Environmental effects on marine turtles (including applicable SOCI) are assessed within the Marine Mammals and Sea Turtles VC. This VC is included in consideration of its ecological	• Several species of marine turtles (including SOCI) 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.	• Existing conditions regarding sea turtles are described in Section 5.2.5. • Project-related environmental effects on sea turtles are assessed in Section 7.3. • Environmental effects of potential

Table 6.2.1 Selected Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
	importance, the legislated protection of applicable SOCI, 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.	• 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).	accidental events on all VCs are assessed in Section 8.5. • Cumulative environmental effects are assessed for all VCs in Section 10.2.
Marine Birds	Environmental effects on marine birds (including applicable SOCI) are assessed within the Marine Birds VC. This VC is included in consideration of its ecological importance, the legislated protection of migratory birds and other applicable SOCI, and the nature of potential Project-VC interactions.	• Several species of marine birds (including SOCI) 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 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).	• Existing conditions regarding marine birds are described in Section 5.2.6. • Project-related environmental effects on marine birds are assessed in Section 7.4. • Environmental effects of potential accidental events on all VCs are assessed in Section 8.5. • Cumulative environmental effects are assessed for all VCs in Section 10.2.
Species at Risk and Species of Conservation Concern	In consideration of the environmental context referred to in the next column, it has been determined that environmental effects on SOCI are more appropriately assessed as part of the Marine Mammals and Sea Turtles VC, the Fish and Fish	• Species at risk and species of conservation concern are collectively referred to in this EIS as SOCI. More specifically, SOCI include the following: o Federally protected species listed as "endangered", "threatened", or of "special concern" on Schedule 1 of SARA, and their critical habitat	• Marine SOCI (including applicable species of fish, mammals, turtles, and birds) with potential to be affected by the Project are summarized in Section 5.2.7. • Project-related environmental effects on fish SOCI are assessed in Section 7.2 (Fish and Fish Habitat VC)

Table 6.2.1 Selected Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
	Habitat VC, and the Marine Birds VC. SOCI will be included as part of these VCs and will not be assessed as a distinct, stand-alone VC.	○ species assessed as "endangered", "threatened", or of "special concern" by the federal Committee on the Status of Endangered Wildlife of Canada (COSEWIC) ○ 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 SOCI are known to occur in the vicinity of the Project Area, including fish, other aquatic species (*e.g.*, marine mammals, turtles) and migratory birds, and have potential to be affected by routine Project activities as well as accidental events associated with the Project. • SOCI 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 SOCI are also protective of secure species. • With respect to marine mammals and sea turtles, many of the species found in the area are considered SOCI and therefore separate VCs to assess secure species and SOCI would be redundant. This redundancy has have been avoided in this EIS through	• Project-related environmental effects on marine mammal SOCI are assessed in Section 7.3 (Marine Mammals and Sea Turtles VC). • Project-related environmental effects on sea turtle SOCI are assessed in Section 7.3 (Marine Mammals and Sea Turtles VC). • Project-related environmental effects on marine bird SOCI are assessed in Section 7.4 (Marine Birds VC). • Environmental effects of potential accidental events on all VCs are assessed in Section 8.5. • Cumulative environmental effects are assessed for all VCs in Section 10.2.

Table 6.2.1 Selected Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
		consideration of SOCI as applicable within the Marine Mammals and Sea Turtles VC.	
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 habitat for certain SOCI.	• Existing conditions regarding Special Areas are described in Section 5.2.8. • Project-related environmental effects on Special Areas are assessed in Section 7.5. • Environmental effects of potential accidental events on all VCs are assessed in Section 8.5. • Cumulative environmental effects are assessed for all VCs in Section 10.2.
Human Environment			
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 for Project-VC interactions.	• 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 with the Project. However, Project activities and components will not interfere with nearshore fisheries due to the use of existing shipping routes by OSVs. • Environmental effects on Aboriginal fisheries (including communal commercial fisheries)	• Existing conditions regarding commercial fisheries are described in Section 5.3.3. • Project-related environmental effects on commercial fisheries are assessed in Section 7.6. • Environmental effects of potential accidental events on all VCs are assessed in Section 8.5. • Cumulative environmental effects are assessed for all VCs in Section 10.2.

Table 6.2.1 Selected Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
		are assessed with respect to the Current Aboriginal Use of Lands and Resources for Traditional Purposes VC.	
Recreational Fisheries	In consideration of the environmental context and the mitigation referred to in the next column, it has been determined that environmental effects on recreational fisheries do not warrant focused assessment. Accordingly, this component has not been selected as a VC.	• DFO has indicated that no recreational fishing licence holders are known to fish offshore in the vicinity of the Project Area (DFO, pers. comm. 2014). • Recreational fishing activity in the nearshore waters of Nova Scotia has potential to be affected by accidental events associated with the Project. However, Project activities and components will not interfere with nearshore fisheries due to the use of existing shipping routes by OSVs. • Nearshore recreational fisheries tend to target the same species that are fished commercially. In general, 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 Fisheries VC are sufficient to mitigate similar environmental effects on recreational fisheries.	• Existing conditions regarding recreational fisheries are described in Section 5.3.3. • Project-related environmental effects on fish and fish habitat are assessed in Section 7.2. • Project-related environmental effects on commercial fisheries are assessed in Section 7.6.
Current Aboriginal Use of Lands and	Environmental effects on Aboriginal communal commercial fisheries and FSC	• Aboriginal communal commercial fishing activity is known to occur in the vicinity of the Project Area and has potential to be	• Existing conditions regarding the current Aboriginal use of lands and resources for traditional purposes are described in

Table 6.2.1 Selected Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
Resources for Traditional Purposes	fisheries 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.	affected by Project activities and components as well as accidental events associated with the Project. • In addition to the offshore Aboriginal fishing activity noted above, Aboriginal commercial and traditional fishing activities are carried out under communal commercial licences and food, social, and ceremonial (FSC) licences in the nearshore waters of Nova Scotia. • Nearshore Aboriginal fisheries have potential to be affected by accidental events associated with the Project. However, Project activities and components will not interfere with nearshore Aboriginal fisheries due to the use of common shipping routes by OSVs. • 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 5.3.4. • Project-related environmental effects on the current Aboriginal use of lands and resources for traditional purposes are assessed in Section 7.7. • Environmental effects of potential accidental events on all VCs are assessed in Section 8.5. • Cumulative environmental effects are assessed for all VCs in Section 10.2. • The report for the TUS undertaken in support of the Project is included in Appendix B.
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, it has been determined that environmental effects on other ocean use do not warrant assessment as a VC. Accordingly,	• 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 users such as military activities and scientific research. In	• Existing conditions regarding offshore ocean uses and infrastructure are described in Section 5.3.2. • Potential interactions between residual Project-related environmental effects and the residual environmental effects of projects or activities carried out by

Table 6.2.1 Selected Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
	this component has not been selected as a VC. However, "other ocean use" is discussed generally in the EIS as indicated.	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.	other offshore users are considered in the cumulative environmental effects assessment in Section 10.
Human Health	In consideration of the environmental context and the mitigation referred to in the next column, it has been determined that environmental effects on human health do not warrant focused assessment. Accordingly, this component has not been selected as a VC.	• 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 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	• Routine waste discharges and emissions associated with the Project are described in Section 2.7.2. • Spill prevention and response measures are discussed in Section 8.4. • The environmental effects of potential accidental events associated with the Project are assessed in Section 8.

Table 6.2.1 Selected Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
		such an incident, thereby preventing human exposure to contaminated food sources. Similarly, the imposition of an exclusion zone around the affected area(s) would prevent human contact with spilled oil.	
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, it has been determined that environmental effects on physical and cultural heritage do not warrant focused assessment. Accordingly, this component has 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. • The results of various surveys conducted in the Project Area prior to seabed disturbance will inform the selection of drilling locations where no heritage resources are present. • OSV and helicopter transport activities will not result in any ground/seabed disturbance. Therefore, they will not affect heritage resources.	• Details regarding site surveys to be undertaken in the Project Area in advance of any seabed disturbance are provided in Section 2.4. • Existing conditions regarding physical and cultural heritage are described in Section 5.3.5.

Regulatory Setting

The regulatory context is described for each individual VC, including an overview of any applicable regulations, policies, or administrative mechanisms. The regulatory setting may be utilized to define the scope of the assessment for the individual VC. In addition, this section may also provide relevant definitions under legislation that may be important to consider in scoping the VC or defining measureable parameters or significance thresholds.

Issues Identification

Any VC-specific issues that have been raised during consultation and engagement activities are summarized, and the extent to which identification and consideration of these issues has influenced the scope of the assessment for the individual VC is explained.

6.2.3 Identification of Environmental Effects 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. Potential Project-related environmental effects are changes to the biophysical or human environment that will be caused by the proposed Project activities and components. 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. The degree of change in the chosen measurable parameters is used to help characterize the environmental effects to identify any residual environmental effects that will then be evaluated for significance. Thresholds or standards are identified for each measurable parameter where possible.

6.2.4 Identification of EA Boundaries

Consideration of environmental effects in this EIS is conceptually bound in both space and time. This consideration is more commonly known as defining the spatial and temporal boundaries of the assessment. 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 in relation to specific Project activities and components. 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
- understood natural variations of each VC

- information gathered on current and traditional land and resource use
- the time required for recovery from an environmental effect
- 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 a four year period, with Project activities at each well taking a maximum of 130 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 as such represents the area within which direct physical disturbance may occur as a result of the Project. Future well locations have not currently been identified, but will occur within the Project Area and represent the actual Project footprint. As such, 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 portions of EL 2424, 2425, 2426, 2429 and 2430 as depicted on Figure 2.2.1.

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 are reasonably expected to occur based on available information and professional judgement. The LAA has also been defined to include OSV 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 encompasses the Gully MPA and terminates at the eastern edge of Banquereau Bank. A portion of the Scotian Shelf and the Nova Scotia coastline to the Bay of Fundy is also included as part of the RAA boundary. The RAA is consistent for all VCs and is depicted on Figure 2.2.1.

6.2.5 Establishing Standards or Thresholds for Characterizing and Determining Significance of Environmental Effects

In consideration of the *Reference Guide for the Canadian Environmental Assessment Act: Determining whether a Project is Likely to Cause Significant Environmental Effects* from the CEA Agency (1994), criteria or established thresholds for determining the significance of residual adverse environmental effects are identified for each VC. These criteria or thresholds are defined:

- in consultation with the appropriate regulatory agency for a particular VC (where applicable)
- using information obtained during stakeholder and Aboriginal engagement
- using available information on the status and characteristics of each VC
- using applicable regulatory documents, environmental standards, guidelines, or objectives where available
- using 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). Thresholds may be based on regulations, standards, resource management objectives, scientific literature, or ecological processes (*e.g.*, desired states for fish or wildlife habitats or populations). Where pre-established standards or thresholds do not exist, significance criteria have been defined qualitatively and justifications for the criteria provided.

Additional analysis 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 6.2.8).

6.2.6 Existing Conditions

Existing conditions of the marine physical environment, marine biological environment, and socio-economic environment are described in Section 5 in order to characterize the setting for the Project, support an understanding of the receiving environment, and provide sufficient context to enable an understanding of how current environmental conditions and processes might be affected by the Project. A brief overview of existing conditions is then provided for each VC in Section 7, highlighting key information to support the assessment of potential environmental effects. Inclusion of existing conditions information in this EIS 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.

6.2.7 Potential Project-VC Interactions

For each VC, a table is used to list all Project activities and components, and to identify potential interactions from those Project activities and components with the VC. This then allows for a rating of the interactions/environmental effects between the Project and the VC. This rating is based on the potential for a Project activity or component to interact with the VC and to result in an environmental effect. The ratings are assigned as follows:

0 No interaction or associated environmental effects are anticipated. Further assessment is considered unnecessary.

1 Interaction may occur; however, based on past experience and professional judgment, the interaction would not result in a significant environmental effect even without mitigation; or the interaction would not be significant due to the application of standard operating procedures, guidelines or codified practices that are known to effectively mitigate the predicted environmental effect. No further assessment is warranted. However, further explanation and justification of the rating is provided in the respective VC analysis section.

2 Interaction could result in an effect of concern. Further assessment is warranted and is provided in the respective VC analysis section (where applicable).

Justifications for the rating of each interaction are provided in the corresponding VC section. The justifications consider the nature of the interactions and the implementation of any applicable codified standards or measures. Where interactions have been rated as 0, there are no predicted environmental effects and therefore these interactions are not considered further in the EIS. The potential residual environmental effects of all Project activities and components that are rated as 1 are determined to be not significant and are therefore not subject to further assessment, except in the analysis of cumulative effects. Where applicable, however, the extent of these residual effects are still characterized. Those interactions with a rating of 2 are subject to further assessment and effects characterization according to the steps outlined below and are also carried forward in cumulative effects assessment (refer to Section 10).

6.2.8 Assessment of Project-Related Environmental Effects

As discussed in Section 6.2.7, the potential environmental effects resulting from the interactions rated as 2 require further assessment for each individual VC. The assessment includes:

- identification of environmental effects mechanisms (*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 Shell will implement
- identification and characterization of the nature and extent of residual environmental effects (*i.e.*, those environmental effects that remain after the proposed mitigation measures have been applied) through application of specific analysis criteria (*i.e.*, magnitude, geographic extent, duration, frequency, reversibility, and context)

- determination of significance

The specific analysis criteria used to identify and characterize residual environmental effects and determine their significance have been identified for each VC (refer to Section 6.2.5). Where standards or established thresholds are available, the potential environmental effects of the Project on each VC are evaluated against these standards or thresholds. Established thresholds reflect – but are not necessarily determinative of – the limits of an acceptable state for an environmental component based on resource management goals, scientific literature, or ecological processes.

The following criteria are used to characterize residual environmental effects on each VC. Definitions are provided in Section 7 when qualitative terms are used.

- Magnitude: refers to the expected nature or degree of the residual effect. When evaluating the magnitude of residual effects, the proportion of the VC affected within the spatial boundaries and the relative effect (*i.e.*, negligible, low, moderate, high) is considered.

- 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 in the area in which the residual effect will occur

A determination of the significance of any residual project effects is included for each VC.

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.

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

6.2.9 Assessment of Potential Accidental Events

Environmental effects associated with potential accidental events are assessed in Section 8. The focus of the assessment is on identified plausible accidental events, including those that could result in significant environmental effects in the unlikely event that they do occur. As part of this assessment, potential events and considered scenarios are described, interactions with VCs are identified, and potential environmental effects are assessed. Additionally, a description of the planned mitigation and contingency measures is provided, as is a conclusion regarding the significance of potential residual environmental effects and their likelihood of occurrence. Section 8 provides further details regarding EA methodology and the scope of assessment for the potential accidental events that have been identified.

6.2.10 Assessment of Effects of the Environment on the Project

Effects of the environment on the Project are assessed in Section 9. The assessment considers potential changes to the Project that may result from interactions with the environment or natural events. This includes the sensitivity of the Project to variations in meteorological conditions and to natural hazards. The assessment of effects of the environment on the Project includes discussion of potential Project interactions as well as details regarding planning, design and construction strategies for reducing the likelihood of potential effects on the Project, thereby also reducing the likelihood of any potential environmental effects. A significance determination is then made regarding the potential residual effects of the environment on the Project. Section 9 provides further details regarding the methodology and scope of assessment for the effects of the environment on the Project.

6.2.11 Assessment of Cumulative Effects

Cumulative environmental effects are assessed in Section 10 of this EIS. 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 EA methodology and scope of assessment for cumulative environmental effects.

6.2.12 Identification of Follow-up and Monitoring

Where applicable, follow-up and monitoring programs are recommended to verify environmental effects predictions or to assess the effectiveness of proposed mitigation

measures. A compilation of monitoring and follow-up commitments from the assessment of Project effects, effects of the environment on the Project, effects from accidental events, and cumulative effects, as applicable, is provided in Section 13.2 of this EIS.

6.2.13 Summary

The final step in the EA methodology is a summary of the residual effects, mitigation and significance of effects. Section 15 of this EIS provides an overall summary of the effects analysis including a summary of mitigation, monitoring and follow-up commitments.

7.0 Environmental Effects Assessment

7.1 OVERVIEW OF PROJECT INTERACTIONS AND POTENTIAL EFFECTS

This section of the EIS identifies and discusses the potential interactions between Project activities and components and the potential environmental effects. An overview of existing knowledge from past EA reports, SEAs, monitoring programs, and scientific literature is provided with respect to the individual Project activities and components to help improve an understanding of the potential interactions and resulting environmental effects, as well as to facilitate the VC-based analysis of environmental effects that follows in Sections 7.2 through 7.7.

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	Marine Birds	Special Areas	Commercial Fisheries	Current Aboriginal use of Lands and Resources for Traditional Purposes
Presence and Operation of the MODU (including safety zone, underwater noise and lights and flares)	✓	✓	✓	✓	✓	✓
Discharge of Drill Muds and Cuttings	✓	✓	✓	✓	✓	✓
Other Discharges and Emissions	✓	✓	✓	✓	✓	✓
VSP	✓	✓	✓	✓	✓	✓
Helicopter Transportation		✓	✓	✓		
OSV Operations	✓	✓	✓	✓	✓	✓
Well Abandonment	✓	✓		✓	✓	✓

7.1.1 Presence and Operation of the MODU

The MODU used to support the Project will be either a semi-submersible drill rig or drill ship. The chosen MODU will be stationed in the Project Area during drilling, testing and abandonment activities and will stay on-site using a DP system; no anchor or footings will be required. In accordance with the *Nova Scotia Offshore Drilling and Production Regulations*, a 500-m safety zone will be established around the MODU within which non-Project-related vessels (*e.g.*, fishing vessels) will be prohibited entry. The MODU will generate and release three main sources of underwater noise. The DP system will employ thrusters to keep the MODU on location. These thrusters will generate underwater noise through vibration and the creation of low pressure points and bubbles known as cavitation. 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 noise into the marine environment. In addition to underwater noise emissions, 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 dependent on the strength of the light as well as the various properties of the water itself (factors that affect attenuation). Temporary short-term (1–2 days per well) flaring will also be required during well testing and may be required as part of well control procedures.

An overview of existing knowledge of environmental effects of MODU presence and operation is provided below.

7.1.1.1 Safety Zone

The Project may use either a semi-submersible or a drill ship as the drilling platform. Either option would rely on a DP system to maintain position and will not require the use of anchors. Under these conditions, the safety zone will consist of a radius of 500 m out from the MODU. No persons other than operational or CNSOPB personnel will be allowed within the safety 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 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 zone boundaries, of the facilities within the safety zone, and of any related potential hazards. A "Notice to Shipping" and "Notice to Mariners" regarding the safety zone will be issued, noting the location and timing of the exclusion area. Although this safety zone represents a very small exclusion area for fishing on the Scotian Slope, details of the safety zone will be communicated during ongoing consultations with commercial and Aboriginal fishers.

7.1.1.2 Underwater Noise Emissions

Fundamentals of Underwater Acoustics

In order to understand the effects of underwater noise on the marine environment, it is first necessary to understand the basic physics of sound. The basic form of sound is the sound wave, which consists of the alternating compression and rarefactions of molecules within a medium (air, 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) 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, 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 vibrations per second. Sounds need to have frequencies within a marine mammal's hearing range to be audible.

Underwater noise includes pulsed sounds (*e.g.*, seismic sound) and continuous sounds (*e.g.*, drilling). Sound can be described using a variety of metrics, the most common ones being sound pressure levels (SPLs) and sound exposure levels (SELs). SPLs can further be measured by either their root-mean-square (RMS) pressure (Richardson *et al.* 1995), which indicates the average SPL over a given amount of time, or by their peak, or maximum pressure (wave amplitude) (Southall *et al.* 2007). Sound level (magnitude) is typically measured on the decibel (dB) scale, with RMS SPLS denoted by dB_{RMS} and peak SPLs denoted by $dB_{0\text{-}p}$. 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). Unlike SPLs, SELs are a measure of the total energy of an acoustic event, and are presented in dB re 1 μPa^2s. SELs can also be measured cumulatively, measuring the total noise energy to which an animal is exposed (Southall *et al.* 2007). Cumulative SELs (SEL_{cum}) capture the overall sound levels experienced by sound receivers, factoring in all sound pressure levels experienced, and the duration over each level (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. Received levels are usually measured at the receiver's position and back-calculated to determine the SPL at 1 m (*e.g.*, 200 dB re 1µPa @ 1m), or predicted through modelling based on the source level and distance to the receiver.

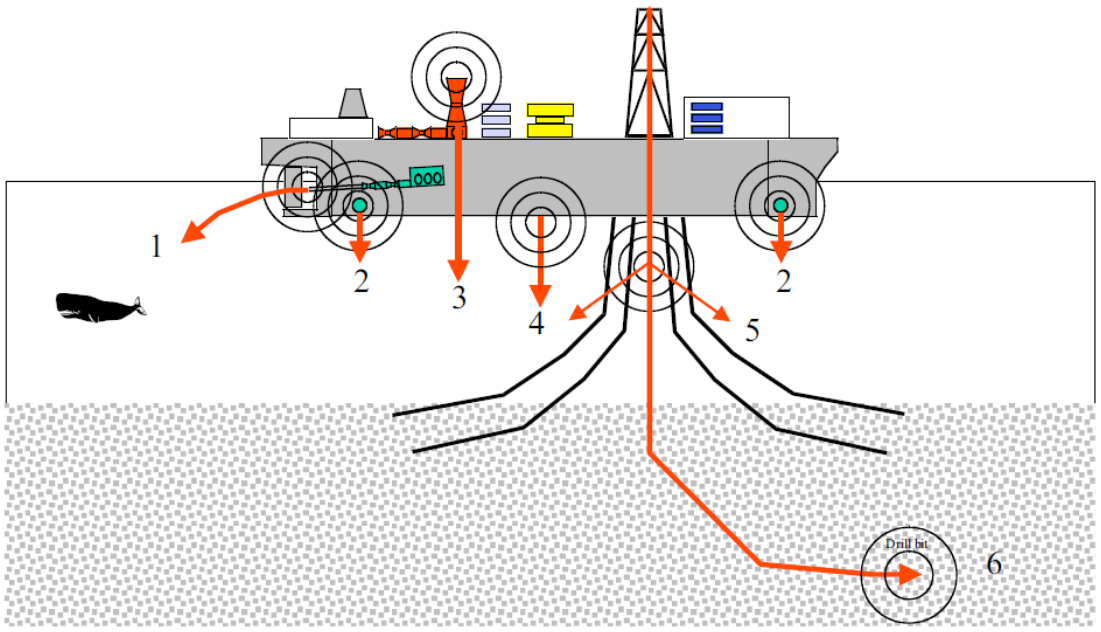
The intensity of sound weakens as it travels through water as a result of spreading, absorption, scattering, and reflection; this is known as transmission loss. Transmission loss underwater can occur in one of two forms: spherical or geometric spreading loss; or cylindrical spreading loss (Richardson *et al.* 1995). Spherical spreading loss assumes a uniform environment, which is typically found in deep waters (>2000 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).

Sound Profiles of Project Activities and Components

Existing ambient noise on the Scotian Shelf and Slope is discussed in Section 5.1.3.6. As a result of the presence and operation of the MODU, the three main sources of noise will be the mechanical and vibrational noise from the MODU, thruster cavitation from the DP system, and direct drilling noise from the drill string and drill bit. Mechanical vibration created by the operation of the MODU will result in underwater noise transferred to the sea via ship hulls (*i.e.*, drill ship) or drilling floats. Within the machinery itself, noise and vibrations are created by propulsion equipment, including diesel engines, thrusters, main motors, and reduction gears. Noise 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 be on at all times, keeping the MODU on station. As a result of this, the MODU's thrusters will be running continuously. As the thruster propeller rotates through the water, regions of low pressure will be created at the propeller tip (WDCS 2004). When these regions of low pressure become sufficiently low, bubbles will form. The bubbles created will collapse in either a turbulent stream or against the surface of the propeller, creating a sharp sound as the bubble collapses in a loud hiss; this process is known as cavitation (WDCS 2004).

In general, MODUs can take on a variety of forms, shapes, and sizes; the MODU design, in combination with the local oceanographic conditions, will affect how much sound is transferred into the water (WDCS 2004). As a general rule, the larger the surface area of the MODU in contact with the water, the more sound it will transmit into the water column. As a result, drill ships will emit more noise than semi-submersible or jack-up rigs because their hulls have a larger surface area in contact with the water (Richardson *et al.* 1995; WDCS 2004, NERI 2011). Figure 7.1.1 depicts sound transmission pathways from a drill ship 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 noise, (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 Noise Associated with a Drill Ship or Semi-submersible Drill Rig

Sound Pressure Levels (SPLs) produced by operating MODUs range from 130–190 dB re 1 µPa @ 1 m (peak frequency 10–10 000 Hz) (Richardson *et al.* 1995; Hildebrand 2005; OSPAR 2009). Based on the Sound Transmission Loss equation (STL= 20 log R + linear range term,) at 10 km from the

source, the received sound levels would be expected to be in the range of 81 dB, for an anchored semi-submersible with source levels of 167–171 dB re 1 µPa @ 1 m and 105 dB for a drill ship with source levels of 179 to 191 dB_{RMS} 1 µPa @ 1 m (DCENR 2007). The drilling noise from a drill rig used in the Beaufort Sea was recorded at approximately 150 dB re 1 µPa @ 1 m at 30–40 Hz (OSPAR 2009). Measurements from the drill ship *Stena Forth* operating in Baffin Bay in 2010 recorded source levels of 184 dB_{RMS} re 1 µPa @ 1 m (NERI 2011). These SPLs take into account the variety of sound sources emitted from the MODU and drill string in combination, as described above. Each well is estimated to take up to a maximum of 130 days to drill with drilling operations occurring 24-hours a day. During drilling it is expected that all sources of noise (thrusters, vessel machinery and vibration, drill string) will be emitted continuously. Noise emissions during testing and abandonment activities may be reduced somewhat as a result of the removal of the drill string and associated drilling noise, but the anticipated noise emissions from the operation of the MODU will be similar throughout all Project activities.

Biological Effects

Biological effects are generally concerned with anthropogenic sounds overlapping in frequencies within the hearing range of specific marine organisms. A sound is audible if the receiver is able to detect it over background (ambient) noise. Determining if and at what distance an animal can hear a sound is important in assessing effects from introduced underwater noise (Richardson *et al.* 1995; Popper 2003). It is generally accepted that exposure to anthropogenic noise can result in effects on marine life. There are two categories of potential effects from noise exposure to marine life: injury/mortality (including pathological and physiological effects) and behavioural. The injury/mortality category includes lethal and sub-lethal injuries, as well as temporary, primary, and secondary stress responses (LGL 2013). These may involve hearing loss (temporary threshold shifts [TTS] or permanent threshold shifts [PTS]), or, in extreme circumstances (*e.g.*, under prolonged and very intense sound emissions when the receiver is very close to the source), mortality (Richardson *et al.* 1995; Popper 2003; Popper *et al.* 2004; Madsen 2005; Nowacek *et al.* 2007; Southall *et al.* 2007). It should be noted that there has been no definitive evidence linking mortality of marine mammals directly to seismic or sonar activity, rather it has been noted that behavioural responses induced in certain extreme circumstances may have resulted in species mortality (*i.e.,* strandings, the bends). Possible behavioural effects include: habitat avoidance, communication masking, discomfort, and behavioural disturbance (*e.g.*, changes in diving/breathing rate or foraging efficiency).

Fish and Fish Habitat

A variety of studies have been conducted on how noise affects fish, including marine, freshwater, and anadromous species. Most, if not all of these studies have concentrated on impulsive sounds created from seismic source arrays, pile-driving, and explosive devices, rather than on non-impulsive sound sources such as that resulting from MODU operations (OSPAR 2009; LGL 2013).

Noise emitted from the operating MODU is likely to be in the range of 130–190 dB re 1 µPa (Hildebrand 2005; Richardson *et al.* 1995), and will be continuous (non-impulse). Studies have shown that peak levels of noise above 206 dB re 1 µPa and cumulative SELs of 187 dB re 1 µPa are needed to elicit damage for fish 2 grams or heavier (Fisheries Hydroacoustic Working Group 2008), and it is therefore extremely unlikely that direct injury to fish will occur due to the presence and operation of the MODU. While injury to fish is therefore deemed unlikely, 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 at start-up (Mueller-Blenkle *et al.* 2008; Fewtrel and McCauley 2012). Over the course of drilling, it is expected that fish will become habituated to the noise and avoidance and startle responses will cease (Chapman and Hawkins 1969; McCauley *et al.* 2000a, 2000b; Fewtrel and McCauley 2012).

To date, the majority of noise-related studies on invertebrates, including snow crab and lobster, have focused on seismic noise. Studies have shown limited stress or behavioural effects due to intense levels of noise created from seismic surveys (Christian *et al.* 2003, 2004; Chadwick 2004; Payne *et al.* 2007) and sound levels generated during exploratory drilling will be much lower than those emitted during seismic surveys. In consideration of results from these previous studies, effects on marine invertebrates from exploratory drilling are likely to be limited to potential startle response or avoidance behaviours for brief and temporary periods of time for marine invertebrates.

Marine Mammals

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 stemming 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 (NOAA 2013r). 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.*, difficult to keep baleen whales in captivity) (Houser *et al.* 2001; Parks *et al.* 2007; Dahlheim and Ljungbald 1990; Reichmuth 2007). The functional hearing ranges of marine mammals are listed in Table 7.1.2.

Table 7.1.2 Functional Hearing Range of Marine Mammals.

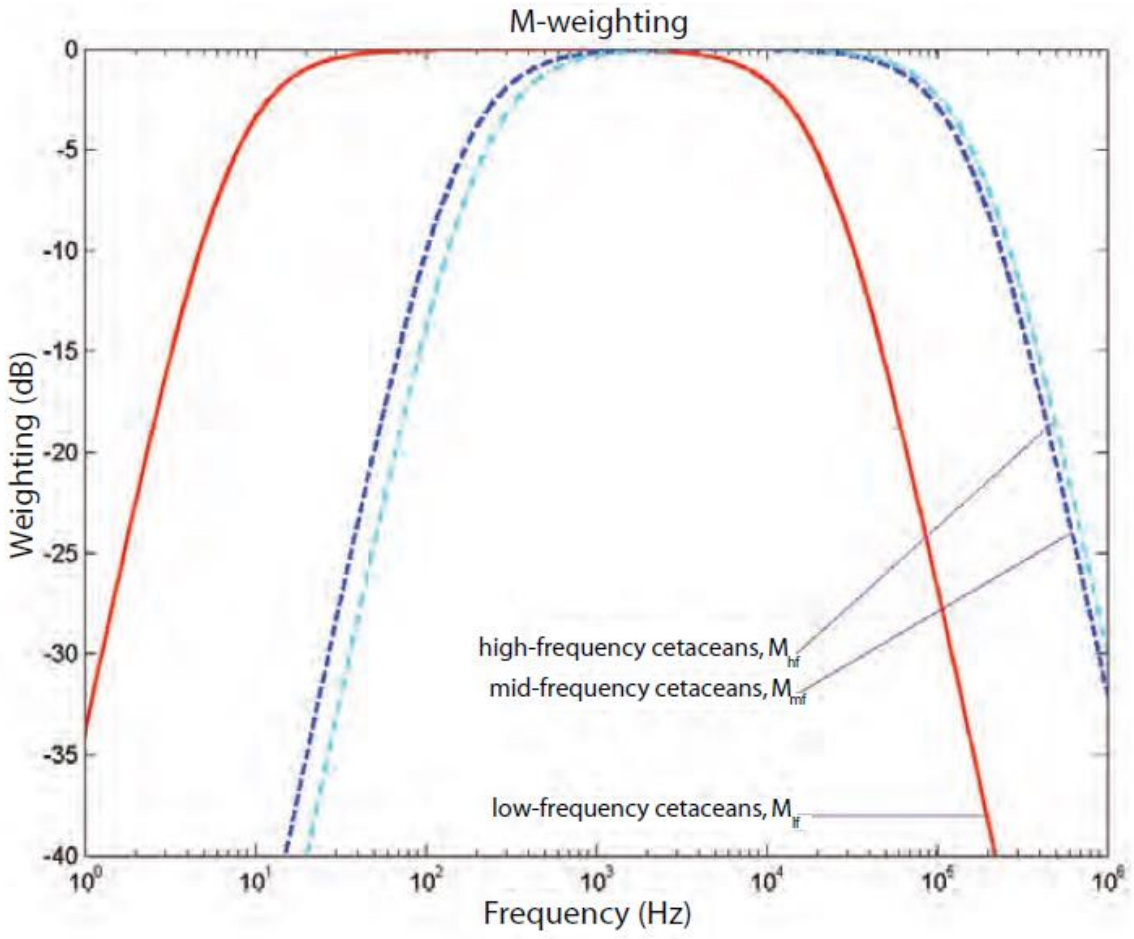
Functional Hearing Group	Functional Hearing Range	Frequency- Weighting Network
Low-Frequency (LF) Cetaceans* (Mysticetes)	7 Hz to 22 kHz	M_{lf} (lf: low-frequency cetacean)
Mid-Frequency (MF) Cetaceans (Odontocetes)	150 Hz to 160 kHz	M_{mf} (mf:mid-frequency cetacean)

Table 7.1.2 Functional Hearing Range of Marine Mammals.

Functional Hearing Group	Functional Hearing Range	Frequency- Weighting Network
High- Frequency (HF) Cetaceans (True Porpoises, Harbour Porpoise, *Kogia,* River Dolphins, cephalorhychid, *Lagnenorhyncus cruciger* and *L. australis*)	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)
*Note: 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.		

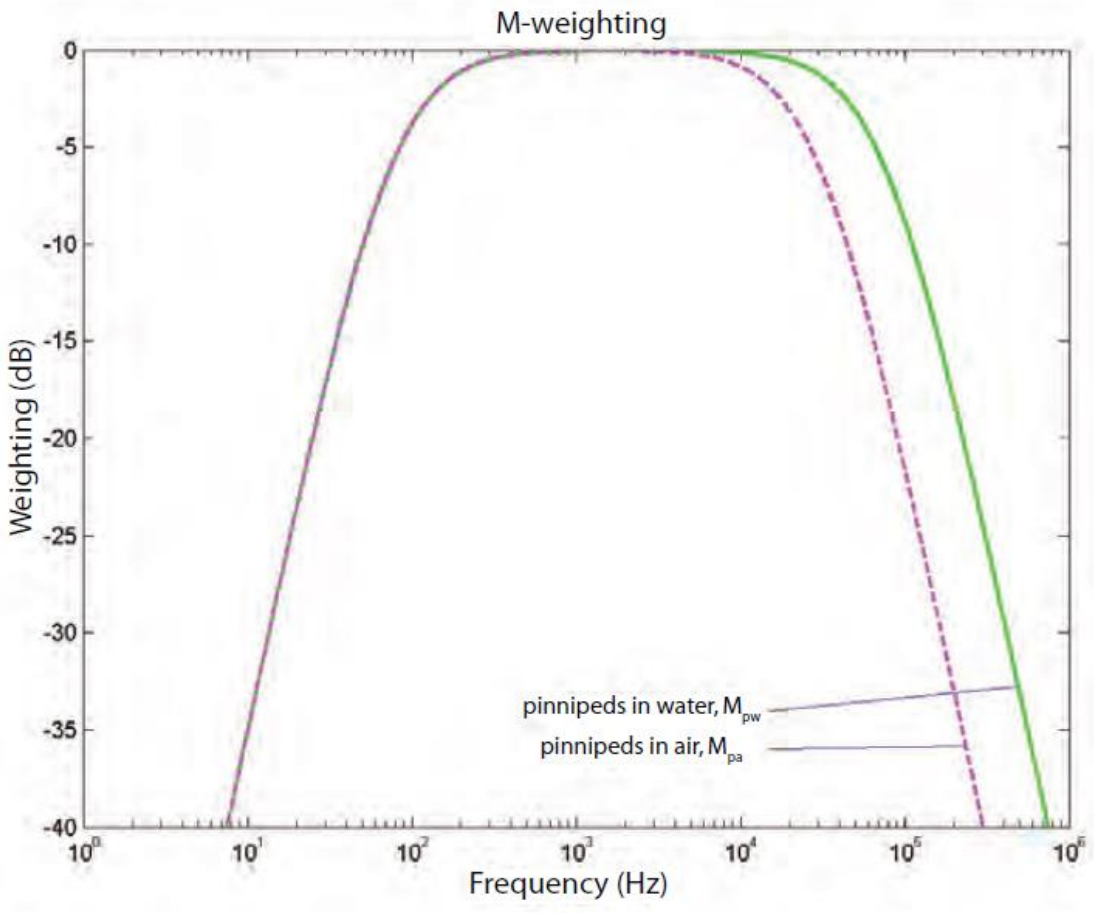
Source: Southall *et al.* 2007

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 (NOAA 2013r). To reflect this higher sensitivity to particular frequencies, sounds 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 SEL_{cum}. 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 7.1.2 and 7.1.3 (Southall *et al.* 2007). The weighted function accounts for a "discount" to sound frequencies outside of the peak hearing frequency for a mammal. If the frequencies produced by a sound source are outside the range of a functional hearing group's prime hearing sensitivity (*i.e.*, where the weighted function amplitude is equal to 0), sounds must be louder in order to produce a similar level of noise-induced hearing loss. The further a sound source's frequency is away from the range of best sensitivity, the louder the noise must be to induce the same amount of damage.



Source: Southall *et al.* 2007

Figure 7.1.2 High-frequency,Mid-frequency, and Low-frequency Cetacean Auditory Weighting Functions



Source: Southall *et al.* 2007

Figure 7.1.3 Pinniped Auditory Weighting Function

Masking

Masking can occur when an anthropogenic noise is strong enough to impair detection of biologically important sound signals including communication signals, echolocation clicks, and passive detection cues that are used to navigate and find prey (OSPAR 2009). This results in a shortening of the range over which communication sounds can be detected and over which species can communicate with one another. It should be noted that most species use a range of frequencies to communicate and it would be unlikely that the full range of frequencies would be masked for extended periods. If biologically important functions, such as foraging or mating, are interrupted by masking events over prolonged periods, this can potentially lead to adverse effects at the individual and potentially the population level. Some species also use areas of thousands of square kilometres to communicate and masking may shrink the distance over which communications can be detected (OSPAR 2009). A recent study on the west coast of Canada conducted by Williams *et al.* (2013) has illustrated that anthropogenic noise can heavily reduce the possible range of cetacean communication. The largest effects were

observed for low- and mid-frequency communication. Under natural, ambient ocean noise conditions (*i.e.,* from natural noise sources including wind and surf noise), fin whales lose less than 1% of their communication space. In contrast, in the noisiest environments humpback whales can lose 80 to 94% of their communication space within the 71 to 708 Hz communication range (Williams *et al.* 2013). Under moderate noise conditions, they lost 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. Odontocete communication frequency ranges from 2 to over 100 kHz (Au and Hastings 2008), which would only partially be overlapped by the low frequency (10 Hz to 10 kHz) range of drilling noise. Mysticetes vocalize in lower frequencies, from 100 Hz to 30 kHz; therefore, their communication has a greater potential to overlap with noise created from drilling (Clark 1990; Erbe 2002).

Behavioural Effects

Behavioural disturbances are those that evoke a change in activity in response to a sound. 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 strong avoidance reactions. They can also sometimes be exhibited by changes in vocal activity. It has been previously concluded that marine mammals are generally more tolerant to stationary sources of noise than moving sources (LGL *et al.* 2000). Information on the reactions of marine mammals to anthropogenic sound is available through a number of studies, although this information is limited in terms of species and situations considered (Richardson *et al.*1995; Gordon *et al.* 2004; Nowacek *et al.* 2007; Southall *et al.* 2007). The majority of this research has focused on the response to seismic sound, and not specifically on drilling noise.

NOAA (2013s) is currently working on developing new guidelines with respect to impacts of sound on behaviour and has created an interim behavioural thresholds for marine mammals (SPLs measured in dB_{RMS}) that apply to both cetaceans and pinnipeds):

- 120 dB_{RMS} re 1 µPa for continuous sounds (*e.g.*, shipping and drilling)
- 160 dB_{RMS} re 1 µPa for pulse sounds (*e.g.*, seismic surveys and VSP)

These criteria are considered in relation to disturbance effects from VSP and drilling operations on marine mammals in Section 7.3 of the EIS.

Examples of observed behavioural responses from mysticetes in relation to seismic activity include deviation from their migrations 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 response to noise as much research has focused on mysticetes; however, some odontocetes 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.

Physiological Effects

One of the more common physiological effects of noise is a threshold shift caused by hair cell fatigue, hair cell damage, 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 minimum level of intensity (dB) at which sound can be heard (WDCS 2004). A certain level of noise (species-dependent) is required to cause a threshold shift. Once this occurs, the threshold of hearing increases resulting in decreased sensitivity to sound. These shifts can either be temporary (TTS) or, in the event of prolonged or intense noise, permanent (PTS). Multiple TTS events can also result in PTS.

Southall *et al.* (2007) have concluded 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. This recommended criteria is currently under review by U.S. regulators taking in account new auditory data acquired since 2007 (NOAA 2013r), and has not been formally accepted. As a result, the scientific reccomendations provided in Southall *et al.* (2007) were used to establish hearing impairment criteria for marine mammals.

The following received levels of sound have been used to assess the risk of hearing impairment effects from pulsed and non-pulsed sound on cetaceans (Southall *et al.* 2007):

Table 7.1.3 Temporary and Permanent Threshold Shift Criteria for Cetaceans

Sound Type	Threshold Shift	
	Temporary Threshold Shift (TTS)	**Permanent Threshold Shift (PTS)**
Non-Pulsed		
Sound Exposure Level	≥ 195 dB re 1 µPa^{2}s (M-weighted)	≥ 215 dB re 1 µPa^{2}s (M-weighted)
Sound Pressure Level	≥ 224 dB re 1 µPa (flat or unweighted)	≥ 230 dB re 1 µPa (flat or unweighted)
Pulsed		
Sound Exposure Level	≥ 183 dB re 1 µPa^{2}s (M-weighted)	≥ 198 dB re 1 µPa^{2}s (M-weighted)
Sound Pressure Level	≥ 224 dB re 1 µPa (flat or unweighted)	≥ 230 dB re 1 µPa (flat or unweighted)

Source: Southall *et al.* 2007

Table 7.1.4 below depicts the sound level criteria for impulsive and non-impulsive noise to induce injury.

Table 7.1.4 Proposed Injury Criteria for Individual Marine Mammals Exposed to "Discrete" Noise Events (Either Single or Multiple Exposures within a 24-h Period)

Hearing Group	Sound Type		
	Single Pulse	**Multiple Pulses**	**Non-Pulses**
Low-frequency (LF) Cetaceans			
Sound Pressure Level	230 dB_{0-p} re 1 µPa (flat)	230 dB dB_{0-p} re 1 µPa (flat)	230 dB_{0-p} re 1 µPa (flat)
Sound Exposure Level	198 dB re 1 μPa^2s (M_{lf})	198 dB re 1 μPa^2s (M_{lf})	215 dB re 1 μPa^2s (M_{lf})
Mid-frequency (MF) Cetaceans			
Sound Pressure Level	230 dB_{0-p} re 1 µPa (flat)	230 dB_{0-p} re 1 µPa (flat)	230 dB_{0-p} re 1 µPa (flat)
Sound Exposure Level	198 dB re 1 μPa^2s (M_{mf})	198 dB re 1 μPa^2s (M_{mf})	215 dB re 1 μPa^2s (M_{mf})
High-frequency (HF) Cetaceans			
Sound Pressure Level	230 dB_{0-p} re 1 µPa (flat)	230 dB_{0-p} re 1 µPa (flat)	230 dB_{0-p} re 1 µPa (flat)
Sound Exposure Level	198 dB re 1 μPa^2s (M_{hf})	198 dB re 1 μPa^2s (M_{hf})	215 dB re 1 μPa^2s (M_{hf})
Pinnipeds (in water)			
Sound Pressure Level	218 dB_{0-p} re 1 µPa (flat)	218 dB_{0-p} re 1 µPa (flat)	218 dB_{0-p} re 1 µPa (flat)
Sound Exposure Level	186 dB re 1 μPa^2s (M_{pw})	186 dB re 1 μPa^2s (M_{pw})	203 dB re 1 μPa^2s (M_{pw})
Pinnipeds (in air)			
Sound Pressure Level	149 dB_{0-p} re 1 µPa (flat)	149 dB_{0-p} re 1 µPa (flat)	149 dB_{0-p} re 1 µPa (flat)
Sound Exposure Level	144 dB re 1 μPa^2s (M_{pa})	144 dB re 1 μPa^2s (M_{pa})	144.5 dB re 1 μPa^2s (M_{pa})
Note: All criteria in the "Sound Pressure Level" lines are based on the peak pressure known or assumed to elicit TTS-onset, plus 6 dB. Criteria in the "Sound Exposure level" lines are based on the SEL eliciting TTS-onset plus (1) 15 dB for any type of marine mammal exposed to single or multiple pulses, (2) 20 dB for cetaceans or pinnipeds in water exposed to non-pulses, or (3) 13.5 dB for pinnipeds in air exposed to non-pulses.			

Source: Southall *et al.* 2007

Based on Table 7.1.3, the onset of TTS from non-impulsive noise (*e.g.*, drilling) can occur from a SEL of 195 dB re 1 μPa^2s (M-weighted) or a SPL of 224 dB_{0-p} re 1 µPa (flat or unweighted). Noise emitted from drilling is in the range of 130–190 dB_{RMS} re 1µPa @ 1m. Although units are not directly comparable, the RMS value for a given SPL is typically approximately 10 dB lower than the peak value (Appendix D of LGL 2013). It is therefore assumed that peak levels of drilling noise will be approximately 140–200 dB_{0-p} re 1 µPa @ 1m, which is below the threshold at which cetaceans would be expected to experience TTS from drilling noise.

The proposed injury criteria for onset of PTS from non-impulsive noise range from a SEL of 215 dB re 1 μPa^2s (M-weighted) to a SPL of 230 dB_{0-p} re 1 µPa (flat or unweighted). As a result, drilling noise is not expected to lead to permanent auditory effects on marine mammals. For most species of marine mammals, drilling noise may only lead to temporary auditory effects in very rare circumstances (*i.e.*, within a few metres from the rig where marine mammals are unlikely to occur based on studies that show that cetaceans move away from intense sound sources) (Stone and Tasker 2006; Moulton and Holst 2010).

Sea Turtles

There is relatively little research on effects of drilling activities on sea turtles. Available information indicates that turtles hear at low frequency ranges (*e.g.*, 100–900 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 1600 Hz and have optimal hearing below 1000 Hz (Dow Piniak *et al.* 2012a). Dow Piniak *et al.* (2012a) 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 noise than cetaceans or fish. In the absence of established hearing impairment thresholds for sea turtles, it has become standard practice to apply the thresholds for PTS or TTS onset in cetaceans (LGL 2013).

Studies to date have focused on seismic sound sources that are far more intense than the noise emitted from drilling. As a result, it is believed that any physical effects from drilling are unlikely due to an expected tendency of sea turtles to avoid sources of intense noise, and since any potential or behavioural effects from drilling-related noise would be of short duration and would only occur within a close radius to the MODU.

Marine Birds

Birds in general are known to have good hearing abilities, although information pertaining to underwater hearing abilities is unknown and generally lacking in study detail (Wiese *et al.* 2001; OSAPR 2009; Stantec 2013b; 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). Birds are generally more resistant to auditory damage than mammals. The effects of anthropogenic noise in air include auditory system damage, and behavioural responses. For birds in air, continuous noise exposure levels above 110 dB(A) SPL or blast noise above 140 dB SPL can result in PTS (Dooling and Therrien 2012). Continuous noise exposure levels above 90–95 dB

SPL, has been shown to cause TTS (in air). To date, there has been a scarcity of data on the effects of underwater noise on marine birds. The few studies that have been done have focused on effects from seismic testing, with little behavioural effect measured or observed (Stemp 1985; Turnpenny and Nedwell 1994; Lacroix *et al.* 2003). More research effort has been spent on if and how birds use hearing underwater (Dooling and Therrien 2012). 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 2–4 kHz (Dooling and Therrien 2012)

As a result of the lack of observed behavioural and physiological effects on diving birds from seismic testing, it can be inferred that lower levels of sound emitted from drilling activities will not have an effect on marine birds. Of greater relevance to marine birds is the potential attraction from lights and flares on the MODU, as discussed below.

7.1.1.3 Lights and Flares

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). Artificial light from drilling rigs and flares can attract birds depending upon the weather, season, age of the birds, and the lunar phase, which can lead to collisions, incineration, and mortality. Night-flying birds such as storm-petrels can be particularly attracted to vessel lighting, specifically during periods when visibility of the moon and stars is poor. Birds may become disoriented and fly into vessel or MODU lights or infrastructure, injuring themselves and becoming stranded. Low-light conditions will prompt vessel lighting, leading to increased potential for seabird attraction. For example, it has been suggested that seabird disorientation occurs most frequently during periods of drizzle and fog (Wiese *et al.* 2001). Moisture droplets in the air, during conditions of drizzle and fog, refract the vessel's light and greatly increase the illuminated area, thus enhancing the attraction. Mortality is higher during migration when large numbers of birds fly relatively low as a result of 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). In the case of offshore oil and gas installations with 30 kW of lighting, birds can be attracted to artificial lighting from distances up to 5 km from the source (Poot *et al.* 2008).

Attraction to artificial lighting is widespread among procellariiform sea bird species (petrels, shearwaters, and storm-petrels), since they feed on bioluminescent prey and are naturally attracted to light (Imber 1975). Light attraction has also been reported for sandpipers (Scolopacidae) but is not believed to lead to mortality. Attraction to ship lights and flares can also result in continuous circling by birds, using energy and delaying foraging or migration, which can result in starvation (Bourne 1979). During migration, small songbirds are commonly attracted

to artificial lighting on offshore ships and installations under the same conditions of moonlight and weather as seabirds and can suffer mortality as a result (Gauthreaux and Belser 2006; Poot *et al.* 2008). In waters offshore Nova Scotia the most common species to strand on vessels are Leach's Storm-petrel and Wilson's Storm-petrel. Other species that are commonly found to strand themselves in Nova Scotia are Greater Shearwater and Scooty Shearwater (LGL 2013). A Norwegian study on bird effects associated with offshore drilling has shown that the effect of flaring on flocks of birds is small and occurs primarily at night during migration periods (OSPAR 2007). Additionally, seabird monitoring conducted as part of the SOEP EEM has shown little to no effect of flaring on birds transiting to and from Sable Island or the Scotian Slope (CNSOPB 2011).

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).

Light emitted from the MODU can also affect fish species in the area of influence. Light can affect the light and dark cycle, causing reactions from fish and invertebrates in the area. Physiological stress to the circadian rhythm can result from the influence of 24-hour light (Stantec 2013b). The disruption of resting period in zebra fish resulted in a decline in daytime locomotive activity and a heightened arousal threshold (Zhdanova and Reebs 2006). Leonardi and Klempau (2003) demonstated that a 24-hour light period for 60 days can induce an increase in cortisol in trout, which lasted for up to two months after the illumination period. Hemre *et al.* (2002) concluded that 24-hour light resulted in anemia and a delay of gonadal maturation in cod.

7.1.2 Discharge of Drill Muds and Cuttings

As discussed in Section 2.4.1, the drilling of each offshore well will consist of two components, starting with riserless drilling (*i.e.*, an open system with no direct drill fluid return connection to the MODU) and continuing with riser drilling (*i.e.*, closed loop system with direct drill fluid return connection to the MODU). During riserless drilling, there is no closed loop fluid (riser) system in place to return drilling fluid back to the MODU; therefore, the drilling fluid (seawater and WBM) is released directly to the seafloor. Once a riser system is installed, the riser creates a conduit to capture the associated drilling fluids (SBM) and cuttings and transport them back to the MODU for further processing. During this phase of drilling, SBM will be the preferred drilling fluid.

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 praticable. In accordance with the OWTG, spent WBM and drilling solids (*e.g.*, cuttings) associated with the use of WBM may be discharged at the wellsite without treatment. No whole SBM base drilling fluid or any whole mud containing SBM as a base fluid will be discharged at sea. Spent SBM that cannot be reused will be transported to shore for disposal. In accordance with the OWTG, drilling cuttings associated with the use of SBM must be treated prior to marine disposal such that the "synthetic-on-cuttings" does not exceed 6.9 g/100 g oil on wet solids. Refer to Section 2.7.1 for more

information on drill muds and cuttings, including typical components, predicted discharge volumes, and a summary of dispersion modelling results (refer to Appendix C for sediment dispersion modelling report).

Numerous laboratory and field studies (including EEM studies) have been conducted to examine the effects of drill waste discharges on the marine environment. Although drill waste discharges can result in temporary elevated levels of TSS as finer sediments from drill cuttings may become entrained in the water column (refer to Appendix C), most environmental effects studies have focused on effects on the marine benthos. Laboratory studies have focused on the toxicity of drill muds and resulting sublethal effects of exposure (*e.g.*, Neff *et al.* 1989; Cranford and Gordon 1992; Cranford *et al.* 1999). In addition to testing toxicity, 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.

Laboratory studies have linked prolonged exposure of bentonite and barite (found in both WBM and SBM) to sublethal effects affecting 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 (Stantec 2014).

As reviewed by Neff (2010), most field study experiments and actual 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
- limited effects on benthic macro- and mega-faunal communities restricted to approximately 100-m radius from the well

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).

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 will die from the mass of the discharges crushing them, while others will 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. This is an average value, and is species-dependent, meaning that some species may be buried at a depth of less than 9.6 mm and still have negative consequences (Neff *et al.* 2004). Drill waste dispersion modelling conducted for this Project has predicted that a sediment thickness of 10 mm could extend up to 155 m from the wellsite, with a maximum footprint of 1.89 ha per well (refer to Appendix C).

A recent review of the environmental effects of Norwegian offshore drilling has concluded that long-term population and ecosystem effects to benthic communities from drill mud (WBM and SBM) and cuttings discharges are low (Bakke *et al.* 2013). 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. Bakke *et al.* (1986) capped sediments with 10 mm of WBM and found that fauna recolonization on sediments cuttings differed little in diversity from natural sediment after as little as one year. The results illustrated that recolonization species were different, although this was hypothesized to be related to the fact that the WBM provides a finer sediment type than the natural sediments in the area. Renaud *et al.* (2008) documented rapid reductions in total hydrocarbon contamination in the Gyda field in the North Sea over three years, with benthic fauna indices following the same pattern. 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).

Diesel-based muds have never been used on the Nova Scotian Shelf or on the Grand Banks, offshore of Newfoundland and will not be used in association with the Project. Comparatively, where EEM has detected effects, the data has indicated the regulated use of SBM and WBM on the Grand Banks has resulted in much lower magnitudes of effects than compared to those found in the North Sea. 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).

7.1.3 Other Discharges and Emissions

All offshore waste discharges associated with the Project will be managed in compliance with 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* and its

regulations and treated in accordance with the OWTG. Section 2.7 discusses waste discharge and emissions and how they will be managed during Project activities. Section 2.7.2.1 discusses air emissions, which are expected to be created in low levels during the Project. Section 2.7.3 discusses liquid waste and how it will be managed. Estimated discharge limits are based on the best available technologies.

Drilling will require the use of seawater for cooling. The volume of cooling water used will be minimal and therefore the area of thermal effects will be negligible (Stantec 2013b). 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. Procellariiforms use olfactory cues to navigate and may be attracted to 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 noise emissions. As mentioned in Section 2.7.3, sanitary and food wastes will be macerated to a particle size of 6 mm or less. Organic matter will be quickly dispersed by ocean currents and wave activity and will be degraded by bacterial communities.

7.1.4 Vertical Seismic Profiling (VSP)

VSP acquisition employs similar technology to that used during a seismic survey (source and receiver) and as such is a source of underwater noise. Although VSP uses a sound source similar to that used in seismic operations (*i.e.*, a source array), the associated size and volume of the array are much smaller than a traditional surface seismic survey. VSP surveys produce sound in the frequency range of 5–300 Hz and SPLs of 220–245 dB re 1 µPa @ 1m (Lee *et al.* 2011). Further description of VSP is provided in Section 2.4.2.

In addition to utilizing a smaller source array, VSP operates over much shorter time frames (*e.g.*, days instead of months) and is conducted over a much smaller spatial scale (*i.e.*, drill site). The zero-offset VSP that Shell is proposing to use for this Project will typically take a day to complete per well and will be located directly above the well bore.

A background discussion on noise and the hearing abilities of marine mammals is provided in Section 7.1.1.2. Studies based on VSP surveys are lacking, although there is an abundance of information surrounding the effects of seismic surveys on marine mammals. Since VSP uses similar equipment and emits similar sound frequencies and SPLs as seismic surveys, for the purposes of this assessment, background studies and acoustic modelling from seismic surveys will be used for reference and considered in association with the effects assessment. Acoustic modelling conducted for the Shelburne 3D Seismic EA (Matthews 2013 in Appendix A of LGL 2013) predicted seismic sound with SPLs of 160 dB re 1 µPa extending up to 26 km from the sound source. This SPL is recognized as a threshold for behavioural effects of seismic sound on marine mammals and has been considered in the delineation of an appropriate LAA for the assessment of Marine Mammals and Sea Turtles.

Effects on Fish and Fish Habitat

In most of the studies to date regarding effects from seismic noise, responses by fish include startle responses, swimming away from the source, swimming towards the source, tightening of schools, downward distributional shifts, and eventual habituation (LGL 2013; Stantec 2013b). Potential damage to larvae and eggs can occur if they are located at very close range to the sound source. Payne *et al.* (2009) exposed capelin and monkfish eggs to seismic sound with SPLs of 199–205 dB re 1 µPa. Conclusions from this study determined that there was no difference in mortality between control and exposed eggs. Booman *et al.* (1996) exposed various life stages (egg to fry) of commercially important north Atlantic fish to SPLs of 220–242 dB re 1 µPa, which corresponded to distances of 0.75 to 6 m from the air source array. The study showed that some injury and mortality occurred, but only at distances which were close to the sound source (<15 m). Similar results from Kostyvchenko (1973) showed mortality to various species of fish eggs after being exposed to SPLs of 215–233 dB re 1 µPa. Approximately 75% of the eggs survived exposure at very close range (0.5 m) and this increased to over 90% survival when the distance was increased to 10 m. Sætre and Ona (1996) used a mathematical model to apply a "worst-case scenario" to investigate the effects of seismic noise on the eggs and larvae of fish. The study concluded that the mortality rates caused by the exposure to seismic noise were so low in comparison to natural mortality, that the impacts of seismic noise on the recruitment of fish stock can be considered insignificant.

Avoidance response has been documented in cod at 130–140 dB re 1 µPa when Müeller-Blenkle *et al.* (2008) played tones to the species through an underwater speaker and found the fish avoided the source when the sound was turned on. Startle and alarm responses vary by species and have been observed to initiate at SPLs above 156–161 dB re 1 µPa depending on the species (Chapman and Hawkins 1969; Pearson *et al.* 1992; Santulli *et al.* 1999; Wardle *et al.* 2001; Hassel *et al.* 2003, 2004). Observations have found that fish behaviour returns to normal once exposure to SPLs from air source arrays ceased (Pearson *et al.* 1992; Santulli *et al.* 1999; McCauley *et al.* 2000a, 2000b; Fewtrell and McCauley 2012). Some studies have also shown that fish can become habituated in the presence of pulsed SPLs and return to normal behaviour even as air source arrays continue to operate (Chapman and Hawkins 1969; McCauley *et al.* 2000a, 2000b; Fewtrel and McCauley 2012).

Thomsen (2002) exposed rainbow trout and Atlantic salmon held in aquaculture enclosures to received SPLs ranging from 142 to 186 dB re 1 µPa. A cod and haddock longline vessel was also operating in the immediate vicinity and the effects on catch rates were analyzed to determine the potential effects of underwater noise. The overall effects on salmonids were minimal with 8 out of 124 seismic shots evoking any kind of behavioural response. No mortality of fish was observed during or after the exposure. There were also no statistically significant adverse effects on catch rates of nearby cod and haddock.

Pathological and physiological effects have been observed in fish species exposed at close range to the seismic source during previous seismic experiments. Extensive damage to sensory epithelium in the inner ear of pink snapper was observed after exposure to an emitted source

level of 223 dB re 1 µPa @ 1m, and a received level of 165–209 dB re 1 µPa (McCauley *et al.* 2000a, 2000b, 2003). There was no evidence of repair or replacement of damaged sensory cells up to 58 days post-exposure. Santulli *et al.* (1999) conducted a study exposing marine fish to pulsed sounds with a source level of 256 dB re 1 µPa; this was shown to cause physiological stress by increasing cortisol, glucose, and lactose levels in the blood of fish species. These elevated levels returned to baseline 72 hours after exposure. A study by Wardle *et al.* (2001) showed that received SPLs of 195–218 dB re 1 µPa caused slight day-night rhythm effects on pollock. In this study, it was noted that if the fish could see the seismic source they retreated from the noise, although if they could not see the source (at night) they were attracted to the source.

In addition to the studies discussed above, there have been several studies to determine effects of seismic noise on invertebrate species, such as crab and lobster. Christian *et al.* (2003, 2004) exposed snow crabs to various SPLs ranging from 191 to 221 dB re 1 µPa and SELs of <130 to 187 dB re 1 μPa^2, which resulted in neither acute nor chronic mortality in adults. There were, however, developmental issues noted between exposed and unexposed eggs and embryos. The study also did not show statistically significant acute or chronic stress indicators or any behavioural responses to the exposed sound levels (Christian *et al.* 2003, 2004). A similar study conducted by Chadwick (2004), in which crabs were exposed to received SPLs of 195 dB re 1 µPa for 132 hours showed similar results, with neither acute nor chronic mortality in female adults.

A study involving American lobster exposed individuals to sound levels of 202 dB re 1 µPa, with follow-up monitoring. No changes in equilibrium, posture, damage to mechanosensors or delayed mortality were observed (Payne *et al.* 2007). During the same study, elevated levels of serum protein and serum calcium were noted in the hemoplymph of animals exposed to seismic sound (Payne *et al.* 2007). During histological analysis conducted four months post-exposure, deposits, likely glycogen, were noted in the hepatopancreas of some of the exposed lobsters. The accumulation of glycogen could be due to the stress or disturbance of cellular processes (Payne *et al.* 2007).

When McCauley *et al.* (2000a, 2000b) exposed squid to noise emitted from air source arrays with a maximum SPL of >200 dB re 1 µPa, a subset of the squid fired their ink sacs and moved quickly away from the sound source in a startle response. It was noted that this startle response started at a level of 174 dB re 1 µPa. Squid were also exposed to a ramp-up approach in which no strong startle response was evoked. Masking, as it applies to marine fish and mammals, can also apply to invertebrates. Some invertebrates produce sounds, whose functionality is not well known or studied (Tolstoganova 2002; Latha *et al.* 2005). Masking of produced or received sounds could potentially have adverse effects on marine invertebrates.

As mentioned previously, there is a lack of information on the auditory effects (injury) on fish. Interim guidance criteria have been developed and adopted by the Fisheries Hydroacoustic Working Group (2008) for exposure to noise generated by pile driving. The exposure limits of SPL of 206 $dB_{0\text{-}p}$ re 1 µPa and SEL_{cum} of 187 dB re 1 μPa^2s have been agreed upon, and exceedances of these noise levels have a high potential for injury to fish species. These exposure limits have been established in consideration of studies that have noted extensive damage to the inner ear

structure with source SPLs of 223 dB re 1 µPa and received SELs of 165–209 dB re 1 µPa. SPLs above 215 dB re 1 µPa have been shown to cause damage to the eggs and embryos of fish at very close distances with nearly 90% survival at 10 m from the source.

Unlike auditory injury thresholds, there are no behavioural thresholds for the response of fish to noise. Behavioural changes have been observed as low as 130–140 dB re 1 µPa (Müeller-Blenkle *et al.* 2008). Startle and alarm responses have been observed at SPLs as low as 156–161 dB re 1 µPa (Chapman and Hawkins 1969; Pearson *et al.* 1992; Santulli *et al.* 1999; Wardle *et al.* 2001; Hassel *et al.* 2003, 2004). It should be cautioned that the responses to noise in fish occur at various levels for various species. Researchers have warned against extrapolating the results of anthropogenic noise across contexts or with differing species (Popper and Hastings 2009). This means that widely-applied thresholds for behaviour, as seen for marine mammals, are not available for fish.

Effects on Marine Mammals and Sea Turtles

Mysticetes generally avoid active air source arrays, although the radius of avoidance can vary (Richardson *et al.*1995; Gordon *et al.* 2004). Numerous studies (as cited in LGL (2013)) 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, 1996; 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). The avoidance can sometimes reach farther than boat-based observers can see whales, and as a result, behavioural observations from vessels can be biased (LGL 2013). Studies of grey, bowhead, and humpback whales have shown that received levels of pulses in the 160–170 dB re 1 µPa 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 120–130 dB re 1 µPa (Miller *et al.* 1999; Manly *et al.* 2007). At the same time, some mysticetes have been shown to tolerate the exposure of full-air source arrays with only localized avoidance and minor changes in behaviour (LGL 2013). 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 2013).

The overall response of odontocetes to seismic pulsed sound is varied (LGL 2013). Data suggests that some odontocete species such as belugas and harbour porpoises are more responsive to low frequency noise than once thought (LGL 2013). Reactions at larger distances may occur when sound propagation conditions are conducive to transmit the higher-frequency components of the pulsed sound (DeRuiter el 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 (Würsig *et al.* 1998) in general 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. There is increasing evidence that strandings of beaked whales may result from sonar (Barlow and Gisiner 2006; D'Amico *et al.* 2009; Filadelfo *et al.* 2009). As a result of no conclusive evidence to date, it is generally concluded that seismic surveys do not result in mortality to marine mammals.

For some odontocetes such as delphinids, data suggest that a sound level of >170 dB re 1 µPa is required to elicit avoidance behaviour (LGL 2013). Seismic operators and marine mammal observers on seismic vessels regularly observed 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 (Bain and Williams 2006).

Visual monitoring from seismic vessels has shown minimal 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 2013).

Masking could potentially occur during VSP, although the sound emitted during the survey would be of very short duration, with periods of silence between shots, resulting in a limited masking effect. The overall effects of masking can be reviewed in Section 7.1.1.2.

Auditory damage can occur from loud impulses of noise, including those emitted from seismic air source arrays. Auditory damage can occur in the form of TTS or PTS. TTS and PTS and their corresponding onset sound levels are described in Section 7.1.1.2.

Evidence from terrestrial mammals can be used to infer that sound may be a potential source of stress in marine mammals (Wright *et al.* 2007a, 2007b, 2009, 2011). Underwater noise can cause stress (Rolland *et al*. 2012; Wright and Kuczaj 2007; Wysocki *et al.* 2006; Hastings and Popper 2005; Rolland *et al.* 2012; Southall *et al.* 2007) that may:

- cause physiological responses such as lowered immune response and diminished reproductive effort (Southall *et al.* 2007)
- affect communication (Clark *et al.* 2009; Popper and Hawkins 2012; Richardson *et al.* 1995; Risch *et al.* 2012; Southall *et al.* 2007; Williams *et al.* 2013)

- trigger avoidance behaviours that can disrupt migration (Southall *et al.* 2007; van Opzeeland and Slabbekoorn 2012) or foraging patterns (*e.g.*, Slotte *et al.* 2004; Sundermeyer *et al.* 2012; Tougaard *et al.* 2012)

However, the actual reactions of marine mammals are difficult to predict and depend on a multitude of variables including the type, magnitude and duration of noise, the species and its distance from the sound source, and the activity state of the animal at the time (Popper and Hawkins 2012; Richardson *et al.* 1995). There is little known about the potential for seismic survey-emitted noise to cause non-auditory physiological effects in marine mammals (LGL 2013). Such effects are considered unlikely and, if they were to occur, would be limited to short distances surrounding the sound source and where the seismic operations are occurring for prolonged periods of time. There is no specific exposure level above which non-auditory effects are expected to occur (Southall *et al.* 2007).

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 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).

Effects on Marine Birds

Observations made during a seismic program in the Davis Strait area showed no evidence of mortality or behavioural effects on marine birds. 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)

7.1.5 Helicopter Transportation

As discussed in Section 2.4.5, Project activities will require helicopter support for transfer of crew and light supply. Helicopter routes (refer to Figure 2.4.1) take into account avoidance of a military "no fly" zone, which would prohibit flying a straight line to the centre of the Project Area, and also avoid Roseway Basin and Sable Island.

The key potential environmental effects associated with helicopter support involve sensory disturbance from helicopter noise. In a Beaufort Sea study, observers recorded marine mammal reactions to a Bell 212 helicopter flying at elevations ranging from 0 to 460 m (Luksenburg and Parsons 2009). It was observed that 14% of bowhead whales responded to the stimulus. Responses included abrupt dives and breaching, with most responses occurring when the helicopter was at altitudes less than 150 m. Beluga whale responses were also observed in the study. Approximately 38% of the belugas reacted to the presence of the helicopter; responses

included abrupt dives, changes in course, changes in behavioural states, and apparent displacement (Luksenburg and Parsons 2009).

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. The greatest effect from helicopter transportation can occur over large nesting colonies. Aircraft passing over colonies can cause birds to panic, leaving eggs and young-of-the-year unprotected from predators (Stantec 2013b).

7.1.6 OSV Operations

OSVs 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 OSVs will be required to support the Project with two to three round trips per week being made for transport purposes. Although the exact routes for the OSVs have not yet been determined, routes are expected to be consistent with the shipping traffic routes/lanes commonly used by other vessels. Once out in the open sea, the support vessel will select the most direct route for reaching the destination. The OSVs may potentially 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 OSV operations and biological VCs are related to routine emissions, underwater noise, and the risk of collision with marine mammals and sea turtles. Effects of OSV lights and emissions would be similar to those associated with MODU presence (refer to Sections 7.1.1 and 7.1.3).

Routine Emissions

Waste discharges associated with OSVs (*e.g.*, ballast water, deck drainage, sanitary discharges, food waste) will be managed in compliance with MARPOL. Sanitary and food wastes disposed in the marine environment could attract birds (which can be predators or prey), fish and larger marine predators although effects are expected to be low given the transitory nature of the OSVs, low volume of discharges, compliance with applicable regulatory requirements, and rapid dilution. A discussion of the potential environmental effects from discharges and emissions is provided in Section 7.1.3.

Underwater Noise

The estimated SPL associated with OSV traffic is expected to be at a peak frequency of 1–500 Hz, with SPLs in the range of 170–180 dB_{RMS} re 1 µPa @ 1 m (Hurley and Ellis 2004; Richardson *et al.* 1995). Increased vessel presence will increase levels of noise below 500 Hz. As discussed in Section 7.1.1.2, increased ambient noise can mask biologically important sounds. For example,

masking can result in the disruption of breeding in animals that use sound during mating and reproduction, and disruption of foraging in animals that use sound to detect prey (Wright 2008). Increased noise can also mask important acoustic environmental cues that animals use to navigate and to detect predators. The greatest potential for masking exists for marine mammals that produce and perceive sounds within the range of sound frequencies produced by vessels. Baleen whales will be the most susceptible to increased levels of noise from OSV traffic (*i.e.*, below 500 Hz). Recent studies on North Atlantic right whales indicate that these species will adjust their vocalizations in the presence of vessel noise (Wright 2008). Some species can alter their communications to avoid being masked by anthropogenic sounds, although these alterations are not optimal behaviour for these species. It is thought that these alterations are potentially costly for the survival and reproductive success of marine mammals (Wright 2008). TTS is unlikely to occur from OSV operations due to the localized nature of noise emissions and the likelihood of an avoidance response, although if effects were to occur they would be expected to be minimal and, by definition, temporary in nature due to to the short duration of exposure. PTS to marine mammals would not be expected to occur at the SPLs associated with OSV traffic.

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). Although underwater noise is believed to be the primary stimuli, other factors, including visual stimuli, may also influence behaviour.

Vessel Strikes

Historical data have been examined from 1885 to 2002 with regards to vessel strikes on marine mammals (Vanderlaan and Taggart 2007). Vessel strikes have been identified as a leading cause of marine mammal mortality. As a result, an increase in vessel traffic from the Project could potentially increase the risk of mortality of marine mammals due to vessel impacts. The most frequent species affected by vessel strikes are:

- fin whales
- humpback whales
- grey whales
- North Atlantic right whales

The North Atlantic right whale is the species most affected by vessel strikes, with mortalities being twice as frequent as any other whale species (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 can reduce the number of deaths by vessel impact (Vanderlaan and Taggart 2007; Vanderlaan *et al.* 2008, 2009; van der Hoop *et al.* 2012).

Sea turtles have been observed avoiding vessels (Hazel *et al.* 2007). 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 fled to avoid the vessel decreased significantly as vessel speed increased, and turtles that fled from moderate (11 km/hour) and fast approaches (19 km/hour) did so at significantly shorter distances from the vessel than turtles that fled from slow (4 km/hour) approaches. The leatherback turtle is able to swim at speeds up to 35.2 km/hour (19 knots) when frightened, which is faster than most vessels will be travelling at in the Project Area.

7.1.7 Well Abandonment

As discussed in Section 2.4.4, all wells drilled as part of the Project will be abandoned in accordance with CNSOPB regulatory requirements. Abandonment activities will include using cement plugs to isolate certain subsurface zones to prevent the escape of any subsurface fluids from the well. As part of well abandonment, approval may be sought to leave the wellhead in place. Where removal of the wellhead is required, the wellhead and associated equipment (casing) will be removed up to 1 m BSF through mechanical means (cutters). Abandonment of individual exploration wells is anticipated to take approximately 7-10 days per well. Well abandonment will result in short-term underwater noise (see Section 7.1.1.2 for a discussion of effects of underwater noise).

7.2 FISH AND FISH HABITAT

7.2.1 Rationale for VC Selection

Fish and fish habitat was selected as a VC in consideration of the ecological value they provide 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. Additionally, fish and fish habitat have regulatory importance under the federal *Fisheries Act*, which includes provisions intended to protect the productivity of commercial, recreational and Aboriginal (CRA) fisheries. For the purposes of this assessment, fish and fish habitat is assessed with consideration of the following definitions under the *Fisheries Act:*

- "Fish" is defined under section 2 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 under 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.

Although the definition of "fish" under the *Fisheries Act* and considered in this section is inclusive of marine mammals and sea turtles as marine animals, environmental effects on marine mammals and sea turtles are considered separately as part of the Marine Mammals and Sea Turtles VC (Section 7.3). This separate consideration is due to differences in the nature and extent of potential Project interactions with fish and potential Project interactions with marine mammals and sea turtles. Additionally, environmental effects on designated Special Areas, including those

that provide important habitat for fish species and/or the prey upon which fish species depend, are assessed with respect to the Special Areas VC (refer to 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 (refer to Section 7.6) and Current Aboriginal Use of Lands and Resources for Traditional Purposes VC (Section 7.7), respectively.

7.2.2 Regulatory Setting

Recent changes to the *Fisheries Act* focus efforts on protecting the productivity of CRA fisheries. These changes include 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 2013a). 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 2013u). Section 36(3) of the *Fisheries Act* prohibits the deposition of a deleterious substance in waters frequented by fish.

SOCI, including applicable marine fish species, are protected under SARA, which focuses on protecting species whose populations are not secure and their associated habitat. 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 all listed 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.

7.2.3 Consideration of Issues Raised During Consultation and Engagement

Key issues raised during stakeholder and Aboriginal engagement for the Project to date include a general concern about the effects of routine activities and accidental events on fish and fish habitat and the biodiversity of marine life in and around the Project Area. Questions have been raised about potential effects of drill waste disposal and VSP surveys on the marine habitat. Stakeholders also inquired about mitigation for effects on the seabed and potential compensation for any damage to fish habitat that occurs during the drilling program.

Key issues related to fish and fish habitat raised during direct Aboriginal engagement with Shell for the Project to date include a general concern about the effects of routine activities and

accidental events on fish and fish habitat and the biodiversity of marine life in and around the Project Area. Additionally, relevant issues raised during the conduct of the TUS include the ecological significance and biodiversity of the RAA; use of the RAA by commercial or other important fish species during various life stages; the importance of the RAA as migration routes and spawning areas for many species; and the presence or use of the RAA by species that represent the primary food source for commercially or culturally important species. The inter-connectedness of the ecosystem was emphasized. These issues and interactions have been addressed with respect to fish and fish habitat in this VC.

7.2.4 Identification of Environmental Effects and Measurable Parameters

Project activities and components have potential to interact with fish and fish habitat, primarily due to underwater noise emissions from OSV traffic, MODU operation and VSP surveys, as well as from operational discharges and emissions (drill muds and cuttings, waste emissions).

As a result of these considerations, 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
- Change in Habitat Quality and Use

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.

Table 7.2.1 Measurable Parameters for Fish and Fish Habitat

Environmental Effect	Measurable Parameter	Rationale for Selection of Measurable Parameter
Change in Risk of Mortality or Physical Injury	Fish injury or mortality (qualitative likelihood of injury or mortality)	• Provides measure of the potential for serious harm to fish that are part of a CRA fishery or support such a fishery (s. 35 of *Fisheries Act*)
Change in Habitat Quality and Use	Area of habitat permanently affected (m^2)	• Provides a quantitative measure of affected habitat for fish that are part of a CRA fishery or fish that support such a fishery
	Change in chemical composition of sediment and water (unit depends on the contaminant)	• Provides a qualitative measure of potential changes to habitat quality, the potential for the deposit of a deleterious substance under section 36 of *Fisheries Act*, or the potential for serious harm to fish that are part of a CRA fishery or support such a fishery under section 35 of the *Fisheries Act*.
	Timing (seasonal), duration (days), sound level (dB) and extent (km from sound source) of underwater noise affecting marine fish	• Provides for consideration of potential behavioural or physiological effects on fish species from underwater noise emissions • Time and duration are used to qualitatively assess changes in behaviour caused by underwater noise where thresholds do not exist

7.2.5 Environmental Assessment Boundaries

7.2.5.1 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 may occur as a result of the Project. Future well locations have not currently been identified, but will occur within the Project Area and represent the actual Project footprint. The Project Area is includes portions of EL 2424, 2425, 2426, 2429 and 2430.

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 Fish and Fish Habitat are reasonably expected to occur. Based on predicted propagation of SPLs from VSP 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. VSP noise 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 OSV 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. 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 terminates at the international maritime boundary between Canada and the United States. The eastern extent of the RAA terminates at the eastern edge of Banquereau Bank. A portion of the Scotian Shelf and the Nova Scotia coastline to the Bay of Fundy is also included as part of the RAA boundary.

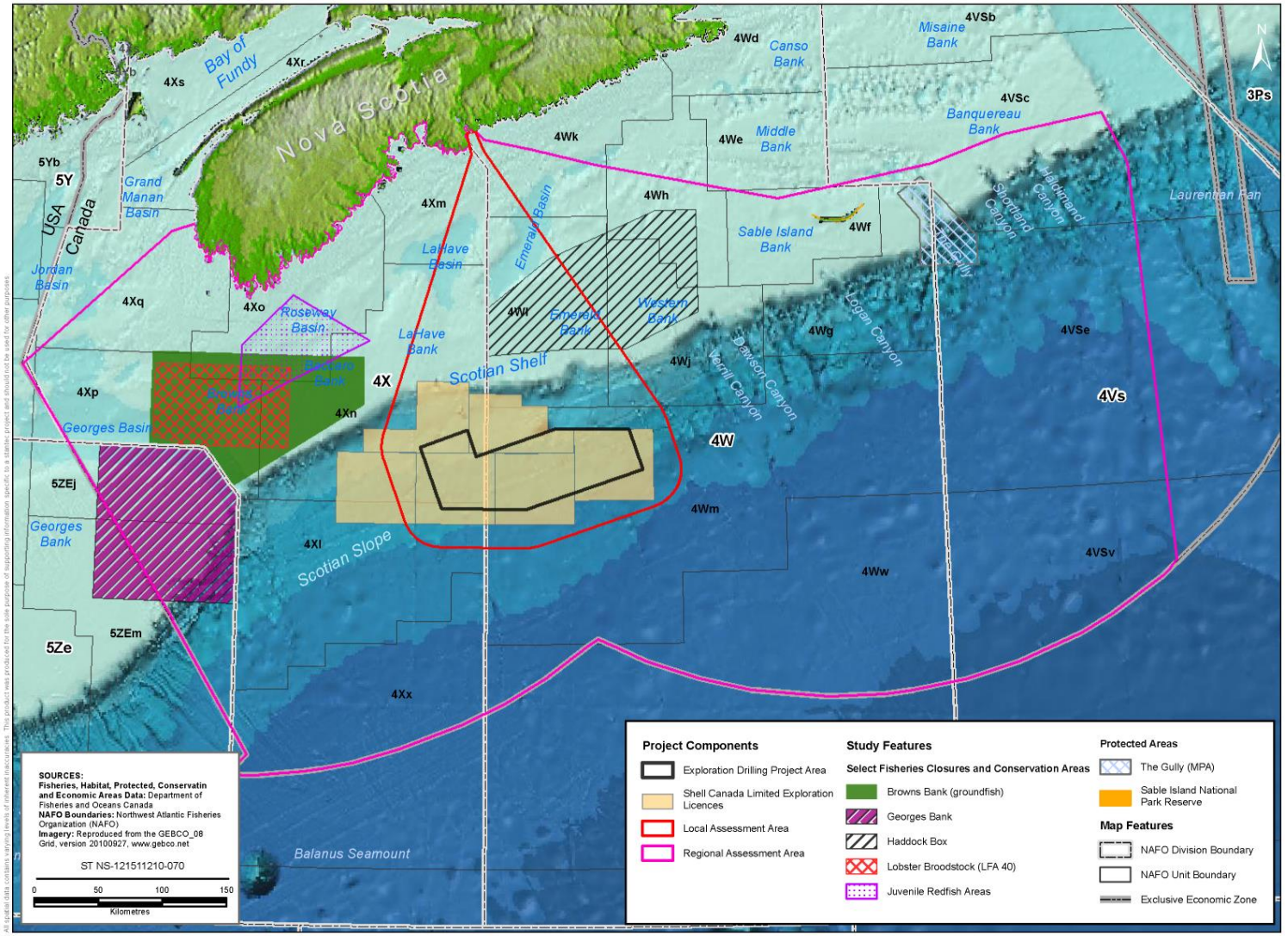


Figure 7.2.1 Assessment Boundaries for Fish and Fish Habitat

7.2.5.2 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 a four year period, with each well taking a maximum of 130 days to drill. It is assumed that Project activities could occur year-round.

Fish can be found year-round in and around the Project Area carrying out various life cycle processes. Refer to Section 5.2.3 for specific details regarding specific marine fish species (*i.e.*, SOCI 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.

7.2.6 Criteria for Characterizing Residual Environmental Effects and Thresholds for Determining Significance

Table 7.2.2 defines descriptors that may be used to characterize residual environmental effects on Fish and Fish Habitat.

Table 7.2.2 Characterization Criteria for Residual Environmental Effects on Fish and Fish Habitat

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Magnitude	Refers to the expected size or severity of the residual effect. When evaluating magnitude of residual effects, consideration is given to the proportion of the VC affected within the spatial boundaries and the relative effect.	**Negligible (N)** – no measurable change in marine species populations, habitat quality or quantity **Low (L)** – a measurable change but within the range of natural variability; will not affect population viability **Moderate (M)** – measurable change outside the range of natural variability but not posing a risk to population viability **High (H)** – measurable change that exceeds the limits of natural variability and may affect long-term population viability
Geographic Extent	Refers to the spatial scale over which the residual effect is expected to occur.	**Project Area (PA)** – effects are restricted to the wellsite and Project Area **LAA** – effects are restricted to the LAA **RAA** – effects are restricted to the RAA

Table 7.2.2 Characterization Criteria for Residual Environmental Effects on Fish and Fish Habitat

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Duration	Refers to the length of time the residual effect persists—which may be longer than the duration of the activity or component that gave rise to the residual effect.	**Short-term (ST)** – effect extends for a portion of the duration of the Project **Medium-term (MT)** – effect extends through the entire duration of the Project **Long-term (LT)** – effects extend beyond the duration of the Project, after well abandonment **Permanent (P)** – measurable parameter unlikely to recover to baseline
Frequency	Refers to how often the residual effect occurs and is usually closely related to the frequency of the activity or component causing the residual effect.	**Once (O)** – effect occurs once **Sporadic (S)** – effect occurs sporadically at irregular intervals **Regular (R)** – effect occurs on a regular basis and at regular intervals throughout the Project **Continuous (C)** – effect occurs continuously
Reversibility	Pertains to whether or not the residual effect on the VC can be reversed once the activity or component causing the disturbance ceases.	**Reversible (R)** – will recover to baseline conditions before or after Project completion (well abandonment) **Irreversible (I)** – permanent
Context	Refers to the influence of past and present human activities on the area in which the residual effect occurs.	**High Disturbance (H)** – effect occurs within a disturbed area that is substantially affected by past or present human activities **Moderate Disturbance (M)** – effect occurs within a moderately disturbed area that is affected by past or present human activities **Low Disturbance (L)** – effect occurs within a relatively pristine area that is unaffected or not adversely affected by past or present human activities

In consideration of the descriptors listed above, 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 LAA, 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 counterbalanced through offsetting measures in accordance with DFO's Fisheries Protection Policy Statement (DFO 2013u)

7.2.7 Existing Conditions

Marine benthic, demersal, and pelagic fish species and habitat are present in and around the Project Area. Section 5.2.3 provides life history details, including information about seasonal occurrence and sensitive periods, for certain marine fish species (*i.e.*, SOCI and species of importance to CRA fisheries) that are likely to occur in the RAA and could potentially interact with the Project.

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 Ophuroid, burrowing anemone and sea urchin as typical benthic fauna likely to be encountered. A seabed survey to be conducted in Q2 2014, as well as the pre-drilling ROV survey at the wellsite will confirm the absence of coral concentrations or other sensitive or unique benthic habitat at the proposed drilling locations.

According to the results of the Scotian Shelf Ichthyoplankton Program conducted from 1976–1982 (refer to Section 5.2.1), eggs/larvae of the following fish species occur along the Scotian Slope, off Browns, Baccaro, and LaHave Banks (*i.e.*, in proximity to the Project Area and/or within the LAA): monkfish, haddock, red hake and redfish (Horsman and Shackell 2009). However, most larval fish species were found to occur along the banks of the Scotian Shelf from Emerald Bank to Sable Island, with some occurring even further east (towards the Laurentian Channel), and others found in nearshore waters.

Subsequent studies have indicated that the eggs/larvae of the majority of fish species that may occur in the vicinity of the Project Area tend to be found on the banks of the Scotian Shelf and/or in nearshore waters, rather than on the Slope (refer to Table 5.2.3 in Section 5.2.1). The following fish species are identified in Table 5.2.3 as potentially having eggs/larvae located on the Scotian Slope and in the vicinity of the Project Area and LAA: Acadian redfish, deepwater redfish, roundnose grenadier, silver hake, and witch flounder. The eggs/larvae of these species are present on the Scotian Shelf and Slope during June-October (silver hake), April-August (Acadian redfish and deepwater redfish), May-December (witch flounder), and in some cases, year-round (roundnose grenadier).

Table 7.2.3 lists the fish SOCI that can be found in the RAA, and their respective statuses under SARA and COSEWIC.

Table 7.2.3 Fish Species of Conservation Interest Found in the RAA

Common Name	Scientific Name	Status	
		SARA	COSEWIC
Groundfish Species			
Acadian redfish (Atlantic population)	*Sebastes fasciatus*	Not Listed	Threatened
American plaice (Maritime population)	*Hippoglossus platessoides*	Not Listed	Threatened
Atlantic cod (Laurentian South population)	*Gadus morhua*	Not Listed	Endangered
Atlantic cod (Southern population)		Not Listed	Endangered
Atlantic (striped) wolffish	*Anarhichas lupus*	Special Concern	Special Concern
Cusk	*Brosme brosme*	Not Listed	Endangered
Deepwater redfish (Northern population)	*Sebastes mentalla*	Not Listed	Threatened
Northern wolffish	*Anarhichas denticulatus*	Threatened	Threatened
Roughhead grenadier	*Macrourus berglax*	Not Listed	Special Concern
Roundnose grenadier	*Coryphaenoides rupestris*	Not Listed	Endangered
Smooth skate (Laurentian-Scotian population)	*Malacoraja senta*	Not Listed	Special Concern
Spiny dogfish (Atlantic population)	*Squalus acanthias*	Not Listed	Special Concern
Spotted wolffish	*Anarhichas minor*	Threatened	Threatened
Thorny skate	*Amblyraja radiate*	Not Listed	Special Concern
Pelagic Species			
American eel	*Anguilla rostrata*	Not Listed	Threatened
Atlantic bluefin tuna	*Thunnus thynnus*	Not Listed	Endangered
Atlantic salmon (Inner Bay of Fundy population)	*Salmo salar*	Endangered	Endangered
Atlantic salmon (Outer Bay of Fundy population)		Not Listed	
Atlantic salmon (Eastern Cape Breton population)			
Atlantic salmon (Nova Scotia Southern Upland population)			
Atlantic sturgeon (Maritimes Populations)	*Ancipenser oxyrinchus*	Not Listed	Threatened
Basking shark (Atlantic population)	*Cetorhinus maximus*	Not Listed	Special Concern
Blue shark (Atlantic population)	*Priomace glauca*	Not Listed	Special Concern
Porbeagle shark	*Lamna nasus*	Not Listed	Endangered

Table 7.2.3 Fish Species of Conservation Interest Found in the RAA

Common Name	Scientific Name	Status	
		SARA	COSEWIC
Shortfin mako	*Isurus oxyrinchus*	Not Listed	Threatened
Striped bass (Southern Gulf of St. Lawrence population)	*Morone saxatilis*	Not Listed	Special Concern
Striped bass (Bay of Fundy population)		Not Listed	Endangered
White shark	*Carcharodon Carcharias*	Endangered	Endangered

Table 7.2.4 lists the commercially important fish species of CRA value that are most likely to occur in the RAA.

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

Common Name	Scientific Name
Groundfish Species	
Acadian redfish	*Sebastes fasciatus*
American plaice	*Hippoglossoides platessoides*
Atlantic cod	*Gadus morhua*
Atlantic halibut	*Hippoglossus hippoglossus*
Cusk	*Brosme brosme*
Deepwater redfish	*Sebastes mentalla*
Haddock	*Melanogrammus aeglefinus*
Hagfish	*Myxine glutinosa*
Monkfish	*Lophius americanus*
Pollock	*Pollachius virens*
Red hake	*Urophycis chuss*
Sandlance	*Ammodytes dubius*
Silver hake	*Merluccius bilinearis*
Turbot – Greenland flounder	*Reinhardtius hippoglossoides*
White hake	*Urophycis tenuis*
Witch flounder	*Glyptocephalus cynoglossus*
Yellowtail founder	*Limanda ferruginea*
Pelagic Species	
Albacore tuna	*Thunnys alalunga*
Atlantic herring	*Clupea harengus*
Atlantic mackerel	*Scomber scombrus*

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

Common Name	Scientific Name
Bigeye tuna	*Thunnus obesis*
Black dogfish	*Centroscyllium fabricii*
Bluefin tuna	*Thunnus thynnus*
Blue shark	*Prionace glauce*
Capelin	*Mallotus villosus*
Porbeagle shark	*Lamna nasus*
Shortfin mako shark	*Leurus oxyringus*
Swordfish	*Xiphias gladuis*
White marlin	*Tetrapturus albidus*
Yellowfin tuna	*Thunnus albacores*
Invertebrates	
American lobster	*Homarus americanus*
Jonah crab	*Cancer borealis*
Atlantic sea scallop	*Placopecten magellanicus*
Iceland sea scallop	*Chlamys islandica*
Northern shrimp	*Panadalus borealis*
Sea cucumber	*Class holothuroidea*
Shortfin Squid	*Illex illecebrosus*
Snow Crab	*Chionoecetes opilio*
Striped shrimp	*Panadalus montagui*
Stimpson's surf clam	*Mactromeris polynyma*

In addition to many of the species listed in Table 7.2.4, other species of interest in the RAA identified during Aboriginal engagement and/or the development of the TUS include American eel, Atlantic salmon, gaspereau, sea urchin, and marine worms. The American eel, Atlantic salmon and gaspereau are more commonly found in coastal waters but may migrate through other portions of the RAA. Sea urchin, a benthic prey species and also harvested commercially, is likely present throughout the RAA including the RAA. Marine worms, another benthic prey species that is commercially harvested by the Mi'kmaq of Nova Scotia, is found in the coastal waters of the RAA.

7.2.8 Potential Project-VC Interactions

Table 7.2.5 lists the Project activities and components and provides a rating of 0, 1, or 2 (as defined in the table) based on the extent to which each Project activity or component will interact with Fish and Fish Habitat and the level of potential effect.

Table 7.2.5 Environmental Effects of Interactions between the Project and Fish and Fish Habitat

Project Activities and Components	Potential Environmental Effects	
	Change in Risk of Mortality or Physical Injury	Change in Habitat Quality and Use
Presence and Operation of MODU (including lights, safety zone and underwater noise)	1	1
Discharge of Drill Muds and Cuttings	1	1
Other Discharges and Emissions (including drilling and testing emissions)	0	1
Vertical Seismic Profiling	1	1
Helicopter Transportation	0	0
OSV Operations (including transit and transfer activities)	0	1
Well Abandonment	0	1

RATING DEFINITIONS

0 No interaction or associated environmental effects are anticipated. Further assessment is considered unnecessary.

1 Interaction may occur; however, based on past experience and professional judgment the interaction would not result in a significant environmental effect even without mitigation; or the interaction would not be significant due to the application of standard operating procedures guidelines or other codified practices that are known to effectively mitigate the predicted environmental effect. No further assessment is warranted. However, further explanation and justification of the rating is provided below.

2 Interaction may result in an effect of concern. Further assessment is warranted.

Interactions Rated as 0

Other Discharges and Emissions

Routine discharges (other than the discharge of drill muds and cuttings) are rated as 0 for a Change in Risk of Mortality or Physical Injury as these discharges will be in accordance with the OWTG. As a result, although these regulated discharges will result in a localized reduction in water or sediment quality, they will not be at levels that would cause mortality to fish species. Potential effects on habitat quality for fish species are rated as 1 and discussed below.

Helicopter Transportation

Helicopter transportation is rated as a 0 for both Change in Risk of Mortality or Physical Injury and Change in Habitat Quality and Use due to a lack of interaction with the marine environment and associated fish and fish habitat.

OSV Operations

The operation of the OSVs (including transit and transfer activities) is rated as 0 for a Change in Risk of Mortality or Physical Injury because the underwater noise levels associated with OSV traffic is not expected to be at levels that would cause injury or mortality to marine fish species. Furthermore, fish are anticipated to temporarily avoid the immediate areas subject to OSV traffic, thereby reducing the risk of fish mortality due to vessel strikes or contact with propeller blades. Potential effects on habitat quality for fish species are rated as 1 and discussed below.

Well Abandonment

Abandonment of individual exploration wells is anticipated to take approximately 7-10 days per well. Removal of the wellhead (if not left in place) during well abandonment is expected to occur via mechanical separation and will have no interaction with fish and fish habitat outside of the wellsite.The mechanical separation of the wellhead will take place at the wellsite and will not produce noise or discharge 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 such that there would be a Change in Risk of Mortality or Physical Injury. Potential effects on Habitat Quality and Use for fish species are rated as 1 and discussed below.

Interactions Rated as 1

Presence and Operation of MODU

The presence and operation of the MODU during drilling, testing and abandonment activities could potentially result in a Change in Risk of Mortality or Physical Injury and a Change in Habitat Quality and Use for marine fish. Drilling operations and station-keeping (*i.e.*, use of dynamic positioning thrusters) during MODU operations will generate localized underwater noise, affecting the quality of the underwater acoustic environment for marine fish species in the Project Area. An accepted SPL threshold for potential auditory injury to fish that weigh 2 grams or more is 206 $dB_{0\text{-}p}$ re 1 µPa (Fisheries Hydroacoustic Working Group 2008; refer to Section 7.1). SPLs generated by the MODU (semi-submersible or drill ship) are anticipated to be in the range of 130–190 dB_{RMS} re 1 µPa @ 1 m. Given that the RMS value for a given SPL is typically approximately 10 dB lower than the peak value (Appendix D in LGL 2013), it is assumed that the peak SPLs emitted from the MODU will be approximately 140–200 $dB_{0\text{-}p}$ re 1 µPa @ 1 m; this is near the 206 $dB_{0\text{-}p}$ re 1 µPa threshold and therefore may have potential to cause physical injury or mortality at close range to fish that weigh less than 2 grams. Although physical effects on small fish may occur within in the vicinity of this magnitude sound source, motile fish will likely be startled and avoid the area temporarily(Stantec 2013a). Given that the majority of motile fish species are generally expected to avoid underwater noise at lower levels than those at which injury or mortality would occur, the SPLs received by these fish are unlikely to result in physical harm.

Noise from the MODU is expected to affect a localized area within the Project Area. However, any changes to habitat quality and use would be temporary, lasting only for the duration of

MODU operations. No permanent or lasting effects to change in habitat quality and use would occur. Displacement of fish from this localized area would therefore also be localized and temporary in nature. Further, the area of habitat affected by the presence and operation of the MODU will be limited relative to the amount of similar fish habitat available in the surrounding RAA.

Due to the temporary and localized avoidance of the area within the Project Area where harmful sound levels may occur, residual environmental effects on fish and fish habitat from the presence and operation of the MODU are predicted to be not significant.

OSV Operations

The operation of OSVs could potentially result in a Change in Habitat Quality and Use for marine fish. This activity will increase vessel traffic within the Project Area and LAA and may therefore locally affect fish habitat quality and use around the OSV due to increased vessel noise. At an estimated SPL of 170–180 dB_{RMS} re 1 µPa @ 1 m (Hurley and Ellis 2004), underwater noise associated with OSV traffic will adversely affect the quality of the acoustic environment. As discussed in Section 7.1, 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 noise is one of displacement or avoidance of the area in which a disturbing or harmful noise is occurring.

Any Change in Habitat Quality and Use attributable to OSV traffic and operations would be short-term in duration, localized around the OSV, and temporary in nature, occurring only for the duration of OSV operations. No permanent or lasting effects to habitat quality and use are predicted to occur. Any change to habitat quality would represent a small incremental increase over similar effects currently associated with existing high levels of marine traffic and shipping activity throughout the RAA. Additionally, the area of habitat to be affected by OSV traffic will be limited in comparison with the amount of similar fish habitat available in the surrounding RAA. As a result, no significant residual environmental effects are predicted on fish and fish habitat as a result of increased OSV traffic.

Discharge of Drill Muds and Cuttings

The discharge of drill muds and cuttings could potentially result in a Change in Risk of Mortality or Physical Injury and a Change in Habitat Quality and Use for marine fish. 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. Discharges of mud and cuttings will be managed in accordance with the OWTG, which allows discharge of untreated WBM cuttings and SBM cuttings treated to achieve 6.9% or less retained synthetic oil on cuttings. Additionally, in advance of drilling, seabed surveys at the proposed wellsites will be conducted to characterize the seabed and confirm the absence of benthos or unique benthic habitat in proximity to the chosen drilling locations.

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). The modelling predicts that the majority of modelled drill cuttings deposition will be confined to an area within 100 m of the wellhead. Considering both spring and fall discharge scenarios, thicknesses at or above 1 mm will extend up to 681 m from the discharge site and occupy a maximum areal extent of 71.18 ha per well; thicknesses greater than 10 mm will extend up to 155 m, with a maximum footprint of 1.89 ha per well; and thicknesses at or above 100 mm will be confined to a distance of 30 m from the wellhead, with a maximum footprint of 0.26 ha per well.

As discussed in Section 7.1.2, 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). 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).

Based on the proposed drilling program for this Project, and assuming an estimate of benthic disturbance (at 1 mm thickness) of 71.18 ha per well, this would result in a total of 498 ha of detectable benthic disturbance (assuming seven wells). Considering the area of disturbance within which benthic communities could potentially be smothered (10 mm thickness), the total affected area decreases to 13 ha. Habitat altered by the deposition of drill muds and cuttings will become available for use as fish habitat immediately following the completion of drilling operations, and is expected to be recolonized by benthic communities within approximately one to five years (refer to Section 7.1.2). As a result, this effect on the benthos would low in magnitude, restricted to the Project Area, and while it could persist beyond the drilling program, would be reversible.

Constituents in drilling fluids will be screened using the OCSG (NEB *et al.* 2009) to assess the viability of using lower toxicity chemicals. Discharges of mud and cuttings will be managed in accordance with the OWTG, which allows discharge of untreated WBM cuttings and SBM cuttings treated to achieve 6.9% or less synthetic oil on cuttings. Additionally, in advance of drilling, seabed surveys at the proposed wellsites will be conducted to characterize the seabed and confirm the absence of unique benthic habitat at and in proximity to the chosen drilling locations. As a result, no significant residual environmental effects are predicted on fish and fish habitat due to discharge of drill muds and cuttings.

Other Discharges and Emissions

The routine discharge of waste and emissions could potentially result in a Change in Habitat Quality and Use for marine fish. 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 be protective of 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 that they are not associated with the formation of a slick, as they will comply with OWTG and Annex I of the *International Convention for the Prevention of Pollution from Ships* (MARPOL). As a result, no significant environmental effects on fish and fish habitat are predicted from routine discharges and emissions.

Vertical Seismic Profiling

Vertical seismic profiling could potentially result in a Change in Risk of Mortality or Physical Injury and a Change in Habitat Quality and Use for marine fish. This activity is expected to generate the largest SPLs associated with Project activities. The energy level from a single VSP shot is expected to have a frequency of 5–300 Hz and a SPL of 220–245 dB re 1 µPa @ 1 m (*i.e.*, at source) (Lee *et al.* 2011). Exposure to received SPLs above 206 dB $_{0\text{-}p}$ re 1 µPa have a high potential for injury to fish species (Fisheries Hydroacoustic Working Group 2008).

According to the results of acoustic modelling conducted for the Shelburne 3D Seismic EA (Matthews 2013 in Appendix A of LGL 2013), horizontal distances for SPLs of ≤ 200 dB_{RMS} re 1 µPa could extend up to 78 m from the wellsite during VSP surveys. Given that the RMS value for a given SPL is typically approximately 10 dB lower than the peak value (Appendix D of LGL 2013), it is assumed that horizontal distances for SPLs ≤ 210 $dB_{0\text{-}p}$ re 1 µPa @ 1 m would similarly extend up to 78 m from the wellsite during VSP surveys. Therefore, based on a conservative approach of applying modelling results for 3D seismic to estimate effects from VSP, injury or mortality to fish (caused by exposure to SPLs ≥ 206 $dB_{0\text{-}p}$ re 1 µPa) has potential to occur up to approximately 78 m from the VSP sound source.

Although 206 $dB_{0\text{-}p}$ re 1 µPa is an accepted SPL threshold for potential auditory injury to fish (refer to Section 7.1), as noted above with respect to underwater noise from the MODU, received SPLs are unlikely to result in physical effects to the majority of motile fish species due to the expectation that they would respond behaviourally (*i.e.*, move) to avoid underwater noise at lower levels than those at which injury or mortality would occur. A ramp-up period will be initiated to further deter motile fish from the area, thereby reducing their risk of being exposed to harmful levels of sound.

Noise from a seismic source array such as that used in VSP may cause mortality of fish eggs/larvae within a few metres of the seismic source. However, the diversity and abundance of fish eggs/larvae in the Project Area and surrounding LAA is generally expected to be low. As a result, the likelihood of marine fish species' eggs/larvae being within a few metres of the sound source while VSP is occurring is low. Furthermore, eggs/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/larvae extends well beyond the LAA to include most or all of the RAA. It is therefore

assumed that the amount of eggs/larvae with potential to be adversely affected by Project activities and components will be negligible relative to the total amount present in the RAA and any mortality attributed to the seismic survey would be within the natural range of mortality of fish eggs and larvae.

The Project Area, within which the wellsites will be located, is not known to presently contain any identified unique or important habitat for marine fish species, including SOCI. Furthermore, a A ramp-up period will be initiated to further deter motile fish from the area, thereby reducing their risk of being exposed to harmful levels of sound. Effects from VSP noise on fish are expected to be limited and localized within the LAA, short-term in duration (approximately one day per well), and reversible. Any potential effects to habitat quality and use are also expected to be temporary and localized, and no permanent or lasting effects would occur. As a result, no significant residual environmental effects on fish and fish habitat are predicted as a result of VSP.

Well Abandonment

Well abandonment could potentially result in a Change in Habitat Quality and Use for marine fish. However, due to the localized disturbance, it is expected that fish would avoid the immediate area where the mechanical separation activities are taking place. No blasting will be utilized in association with abandonment activities. 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. As a result of the temporary and localized nature of these activities, no significant residual environmental effects on fish and fish habitat are predicted from well abandonment.

7.2.9 Summary of Residual Project-Related Environmental Effects

In consideration of the extent of the interactions and the planned implementation of known and proven mitigation as well as adherence to applicable guidelines, residual environmental effects on Fish and Fish Habitat are predicted to be not significant. Project activities and components are not expected to result in serious harm to fish that are part of a CRA fishery, or permanent alteration or destruction of habitat for fish that are part of a CRA fishery or fish that support such a fishery.

7.3 MARINE MAMMALS AND SEA TURTLES

7.3.1 Rationale for VC Selection

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 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 turtle SOCI listed under SARA or considered at risk by COSEWIC. The marine mammals component includes consideration of baleen whales (*mysticetes*), toothed whales (*odontocetes*), and seals (*pinnipeds*). 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 SOCI, including applicable species of marine mammals and sea turtles.

7.3.2 Regulatory Setting

Marine mammals and sea turtles are "marine animals" and are 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 fishery. Marine mammals and sea turtles are "marine animals" and is therefore included within the definition of "fish" under the *Fisheries Act*. It also prohibits the deposit of a deleterious substance in water frequented by fish.

SARA focuses on protecting species whose populations are not secure and their associated habitat. 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. 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 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 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.

7.3.3 Consideration of Issues Raised During Consultation and Engagement

During consultation and engagement, questions were raised about how Shell has incorporated marine mammal migration routes into Project planning and effects assessment of accidental events on the marine environment in and around the Project Area. General questions raised about effects of the drilling program, including effects of drilling, heat, light and noise emissions on the marine environment have also been considered as relevant to this VC.

7.3.4 Identification of Environmental Effects and Measurable Parameters

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 noise emissions produced by operation of the MODU, OSV and helicopter transportation, as well during VSP surveys. Additionally, OSV traffic presents a potential risk of collision which could potentially result 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 noise or operation discharges.

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
- Change in Habitat Quality and Use

The measurable parameters used for the assessment of these environmental effects and the rationale for their selection are provided in Table 7.3.1.

Table 7.3.1 Measurable Parameters for Marine Mammals and Sea Turtles

Environmental Effect	Measurable Parameter	Rationale for Selection of Measurable Parameter
Change in Risk of Mortality or Physical Injury	Species injury or mortality (qualitative likelihood of species injury or mortality)	• Provides a measure of potential for physiological effects on marine mammals or sea turtles • Loss of an individual protected under SARA is prohibited
Change in Habitat Quality and Use	Change in chemical composition of water (unit depends on the contaminant)	• Provides a quantitative measure of changes to habitat quality and indicates compliance with, or contravention of, the OWTG and section 36 of the *Fisheries Act*
	Timing (seasonal), duration (days), sound level (dB) and extent (km from sound source) of underwater noise affecting marine mammals and sea turtles	• Provides for consideration of potential behavioural effects on fish species from underwater noise emissions • Time and duration are used to qualitatively assess changes in behaviour caused by underwater noise where thresholds do not exist

7.3.5 Environmental Assessment Boundaries

7.3.5.1 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 as such represents the area within which direct physical disturbance may occur as a result of the Project. Future well locations have not currently been identified, but will occur within the Project Area and represent the actual Project footprint. The Project Area is includes portions of EL 2424, 2425, 2426, 2429 and 2430.

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. Based on predicted propagation of SPLs from VSP and minimum thresholds for behavioural effects on cetaceans, a buffer of 30 km around the Project Area boundaries has been established to represent the LAA. VSP noise 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 OSV 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. 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 terminates at the international maritime boundary between Canada and the United States. The eastern extent of the RAA terminates at the eastern edge of Banquereau Bank. A portion of the Scotian Shelf and the Nova Scotia coastline to the Bay of Fundy is also included as part of the RAA boundary.

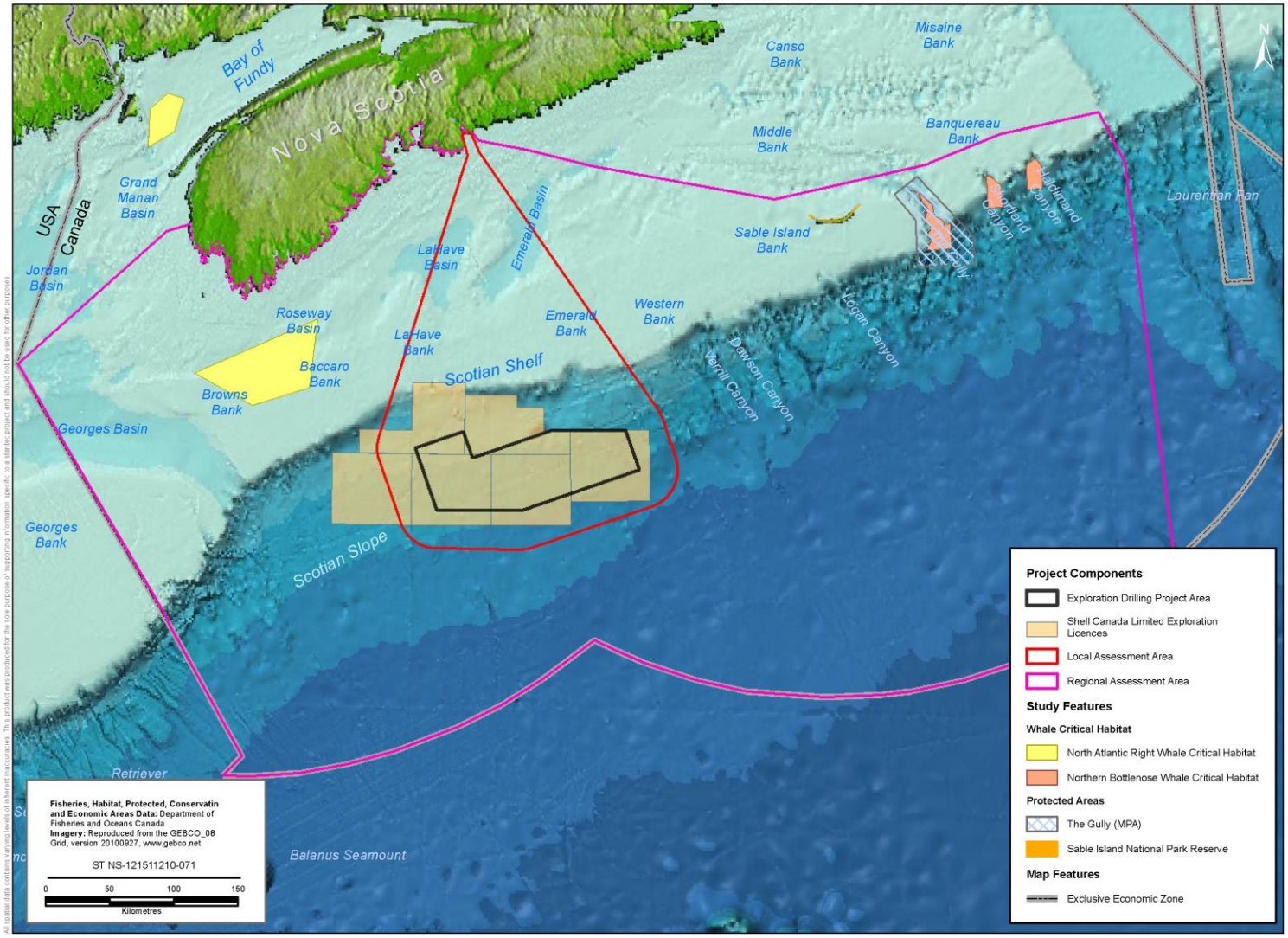


Figure 7.3.1 Assessment Boundaries for Marine Mammals and Sea Turtles

7.3.5.2 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 a four year period, with Project activities at each well taking a maximum of 130 days to drill. 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 mammals and sea turtle species known to occur in the RAA, including their sensitive life stages, and their relation to the Project Area.

7.3.6 Criteria for Characterizing Residual Environmental Effects and Thresholds for Determining Significance

Table 7.3.2 defines various descriptors that may be used to characterize residual environmental effects on Marine Mammals and Sea Turtles.

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

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Magnitude	Refers to the expected size or severity of the residual effect. When evaluating magnitude of residual effects, consideration is given to the proportion of the VC affected within the spatial boundaries and the relative effect.	**Negligible (N)** – no measurable change in marine species populations, habitat quality or quantity **Low (L)** – a measurable change but within the range of natural variability ; will not affect population viability **Moderate (M)** – measurable change outside the range of natural variability but not posing a risk to population viability **High (H)** – measurable change that exceeds the limits of natural variability and may affect long-term population viability
Geographic Extent	Refers to the spatial scale over which the residual effect is expected to occur.	**Project Area (PA)** – effects are restricted to the wellsite or Project Area **LAA** – effects are restricted to the LAA **RAA** – effects are restricted to the RAA

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

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Duration	Refers to the length of time the residual effect persists—which may be longer than the duration of the activity or component that gave rise to the residual effect.	**Short-term (ST)** – effect extends for a portion of the duration of Project activities **Medium-term (MT)** – effect extends through the entire duration of Project activities **Long-term (LT)** – effects extend beyond the duration of Project activities, after well abandonment **Permanent (P)** – measurable parameter unlikely to recover to baseline
Frequency	Refers to how often the residual effect occurs and is usually closely related to the frequency of the activity or component causing the residual effect.	**Once (O)** – effect occurs once **Sporadic (S)** – effect occurs sporadically at irregular intervals **Regular (R)** – effect occurs on a regular basis and at regular intervals throughout the Project **Continuous (C)** – effect occurs continuously
Reversibility	Pertains to whether or not the residual effect on the VC can be reversed once the activity or component causing the disturbance ceases.	**Reversible (R)** – will recover to baseline conditions before or after Project completion (well abandonment) **Irreversible (I)** – permanent
Context	Refers to the influence of past and present human activities on the area in which the residual effect occurs.	**High Disturbance (H)** – effect occurs within a disturbed area that is substantially affected by past or present human activities **Moderate Disturbance (M)** – effect occurs within a moderately disturbed area that is affected by past or present human activities **Low Disturbance (L)** – effect occurs within a relatively pristine area that is unaffected or not adversely affected by past or present human activities

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 LAA, 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 or

- results in permanent and irreversible loss of critical habitat as defined in a recovery plan or an action strategy

7.3.7 Existing Conditions

A number of marine mammal and sea turtle SOCI are known to occur within the Scotian Slope region and as a result may occur within the Project Area and potentially interact with the Project. Sections 5.2.4 and 5.2.5 describe the marine mammals and sea turtles respectively that are likely to occur in the RAA, including life history details, seasonal occurrence and sensitive periods. There are six species of mysticetes and ten species of odontocetes known to occur on the Western Scotian Slope which could potentially interact with the Project. Marine mammals are present on the Scotian Shelf and Slope year-round, although more species are commonly present between May and September. As noted, cetaceans are sighted more often in areas where there are greater bathymetric changes such as along the shelf edge, in the slopes of basins on the shelf, and in the canyons connecting the deep slope waters up to the shallower waters of the shelf as a result of high levels of primary productivity due to bathymetric variations. There are five species of pinnipeds (seals) that can be found foraging year-round in the waters over the Scotian Shelf and Slope, although only the grey seal and harbour seal are known to breed offshore Nova Scotia (Sable Island). There are four species of sea turtles that can be found migrating and foraging on the Scotian Shelf and Slope, although only the endangered leatherback turtle and the loggerhead turtle are known to regularly forage in Atlantic Canada waters. These species are known to occur in the vicinity of the Project Area primarily between April and December.

Table 7.3.3 lists the marine mammal and sea turtle SOCI which have the potential to occur in the RAA, and their respective statuses under SARA and COSEWIC. This list of SOCI represents approximately half of the total marine mammal and sea turtle species that may occur in the RAA. No seal populations within the RAA are considered SOCI.

Table 7.3.3 Marine Mammal and Sea Turtle Species of Conservation Interest Found in the RAA

Common Name	Scientific Name	Status	
		SARA	COSEWIC
Marine Mammals			
Mysticetes			
Blue whale (Atlantic population)	*Balaenoptera musculus*	Schedule 1, Endangered	Endangered
Fin whale (Atlantic Population)	*Balaenoptera physalus*	Schedule 1, Special Concern	Special Concern
Humpback whale (Western North Atlantic population)	*Megaptera novaeangliae*	Schedule 3, Special Concern	Not at Risk
North Atlantic right whale	*Eubalaena glacialis*	Schedule 1, Endangered	Endangered

Table 7.3.3 Marine Mammal and Sea Turtle Species of Conservation Interest Found in the RAA

Common Name	Scientific Name	Status	
		SARA	COSEWIC
Odontocetes			
Harbour porpoise (Northwest Atlantic population)	*Phocoena phocoena*	Schedule 2, Threatened	Special Concern
Killer whale (Northwest Atlantic/Eastern Arctic population)	*Orcinus orca*	Not Listed	Special Concern
Northern bottlenose whale (Scotian Shelf Population)	*Hyperoodon ampullatus*	Schedule 1, Endangered	Endangered
Sowerby's beaked whale	*Mesoplodon bidens*	Schedule 1, Special Concern	Special Concern
Sea Turtles			
Leatherback sea turtle	*Dermochelys coriacea*	Schedule 1, Endangered	Endangered
Loggerhead sea turtle	*Caretta caretta*	Not Listed	Endangered

No critical habitat for marine mammals or sea turtle species has been designated within the Project Area or LAA presently, but critical habitat for marine mammal SOCI does occur within the RAA. Critical habitat for the North Atlantic right whale has been identified in Roseway Basin (approximately 95 km northwest of the Project Area and 65 km from the LAA) and critical habitat for the northern bottlenose whale has been identified in the Gully, and Shortland and Haldimand canyons (approximately 260 km northeast of the Project Area and 230 km from the LAA) (refer to Figure 7.3.1). Although critical habitat has not yet been designated for the leatherback sea turtle within any of the spatial bounds of the Project, they and other sea turtles are known to migrate through and forage along the Scotian Slope. Critical habitat for the leatherback sea turtle is expected to be designated in 2014 and will likely encompass a large area within the RAA. This critical habitat would be designated in association with migration as well as foraging. No critical breeding or nesting habitat for sea turtle exists or is expected to be designated within the RAA.

7.3.8 Potential Project-VC Interactions

Table 7.3.4 lists the Project activities and components and provides a rating of 0, 1, or 2 (as defined in the table) based on the extent to which a Project activity or component will interact with Marine Mammals and Sea Turtles and the level of potential effect.

Table 7.3.4 Environmental Effects of Interactions between the Project and Marine Mammals and Sea Turtles

Project Activities and Components	Potential Environmental Effects	
	Change in Risk of Mortality or Physical Injury	Change in Habitat Quality and Use
Presence and Operation of MODU (including lights, safety zone and underwater noise)	1	2
Discharge of Drill Muds and Cuttings	0	1
Other Discharges and Emissions (including drilling and testing emissions)	0	1
Vertical Seismic Profiling	2	2
Helicopter Transportation	0	1
OSV Operations (including transit and transfer activities)	2	1
Well Abandonment	0	1

RATING DEFINITIONS

0 No interaction or associated environmental effects are anticipated. Further assessment is considered unnecessary.

1 Interaction may occur; however, based on past experience and professional judgment, the interaction would not result in a significant environmental effect even without mitigation; or the interaction wold not be significant due to the application of standard operating procedures that are known to effectively mitigate the predicted environmental effect, guidelines or codified practices. No further assessment is warranted. However, further explanation and justification of the rating is provided below.

2 Interaction may result in an effect of concern. Further assessment is warranted and provided in Section 7.3.9.

Interactions Rated as 0

Discharge of Drill Muds and Cuttings and Other Discharges and Emissions

Discharge of drill muds and cuttings as well as other routine discharges are rated as 0 with respect to risk of mortality or injury as these discharges will be in accordance with the OWTG. Waste discharges that do not meet OWTG requirements will not be discharged to the ocean, but brought to shore for disposal. These 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 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 below (Interactions Rated as 1) in the context of Change in Habitat Quality and Use.

Helicopter Transportation

Helicopter transportation is also rated as a 0 with respect to a Change in Risk of Mortality or Physical Injury due to a lack of interaction with the marine environment and since the sound levels associated with helicopter transportation will not reach thresholds known to cause injury or

mortality to marine mammals and sea turtles (refer to Section 7.1). However, noise emissions from helicopter transportation have the potential to affect habitat quality and use for marine mammals and sea turtles and are discussed in relation to a Change in Habitat Quality and Use under Interactions Rated as 1.

Well Abandonment

Well abandonment is rated as a 0 with respect to a Change in Risk of Mortality or Physical Injury since wellhead removal, if required, will occur through mechanical separation without producing excess sound or discharges. There is therefore no interaction that would result in potential mortality or physical injury to marine mammals or sea turtles. Well abandonment activities that could potentially result in a Change in Habitat Quality and Use are discussed below (Interactions Rated as 1).

Interactions Rated as 1

Presence and Operation of the MODU

As discussed in Section 7.1.1, SPLs generated by a MODU (semi-submersible or drill ship) are estimated to range from 130 to 190 dB re 1 µPa @ 1 m (peak frequency 10–10 000 Hz) (Richardson *et al.* 1995; Hildebrand 2005; OSPAR 2009). Based on published thresholds for auditory injury (*e.g.*, TTS, PTS) for various marine mammals, detailed in Section 7.1.1.2, it is not expected that cetaceans would experience a temporary or permanent auditory threshold shift from drilling noise. Although behavioural responses of marine mammals to noise are highly variable and dependent on several internal and external factors (NRC 2005), some studies have documented avoidance of intense sound sources by marine mammals and temporary displacement, particularly if the marine mammals have been exposed to multiple simultaneous noise sources (Richardson *et al.* 1995; Richardson and Wursig 1995). Therefore, marine mammals may not approach close enough to the MODU to be exposed to sound levels capable of causing auditory injury. Less is known about the physiological and behavioural effects of underwater noise on sea turtles; however, it is assumed that they would be comparable to the effects of underwater noise on cetaceans (LGL 2013), and that sea turtles similarly may not approach close enough to the MODU to be exposed to sound levels capable of causing auditory injury.

Based on these considerations, residual environmental effects of MODU operation and presence on Change in Risk of Mortality or Physical Injury for marine mammals and sea turtles are predicted to be not significant. Additional discussion around underwater noise and behavioural effects on marine mammals and sea turtles is provided in Section 7.3.9 in the context of effects on Change in Habitat Quality and Use.

Discharge of Drill Muds and Cuttings

The discharge of mud and cuttings could potentially result in a Change in Habitat Quality and Use for marine mammals and sea turtles. 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. Additionally, 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, which the results of drill waste sediment dispersion modelling indicate will extend up to 155 m from each well (refer to Appendix C); however, these species do not represent primary prey for marine mammals and sea turtles. Baleen whales feed 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.

Localized increases in TSS in the water column during discharge of SBM drill cuttings from the MODU may temporarily affect water quality in a portion of the LAA; but this effect is predicted to be short-term and reversible and is not predicted to affect marine mammal or sea turtle prey or species migration patterns. Residual environmental effects on marine mammals and sea turtles associated with the discharge of drill muds and cuttings on Habitat Quality and Use are predicted to be not significant with adherence to standard practices and guidelines (*i.e.*, OWTG).

Other Discharges and Emissions

The routine discharge of waste and emissions 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 waste and emissions is regulated for compliance against these requirements and, as a result, these discharges have a low potential for toxicity effects to the marine environment and low risk of affecting any marine species. Discharges are expected to be short-term and localized within the Project Area. They will be 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.

Residual hydrocarbons in discharges are generally not associated with the formation of a slick as they will comply with OWTG and Annex I of the *International Convention for the Prevention of Pollution from Ships* (MARPOL). As a result, routine discharges and emissions are predicted to not adversely affect marine mammals or sea turtles, either directly or indirectly via their prey. Residual environmental effects on marine mammals and sea turtles associated with other discharges and emissions on Habitat Quality and Use are therefore predicted to be not significant.

Helicopter Transportation

Helicopter transportation will not interact with the marine environment and will not substantially interfere with marine mammals or sea turtles. There is potential for helicopter transportation to elicit diving behaviour in marine mammals in response to physical presence or noise, although these behaviours will be temporary in nature. Flights to and from the MODU will be short-term and sporadic in nature. Any effects from the presence of helicopters will be brief both spatially and temporally. Except in the case of an emergency, helicopters will also avoid flying over Sable Island, which is the standard protocol for other oil and gas operators working offshore Nova Scotia. Therefore, helicopter transportation is not predicted to affect seals that could be feeding, breeding or pupping on the Island. As a result, residual environmental effects from helicopter transportation on Habitat Quality and Use are predicted to be not significant.

OSV Operations

Underwater noise associated with OSV 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. An OSV is estimated to have an operating SPL of 170–180 dB_{RMS} re 1 µPa @ 1 m (Hurley and Ellis 2004). These sound levels, while not high enough to cause direct physical harm, could result in changes to swimming, foraging, or vocal behaviours (Richardson *et al.* 1995; Clark *et al.* 2009; Nowacek *et al.* 2007; Sundermeyer *et al.* 2012; Tougaard *et al.* 2012; Parks *et al.* 2012). As indicated in Section 5.1.3.6, the acoustic environment in the LAA is currently dominated by shipping noise. Any incremental environmental effects associated with the Project OSVs are expected to occur at a regular frequency over the duration of the drilling program (medium-term) and be of low magnitude. As a result, residual environmental effects of OSV operations on Change in Habitat Quality and Use are predicted to be not significant. The potential Change in Risk of Mortality or Physical Injury with respect to vessel collisions is discussed in Section 7.3.9.

Well Abandonment

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 and will also have little interaction with marine mammals and sea turtles. The mechanical separation of the wellhead from the seabed will not produce excess sound or discharge (no blasting will occur), but it is likely that marine mammals and sea turtles may temporarily avoid the immediate area around the wellhead during this activity (which may take 7-10 days per well). Residual environmental effects on marine mammals and sea turtles associated with well abandonment on Habitat Quality and Use are predicted to be not significant.

Summary

In consideration of the extent of the interactions and the planned implementation of known and proven mitigation, residual environmental effects on Marine Mammals and Sea Turtles are determined to be not significant for all Project activities and components rated as a 1 in Table 7.3.3. As a result, these residual environmental effects are not considered further in the assessment of Project-related environmental effects, but are considered, as applicable, in the assessment of cumulative environmental effects (Section 10).

7.3.9 Assessment of Project-Related Environmental Effects

The following section assesses the potential environmental effects on Marine Mammals and Sea Turtles resulting from the interactions rated as 2 in Table 7.3.3. These effects include;

- Change in Risk of Mortality or Physical Injury as a result of potential underwater noise effects during VSP
- Change in Risk of Mortality or Physical Injury as a result of the potential for vessel collision with marine mammals or sea turtles during OSV operations
- Change in Habitat Quality and Use as a result of the presence and operation of the MODU (including drilling noise and safety zone) and VSP

7.3.9.1 Environmental Effect Mechanisms

Change in Risk of Mortality or Physical Injury

VSP

The emission of noise from vertical seismic profiling is expected to be the most intense sound generated by the Project. As a result, VSP activities could result in a Change in Risk of Mortality or Physical Injury to marine mammals. Although VSP uses a sound source similar to that used in seismic operations (*i.e.*, a source array), the associated size and volume of the array are much smaller than a traditional surface seismic survey. The energy level from a single VSP shot is expected to be at a frequency of 5–300 Hz with a sound pressure level of 220–245 dB re 1 µPa @ 1 m (Lee *et al.* 2011). VSP surveys are expected to take up to one day at each well.

As previously outlined in Section 7.1.1.2, the onset of temporary and permanent auditory threshold shifts in marine mammals can occur from impulsive sounds such as seismic surveys, at levels as low as 224 $dB_{0\text{-}p}$ and 230 $dB_{0\text{-}p}$, respectively. Although less is known about the physiological effects of underwater noise on sea turtles, it is assumed that they would be comparable to the effects of underwater noise on cetaceans (LGL 2013).

According to the results of acoustic modelling conducted for the Shelburne 3D Seismic EA (Matthews 2013 in Appendix A of LGL 2013), horizontal distances for SPLs of ≤ 200 dB_{RMS} re 1 µPa (approximately 210 $dB_{0\text{-}p}$ re 1 µPa) could extend up to 78 m from the wellsite during VSP surveys.

Therefore, based on a conservative approach of applying modelling results for 3D seismic to estimate effects from VSP, a Change in Risk of Mortality or Physical Injury for marine mammals and sea turtles has potential to occur up to distances of approximately less than 78 m from the VSP sound source. However, marine mammals and sea turtles are generally expected to temporarily avoid localized areas subject to seismic noise (LGL 2013) and are therefore unlikely to approach close enough to the VSP sound source to be exposed to sound levels capable of causing auditory injury.

A number of mitigation measures will be implemented to further reduce the effects to marine mammals and sea turtles during VSP activities (see Section 7.3.9.2 below).

OSV Operations

The presence and operation of OSVs will result in an increase in marine traffic within the LAA. As a result, the Project could result in a Change in Risk of Mortality or Physical Injury due to potential for vessel collision with marine mammals and sea turtles during transiting activities. In general, and as noted in Section 7.1.6, odontocetes and pinnipeds are less likely to be struck by vessels as a result of their small, agile and quick-swimming nature, which allows them to avoid strikes (Laist *et al.* 2001; Jensen and Silber 2003). In contrast, mysticetes (*e.g.*, North Atlantic right whales) are known to be more vulnerable to collisions with vessels (Vanderlaan and Taggart 2007). 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).

There is limited information with respect to the effects of vessel collisions on sea turtles. Although sea turtles have been observed avoiding vessels (refer to Section 7.1.6), existing research indicates that vessel operators cannot rely on turtles to actively avoid being struck by the vessel if speeds exceed 4 km/hour (2 knots) (Hazel *et al.* 2007). However, reduced speeds within the Project Area, where leatherback sea turtles could be foraging, will still be of benefit in reducing the likelihood of vessel strikes.

Change in Habitat Quality and Use

Presence and Operation of the MODU

The sound effects from the presence and operation of the MODU could potentially result in a Change in Habitat Quality and Use with regard to marine mammals and sea turtles. Drilling operations as well as dynamic positioning activity of the drill ship (*i.e.*, use of thrusters) will generate underwater noise, 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 (up to a maximum of 130 days per well). As discussed above, under Interactions Rated as 1, marine mammals and sea turtles may not approach close enough to the MODU to be exposed to sound levels capable of causing auditory injury.

NOAA (2013s) has established an interim behavioural threshold for marine mammals for continuous sounds (*e.g.*, shipping and drilling) at 120 dB_{RMS} re 1 µPa for continuous sounds (shipping and drilling). At received sound levels above this threshold, marine mammals may exhibit behavioural changes including changes in vocalization, foraging, breeding and/or migration routes (refer to Section 7.1.1.2 for additional information on behavioural effects of drilling noise). Mysticetes vocalize in lower frequencies (100 Hz to 30 kHz) and therefore have a greater potential to overlap with noise created from drilling (Clark 1990; Erbe 2002).

VSP

The noise emissions from VSP activities could potentially result in a Change in Habitat Quality and Use with regard to marine mammals and sea turtles. With respect to the impulsive sounds created by VSP surveys, a threshold of 160 dB_{RMS} re 1 µPa is recognized as a general threshold for behavioural response in marine mammals. Based on an extrapolation of acoustic modelling that was conducted as part of Shell's EA for the Shelburne Basin 3D Seismic Survey (Matthews 2013 in Appendix A of LGL 2013), it is assumed that these sound levels (and corresponding behavioural effects) could reach up 26 km from the VSP source.

7.3.9.2 Mitigation of Project-Related Environmental Effects

VSP surveys will adhere to mitigation measures described in the SOCP and outlined in Shell's EA for the Shelburne Basin 3D Seismic Survey (LGL 2013). In March 2014, the Canadian Science Advisory Secretariat (CSAS) held a national peer review process of 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. The CSAS review focused on sound exposure criteria and additional mitigation and monitoring measures which should be considered to avoid or reduce adverse effects on cetacean species at risk. It is expected that results from this review will be available in the fall of 2014. Shell will consult with DFO regarding relevant findings from the CSAS review including additional recommended mitigation that would be appropriate for implementation during VSP prior to Project commencement.

Marine Mammal Observers (MMOs) will be employed to monitor and report on marine mammal and sea turtle sightings during VSP surveys to enable shutdown or delay 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.

Because avoidance behaviour occurs at lower thresholds, 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. Additionally, 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 1 km of the wellsite. This is larger than the minimum distance (500 m) specified in the SOCP in recognition of the potential for SOCI to be foraging or migrating through the LAA and in consideration of species sensitivities to operating

frequencies of the VSP sound source as well as acoustic modelling completed to support the EA for the Shelburne Basin 3D Seismic Survey conducted in 2013 (Matthews 2013 in Appendix A of LGL 2013). Passive acoustic monitoring (PAM) will be used to detect vocalizing marine mammals during conditions of low visibility (*e.g.*, fog and darkness).

To reduce risk of collision, Project OSVs will avoid identified important marine mammal areas, specifically critical habitat for the North Atlantic right whale (Roseway Basin) and northern bottlenose whale (The Gully, and Shortland and Haldimand canyons) and during transiting activities within the LAA and outside the Project Area. As a result of this recognized correlation between vessel speeds and increased collision risk, Project OSVs will restrict maximum speed to 18.5 km/hour (10 knots) within the Project Area. During transit to/from the Project Area, OSVs will travel at vessel speeds not exceeding 22 km/hour (12 knots). 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.

Standard mitigation previously described in Section 7.3.8 will also be implemented to reduce adverse environmental effects on marine mammals and sea turtles from Project activities and components. This mitigation includes the following:

- adherence to the OWTG
- seasonal (June 1 to December 31)avoidance of Roseway Basin
- avoidance of Sable Island by OSV and helicopter

7.3.9.3 Characterization of Residual Project-Related Environmental Effects

The risk of mortality or physical injury to marine mammals and sea turtles as a result of VSP surveys is determined to be low in magnitude, restricted to the LAA, short-term in duration and reversible given the transmission loss of underwater noise from the source, and implementation of mitigation measures. The risk of mortality and injury to marine mammals and sea turtles due to an increase in OSV traffic is predicted to be restricted to the LAA, medium-term in duration, low in magnitude and reversible. The increase in traffic will be minimal compared with local marine traffic in the area. Additionally, any potential for a Change in Risk of Mortality or Physical Injury due to collision will be reduced as a result of the reduced vessel speeds within the Project Area and avoidance of known sensitive areas or aggregations of marine mammals or sea turtles during transit activities within the LAA.

A temporary Change in Habitat Quality and Use (*e.g.*, avoidance of the Project Area by marine mammals and sea turtles) during drilling (up to 130 days per well) and VSP activities (up to one day per well) is predicted to be low in magnitude, localized to the LAA, medium to short-term in nature and reversible. Behavioural effects are not expected to occur outside of the LAA, or extend beyond the end of the drilling or VSP program. Additionally, there is no known unique habitat or feeding areas for marine mammals or sea turtles that occurs exclusively within the Project Area or the LAA. Any temporary avoidance of the LAA by marine mammals or sea turtles is therefore not likely to result in population level effects.

7.3.10 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 Marine Mammals and Sea Turtles 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 limited understanding of the effects of noise on sea turtles, but a good understanding of the general effects of exploration drilling and VSP on marine mammals and the effectiveness of mitigation measures including those discussed in Sections 7.3.8 and 7.3.9.2. Residual environmental effects associated with interactions rated as 1 in Table 7.3.4 were also determined to be not significant.

7.3.11 Follow-up and Monitoring

MMOs will be employed to monitor and report on marine mammal and sea turtle sightings during VSP surveys to enable shutdown or delay 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. Monitoring will involve visual observations as well as use of PAM.

MMO duties will involve watching for and identifying marine mammals and sea turtles; recording their numbers, distances and reactions 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.

PAM will be used to detect marine mammals during periods of low visibility (*e.g.*, fog and darkness) and during the 60-minute ramp-up watch. Following the program, access to PAM data recorded will be provided to DFO such that this data may be used to help inform knowledge of marine mammals in the area.

Shell will also consult with DFO regarding relevant findings from the 2014 CSAS review including additional recommended monitoring that would be appropriate for implementation during VSP.

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

7.3.12 Summary of Residual Project-Related Environmental Effects

Table 7.3.5 summarizes the environmental effects assessment and prediction of residual environmental effects resulting from those interactions between the Project and Marine Mammals and Sea Turtles that were rated as 2 in Table 7.3.4.

Table 7.3.5 Summary of Residual Project-Related Environmental Effects on Marine Mammals and Sea Turtles

Project Activities and Components	Mitigation/Compensation Measures	Nature of Effect	Residual Environmental Effects Characteristics						Significance	Prediction Confidence	Recommended Follow-up and Monitoring
			Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context			
Change in Risk of Mortality or Physical Injury											
Vertical Seismic Profiling	• Adherence to the SOCP and consultation with DFO regarding additional relevant mitigation for SOCI pending CSAS review • Ramp-up of air gun source with temporary shutdown if a marine mammal or sea turtle listed on Schedule 1 of SARA as well as any other baleen whale or sea turtle is detected within 1 km of the airgun source	A	L	LAA	ST	S	R	M	N	M-H	Monitoring for marine mammals and sea turtles during VSP surveys. Monitoring will involve visual observations as well as use of PAM.

Table 7.3.5 Summary of Residual Project-Related Environmental Effects on Marine Mammals and Sea Turtles

Project Activities and Components	Mitigation/Compensation Measures	Residual Environmental Effects Characteristics								Recommended Follow-up and Monitoring
		Nature of Effect	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Significance	Prediction Confidence	
OSV Operations	• Avoidance of Roseway Basin and Sable Island • Reduction of OSV transit speed in the presence of sighted marine mammals and sea turtles • Reduction of OSV speed within the Project Area to 18.5 km/hour (10 knots) and 22 km/hour (12 knots) outside the Project Area	A	L	LAA	MT	R	R	M	N	H	In the event that a vessel collision with a marine mammal or sea turtle occurs, Shell will contact the Marine Animal Response Society (MARS) or the Coast guard to relay the incident information.
Change in Habitat Quality and Use											
Presence and Operation of MODU (including drilling noise and safety zone)	• Adherence to the OWTG for discharges	A	L	LAA	MT	R	R	M	N	M	N/A

Table 7.3.5 Summary of Residual Project-Related Environmental Effects on Marine Mammals and Sea Turtles

Project Activities and Components	Mitigation/Compensation Measures	Residual Environmental Effects Characteristics								Recommended Follow-up and Monitoring
		Nature of Effect	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Significance	Prediction Confidence	
Vertical Seismic Profiling	• Adherence to the SOCP and consultation with DFO regarding additional relevant mitigation for SOCI pending CSAS review • Ramp-up of air gun source with temporary shutdown if a marine mammal or sea turtle listed on Schedule 1 of SARA as well as any other baleen whale or sea turtle is detected within 1 km of the air gun source	A	L	LAA	ST	S	R	M	N	M	Monitoring for marine mammals and sea turtles during VSP surveys. Monitoring will involve visual observations as well as use of PAM.

Table 7.3.5 Summary of Residual Project-Related Environmental Effects on Marine Mammals and Sea Turtles

KEY (refer to Table 7.3.2 for definitions) ***Nature of Effect:*** P Positive A Adverse ***Magnitude:*** L Low M Moderate H High ***Geographic Extent:*** Project Area Includes Project Area and 200 m beyond LAA Within the LAA RAA Within the RAA	***Duration:*** ST Short-term MT Medium-term LT Long-term P Permanent ***Frequency:*** O Occasionally S Occurs sporadically R Occurs on a regular basis and at regular intervals C Continuous ***Reversibility:*** R Reversible I Irreversible	***Context:*** H High disturbance M Moderate disturbance L Low disturbance **High Disturbance (H)** – effect occurs within a disturbed area that is substantially affected by past or present human activity **Moderate Disturbance (M)** – effect occurs within a moderately disturbed area that is affected by past or present human activity **Low Disturbance (L)** – effect occurs within a relatively pristine area ***Significance:*** S Significant N Not Significant ***Prediction Confidence:*** Based on scientific information and statistical analysis, professional judgment and effectiveness of mitigation L Low level of confidence M Moderate level of confidence H High level of confidence

7.4 MARINE BIRDS

7.4.1 Rationale for VC Selection

Marine 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 Marine Birds VC includes pelagic (*i.e.*, offshore) and neritic (*i.e.*, inshore) seabirds, waterfowl, and shorebirds that are protected under the MBCA. This VC considers all marine birds listed under Schedule 1 of SARA, COSEWIC, and/or NS ESA, which are collectively being referred to as SOCI.

This VC is related to the Fish and Fish Habitat VC (Section 7.2) in recognition of prey species on which marine birds may rely. This VC is also related to the Special Areas VC (Section 7.5), as Special Areas are often designated to protect SOCI, including applicable species of marine birds.

7.4.2 Regulatory 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 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 SOCI, including marine 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 Nova Scotia Department of Natural Resources (NSDNR). Although marine species are not generally listed under the Act, there are select shorebird, neritic sea bird or waterfowl species listed under the Act that are considered in the context of Marine Birds for this assessment.

7.4.3 Consideration of Issues Raised During Consultation and Engagement

Based on feedback from consultation and engagement activities conducted to date by Shell for the Project, there have been no issues or concerns specifically raised with respect to Marine Birds. However, general issues and concerns about the effects of Project activities and components on the marine environment have been raised and are addressed as applicable in this VC.

7.4.4 Identification of Environmental Effects and Measurable Parameters

Project activities and components have potential to interact with marine birds and their associated habitat due to attraction to the lights and flares of the MODU, operational discharges and underwater noise emissions.

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

- Change in Risk of Mortality or Physical Injury
- 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.

Table 7.4.1 Measurable Parameters for Marine Birds

Environmental Effect	Measurable Parameter	Rationale for Selection of Measurable Parameter
Change in Risk of Mortality or Physical Injury	Species injury or mortality (qualitative likelihood of species injury or mortality)	• Provides a measure of marine birds affected • Loss of an individual protected under SARA, NS ESA, or MBCA is prohibited
	Increase in predator species (qualitative likelihood of predator species attraction)	• Provides for consideration of potential effects on marine bird species as a result of attraction to the MODU from Project activities

Table 7.4.1 Measurable Parameters for Marine Birds

Environmental Effect	Measurable Parameter	Rationale for Selection of Measurable Parameter
Change in Habitat Quality and Use	Change in area of available feeding habitat (m^2)	• Provides a quantitative measure of changes to habitat quality due to degradation of water quality and/or the quality of prey species
	Timing (seasonal), duration (days), sound level (dB) and extent (km from sound source) of underwater noise affecting marine birds	• Provides for consideration of potential effects on marine bird species from Project noise

7.4.5 Environmental Assessment Boundaries

7.4.5.1 Spatial Boundaries

The spatial boundaries for the environmental effects assessment with respect to Marine 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 may occur as a result of the Project. Future well locations have not currently been identified, but will occur within the Project Area and represent the actual Project footprint. The Project Area is includes portions of EL 2424, 2425, 2426, 2429 and 2430.

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 Fish and Fish Habitat are reasonably expected to occur. Based on predicted propagation of SPLs from VSP, a buffer of 30 km around the Project Area boundaries has been established to represent the LAA. VSP noise 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 OSV 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. 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 terminates at the international maritime boundary between Canada and the United States. The eastern extent of the RAA terminates at the eastern edge of Banquereau Bank. A portion of the Scotian Shelf and the Nova Scotia coastline to the Bay of Fundy is also included as part of the RAA boundary.

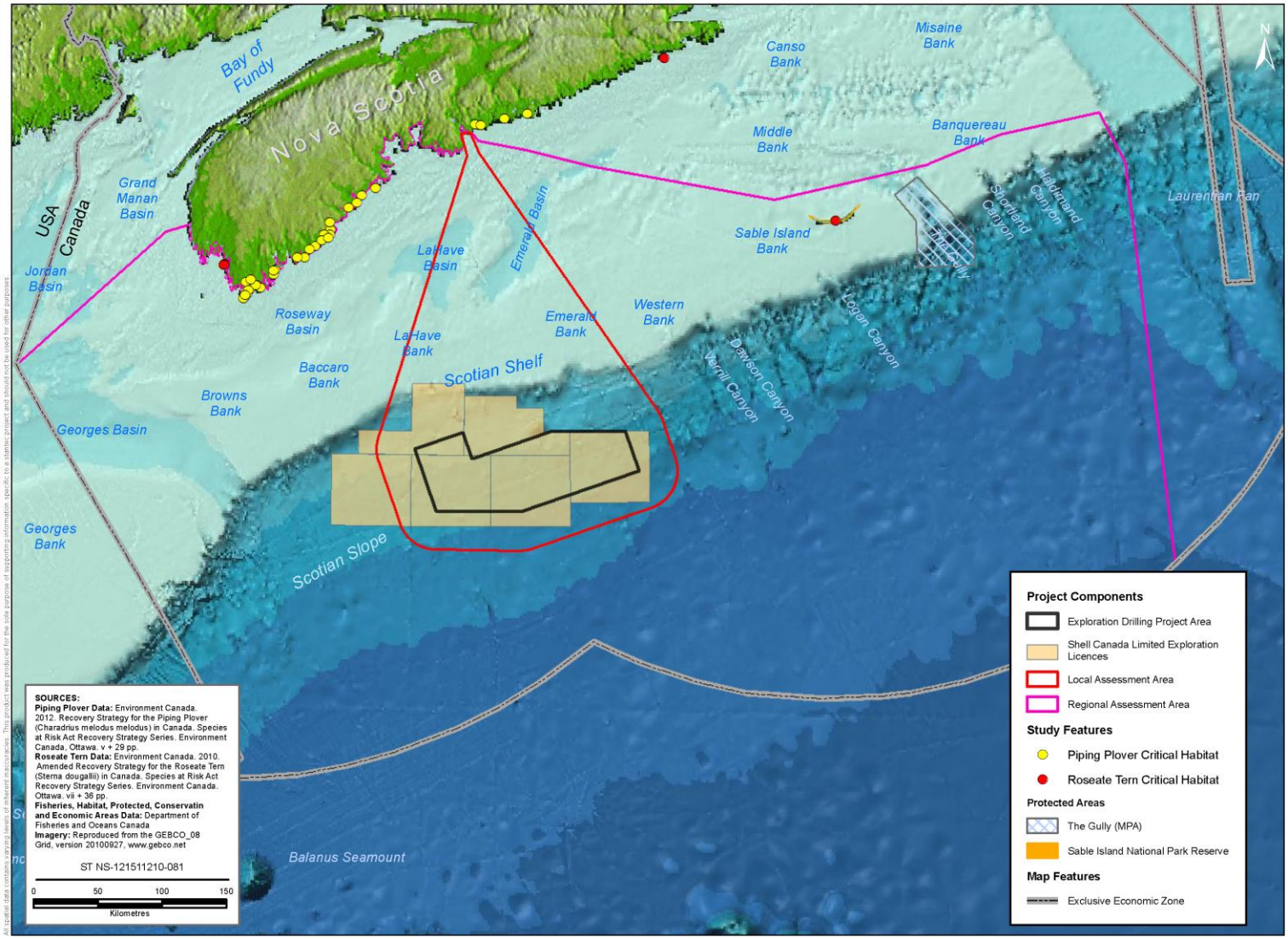


Figure 7.4.1 Assessment Boundaries for Marine Birds

7.4.5.2 Temporal Boundaries

The temporal boundaries for the assessment of potential Project-related environmental effects on Marine Birds encompass all Project phases, including well drilling, testing and abandonment. Up to seven exploration wells will be drilled over a four year period, with Project activities at each well taking a maximum of 130 days to drill. It is assumed that Project activities could occur year-round.

Marine birds can be found in and around the Project Area year-round carrying out various life cycle processes. Refer to Section 5.2.6.5 for specific details regarding the specific marine bird SOCI known to occur in the RAA, including their sensitive periods and their relation to the Project Area. An overview is also provided below in Section 7.4.7.

7.4.6 Criteria for Characterizing Residual Environmental Effects and Thresholds for Determining Significance

Table 7.4.2 defines various descriptors that may be used to characterize residual environmental effects on Marine Birds.

Table 7.4.2 Characterization Criteria for Residual Environmental Effects on Marine Birds

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Magnitude	Refers to the expected size or severity of the residual effect. When evaluating magnitude of residual effects, consideration is given to the proportion of the VC affected within the spatial boundaries and the relative effect.	**Negligible (N)** – no measurable change in marine species populations, habitat quality or quantity **Low (L)** – a measurable change but within the range of natural variability (change in population levels consistent with baseline levels); will not affect population viability **Moderate (M)** – measurable change outside the range of natural variability but not posing a risk to population viability **High (H)** – measurable change that exceeds the limits of natural variability and may affect long-term population viability
Geographic Extent	Refers to the spatial scale over which the residual effect is expected to occur.	**Project Area (PA)** – effects are restricted to the wellsite and Project Area **LAA** – effects are restricted to the LAA **RAA** – effects are restricted to the RAA

Table 7.4.2 Characterization Criteria for Residual Environmental Effects on Marine Birds

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Duration	Refers to the length of time the residual effect persists—which may be longer than the duration of the activity or component that gave rise to the residual effect.	**Short-term (ST)** – effect extends for a portion of the duration of Project activities **Medium-term (MT)** – effect extends through the entire duration of Project activities **Long-term (LT)** – effects extend beyond the duration of Project activities, after well abandonment **Permanent (P)** – measurable parameter unlikely to recover to baseline
Frequency	Refers to how often the residual effect occurs and is usually closely related to the frequency of the activity or component causing the residual effect.	**Once (O)** – effect occurs once **Sporadic (S)** – effect occurs sporadically at irregular intervals **Regular (R)** – effect occurs on a regular basis and at regular intervals throughout the Project **Continuous (C)** – effect occurs continuously
Reversibility	Pertains to whether or not the residual effect on the VC can be reversed once the activity or component causing the disturbance ceases.	**Reversible (R)** – will recover to baseline conditions before or after Project completion (well abandonment) **Irreversible (I)** – permanent
Context	Refers to the influence of past and present human activities on the area in which the residual effect occurs.	**High Disturbance (H)** – effect occurs within a disturbed area that is substantially affected by past or present human activities **Moderate Disturbance (M)** – effect occurs within a moderately disturbed area that is affected by past or present human activities **Low Disturbance (L)** – effect occurs within a relatively pristine area that is unaffected or not adversely affected by past or present human activities

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

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

- causes a decline in abundance or change in distribution of marine birds within the LAA, 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, or

- results in permanent and irreversible loss of critical habitat as defined in a recovery plan or an action strategy for a listed species

7.4.7 Existing Conditions

Waters off the Scotian Shelf are known to be nutrient rich and highly productive due to the complex oceanographic conditions of the area and it has been estimated that over 30 million seabirds use eastern Canadian waters each year (Fifield *et al.* 2009). Large numbers of breeding marine birds as well as 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). The combination of northern hemisphere birds and southern hemisphere migrating birds results in a diversity peak during spring months (Fifield *et al.* 2009). During the fall and winter, significant numbers of overwintering alcids, gulls, and Northern Fulmars can be found in Atlantic Canadian waters (Brown 1986), whereas in the summer, species assemblages are dominated by shearwaters, storm-petrels, Northern Fulmars, and gulls (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 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.

There are six marine bird SOCI that occur within the RAA for the Project: Ivory Gull, Piping Plover, Roseate Tern, Red Knot, Harlequin Duck, and Barrow's Goldeneye. Critical habitat is identified for both Piping Plover and Roseate Tern within the RAA but does not occur within the LAA (Figure 7.4.1). Information on the regional importance, abundance, and distribution of these SOCI is provided in Section 5.2.7, along with other key information on habitat requirements, general life history, and recovery strategies.

Table 7.4.3 Marine Birds Found in the RAA[1]

Common Name	Species Name
Pelagic Seabirds	
Atlantic Puffin	*Fratercula arctica*
Black-legged Kittiwake	*Rissa tridactyla*
Common Murre	*Uria aalge*
Cory's Shearwater	*Calonectris diomedea borealis*
Dovekie	*Alle alle*
Great Shearwater	*Puffinus gravis*
Great Skua	*Stercorarius skua*
Leach's Storm-Petrel	*Oceanodroma leucorhoa*
Long-tailed Jaeger	*Stercorarius longicaudus*
Manx Shearwater	*Puffinus puffinus*
Northern Fulmar	*Fulmarus glacialis*
Northern Gannet	*Morus bassanus*
Parasitic Jaeger	*Stercorarius parasiticus*

Table 7.4.3 Marine Birds Found in the RAA[1]

Common Name	Species Name
Pomarine Jaeger	*Stercorarius pomarinus*
Razorbill	*Alca torda*
Sooty Shearwater	*Puffinus griseus*
South Polar Skua	*Stercorarius maccormicki*
Thick-Billed Murre	*Uria lomvia*
Wilson's Storm-Petrel	*Oceanites oceanicus*
Neritic Seabirds	
Arctic Tern	*Sterna paradisaea*
Black Guillemot	*Cepphus grille*
Black-headed Gull	*Larus ridibundus*
Bonaparte's Gull	*Larus philadelphia*
Common Tern	*Sterna hirundo*
Double-Crested Cormorant	*Phalacrocorax auritus*
Glaucous Gull	*Larus hyperboreus*
Great Black-backed Gull	*Larus marinus*
Great Cormorant	*Phalacrocorax carbo*
Herring Gull	*Larus argentatus*
Iceland Gull	*Larus glaucoides*
Ivory Gull[2]	***Pagophila eburnea***
Ring-billed Gull	*Larus delawarensis*
Roseate Tern[3]	***Sterna dougallii***
Waterfowl	
American Black Duck	*Anas rubripes*
American Green-winged Teal	Anas crecca
Barrows Goldeneye[4]	***Bucephala islandica***
Black Scoter	Melanitta nigra
Bufflehead	*Bucephala albeola*
Canada Goose	*Branta Canadensis*
Common Eider	*Somateria mollissima*
Common Goldeneye	*Bucephala clangula*
Common Loon	*Gavia immer*
Greater Scaup	*Aythya marila*
Harlequin Duck[5]	***Histrionicus histrionicus***
Lesser Scaup	Aythya affinis
Long-tailed Duck	*Clangula hyemalis*
Mallard	Anas platyrhynchos
Red-breasted Merganser	*Mergus serrator*
Red-throated Loon	*Gavia stellata*
Surf Scoter	Melanitta perspicillata
White-winged Scoter	Melanitta fusca
Shorebirds	
American Golden-Plover	*Pluvialis dominica*
Black-bellied Plover	*Pluvialis squatarola*
Dunlin	*Calidris alpina*

Table 7.4.3 Marine Birds Found in the RAA[1]

Common Name	Species Name
Greater Yellowlegs	*Tringa melanoleuca*
Killdeer	*Charadrius vociferus*
Least Sandpiper	*Calidris minutilla*
Lesser Yellowlegs	*Tringa flavipes*
Pectoral Sandpiper	*Calidris melanotos*
Piping Plover (melodus subspecies)[6]	***Charadrius melodus melodus***
Purple Sandpiper	*Calidris maritima*
Red Knot rufa ssp[7]	***Calidris canutus rufa***
Red Phalarope	*Phalaropus fulicaria*
Red-necked Phalarope	*Phalaropus lobatus*
Ruddy Turnstone	*Arenaria interpres*
Sanderling	*Calidris alba*
Semipalmated Plover	*Charadrius semipalmatus*
Semipalmated Sandpiper	*Calidris pusilla*
Short-billed Dowitcher	*Limnodromus griseus*
Spotted Sandpiper	*Actitis macularius*
Whimbrel	*Numenius phaeopus*
White-rumped Sandpiper	*Calidris fuscicollis*
Willet	*Tringa semipalmata*

[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]Barrows Goldeneye is designated as a species of special concern under SARA (Schedule 1) and by COSEWIC.
[5]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.
[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.

The richness and abundance of marine birds on the Scotian Shelf and Slope during summer months reflects the presence of migrating birds and those that breed in nearby areas. During summer months, the coastline of the RAA supports over a hundred colonies of nesting marine birds, ranging in size from a few individuals to thousands of breeding pairs. These colonies are known to support Atlantic Puffins, Black-legged Kittiwakes, Common Eiders, cormorants, Leach's Storm-Petrels, Great Black-back Gulls, Herring Gulls, Razorbills, and terns (including Common, Arctic, and Roseate 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.

Nine coastal IBAs are present within the RAA: The Brothers (NS003), Bon Portage Island (NS015), South Shore (Barrington Bay Sector) (NS018), Eastern Cape Sable Island (NS016), South Shore (Roseway to Baccaro) (NS017), South Shore (Port Joli Sector) (NS004), South Shore - East Queens Co. Sector (NS024), Grassy Island Complex (NS026), and Sable Island (NS025). These areas have been designated as IBAs for a variety of reasons including the presence of breeding habitat for species at risk, important shorebird migration habitat, important coastal waterfowl habitat,

and/or the occurrence of regionally significant colonial marine bird colonies. Additional information on these IBAs is provided in Section 5.2.6.4. No IBAs are present within the LAA or Project Area.

7.4.8 Potential Project-VC Interactions

Table 7.4.4 lists the Project activities and components and provides a rating of 0, 1, or 2 (as defined in the table) based on the extent to which a Project activity or component will interact with Marine Birds and the anticipated nature of potential environmental effects.

Table 7.4.4 Environmental Effects of Interactions between the Project and Marine Birds

Project Activities and Components	Potential Environmental Effects	
	Change in Risk of Mortality or Physical Injury	Change in Habitat Quality and Use
Presence and Operation of MODU (including lights, safety zone and underwater noise)	2	1
Discharge of Drill Muds and Cuttings	0	1
Other Discharges and Emissions (including drilling and testing emissions)	1	1
Vertical Seismic Profiling	1	1
Helicopter Transportation	1	1
OSV Operations (including transit and transfer activities)	2	1
Well Abandonment	0	0

RATING DEFINITIONS

0 No interaction or associated environmental effects are anticipated. Further assessment is considered unnecessary.

1 Interaction may occur; however, based on past experience and professional judgment, the interaction would not result in a significant environmental effect even without mitigation; or the interaction would not be significant due to the application of standard operating procedures, guidelines or codified practices that are known to effectively mitigate the predicted environmental effect. No further assessment is warranted. However, further explanation and justification of the rating is provided below.

2 Interaction may result in an effect of concern. Further assessment is warranted and provided in Section 7.4.9.

Interactions Rated as 0

Discharge of Drill Muds and Cuttings

Discharge of drill muds and cuttings are predicted to not result in any Change in Risk of Mortality or Physical Injury for Marine Birds primarily due to adherence to the OWTG and the understood non-toxicity of drill muds. WBM and cuttings released at the seafloor will not interact with surface waters such that marine birds or their prey would be affected. However, drill cuttings associated with SBM use will be discharged approximately 2 m below 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). In recognition of this limited interaction with

the water column in which diving bird seabirds could be present, a Change in Habitat and Use has been rated as 1 and discussed below.

Well Abandonment

Well abandonment will occur underwater at sufficient depths to prevent any potential interaction with marine birds, including diving species. In particular, water depths range from 1500 to 3000 m in the Project Area, which is well beyond the depth of diving seabirds found in the area. Of the marine 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). Therefore, this activity is not predicted to interact with Marine Birds including diving seabirds.

Interactions Rated as 1

Presence and Operation of the MODU

The presence and operation of the MODU could potentially result in a Change in Habitat Quality for Marine Birds due to the generation of drilling noise, lights, and flares. Noise from the MODU (underwater and atmospheric sound) may result in sensory disturbance of marine birds, leading to behavioural responses such as temporary habitat avoidance or changes in activity state (*e.g.*, feeding, resting, or travelling). As the MODU will remain on-site at the drilling location during Project activities, changes to habitat quality for marine birds as a result of the presence and operation of the MODU would be localized within the Project Area and LAA. No defined critical habitat for marine birds has been defined within the LAA. As a result, residual effects on Habitat Quality and Use as a result of the presence and operation of the MODU are predicted to be not significant. Attraction of marine birds to the MODU may result in a Change in Risk of Mortality or Physical Injury which has been rated as a 2 and assessed in Section 7.4.9.

Discharge of Drill Muds and Cuttings

The discharge of mud and cuttings could potentially result in a Change in Habitat Quality for Marine Birds. Discharge of drill muds and cuttings will be in accordance with the OWTG. WBM and cuttings released at the seafloor will not interact with surface waters such that marine birds or their prey would be affected. Drill cuttings associated with SBM use will be treated in accordance with the OWTG prior to discharge approximately 2 m below sea surface. Constituents in drilling fluids will be screened using the OCSG (NEB *et al.* 2009) to assess the viability of using lower toxicity chemicals.

Discharged drill cuttings will settle rapidly to the seabed and not interact with Marine Birds, while extremely small volumes and fine particle sizes associated with the 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). Temporary elevated

TSS levels in the water column could result in temporary avoidance of a localized area of the Project Area by marine birds during discharge of SBM cuttings at the surface. As a result, residual environmental effects on Habitat Quality and Use as a result of the discharge of mud and cuttings are predicted to be not significant.

Other Discharges and Emissions

The routine discharge of waste and emissions could potentially result in a Change in Risk of Mortality or Physical Injury and a Change in Habitat Quality and Use for Marine Birds. During Project activities, there are several types of discharges that marine birds may interact with during drilling of the well (see Section 2.7). All of these discharges will be in compliance with the OWTG and in adherence to Annex I of the International Convention for the Prevention of Pollution from Ships (MARPOL) both of which have been established to protect the marine environment. All discharges and emissions are expected to be temporary, localized, non-toxic, and subject to high dilution in the open ocean. Deck drainage and bilge waters have potential to negatively affect marine bird health due to 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 marine 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, but non-hazardous waste will be macerated to maximum particle size (6 mm) and treated on board 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, 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. Attraction of marine birds to the MODU may result in a Change in Risk of Mortality or Physical Injury which has been rated as a 2 and assessed in Section 7.4.9.

As a result of compliance with the requirements listed above, routine discharge of waste and emissions will have a low risk of affecting marine bird species or the environment through Changes in Risk of Mortality or Physical Injury and/or Changes in Habitat Quality and Use. As a result, residual environmental effects of routine discharge of waste and emissions on Marine Birds are predicted to be not significant.

VSP

The noise emissions from VSP activities could potentially result in a Change in Risk of Mortality or Physical Injury and a Change in Habitat Quality and Use with regard to Marine Birds. The emission of noise from VSP is expected to be the most intense sound generated by the Project, however it will be generated for approximately one day per well. Although marine birds diving in close proximity to a loud underwater sound have potential to be injured, VSP operations are not anticipated to have a measurable adverse effect on marine bird mortality risk. Many species of seabirds that may be present in the Project Area spend generally less than one minute

underwater during a foraging dive, resulting in a short temporal overlap with VSP (which would occur up to one day per well). Of the marine birds that may be found within the Project Area, alcids (*e.g.*, Dovekie, Common Murre, Thick-billed Murre, Atlantic Puffin) spend 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 marine birds from the area and reduce their exposure to harmful underwater sound waves. As a result, residual environmental effects of VSP on Marine Birds are predicted to be not significant.

Helicopter Transportation

Helicopter transportation activities could potentially result in a Change in Risk of Mortality or Physical Injury and a Change in Habitat Quality and Use with regard to Marine Birds. As discussed in Section 7.1.5, marine birds can react to low-level helicopter flights although their reactions are often temporary in nature. Helicopters transiting to and from the MODU will fly at altitudes greater than 300 m and at a lateral distance of 2 km over active colonies when possible; thus reducing disturbance to marine birds and potential for collisions. The effects of helicopter presence will be brief both spatially and temporally, thus negating any long lasting effects. Helicopters will also avoid flying over Sable Island (a 2 km buffer will be recognized) except 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 marine birds near the MODU may be disturbed during take-off and landing, they are likely to become habituated to the activity. In consideration of above, residual environmental effects of helicopter transportation on Marine Birds are predicted to be not significant.

OSV Operations

OSV activities could potentially result in a Change in Habitat Quality and Use with regard to Marine Birds. The presence of an approaching OSV may alert birds and flush some species from the area. Although OSV transiting and operations are expected to result in a Change in Habitat Quality and Use for Marine Birds, effects will be temporary and limited to a portion of the LAA.

The potential for OSVs to disturb bird colonies will be minimal as the only colonies in the vicinity of the travel routes are in the Halifax Harbour, where nesting birds are currently habituated to relatively high shipping activity. OSVs will not come in close proximity to any critical habitat for marine birds (*i.e.*, Piping Plover or Roseate Tern), or IBAs. Additionally, OSV activities are expected to be minimal compared to ongoing ship activity within the LAA; two or three OSVs 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 OSV must also be present on-site at all times as a standby vessel, as required by Shell's operating standards and under the CNSOPB regulations. OSVs travelling from mainland Nova Scotia will follow established shipping lanes in proximity to shore and will reduce speeds to 18.5 km/hour (10 knots) within the Project Area. In consideration of the above, residual environmental effects of OSV operations on Habitat Quality and Use for Marine Birds are predicted to be not significant. Effects of OSV operations related to a Change in Risk of Mortality or Physical Injury are assessed in Section 7.4.9.

Summary

In consideration of the extent of the interactions and the planned implementation of known and proven mitigation, residual environmental effects on Marine Birds are determined to be not significant for all Project activities and components rated as 1 in Table 7.4.4. These residual environmental effects are not considered further in the assessment of Project-related environmental effects, but are considered as applicable in the assessment of cumulative environmental effects (Section 10).

7.4.9 Assessment of Project-Related Environmental Effects

The following section assesses the potential environmental effects on Marine Birds resulting from the interactions rated as 2 in Table 7.4.4. These effects include a Change in Risk of Mortality or Physical Injury as a result of the presence and operation of the MODU and OSVs.

7.4.9.1 Environmental Effect Mechanisms

Change in Risk of Mortality or Physical Injury

Presence and Operation of the MODU and OSVs

Marine birds are known to aggregate around drilling features in higher than average concentrations as a result of night lighting, flaring, food, and other visual cues and to be subject to increased risk of mortality due to impacts with structures, predation by other marine bird species, and incineration from flares (Wiese *et al.* 2001). As such, the presence and operation of the MODU could result in Changes to Risk of Mortality or Physical Injury. Similarly, increased artificial lighting during transiting and operations of the OSVs may also present a mortality risk to marine birds.

As discussed in Section 7.1.1.3, artificial lighting associated with the MODU and OSVs has potential to result in strandings and increased opportunities for predation, collisions and exposure to vessel-based threats. Many marine birds primarily navigate by sight, and lights can be an eye-catching visual cue (Wiese *et al.* 2001). Marine birds that are attracted to offshore installations may experience mortality through direct collision with the MODU and OSV or may become disoriented by lights and become stranded.

Short-duration flaring by the MODU during testing may attract marine birds and result in increased mortality risk. Lights and flares are known to particularly attract storm-petrels, Dovekies, and shearwaters (Wiese *et al.* 2001) and 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). In addition to incineration, seabirds have been observed to circle flares for days, eventually dying of starvation (Bourne 1979). Documenting bird mortality as a result of flaring may be challenged by certain environmental conditions (*e.g.*, wind speed and direction), the morphological characteristics of some species (*e.g.*, relatively low mass), and the occurrence of predators in

the vicinity of the MODU. 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. Similarly, it may be difficult to quantify the effect of flaring on other injured and dead birds that fall directly into the water.

7.4.9.2 Mitigation of Project-Related Environmental Effects

In consideration of the environmental effects mechanisms described above, mitigation measures will be employed to avoid or reduce the potential environmental effects of the Project on Marine Birds from a Change in Risk of Mortality or Physical Injury.

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

In addition to emergency flaring to address encounters with gas pockets, lesser levels of flaring may be required for solution or production gas. Flaring will be reduced to events required to maintain safe operations and will occur in accordance with the *CNSOPB Drilling and Production Guidelines*. Exploration drilling will be conducted to restrict flaring to the amount necessary to characterize the well potential and that which is necessary for the safety of the operation. Lighting will be reduced to the extent that worker safety and safe operations is not compromised. Routine checks for stranded birds will be conducted on the MODU and OSVs 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. To differentiate between Wilson's Storm-Petrel and Leach's Storm-Petrel, photographs depicting their differences will be provided to crew members trained to check for and handle stranded birds.

In addition to the mitigation described above, standard mitigation described in Section 7.4.8 and listed below will be implemented to reduce adverse environmental effects on Marine Birds:

- Emissions and discharges will be in adherence to OWTG and MARPOL.
- Helicopters transiting to and from the drill rig will fly at altitudes greater than 300 m and at a lateral distance of 2 km over active colonies when possible. Helicopters will also avoid flying over Sable Island (a 2 km buffer will be recognized) except in the case of an emergency.
- OSVs travelling from mainland Nova Scotia will follow established shipping lanes in proximity to shore and will reduce speeds to 18.5 km/hour (10 knots) within the Project Area.

7.4.9.3 Characterization of Residual Project-Related Environmental Effects

The mobilization, presence, and operations of the OSVs and MODU, and associated lighting (including flares), could result in a Change in Risk of Mortality or Physical Injury. In consideration of the implementation of applicable mitigation measures to reduce effects of lighting (including flares) on marine bird species, the residual effect on a Change in Risk or Mortality or Physical Injury is considered to be low to moderate in magnitude, restricted to the LAA, medium-term in duration, and reversible (*i.e.*, will not occur once the drilling program is completed).

7.4.10 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 on Marine 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 exploration drilling and the effectiveness of mitigation measures. Residual environmental effects associated with interactions rated as 1 in Table 7.4.4 were also determined to be not significant.

7.4.11 Follow-up and Monitoring

Follow-up and monitoring will focus on quantifying and determining the nature, timing and extent of bird mortality caused by the Project. This will involve routine checks for stranded birds on the MODU and OSVs (with handling as per the Williams and Chardine protocol) and compliance with the requirements for documenting and reporting any stranded birds (or bird mortalities) to the CWS during the drilling program.

7.4.12 Summary of Residual Project-Related Environmental Effects

Table 7.4.5 summarizes the environmental effects assessment and prediction of residual environmental effects resulting from those interactions between the Project and Marine Birds that were rated as 2 in Table 7.4.4.

Table 7.4.5 Summary of Residual Project-Related Environmental Effects on Marine Birds

Project Activities and Components	Mitigation/Compensation Measures	Residual Environmental Effects Characteristics								Recommended Follow-up and Monitoring
		Nature of Effect	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Significance	Prediction Confidence	
Change in Mortality Risk											
Presence and Operation of MODU OSV Operations	• Reduction of lighting on the MODU and OSVs to the extent that worker safety is not compromised • Reduction of routine flaring to events required to maintain safe operations and avoidance during migration and inclement weather (*e.g.*, fog) when possible • Routine checks on the MODU and OSVs to check for stranded birds; if stranded birds are found, they will be handled using the Williams and Chardine protocol including obtaining the associated permit from CWS	A	L-M	LAA	MT	R	R	M	N	H	• Routine checks for stranded or dead birds on the MODU • Recording of any recovered stranded or dead birds

KEY		
Nature of Effect: P Positive A Adverse ***Magnitude:*** N Negligible L Low M Moderate H High ***Geographic Extent:*** PA Project Area LAA Within the LAA RAA Within the RAA	***Duration:*** ST Short-term MT Medium-term LT Long-term P Permanent ***Frequency:*** O Once S Sporadic R Regular C Continuous ***Reversibility:*** R Reversible I Irreversible	***Context:*** H High disturbance M Moderate disturbance L Low disturbance ***Significance:*** S Significant N Not Significant ***Prediction Confidence:*** Based on scientific information and statistical analysis, professional judgment and effectiveness of mitigation L Low level of confidence M Moderate level of confidence H High level of confidence

7.5 SPECIAL AREAS

7.5.1 Rationale for VC Selection

Special Areas are selected as a VC due to their ecological and/or socio-economic importance, stakeholder and regulatory interests, and potential to interact with the Project. Special Areas provide important habitat and may be relatively more vulnerable to Project-related effects than other areas. Adverse effects on Special Areas could degrade the ecological integrity of the Special Area such that it is not capable of providing the same ecological function for which it was designated (*e.g.*, protection of sensitive or commercially important species). The assessment of Special Areas is therefore closely linked to all of the other VCs considered in this assessment.

Special Areas includes consideration of areas noted for their ecological significance including but not limited to, protected areas and EBSAs. Although EBSAs do not have the same regulatory status as protected areas, they have been recognized as warranting consideration for conservation given their ecological and biological significance. In many cases, EBSAs overlap with other designated Special Areas which may already receive regulatory protection under federal legislation (*e.g.*, Northeast Channel EBSA and the Northeast Channel Coral Conservation Area; Georges Bank EBSA and the Georges Bank Oil and Gas Moratorium Area). In these circumstances, the VC analysis focuses on the designated protected area, rather than the EBSA itself. The Scotian Slope/Shelf Break EBSA extends through the Project Area. Therefore, this VC considers designated protected areas and the Scotian Slope/Shelf Break EBSA as the primary areas of focus to reduce overlap and redundancy.

7.5.2 Regulatory Setting

Many of the Special Areas considered in this assessment are under regulatory protection to protect the ecological integrity of the Special Area and/or the resources it hosts. The Georges Bank Oil and Gas Moratorium Area, located approximately 120 km from the Project Area, is considered to be an ecologically sensitive area in which petroleum activities (including exploration) are prohibited. This moratorium has been in place since 1988. Schedule IV of the Accord Acts delineates the Canadian portion of the moratorium area. In December 2010, the Province of Nova Scotia passed the *Offshore Licensing Policy Act* which prohibits the exploration or drilling for, or the production, conservation, processing or transportation of petroleum on Georges Bank indefinitely. The United States established a moratorium on their portion of Georges Bank in 1990 and this moratorium has been extended until 2017.

Petroleum exploration is also prohibited on Sable Island National Park Reserve (approximately 220 km northeast of the Project Area) and in The Gully MPA (approximately 262 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 in the vicinity of the MPA that disturbs, damages, destroys or removes any living marine organism or any part of

its habitat within the MPA and in the vicinity of the MPA as per the *Gully Marine Protected Area Regulations*.

The Northeast Channel Coral Conservation Area (approximately 130 km northwest of the Project Area) was established in accordance with the *Fisheries Act* and *Oceans Act* and restricts bottom fisheries activities. Similar closures have been established on the eastern Scotian Shelf (Sambro Bank and Emerald Basin) to protect *Vazella Pourtalesi* (Russian hat glass sponges) from bottom fishing activities. Although petroleum exploration is not specifically prohibited, the designations to protect high densities of intact octocorals and glass sponges from benthic disturbance effectively negates drilling activity in these areas.

Under SARA, critical habitat for the endangered North Atlantic Right Whale has been designated in the Roseway Basin (refer to Section 7.3.2 for information on the regulatory significance of SARA). This area is also recognized by Transport Canada 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 95 km northwest of the Project Area.

Other than the Scotian Slope/Shelf Break 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 an ecological and socio-economic perspective. These include the Browns Bank Haddock Spawning Closure (approximately 56 km from the Project Area), the Haddock Box (approximately 60 km from the Project Area and within the LAA for OSV traffic) and the Redfish Nursery Closure (the Bowtie) (approximately 92 km from the Project Area).

7.5.3 Consideration of Issues Raised During Consultation and Engagement

Although no specific issues have been raised to date with respect to Special Areas, general questions and concerns around effects on fish and fish habitat (including the seabed), the biodiversity of marine life in and around the Project Area, and marine mammal migration have been considered as applicable to this VC.

7.5.4 Identification of Environmental Effects and Measurable Parameters

Project activities and components could potentially interact with Special Areas, which could affect the ability of the Special Area to continue to provide important 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 provided by these Special Areas. In consideration of these potential interactions, the assessment of Project-related environmental effects on Special Areas is therefore focused on the following potential environmental effect:

- Change in Habitat Quality and Use

The measurable parameters for the assessment of the environmental effect presented above and the rationale for selection is provided in Table 7.5.1.

Table 7.5.1 Measurable Parameters for Special Areas

Environmental Effect	Measurable Parameter	Rationale for Selection of Measurable Parameter
Change in Habitat Quality and Use	Area of habitat permanently affected (m^2)	• Provides a quantitative measure of affected habitat for fish that are part of a CRA fishery or fish that support such a fishery
	Change in chemical composition of sediment and water (unit depends on the contaminant)	• Provides a quantitative measure of changes to habitat quality and indicates compliance with, or contravention of, the OWTG and section 36 of the *Fisheries Act*
	Timing (seasonal), duration (days), sound level (dB) and extent (km from sound source) of underwater noise affecting marine fish, marine mammals, and/or sea turtles	• Provides for consideration of potential behavioural effects from underwater noise emissions • Time and duration are used to qualitatively assess changes in behaviour caused by underwater noise where threshold do not exist

7.5.5 Environmental Assessment Boundaries

7.5.5.1 Spatial Boundaries

The spatial boundaries for the environmental effects assessment with respect to 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 as such represents the area within which direct physical disturbance may occur as a result of the Project. Future well locations have not currently been identified, but will occur within the Project Area and represent the actual Project footprint. The Project Area is includes portions of EL 2424, 2425, 2426, 2429 and 2430.

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 Special Areas are reasonably expected to occur.

Based on predicted propagation of SPLs from VSP and minimum thresholds for behavioural effects on cetaceans, a buffer of 30 km around the Project Area boundaries has been established to represent the LAA. VSP noise 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 OSV 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. 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 terminates at the international maritime boundary between Canada and the United States. The eastern extent of the RAA terminates at the eastern edge of Banquereau Bank. A portion of the Scotian Shelf and the Nova Scotia coastline to the Bay of Fundy is also included as part of the RAA boundary.

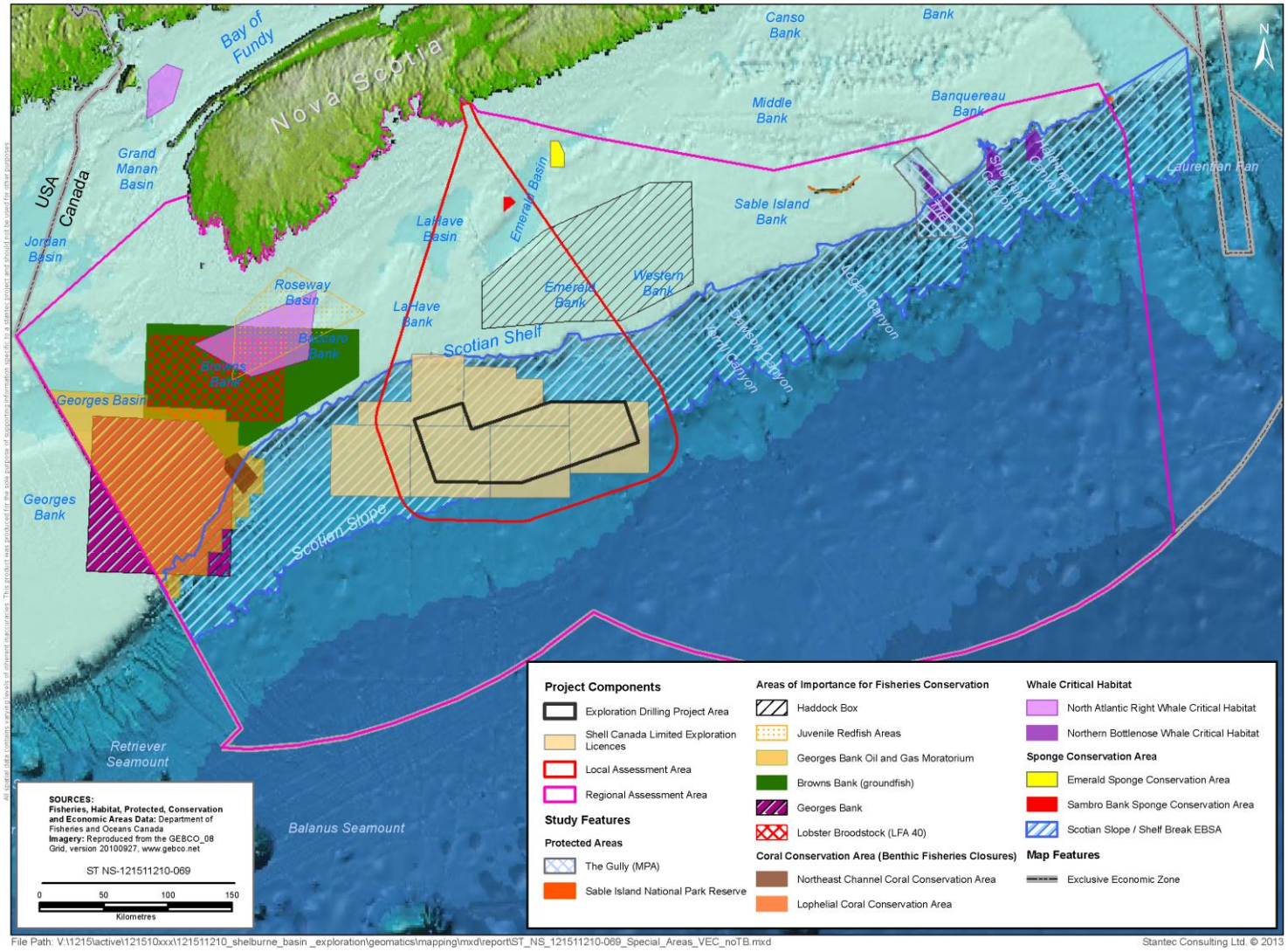


Figure 7.5.1 Assessment Boundaries for Special Areas

7.5.5.2 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 a four year period, with Project activities at each well taking a maximum of 130 days to drill. It is assumed that Project activities could occur year-round.

Special Areas provide important habitat year-round, although some areas (*e.g.*, Roseway Basin) are more commonly used by species during the summer and fall months. The Scotian Slope/Shelf Break 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 5.2.8 for information on species use of Special Areas.

7.5.6 Criteria for Characterizing Residual Environmental Effects and Thresholds for Determining Significance

Table 7.5.2 defines various descriptors that may be used to characterize residual environmental effects on Special Areas.

Table 7.5.2 Characterization Criteria for Residual Environmental Effects on Special Areas

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Magnitude	Refers to the expected size or severity of the residual effect. When evaluating magnitude of residual effects, consideration is given to the proportion of the VC affected within the spatial boundaries and the relative effect.	**Negligible (N)** – no measurable change in marine species populations, habitat quality or quantity **Low (L)** – a measurable change but within the range of natural variability (change in population levels consistent with baseline levels); will not affect population viability **Moderate (M)** – measurable change outside the range of natural variability but not posing a risk to population viability **High (H)** – measurable change that exceeds the limits of natural variability and may affect long-term population viability
Geographic Extent	Refers to the spatial scale over which the residual effect is expected to occur.	**Project Area (PA)** – effects are restricted to the wellsite and Project Area **LAA** – effects are restricted to the LAA **RAA** – effects are restricted to the RAA

Table 7.5.2 Characterization Criteria for Residual Environmental Effects on Special Areas

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Duration	Refers to the length of time the residual effect persists—which may be longer than the duration of the activity or component that gave rise to the residual effect.	**Short-term (ST)** – effect extends for a portion of the duration of Project activities **Medium-term (MT)** – effect extends through the entire duration of Project activities **Long-term (LT)** – effects extend beyond the duration of Project activities, after well abandonment **Permanent (P)** – measurable parameter unlikely to recover to baseline
Frequency	Refers to how often the residual effect occurs and is usually closely related to the frequency of the activity or component causing the residual effect.	**Once (O)** – effect occurs once **Sporadic (S)** – effect occurs sporadically at irregular intervals **Regular (R)** – effect occurs on a regular basis and at regular intervals throughout the Project **Continuous (C)** – effect occurs continuously
Reversibility	Pertains to whether or not the residual effect on the VC can be reversed once the activity or component causing the disturbance ceases.	**Reversible (R)** – will recover to baseline conditions before or after Project completion (well abandonment) **Irreversible (I)** – permanent
Context	Refers to the influence of past and present human activities on the area in which the residual effect occurs.	**High Disturbance (H)** – effect occurs within a disturbed area that is substantially affected by past or present human activities **Moderate Disturbance (M)** – effect occurs within a moderately disturbed area that is affected by past or present human activities **Low Disturbance (L)** – effect occurs within a relatively pristine area that is unaffected or not adversely affected by past or present human activities

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 of the identified Special Area 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 species at risk; or a change in community structure, beyond which natural recruitment (reproduction and immigration from unaffected areas) would not sustain the population or community within the Special Area and would not return to its original level within one generation.

7.5.7 Existing Conditions

Section 5.2.8 describes the Special Areas in the RAA. Other than the Scotian Slope/Shelf Break EBSA, there are no Special Areas located within the Project Area. The Scotian Slope/Shelf Break EBSA is recognized for: unique geology; high finfish and squid diversity; value as a migratory route for large pelagic fishes, cetaceans, and sea turtles; overwintering habitat for a number of shellfish and finfish species (*e.g.*, lobster, Atlantic halibut); foraging area for leatherback sea turtles; feeding and overwintering area for seabirds; and habitat for Greenland sharks (Doherty and Horsman 2007). Approximately 97% of the Project Area falls within the Scotian Slope/Shelf Break EBSA. However, the EBSA is very large (approximately 68 603 km^2); the Project Area constitutes only about 11% of the total area of the EBSA.

The LAA for the OSV route crosses through the Haddock Box and encompasses the Sambro Bank Sponge Conservation Area. Located 60 km and 152 km, respectively, from the Project Area, these Special Areas are not expected to be affected by well drilling, testing or abandonment activities, including noise or other discharges.

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

Table 7.5.3 Proximity of Special Areas to the Project Area and LAA

Special Area	Distance from Project Area	Distance from LAA
Scotian Slope/Shelf Break EBSA	0 km	0 km
Browns Bank (Haddock Spawning Closure)	56 km	26 km
Haddock Nursery Closure, Emerald/Western Bank (Haddock Box)	60 km	0 km
Redfish Nursery Closure Area (Bowtie)	92 km	33 km
North Atlantic Right Whale Critical "Habitat/Area to be Avoided	95 km	65 km
Lobster Fishing Area 40 (Georges Bank)	105 km	75 km
Georges Bank Oil and Gas Moratorium Area	120 km	107 km
Northeast Channel Coral Conservation Area	130 km	100 km
Hell Hole (Northeast Channel)	135 km	105 km
Sambro Bank and Emerald Basin Sponge Conservation Areas	152 km, 182 km	0 km, 27 km
Georges Bank Fishery Closure (5Z)	158 km	117 km
Sable Island National Park Reserve	220 km	185 km
The Gully Marine Protected Area (MPA)	262 km	232 km
Northern Bottlenose Whale Critical Habitat (Sanctuaries): The Gully, Shortland Canyon, Haldimand Canyon	273 km, 330 km, 366 km	243 km, 300 km, 336 km
Lophelia Conservation Area (LCA)	442 km	412 km

7.5.8 Potential Project-VC Interactions

Table 7.5.4 lists Project activities and components and provides a rating of 0, 1, or 2 (as defined in the table) based on the extent to which each Project activity or component will interact with Special Areas and level of potential effect.

Table 7.5.4 Environmental Effects of Interactions between the Project and Special Areas

Project Activities and Components	Potential Environmental Effect
	Change in Habitat Quality and Use
Project Activities and Components	
Presence and Operation of MODU (including lights, safety zone and underwater noise)	1
Discharge of Drill Muds and Cuttings	1
Other Discharges and Emissions (including drilling and testing emissions)	1
Vertical Seismic Profiling	1
Helicopter Transportation	1
OSV Operations (including transit and transfer activities)	1
Well Abandonment	1

RATING DEFINITIONS

0 No interaction or associated environmental effects are anticipated. Further assessment is considered unnecessary.

1 Interaction may occur; however, based on past experience and professional judgment, the interaction would not result in a significant environmental effect even without mitigation; or the interaction would not be signifianct due ot the application of standard operating procedures, guidelines or codified practices that are known to effectively mitigate the predicted environmental effect. No further assessment is warranted. However, further explanation and justification of the rating is provided below.

2 Interaction may result in an effect of concern. Further assessment is warranted.

Interactions Rated as 0

No interactions are rated as 0.

Interactions Rated as 1

All Project interactions for routine activities are rated as 1 in recognition of distances of Special Areas from the Project Area and LAA and implementation of standard mitigation measures. Other than the Scotian Slope/Shelf Break EBSA, there are no Special Areas located within the Project Area. The Haddock Box and the Sambro Bank Sponge Conservation Area are within the LAA portion surrounding the OSV route to Halifax Harbour. Given the distance of the Project Area and LAA from Special Areas, any anticipated interactions associated with the presence and operation of the MODU, discharge of drill muds and cuttings and other routine discharges

as well as VSP surveys, and well abandonment activities would be restricted to the Scotian Slope/Shelf Break EBSA. Environmental effects from these activities would be localized and not extend to distances required to interact with other Special Areas (refer to Table 7.5.3 for distances). The discussion of Project interactions with Special Areas is therefore limited to potential effects of Project activities and components on the Scotian Slope/Shelf Break EBSA located within the LAA, and vessel and helicopter transportation, which could potentially interact with Special Areas located within the LAA. Existing knowledge related to effects of Project activities and components, as well as standard mitigation, is provided in Section 7.1. Effects on species that could occur within the EBSA are assessed within their respective VCs (refer to Sections 7.2 (Marine Fish) 7.3 (Marine Mammals and Sea Turtles), and 7.4 (Marine Birds).

Presence and Operation of the MODU

Within a localized area (*i.e.*, less than 30-km radius of the wellsite), the Scotian Slope/Shelf Break EBSA could experience effects from the presence and operation of the MODU including underwater noise and lights. As discussed in Section 7.1.1, drilling operations as well as dynamic positioning of the MODU will generate underwater noise, affecting the quality of the underwater acoustic environment and potentially resulting in temporary avoidance of habitat by marine mammals and sea turtles. This underwater noise (expected to be in the range of 130–190 dB re 1 µPa @ 1 m could occur at any time of the year and is likely to be continuous during the time it takes to drill each well (*i.e.*, up to 130 days). Potential behavioural effects from underwater noise due to the presence and operation of the MODU on marine mammals and sea turtles are predicted to be limited to the LAA. Although there is no specific mitigation to reduce effects of MODU underwater noise on habitat quality of the EBSA, these effects have been assessed in Section 7.3 to be not significant for marine mammals and sea turtles which could be present in the affected area.

Lights from the MODU will affect a portion of the visual environment of the EBSA within the LAA and may attract fish and migratory birds, however these effects are predicted to be of low to moderate magnitude and not likely to affect viability of populations using the EBSA. As a result, residual environmental effects associated with the presence and operation of the MODU on Special Areas are predicted to be not significant.

Discharge of Drill Muds and Cuttings

A temporary, localized reduction in water and sediment quality within the portion of the EBSA that falls within the LAA could be realized during the discharge of drill muds and cuttings. A slurry of WBM and cuttings will be released at the seafloor prior to installation of the riser, resulting in localized smothering of the benthos. There will be no discharge of WBM at the surface. SBM will be used for subsequent well sections, with SBM cuttings treated on the MODU to extract SBM for reuse during drilling. Cuttings containing residual SBM (no greater than 6.9% oil on cuttings as per the OWTG) will be discharged from the MODU.

Constituents in drilling fluids will be screened using the OCSG (NEB *et al.* 2009) to assess the viability of using lower toxicity chemicals. Previous studies have shown little or no risk of drilling

base chemicals to bioaccumulate to potentially harmful concentrations in tissues of benthic animals or to be transferred through marine food chains to fishery species (Neff *et al.* 2000).

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). The modelling predicts that thicknesses of 0.1 mm will extend up to 1380 m from the release site; however, on average for each well drilled in the Project Area, the majority of modelled drill cuttings deposition will be confined to an area within 100 m of the wellsite. Considering both spring and fall discharge scenarios, thicknesses at or above 1 mm will extend up to 681 m from the discharge site and occupy a maximum areal extent of 71.18 ha per well; thicknesses greater than 10 mm will extend up to 155 m, with a maximum footprint of 1.89 ha per well; and thickness at or above 100 mm will be confined to a distance of 30 m from the wellsite, with a maximum footprint of 0.26 ha per well.

As discussed in Section 7.1.2, 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). 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).

Based on the proposed drilling program for this Project, and assuming an estimate of benthic disturbance (at 1 mm thickness) of 71.18 ha per well, this would result in a total of 498 ha of detectable benthic disturbance (assuming seven wells) within the EBSA. Considering the area of disturbance within which benthic communities could potentially be smothered (10 mm thickness), the affected area decreases to 13 ha. This effect on the benthos would low in magnitude, restricted to the Project Area, and while it could persist beyond the drilling program, would be reversible.

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 Ophuroid, burrowing anemone and sea urchin as typical benthic fauna likely to be encountered. A seabed survey to be conducted in Q2 2014, as well as the pre-drilling ROV survey at the wellsite will confirm the absence of coral concentrations or other sensitive or unique benthic habitat at and in proximity to the proposed drilling locations prior to the commencement of drilling activities. As a result of these considerations, residual environmental effects associated with the discharge of drill muds and cuttings on Special Areas are predicted to be not significant.

Other Discharges and Emissions

Other discharges and emissions will be emitted on a regular basis during the duration of the drilling program. Standard mitigation including adherence to discharge limits specified in the OWTG, will reduce effects of routine discharges on habitat quality of the EBSA within the Project Area. Waste discharges that do not meet OWTG requirements will not be discharged to the

ocean, but brought to shore for disposal. Marine fish may be attracted to certain discharges from the MODU (*e.g.*, sanitary and organic wastes), although these discharges are not predicted to have measurable effects on water quality such that species use of the EBSA would be affected at a population level. As a result, residual effects associated with other discharges and emissions on Special Areas are predicted to be not significant.

VSP

Physiological and biological effects of underwater noise from VSP activities on marine species are discussed in Section 7.1.4. Considering the potential zone of influence on marine mammal behaviour to be approximately 26 km (a conservative estimate based on predicted extrapolation of seismic modelling conducted in support of Shell's Shelburne Basin Venture Seismic Survey conducted in 2013 as well as published thresholds for behavioural effects), it is assumed that habitat use by marine mammals and sea turtles could be affected in the portion of the Scotian Slope/Shelf Break EBSA that falls within the LAA (30-km radius from any individual drill site located within the Project Area). This change in habitat use would be short-term (the VSP will take approximately one day) and reversible, with no predicted lasting effects once the VSP survey is completed. Effects of habitat use by marine fish would similarly be localized, temporary and reversible (refer to Section 7.2.8). Adherence to mitigation implemented for the Shelburne Basin 3D Seismic Survey, which is more stringent than mitigation specified in the SOCP (refer to Section 7.3.9.2), will minimize effects of VSP on habitat quality and use. Residual environmental effects related to VSP on Special Areas are predicted to be not significant.

Helicopter Transportation

Helicopter transportation is not predicted to have any substantial interaction with Special Areas. As is the standard code of practice for operators working offshore, helicopters will avoid flying at altitudes less than 300 m and at a lateral distance of 2 km over Sable Island, except in the case of an emergency. These restrictions will also apply to other active coastal colonies. In recognition of this standard mitigation and avoidance of Sable Island, residual environmental effects related to helicopter transportation on Special Areas are predicted to be not significant.

OSV Operations

OSV traffic could affect habitat quality and use of Special Areas as a result of underwater noise emissions. Collision risk 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 distance of the Project Area from other Special Areas as well as adherence to the following standard mitigation will reduce the likelihood of any interaction (and resulting effects) with Special Areas:

- Seasonal avoidance of the Roseway Basin Critical Habitat/Area to be Avoided

- Avoidance of Sable Island by vessel (maintain a 2 km buffer as is the industry standard for petroleum operators currently working on the Scotian Shelf)

- Avoidance of The Gully as per the *Gully Marine Protected Area Regulations*

In recognition of this mitigation, effects of OSV operations on habitat quality and use of Special Areas do not warrant further consideration. Residual environmental effects of OSV operations are predicted to be not significant.

Well Abandonment

Well abandonment is expected to occur via mechanical separation and will have little interaction with the Scotian Slope/Shelf Break EBSA outside the immediate vicinity of the wellhead. This activity will not produce excess noise or discharge. Blasting will not be required as part of this activity. As a result, the residual environmental effects of well abandonment on Special Areas (Scotian Slope/Shelf Break EBSA) are predicted to be not significant.

7.5.9 Summary of Residual Project-Related Environmental Effects

Given the distance of most Special Areas from the Project Area or LAA, interactions during Project activities will be limited. Habitat quality will be temporarily reduced within a localized portion of the Scotian Slope/Shelf Break EBSA although residual effects are predicted to be not significant with the implementation of standard mitigation.

Within a localized area (*i.e.*, 30-km radius of the wellsite) the Scotian Slope/Shelf Break EBSA could experience effects from the presence and operation of the MODU including drilling noise, discharge of drill muds and cuttings and other routine discharges as well as VSP surveys, and well abandonment activities.

OSV and helicopter transportation could potentially interact with Special Areas, although only the Haddock Box and Sambro Bank Sponge Conservation Area occurs within the anticipated transit routes and applicable regulations and guidelines will be adhered to in order to minimize interactions and resulting environmental effects.

In consideration of the extent of the interactions and the planned implementation of known and proven mitigation, residual environmental effects on Special Areas, including the Scotian Slope/Shelf Break EBSA, are determined to be not significant for all Project activities and components rated as 1 in Table 7.5.2. These residual environmental effects are not considered further in the assessment of Project-related environmental effects, but are considered as applicable in the assessment of cumulative environmental effects (Section 10). There are no environmental effects predicted to occur on Special Areas that require monitoring or follow-up.

7.6 COMMERCIAL FISHERIES

7.6.1 Rationale for VC Selection

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

Effects on Aboriginal fisheries (including Aboriginal commercial fisheries) are discussed in Section 7.6 (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).

7.6.2 Regulatory Setting

The Project Area is located within NAFO Unit Areas 4Wm, 4Xl, and 4Xn. These boundaries include Scallop Fishing Areas (SFA) 25 and 26 and Crab Fishing Areas (CFA) 24E and 24W (refer to Figure 5.3.1). Recent changes to the *Fisheries Act* focus efforts on protecting the productivity of commercial, recreational and Aboriginal (CRA) fisheries. These changes include 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* govern 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. 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. Other broad mechanisms for the protection of marine resources are provided in the federal *Oceans Act* (*e.g.*, authority to establish MPAs).

7.6.3 Consideration of Issues Raised During Consultation and Engagement

Key issues raised during direct stakeholder and Aboriginal engagement for the Project to date revolve around an understanding of the effects of Project activities and components as well as accidental events on fish and fish habitat, as well as fishing activities (*e.g.*, loss of access). Questions have been raised regarding compensation for potential loss of fish habitat and/or lost fishing opportunity. A discussion of environmental effects on fish and fish habitat is provided in

Section 7.2. An assessment of environmental effects of accidental events is provided in Section 8.

Both commercial fishing and Aboriginal representatives have requested that Shell develop a Fisheries Communication Plan during drilling operations to keep fisheries representatives informed of planned routine activities as well as to facilitate communication in the event of an emergency. Shell has committed to continue to engage key fisheries stakeholders and develop Fisheries Communication Plans to coordinate communication with commercial and Aboriginal fisheries representatives during Project activities.

7.6.4 Identification of Environmental Effects and Measurable Parameters

The Project could have an effect on the fisheries resource (direct or indirect effects on fished species) and/or effects on fishing activity (displacement from fishing areas, gear loss or damage).

The assessment of Project-related environmental effects on Commercial Fisheries is therefore 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 their selection is provided in Table 7.6.1.

Table 7.6.1 Measurable Parameters for Commercial Fisheries

Environmental Effect	Measurable Parameter	Rationale for Selection of Measurable Parameter
Change in Availability of Fisheries Resources	Change in access to area used for commercial fisheries (ha)	• 500-m radius safety zone around the MODU represents a loss of fisheries access during drilling
	Change in catch rates (qualitative)	• Fishers may have to work harder to achieve the same catch due to displacement of fish or fisheries
	Area of fish habitat permanently affected (m^2)	• Provides a quantitative measure of affected habitat for fish that are part of a CRA fishery or fish that support such a fishery
	Mortality of commercially important species (qualitative)	• Provides indication of serious harm to fish that are part of a CRA fishery, or fish that support such a fishery
	Damage to fishing gear	• Damage to fishing gear could affect a fisher's ability to harvest fish and therefore result in an economic effect on fisheries

7.6.5 Environmental Assessment Boundaries

7.6.5.1 Spatial Boundaries

The spatial boundaries for the environmental effects assessment with respect to 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 as such represents the area within which direct physical disturbance may occur as a result of the Project. Future well locations have not currently been identified, but will occur within the Project Area and represent the actual Project footprint. The Project Area is consistent for all VCs and includes portions of EL 2424, 2425, 2426, 2429 and 2430.

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 Commercial Fisheries are reasonably expected to occur. Based on predicted propagation of SPLs from VSP 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. VSP noise 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 OSV routes to and from the Project Area. In the context of Commercial Fisheries, the LAA,(including the OSV route) falls within NAFO Unit Areas 4Wm, 4Xl, 4Xn, and 4Xm and 4Wk.

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 terminates at the international maritime boundary between Canada and the United States. The eastern extent of the RAA terminates at the eastern edge of Banquereau Bank. A portion of the Scotian Shelf and the Nova Scotia coastline to the Bay of Fundy is also included as part of the RAA boundary.

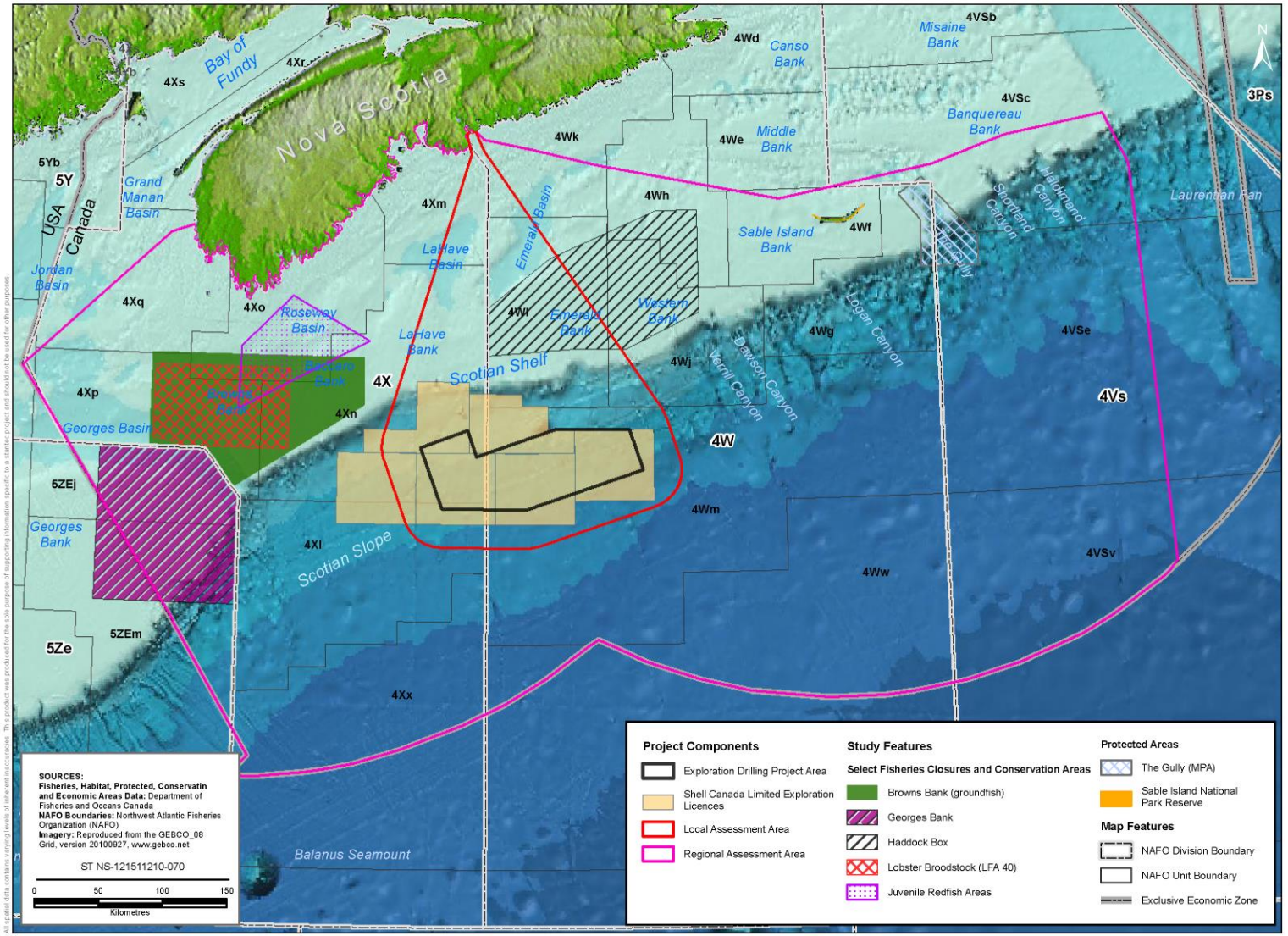


Figure 7.6.1 Assessment Boundaries for Commercial Fisheries

7.6.5.2 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 a four year period, with Project activities at each well taking a maximum of 130 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 in the vicinity of the Project Area occurs between February and October. Refer to Section 5.3.3 for a description of the fisheries conducted in 4W and 4X.

7.6.6 Criteria for Characterizing Residual Environmental Effects and Thresholds for Determining Significance

Table 7.6.2 defines various descriptors that may be used to characterize residual environmental effects on Commercial Fisheries.

Table 7.6.2 Characterization Criteria for Residual Environmental Effects on Commercial Fisheries

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Magnitude	Refers to the expected size or severity of the residual effect. When evaluating magnitude of residual effects, consideration is given to the proportion of the VC affected within the spatial boundaries and the relative effect.	**Negligible (N)** – no measurable change to commercial fisheries **Low (L)** – very small detectable change to commercial fisheries in low-use areas **Moderate (M)** – measurable change to commercial fisheries in moderate-use areas **High (H)** – measurable change to commercial fisheries in high-use areas
Geographic Extent	Refers to the spatial scale over which the residual effect is expected to occur.	**Project Area (PA)** – effects are restricted to the wellsite and Project Area **LAA** – effects are restricted to the LAA **RAA** – effects are restricted to the RAA
Duration	Refers to the length of time the residual effect persists—which may be longer than the duration of the activity or component that gave rise to the residual effect.	**Short-term (ST)** – effects are measurable for less than one fishing season **Medium-term (MT)** – effects are measurable for approximately one fishing season **Long-term (LT)** – effects are measurable for more than one fishing season but are not permanent **Permanent (P)** – effects are permanent

Table 7.6.2 Characterization Criteria for Residual Environmental Effects on Commercial Fisheries

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Frequency	Refers to how often the residual effect occurs and is usually closely related to the frequency of the activity or component causing the residual effect.	**Once (O)** – effect occurs once **Sporadic (S)** – effect occurs sporadically at irregular intervals **Regular (R)** – effect occurs on a regular basis and at regular intervals throughout the Project **Continuous (C)** – effect occurs continuously
Reversibility	Pertains to whether or not the residual effect on the VC can be reversed once the activity or component causing the disturbance ceases.	**Reversible (R)** – will recover to baseline conditions before or after Project completion (well abandonment) **Irreversible (I)** – permanent
Context	Refers to the influence of past and present human activities on the area in which the residual effect occurs.	**High Interference (H)** – effect occurs within a an area where past or present human activities substantially interfere with commercial fisheries **Moderate Interference (M)** – effect occurs within an area where past or present human activities moderately interfere with commercial fisheries **Low Interference (L)** – effect occurs within an area where past or present human activities do not interfere, or generally do not interfere, with commercial fisheries

In consideration of the descriptors listed above, 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 residual Project-related environmental effect that results in an 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
- unmitigated damage to fishing gear

7.6.7 Existing Conditions

Section 5.3.3 provides a description of the fisheries conducted in 4W and 4X, focusing on NAFO Unit Areas 4Xn, 4Wm and 4Xl. A description of fish species and their life histories is included in Section 5.2.3. As evident in Figures 5.3.9 to 5.3.11, there is minimal fishing effort within and surrounding the Project Area. Harvesting in the LAA surrounding the Project Area is primarily focused on Atlantic halibut, Atlantic cod, Atlantic hagfish, cusk, monkfish, redfish, red hake, silver hake, swordfish, white hake, shark species such as porbeagle, and bluefin and other species of tuna.

Figure 5.3.11 depicts a productive harvesting area approximately 50 km northwest of the Project Area between Baccaro and LaHave Banks. This region represents productive fishing grounds for Atlantic halibut, cod, haddock, pollock, cusk, flatfish, redfish, white hake, wolfish and monkfish with limited fishing for crab and lobster. Within the Project Area and LAA, in general, fishing effort appears to be low.

7.6.8 Potential Project-VC Interactions

Table 7.6.3 lists Project activities and components, and provides a rating of 0, 1, or 2 (as defined in the table) based on the extent to which each Project activity or component will interact with Commercial Fisheries and level of potential effect.

Table 7.6.3 Environmental Effects of Interactions between the Project and Commercial Fisheries

Project Activities and Components	Potential Environmental Effects
	Change in Availability of Fisheries Resources
Presence and Operation of MODU (including lights, safety zone and underwater noise)	1
Discharge of Drill Muds and Cuttings	1
Other Discharges and Emissions (including drilling and testing emissions)	1
Vertical Seismic Profiling	1
Helicopter Transportation	0
OSV Operations (including transit and transfer activities)	1
Well Abandonment	1

Table 7.6.3 Environmental Effects of Interactions between the Project and Commercial Fisheries

Project Activities and Components	Potential Environmental Effects
	Change in Availability of Fisheries Resources
RATING DEFINITIONS	
0 No interaction or associated environmental effects are anticipated. Further assessment is considered unnecessary.	
1 Interaction may occur; however, based on past experience and professional judgment, the interaction would not result in a significant environmental effect even without mitigation; or the interaction would not be significant due to the application of standard operating procedures, guidelines or codified practices that are known to effectively mitigate the predicted environmental effect. No further assessment is warranted. However, further explanation and justification of the rating is provided below.	
2 Interaction may result in an effect of concern. Further assessment is warranted.	

Interactions Rated as 0

Helicopter Transportation

Helicopter transportation will not interact with the marine environment and therefore will not affect commercial fisheries. This interaction has thus been rated as 0; no environmental effects are anticipated.

Interactions Rated as 1

Presence and Operation of MODU

The mobilization, presence and operation of the MODU could interact with commercial fisheries in the LAA as a 500-m radius safety 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 130 days for each well to be drilled. However, this temporary and localized fishing exclusion is not likely to have a significant effect on fishing activities (and therefore availability of fisheries resource) since the LAA does not include any unique fishing grounds or concentrated fishing effort that occurs exclusively within the LAA. Additionally fishing activities in the LAA are transient in nature and similar alternative sites are readily available within the immediate area.

Shell will communicate with fishers before, during and after drilling programs and details of safety zones will be published in Notices to Mariners, which will allow fishers to plan accordingly and mitigate potential effects. 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).

Underwater noise as a result of the presence of the MODU and its operation during drilling, testing and abandonment is expected to range from 130 to 190 dB re 1µPa @ 1 m. This noise

generation may cause fisheries species to temporarily avoid the area around the MODU, particularly during start-up of drilling. However, this avoidance behaviour is expected to be localized and 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 localized nature of the noise, it is not expected to affect commercial fisheries species such that fishers would be adversely affected (refer to Section 7.2 for additional information on Project effects on fish and fish habitat).

The likelihood of the presence and operation of the MODU causing a Change in Availability of Fisheries Resources is therefore considered low. As a result, environmental effects of MODU presence and operation on Commercial Fisheries are predicted to be not significant.

Discharge of Drill Muds and Cuttings

The discharge of drill muds and cuttings has the potential to interact with fisheries species within a localized area as a result of sedimentation and localized changes in water quality. Constituents in drilling fluids will be screened using the OCSG (NEB *et al*. 2009) to assess the feasibility of user low toxicity chemicals. Discharges of muds and cuttings will be managed in accordance with the OWTG which allows discharge of untreated WBM cuttings, and SBM cuttings treated to achieve 6.9% or less synthetic oil on cuttings.

Localized mortality of sedentary or slow moving benthic species is expected to occur within the wellsite and within a portion of the footprint of dispersion of WBM and SBM cuttings. As presented in Appendix C and summarized in Section 7.1.2, drill waste discharges are predicted to be at or above 1 mm in thickness up to 681 m from the discharge site for each well. Smothering effects on sedentary benthic species (10 mm deposition thickness) may be realized up to 155 m from the discharge point, with an areal extent of 1.89 ha per well.

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.

Residual environmental effects of discharges of drill muds and cuttings on Commercial Fisheries are therefore predicted to be not significant.

Other Discharges and Emissions

Other discharges and emissions (including drilling and testing emissions) will result in temporary and localized effects on water quality around the wellsite in the Project Area. Discharges will be in accordance with the OWTG and are not predicted to adversely affect fish species in the Project Area or the LAA. Such discharges may include organic matter, substances containing minor amounts of chemicals and/or residual hydrocarbons and are expected to disperse quickly in the open ocean environment and/or be degraded by bacterial communities. Given compliance with the OWTG, discharges are not expected to create toxic effects on fisheries or

their prey species and therefore are not expected to cause a Change in Availability of Fisheries Resources.

Residual environmental effects of other discharges on emissions on Commercial Fisheries are therefore predicted to be not significant.

VSP

Sound levels associated with VSP surveys will be in the range of 220–245 dB re1 µPa @ 1 m and could occur up to one day per well. According to the results of acoustic modelling conducted for the Shelburne 3D Seismic EA (Matthews 2013 in Appendix A of LGL 2013), horizontal distances for SPLs of ≤ 160 dB_{RMS} re 1 µPa could extend up to 26 km from the wellsite during VSP surveys. As noted in Section 7.1.4, startle and alarm responses in fish have been observed at SPLs as low as 156–161 dB re 1 µPa; therefore, based on a conservative approach of applying modelling results for 3D seismic to estimate effects from VSP, behavioural responses in fish (*e.g.*, swimming activity) have potential to occur up to approximately 26 km from the VSP sound source. Even with this conservative estimate, effects from VSP noise on Commercial Fisheries are expected to be limited and localized within the LAA, short-term in duration (approximately one day per well), and reversible. There are no important spawning areas or unique fishing grounds within 26 km of the Project Area, and given the short-term nature of this interaction (up to one day per well), adverse effects on commercial fisheries are not anticipated.

Residual environmental effects of VSP on Commercial Fisheries are predicted to be not significant.

OSV Operations

OSVs will use existing shipping routes when travelling between the MODU and the supply base in Halifax Harbour and will adhere to standard navigation procedures, thereby avoiding potential conflicts with commercial fisheries. Additionally, as noted in Section 7.2.8, any environmental effects on fish attributable to OSV traffic and operations would represent a small incremental increase over similar effects currently associated with existing high levels of marine traffic and shipping activity throughout the RAA.

Residual environmental effects of OSV operations on Commercial Fisheries of are therefore predicted to be not significant.

Well Abandonment

Abandonment of wells could potentially interact with commercial fishing activity in the Project Area, either through a change in fish habitat (if the wellhead is kept in place) or temporary underwater noise. Wells will be abandoned in accordance with CNSOPB requirements and will take approximately 7–10 days. Where removal of the wellhead is required, the wellhead and associated equipment will be removed up to 1 m BSF through mechanical means (cutters). If approval is sought and provided to keep the wellhead in place, the wellhead will be marked on

nautical charts. However, wellheads are 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.

Residual environmental effects of well abandonment on Commercial Fisheries are predicted to be not significant.

7.6.9 Summary of Residual Project-Related Environmental Effects

In consideration of the extent of the interactions, residual environmental effects on Commercial Fisheries are determined to be not significant for all Project activities and components rated as 1 in Table 7.6.3. These residual effects are not considered further in the assessment of Project-related effects but are considered, as applicable, in the context of cumulative effects assessment (refer to Section 10). In addition to any standard mitigation described above, Shell has committed to developing and implementing Fisheries Communications Plans for Commercial and Aboriginal fisheries representatives which will facilitate coordinated communication around routine Project activities and components as well as accidental events. Additional information on these plans is provided in Sections 3, 4 and 8 of this EIS.

7.7 CURRENT ABORIGINAL USE OF LANDS AND RESOURCES FOR TRADITIONAL PURPOSES

7.7.1 Rationale for VC Selection

Current Aboriginal Use of Lands and Resources for Traditional Purposes refers to communal commercial, as well as 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 also 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).

7.7.2 Regulatory Setting

The Project Area is located within NAFO Unit Areas 4Wm, 4Xl, and 4Xn. These boundaries include Scallop Fishing Areas (SFA) 25 and 26 and Crab Fishing Areas (CFA) 24E and 24W (refer to Figure 5.3.8). Recent changes to the *Fisheries Act* focus efforts on protecting the productivity of CRA fisheries. These changes include a prohibition against causing serious harm to fish that are part of or support a CRA fishery without authorization. As indicated in Section 5.3.2.4, 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 also two key guidelines which 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).

7.7.3 Consideration of Issues Raised During Consultation and Engagement

Shell is committed to meaningful and productive engagement with Aboriginal communities during Project planning and implementation. Through Project information packages, face-to-face meetings, phone calls and emails, Shell has engaged First Nations and Aboriginal communities to better understand the potential for Project effects on Aboriginal and Treaty rights and opportunities to mitigate these effects (refer to Section 4).

Key issues raised during direct Aboriginal engagement with Shell for the Project to date include a general concern about the effects of routine activities and accidental events on fish and fish habitat and the biodiversity of marine life in and around the Project Area. In particular, questions were raised about the effects of light, heat, noise, and drilling discharges on marine species and Aboriginal communal commercial fisheries. Questions were also raised regarding spill modelling and predicted fate and behaviour of a Project-related spill, use of dispersants, and overall environmental effects of accidental events. A discussion of environmental effects on fish and fish habitat is provided in Section 7.2. Accidental events, including a summary of the predicted fate and behaviour of spills, potential use of dispersants, and environmental effects, are discussed in Section 8.

To better understand traditional use of lands and resources by Aboriginal peoples and potential Project-related effects on Aboriginal and Treaty rights, MGS and UINR were commissioned to undertake a Traditional Use Study (TUS) (refer to Appendix B). Key issues raised within the TUS include: the ecological significance and biodiversity of the RAA; use of the RAA by commercial or other important fish species during various life stages; the importance of the RAA as migration routes and spawning areas for many species; and the presence or use of the RAA by species that represent the primary food source for commercially or culturally important species. The inter-connectedness of the ecosystem was emphasized. Concerns raised during the TUS include the effects on habitats and species that could result from any development in the area, ecological impacts if there is a spill, and potential limitations to current fishing practices and/or locations of fishing. Important fisheries areas were identified, including the inner shelf, outer shelf and slope/channel areas.

For specific details regarding Shell's Aboriginal engagement efforts and questions and concerns raised, refer to Section 4.5 of this EIS and the TUS which is included in Appendix B.

7.7.4 Identification of Environmental Effects 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 (effects on fished species) and/or effects on fishing activity (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 measurable parameters used for the assessment of the environmental effect presented above and the rationale for selection is provided in Table 7.7.1.

Table 7.7.1 Measurable Parameters for Current Aboriginal Use of Lands and Resources for Traditional Purposes

Environmental Effect	Measurable Parameter	Rationale for Selection of Measurable Parameter
Change in Traditional Use	Change in access to area used for communal commercial or FSC fisheries (ha)	• 500-m radius safety zone around the MODU represents a loss of fisheries access during drilling • Change in access to traditional fishing areas could affect a fisher's ability to harvest fish for commercial and/or FSC purposes and therefore have economic and cultural effects • Limitations on current fishing practices and the location of fishing was identified as a concern in the TUS
	Change in catch rates (qualitative)	• Fishers may have to work harder to achieve the same catch due to displacement of fish or fisheries • Limitations on current fishing practices was identified as a concern in the TUS
	Area of fish habitat permanently affected (m^2)	• Provides a quantitative measure of affected habitat for fish that are part of a CRA (including FSC) fishery or fish that support such a fishery • Changes to important fisheries areas such as the inner shelf, outer shelf, and slope/channel areas were identified in the TUS as a concern • Project effects on habitat was identified

Table 7.7.1 Measurable Parameters for Current Aboriginal Use of Lands and Resources for Traditional Purposes

Environmental Effect	Measurable Parameter	Rationale for Selection of Measurable Parameter
		as a concern in the TUS
	Mortality of commercially or culturally important species (qualitative)	• Provides indication of serious harm to fish that are part of a CRA fishery, or fish that support such a fishery • Effects on commercially or culturally important species that could result from the Project were identified as a concern in the TUS
	Damage to fishing gear	• Damage to fishing gear could affect a fisher's ability to harvest fish and have an economic effect on Aboriginal fisheries

7.7.5 Environmental Assessment Boundaries

7.7.5.1 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.

Project Area: The Project Area encompasses the immediate area where Project activities and components may occur and as such represents the area within which direct physical disturbance may occur as a result of the Project. Future well locations have not currently been identified, but will occur within the Project Area and represent the actual Project footprint. The Project Area is consistent for all VCs and includes portions of EL 2424, 2425, 2426, 2429 and 2430 as depicted on Figure 7.7.1.

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 the Current Aboriginal Use of Lands and Resources for Traditional Purposes are reasonably expected to occur. Based on predicted propagation of SPLs from VSP 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. VSP noise 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 OSV routes to and from the Project Area. In the context of Current Aboriginal Use of Lands and Resources for Traditional Purposes, the LAA (including the OSV route) falls within NAFO Unit Areas 4Wm, 4Xl, 4Xn, and 4Xm and 4Wk.

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 terminates at the international maritime boundary between Canada and the United States. The eastern extent of the RAA terminates at the eastern edge of Banquereau Bank. A portion of the Scotian Shelf and the Nova Scotia coastline to the Bay of Fundy is also included as part of the RAA boundary.

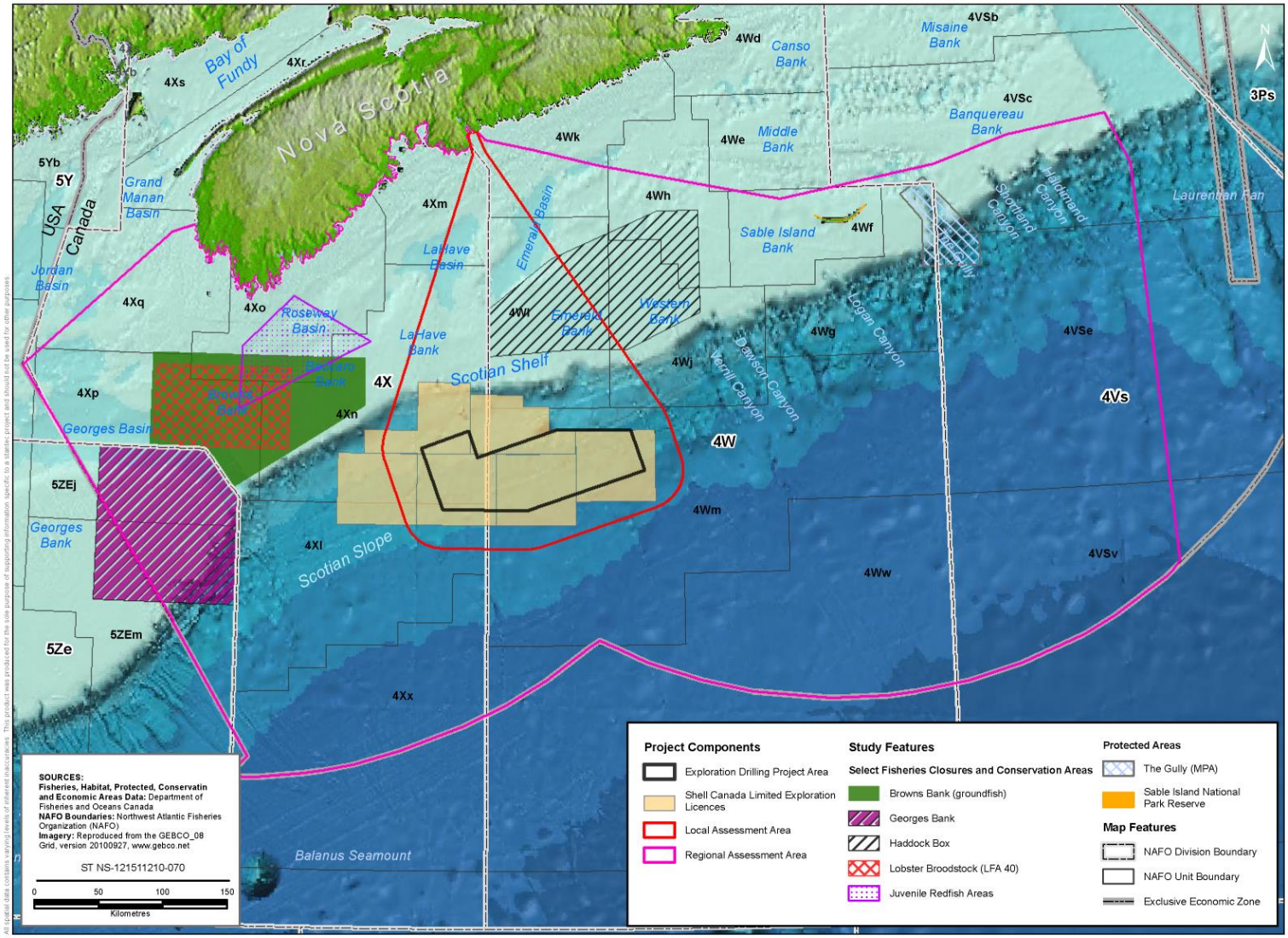


Figure 7.7.1 Assessment Boundaries for Current Aboriginal Use of Lands and Resources for Traditional Purposes

7.7.5.2 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 a four year period, with Project activities at each well expected to take up to 130 days to drill. It is assumed that Project activities could occur year-round.

7.7.6 Criteria for Characterizing Residual Environmental Effects and Thresholds for 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 Criteria for Residual Environmental Effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Magnitude	Refers to the expected size or severity of the residual effect. When evaluating magnitude of residual effects, consideration is given to the proportion of the VC affected within the spatial boundaries and the relative effect.	**Negligible (N)** – no measurable change from baseline **Low (L)** – very small detectable change from baseline **Moderate (M)** – varies from baseline and may result in noticeable changes to traditional practices, traditional knowledge or community perceptions of traditional territory, practices or knowledge **High (H)** – varies from baseline to a high degree, has serious implication for the continuance of traditional practices and traditional knowledge
Geographic Extent	Refers to the spatial scale over which the residual effect is expected to occur.	**Project Area (PA)** – effects are restricted to the Project Area **LAA** – effects are restricted to the LAA **RAA** – effects are restricted to the RAA
Duration	Refers to the length of time the residual effect persists—which may be longer than the duration of the activity or component that gave rise to the residual effect.	**Short-term (ST)** – effects are measurable for less than one fishing season **Medium-term (MT)** – effects are measurable for approximately one fishing season **Long-term (LT)** – effects are measurable for more than one fishing season but are not permanent **Permanent (P)** – effects are permanent

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

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Frequency	Refers to how often the residual effect occurs and is usually closely related to the frequency of the activity or component causing the residual effect.	**Once (O)** – effect occurs once **Sporadic (S)** – effect occurs sporadically at irregular intervals **Regular (R)** – effect occurs on a regular basis and at regular intervals throughout the Project **Continuous (C)** – effect occurs continuously
Reversibility	Pertains to whether or not the residual effect on the VC can be reversed once the activity or component causing the disturbance ceases.	**Reversible (R)** – will recover to baseline conditions before or after Project completion (well abandonment) **Irreversible (I)** – permanent
Context	Refers to the influence of past and present human activities on the area in which the residual effect occurs.	**High Interference (H)** – effect occurs within a an area where past or present human activities substantially interfere with current Aboriginal use of lands and resources for traditional purposes **Moderate Interference (M)** – effect occurs within an area where past or present human activities moderately interfere with current Aboriginal use of lands and resources for traditional purposes **Low Interference (L)** – effect occurs within an area where past or present human activities do not interfere, or generally do not interfere, with current Aboriginal land and resource use for traditional purposes

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
- Unmitigated damage to fishing gear

7.7.7 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 NCNS. Eleven of these communal licences are held by groups in Nova Scotia while the remaining five are held by groups in New Brunswick. These communal licences are for inland and inshore areas; DFO does not provide access for FSC purposes in offshore areas (DFO pers. comm, cited in Stantec 2014).

There are 144 communal commercial licences held by Aboriginal groups in the DFO Maritimes Region within the Western Scotian Shelf and Slope region. These licences are for crab, groundfish, hagfish, swordfish, bluefin tuna, mackerel, and lobster (refer to Table 5.3.1). Additional species which may be harvested in the RAA include Atlantic cod, Atlantic herring, northern shrimp, pollock, and scallop (MGS and UINR 2014; Appendix B). For more information on Aboriginal fishing, refer to Section 5.3.4 and the TUS (Appendix B).

Membertou Geomatics and Unama'ki Institute of Natural Resources undertook a TUS (MGS and UINR 2014) (Appendix B) which provided information on Aboriginal fishing activities in the RAA, with a focus on waters surrounding the Project Area. This scope of work included conducting a background review of commercial licences, and FSC agreements, as well as interviews with elders, fishers and fisheries managers from a representative subset of First Nations in Nova Scotia and New Brunswick, as well as the NCNS. Based on these interviews, the TUS includes information on target species, general fishing areas, and fishing seasons, along with additional information pertaining to fish or sensitive areas.

Commercial harvesting by the Mi'kmaq of Nova Scotia and Mi'kmaq and Maliseet in New Brunswick in the RAA targets many of the same species fished by non-Aboriginal commercial fishers, including albacore tuna, bigeye tuna, bluefin tuna, cod, cusk, flounder, haddock, hagfish, hake, halibut, herring, Jonah crab, lobster, pollock, redfish, scallop, shark, shrimp, snow crab, swordfish and yellowfin tuna. Based on interviews conducted as of April 2014, 37 fish species, one mammal (seal), and nine invertebrate groups were identified as species harvested for FSC purposes. The TUS states that there is currently no FSC fishing reported as occurring in the Project Area. However, the TUS also acknowledges that this does not imply that FSC fisheries are not occurring in the Project Area or that the Project Area may not be accessed for future FSC fisheries needs. Lobster and herring were identified as currently being harvested within the LAA and several species (cod, herring, halibut, cusk, gaspereau, haddock, monkfish, pollock, red hake, silver hake, white hake, lobster, scallop, Jonah crab, and marine worms) were identified as being harvested for FSC purposes within the RAA (MGS and UINR 2014). A precautionary approach is therefore taken, assuming that FSC fisheries could potentially occur in the Project Area and LAA, as well as the RAA. Shell also acknowledges that species fished for FSC purposes could be harvested outside the RAA but could potentially temporarily interact with the Project during migration activities through the Project Area or LAA.

7.7.8 Potential Project-VC Interactions

Table 7.7.3 lists Project activities and components, and provides a rating of 0, 1, or 2 based on the extent to which each Project activity or component will interact with the Current Aboriginal Use of Lands and Resources for Traditional Purposes and the level of potential effect.

Table 7.7.3 Environmental Effects of Interactions between the Project and Current Aboriginal Use of Lands and Resources for Traditional Purposes

Project Activities and Components	Potential Environmental Effects
	Change in Traditional Use
Presence and Operation of MODU (including lights, safety zone and underwater noise)	1
Discharge of Drill Muds and Cuttings	1
Other Discharges and Emissions (including drilling and testing emissions)	1
Vertical Seismic Profiling	1
Helicopter Transportation	0
OSV Operations (including transit and transfer activities)	1
Well Abandonment	1

RATING DEFINITIONS

0 No interaction or associated environmental effects are anticipated. Further assessment is considered unnecessary.

1 Interaction may occur; however, based on past experience and professional judgment, the interaction would not result in a significant environmental effect, even without mitigation; or interaction would not be significant due to application of standard operating procedures, guidelines or codified practices that are known to effectively mitigate the predicted environmental effect. No further assessment is warranted. However, further explanation and justification of the rating is provided in the respective VC analysis section.

2 Interaction may result in an effect of concern. Further assessment is warranted and is provided in the respective VC analysis section.

Interactions Rated as 0

Helicopter transportation will not interact with the marine environment and therefore will not affect fish species or Aboriginal commercial or traditional fisheries. Except 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).

Interactions Rated as 1

Presence and Operation of MODU

The presence and operation of the MODU could interact with Aboriginal fisheries in the LAA as a 500-m radius safety 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 affecting an area of approximately 0.8 km^2 (80 ha) for an expected maximum of 130 days for each well to be drilled. However, this temporary and localized fishing exclusion is not likely to have a significant effect on Traditional Use since the Project Area does not include any unique fishing grounds or concentrated fishing effort, and fishing activities are transient in nature. Similar alternate sites are readily available in the immediate area.

Shell will communicate with fishers before, during and after drilling programs and details of safety zones will be published in Notices to Mariners, which will allow fishers to plan accordingly and mitigate potential effects. 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).

Underwater noise will be generated as a result of the presence of the MODU and its operations during drilling, testing and abandonment. Underwater noise from a semi-submersible or DP drill ship is expected to range from 130 to 190 dB re 1µPa @ 1 m, and may cause fisheries species to temporarily avoid the area around the MODU, particularly during start-up of drilling. However, this avoidance behaviour is expected to be localized and 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, 200b; Fewtrel and McCauley 2012). Given the localized nature of the noise, it is not expected to affect spawning habitat, migratory behaviour or health of fisheries species such that Aboriginal fisheries would be adversely affected (refer to Section 7.2 for additional information on Project effects on fish and fish habitat).

The likelihood of the presence and operation of the MODU causing a Change in Traditional Use is therefore considered low. As a result, residual environmental effects of MODU presence and operation on Current Aboriginal Use of Lands and Resources for Traditional Purposes are predicted to be not significant.

Discharge of Drill Muds and Cuttings

The discharge of drill muds and cuttings has the potential to interact with fisheries species within a localized area as a result of sedimentation and localized changes in water quality. Constituents in drilling fluids will be screened using the OCSG (NEB *et al*. 2009) to assess the feasibility of user low toxicity chemicals. Discharges of muds and cuttings will be managed in accordance with the OWTG which allows discharge of untreated WBM cuttings and SBM cuttings treated to achieve 6.9% or less synthetic oil on cuttings.

Localized mortality of sedentary or slow-moving benthic species is expected to occur at the wellsite and within a portion of the footprint of dispersion of WBM and SBM cuttings due to smothering effects. As presented in Appendix C and summarized in Section 7.1.2, drill waste discharges are predicted to be at or above 1 mm in thickness up to a 681-m radius from the discharge site for each well. Smothering effects on sedentary benthic species (assuming a 10 mm deposition thickness) may occur up to 155 m from the discharge point, with an areal extent of 1.89 ha per well. Benthic species identified as important to First Nations include sea urchin, lobster, scallop and crab. These species are not actively fished in the Project Area and are unlikely to be present within 155 m of the wellsites given the depths at which the wells will be drilled.

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.

Residual environmental effects of discharges of drill muds and cuttings on Current Aboriginal Use of Lands and Resources for Traditional Purposes Aboriginal fisheries are therefore predicted to be not significant.

Other Discharges and Emissions

Other discharges and emissions (including drilling and testing emissions) will result in temporary and localized effects on water quality around the wellsite in the Project Area. Discharges will be in accordance with the OWTG and are not predicted to adversely affect fish species or their prey in the Project Area or the LAA. Such discharges may include organic matter, substances containing minor amounts of chemicals and/or residual hydrocarbons and are expected to disperse quickly in the open ocean environment and/or be degraded by bacterial communities. Given compliance with the OWTG, discharges are not expected to create toxic effects on fisheries or their prey species. Discharges and emission are therefore not expected to cause a Change in Traditional Use.

Residual environmental effects of other discharges and emissions on Current Aboriginal Use of Lands and Resources for Traditional Purposes are therefore predicted to be not significant.

VSP

Sound levels associated with VSP surveys will be in the range of 220–45 dB re1 µPa @ 1 m and could occur up to one day per well. According to the results of acoustic modelling conducted for the Shelburne Basin 3D Seismic EA (Matthews 2013 in Appendix A of LGL 2013), horizontal distances for SPLs of ≤ 160 dB_{RMS} re 1 µPa could extend up to 26 km from the wellsite during VSP surveys. As noted in Section 7.1.4, startle and alarm responses in fish have been observed at SPLs as low as 156–161 dB re 1 µPa; therefore, based on a conservative approach of applying modelling results for 3D seismic to estimate effects from VSP, behavioural responses in fish (*e.g.*, swimming activity) have potential to occur up to approximately 26 km from the VSP sound source. Even with this conservative estimate, effects from VSP noise on Aboriginal fisheries are

expected to be limited and localized within the LAA, short-term in duration, and reversible. There are no important spawning areas or unique fishing grounds within 26 km of the Project Area, and given the short-term nature of this interaction (up to one day per well), adverse effects on species migration and spawning are not anticipated.

Residual environmental effects of VSP on the Current Aboriginal Use of Lands and Resources for Traditional Purposes are therefore predicted to be not significant.

OSV Operations

OSVs will use existing shipping routes when travelling between the MODU and the supply base in Halifax Harbour and will adhere to standard navigation procedures, thereby avoiding potential conflicts with Aboriginal FSC or communal commercial fisheries. As noted in Section 7.2.8, any environmental effects on fish attributable to OSV traffic and operations would represent a small incremental increase over similar effects currently associated with existing high levels of marine traffic and shipping activity throughout the RAA.

Residual environmental effects of OSV operations on Current Aboriginal Use of Lands and Resources for Traditional Use are therefore predicted to be not significant.

Well Abandonment

Abandonment of wells could potentially interact with Aboriginal fishing activities in the Project Area, either through a change in fish habitat (if the wellhead is kept in place) or temporary underwater noise. Wells will be abandoned in accordance with CNSOPB requirements and will take approximately 7–10 days. Where removal of the wellhead is required, the wellhead and associated equipment will be removed up to 1 m BSF through mechanical means (cutters).If approval is sought and provided to keep the wellhead in place, the wellhead will be marked on nautical charts. However, wellheads are not expected to interact with Aboriginal fisheries given the temporary nature of the abandonment operation, the localized effects around the wellhead, and the water depths at the wellsite and in the Project Area.

Residual environmental effects of well abandonment on Current Aboriginal Use of Lands and Resources for Traditional Purposes are therefore predicted to be not significant.

7.7.9 Summary of Residual Project-Related Environmental Effects

In consideration of the extent of the interactions, potential environmental effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes are determined to be not significant for all Project activities and components rated as 1 in Table 7.7.3. These residual effects are not considered further in the assessment of Project-related effects but are considered, as applicable, in the context of cumulative effects assessment (refer to Section 10). In addition to any standard mitigation described above, Shell has committed to developing and implementing Fisheries Communications Plans for commercial and Aboriginal fisheries representatives which will facilitate coordinated communication around routine Project activities

and components as well as accidental events. Additional information on these plans is provided in Sections 3, 4 and 8 of this EIS.

Environmental effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes are predicted to be not significant.