The Shelburne Basin Venture Exploration Drilling Project: Environmental Review of Riser/Lower Marine Riser Package Response Options

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GLOSSARY

Blowout Preventer (BOP): A safety device that connects to the wellhead to prevent an uncontrolled release of fluids

Buoyancy Modules: Buoyant material added to the riser to reduce the weight of the riser in water

Lower Marine Riser Package (LMRP): A connector system that allows the riser to be disconnected from the BOP on the wellhead

Remotely Operated Vehicle (ROV): An unmanned submersible unit for performing underwater functions and observations

Riser: The conduit that connects the drillship to the Blowout Preventer (BOP) on the wellhead

Synthetic Based Muds (SBM): Synthetic fluid based drilling mud

Valued Components (VCs): 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

EXECUTIVE SUMMARY

Shell Canada Limited (Shell) is considering one or more of the following response options following an event in which the riser and Lower Marine Riser Package (LMRP) accidentally fell to the seabed at the Cheshire wellsite during the course of activities associated with Shell's Shelburne Basin Venture Exploration Drilling Project:

- abandonment of the riser and/or LMRP in place
- recovery of the riser and/or LMRP

An independent environmental review of riser/LMRP response options was conducted by Stantec Consulting Ltd. (Stantec) to evaluate the potential environmental effects associated with each of the response options listed above. This review is intended to inform proponent and regulatory decision-making on potential environmental effects, but does not compare the relative advantages and disadvantages of the options under consideration or make recommendations for a preferred option.

The environmental review is focused on the following Valued Components (VCs):

- Fish and Fish Habitat
- Marine Mammals and Sea Turtles
- Marine Birds
- Special Areas
- Commercial Fisheries
- Current Aboriginal Use of Lands and Resources

The review evaluates the potential environmental effects for each VC that may arise from each response option under consideration, as well as from accidental events. Mitigation is proposed to reduce, eliminate and/or control potential adverse environmental effects, including: adherence to Shell's Health, Safety, Security, Environment and Social Performance (HSSE & SP) Control Framework and applicable operational procedures, ongoing communication with Aboriginal and non-Aboriginal fishers, measures to reduce marine traffic-related risks, and compensation for Project-related damage to fishing gear (if any). The evaluation of potential cumulative effects considers whether there is potential for the residual environmental effects of the Project (*i.e.*, those environmental effects that remain after application of the proposed mitigation measures) to interact cumulatively with the residual environmental effects of other past, present, or future physical activities in the vicinity of the Project.

The review concludes that for both response options, (*i.e.*, abandonment of the riser and/or LMRP, or recovery of the riser and/or LMRP), residual adverse environmental effects are predicted to be not significant for any VCs, including environmental effects associated with accidental events and cumulative environmental effects, provided that the proposed mitigation is implemented, including application of existing best management practices.

1.0 INTRODUCTION

Shell Canada Limited (Shell) engaged Stantec Consulting Ltd. (Stantec) to conduct an independent environmental review of various response options under consideration following an event in which the marine riser and Lower Marine Riser Package (LMRP) accidentally fell to the seabed near the Cheshire wellsite during the course of activities associated with Shell's Shelburne Basin Venture Exploration Drilling Project.

This review document evaluates potential environmental effects associated with 1) abandonment of the riser and/or LMRP on the seafloor, and 2) recovery of the riser and/or LMRP. The review is intended to inform Shell and the Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) regarding the fate of the marine riser system, but is not intended to compare the relative advantages and disadvantages of the options under consideration, or make recommendations for a preferred option. Selection of a preferred response option will be undertaken by Shell in consultation with the CNSOPB as lead agency with regulatory oversight for drilling activities in the Nova Scotia offshore, and following discussions with First Nations and stakeholders.

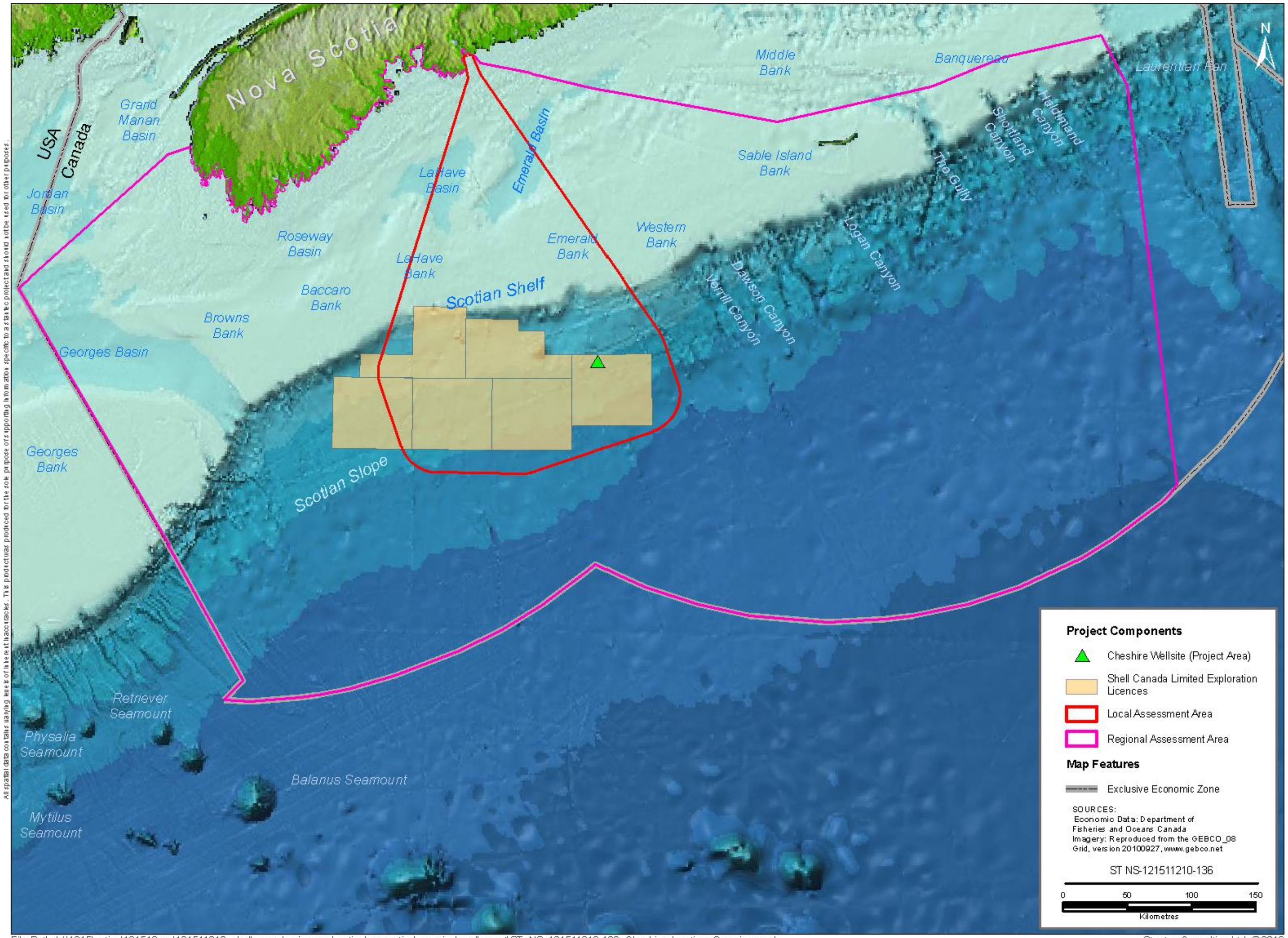
2.0 INCIDENT DESCRIPTION AND RESPONSE OPTIONS

2.1 INCIDENT DESCRIPTION

On March 5, 2016 while waiting on weather, the Stena IceMAX (the IceMAX) disconnected from the Cheshire L-97 well at the blowout preventer (BOP) via the LMRP. After this successful disconnection, the IceMAX was in the process of moving away from the wellsite to a pre-designated location, when the riser tensioner load ring released from the riser slip joint, allowing the LMRP and riser to drop to the seafloor. No personnel were injured during this event. No synthetic based muds (SBM) or other hydrocarbons or hydrocarbon-based products were released to the environment.

Surveys of the seafloor were completed following the incident using a remotely-operated vehicle (ROV). The surveys confirmed the location and configuration of the 2 km long marine riser and the LMRP on the seabed. The riser string crisscrosses and/or loops over itself at least 20 times on the seabed. The maximum elevation of the riser above the seabed was approximately 7 m. The majority of the riser is located northeast, east, southeast and south of the Cheshire well location within an approximate 280 m x 240 m area (Shell 2016). Of the 804 buoyancy modules originally affixed to the riser, nine were dislodged and released to surface (and subsequently lost at sea) during the incident. Eight modules were found to be dislodged and partially attached to the riser. Observations during the ROV survey suggested that the remaining 787 buoyancy modules at the seabed remained securely attached. The ROV survey also determined that the LMRP is completely buried in the seabed silt, with no part of the unit visible. In May 2016, the riser was resurveyed using the ROV. The maximum elevation of the riser above the seabed was observed to be 6 m. The eight buoyancy modules identified as dislodged in the previous survey were still attached to the riser. Six of these modules were recovered and the remaining modules were confirmed to be secure.

The location of the Cheshire wellsite is shown on Figure 1. The well is located approximately 250 km offshore Nova Scotia, in the Shelburne Basin. The water depth at the wellsite and where the riser/LMRP is located is approximately 2143 m.



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Stantec Consulting Ltd. ©2016

Figure 1 Project Location

2.2 RESPONSE OPTIONS UNDER CONSIDERATION

Shell is considering one or more of the following response options:

- abandonment of the riser and/or LMRP in place
- recovery of the riser and/or LMRP

The term 'the Project' is used throughout this document to refer to the potential implementation of any one of these response options, or the potential implementation of more than one of these response options in combination. Each individual response option under consideration represents a potential 'Project activity' in this environmental review and is described below.

The following descriptions are based primarily on project-specific information provided by Shell.

2.2.1 Abandonment of Riser and/or LMRP

This potential Project activity would consist of leaving the riser and/or LMRP in place (*i.e.*, laying on and/or embedded into the seafloor) indefinitely, with no plans for future recovery.

There is the potential for buoyancy modules on the abandoned riser to break apart and/or become loose and detach over time, in which case they could ascend to the surface in an uncontrolled manner and become lost at sea.

2.2.2 Recovery of Riser and/or LMRP

This potential Project activity would likely include underwater cutting of the riser into smaller segments, excavation via trenching/jetting into the seabed, and slinging and lifting the riser and/or LMRP to the surface and onto a recovery vessel. The recovered components of the riser and/or LMRP would then be disposed and/or recycled at appropriate land-based facilities. A safety zone may be established around Project vessels actively engaged in recovery activities in the Project Area.

It is anticipated that fragments of buoyancy modules released during underwater cutting operations of the riser could rise to the surface, resulting in floating debris. Although all reasonable efforts would be made to recover this material, it is anticipated that only some of the debris would be recoverable and the remainder would be lost at sea.

Riser and LMRP-specific response activities are described below.

2.2.2.1 Riser

The recovery of the riser would be conducted in stages: 1) surveying, 2) excavation, and 3) cutting and recovery of the riser joints. Prior to commencing any recovery operation, a detailed ROV survey of the riser, identifying each joint individually, would be carried out in the Project

Area. A cutting and recovery plan would also be developed to safely and effectively manage the sequence of the recovery operations.

The recovery efforts would be completed with a specialized salvage vessel, equipped with a suitable crane. The cutting operations would be carried out using the Diamond Wire Cutting Machine (DWCM). Alternatively, a Platform Supply Vessel (PSV) could be utilized to transport the riser debris ashore.

Removal of the riser would require excavation at designated locations along the riser. An ROV mounted with an excavator tool would be deployed to excavate 0.5 m under the riser joints for the installation of lifting slings. A soft sling would be threaded under the riser (in the excavated locations) and choked around the buoyancy material. The ROV excavator would then be used as required to excavate under the area of the riser where the DWCM would be positioned to cut. Once cut and secured, the cut riser joint would be lifted to the surface via a specialized crane and secured on the deck of the recovery vessel. This process would be completed for each riser joint to be recovered.

It is estimated that recovery of the approximately 2 km length of riser (comprising 85 marine riser joints) from the seabed could take approximately 6 months or more to complete. Operations will be limited to suitable weather conditions and the availability of a specialized vessel.

2.2.2.2 Lower Marine Riser Package (LMRP)

There are several variables determining the actual procedures to be implemented for the recovery of the LMRP. The angle at which the LMRP came to rest has to be established initially. If the LMRP is in the vertical or near vertical position, recovery procedures would be less complex compared with if the LMRP is on its side).

Prior to commencing any excavation work, a site survey of the area around the LMRP impact location would be completed using an ROV. This survey would locate the point where the riser enters the seabed leading back from the LMRP. Excavation operations would commence at that location, removing the silt from the riser/booster joint and working back towards the LMRP until the actual location and attitude of the LMRP is established.

Excavation of the seabed would also be required to access the LMRP for recovery. Excavation would be carried out using the EVO 250 Jetprop Mass Flow Excavating (MFE) tool. The excavation tool would be run on drill pipe. The tool produces 25000 m^3 of water per hour and is powered by seawater pressure (up to 3,000 psi) through the drill string from the rig mud pumps. Once the initial excavation location is determined, the MFE would be lowered and positioned at the identified site. Pumping would be initiated and excavation would begin.

Excavation would continue around the circumference of the LMRP until a crater has been opened up all the way around the unit. Excavation would continue under, through, and around the LMRP until it is determined the unit is sufficiently free to allow it to be lifted clear of the seabed and recovered to the rig. The position of the LMRP in the seabed would determine how the LMRP would be disconnected from the riser to enable lifting/recovery, and this could require cutting.

Recovery of the LMRP would likely be undertaken by a drillship and is expected to take approximately 20-30 days, assuming the LMRP is in a generally upright position in the seabed. Additional time may be required if it is discovered that the LMRP is lying on its side.

3.0 ENVIRONMENTAL EFFECTS ASSESSMENT SCOPE AND METHODS

The scope of the Project to be assessed in this review is limited to the potential implementation of one or more of the response options described in Section 2.2. Each response option under consideration represents a potential Project activity.

Table 1 identifies the Valued Components (VCs) considered in this review and provides the rationale for selection of each VC.

Table 1 Selection of Valued Components

Valued Component	Rationale for Selection
Fish and Fish Habitat	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), and the potential for interactions with Project activities and components. 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.
Marine Mammals and Sea Turtles	Marine Mammals and Sea Turtles were selected as a VC in recognition of the ecological value they provide to marine ecosystems, specific regulatory requirements under the *Species at Risk Act* (SARA), and potential interactions with the Project. This VC considers secure species as well as species of marine mammals and sea turtle species of conservation interest (SOCI) listed under SARA or considered at risk by the Committee on the Status of Endangered Wildlife in Canada (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.
Marine Birds	Marine Birds were selected as a VC due to their ecological value to marine and coastal ecosystems, potential interaction with Project activities and components, and regulatory considerations. The Marine Birds VC includes pelagic (*i.e.*, offshore) and neritic (*i.e.*, inshore) seabirds, waterfowl, and shorebirds that are protected under the *Migratory Birds Convention Act* (MBCA). This VC considers all marine birds listed under Schedule 1 of SARA, COSEWIC, and/or the Nova Scotia *Endangered Species Act* (NS ESA), which are collectively being referred to as SOCI.
Special Areas	Special Areas were 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. The assessment of Special Areas is therefore closely linked to all of the other VCs considered in this assessment.

Table 1 Selection of Valued Components

Valued Component	Rationale for Selection
Commercial Fisheries	Commercial Fisheries were selected as a VC due to the commercial and cultural importance of commercial fisheries to the region, specific regulatory requirements of the *Fisheries Act*, 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.
Current Aboriginal Use of Lands and Resources for Traditional Purposes	Current Aboriginal Use of Lands and Resources for Traditional Purposes refers to communal commercial, as well as food, social and ceremonial (FSC) fishing activities by Aboriginal peoples that could potentially interact with the Project. It is included as a VC in recognition of the social, cultural and economic importance of marine life and fishing to Aboriginal peoples and also in recognition of potential or established Aboriginal and Treaty rights.

Section 4 provides a description of existing environmental conditions pertaining to each VC.

Potential Project-related effects on each VC are identified and assessed in Section 5.1. The effects assessment is subject to the following temporal and spatial boundaries:

- The temporal boundaries for the Project to be assessed encompass all potential Project activities under consideration. Thus, the temporal boundaries range from an estimated ≥ 6 months for recovery of the riser and/or LMRP to indefinitely for abandonment of the riser and/or LMRP. It is assumed that Project activities could occur at any time of day/night and at any time of year.
- The spatial boundaries for the Project to be assessed are defined below.
  - **Project Area:** The Project Area encompasses the immediate area in which Project activities and components may occur, including direct physical disturbance (*i.e.*, Project footprint). The Project Area is illustrated on Figure 1 as the Cheshire wellsite.
  - **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 is illustrated on Figure 1.
  - **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 physical activities. The RAA is illustrated on Figure 1.

The environmental effects assessment begins in Section 5 with identification of potential Project-VC interactions.

The mitigation measures proposed to reduce, eliminate and/or control potential adverse environmental effects are listed in Section 5.2.

Descriptors for residual effects (*i.e.*, magnitude, geographic extent, duration, frequency, reversibility and context) are defined in Section 5.3.1. Section 5.3.2 establishes VC-specific thresholds for determining significance of residual environmental effects.

The residual effects characterization criteria defined in Section 5.3.1 are applied in Section 5.4 to support characterization of the nature and extent of residual environmental effects (*i.e.*, those environmental effects that remain after application of the mitigation measures proposed in Section 5.2) on each VC. Determinations of significance are also provided in Section 5.4, in consideration of the characteristics of residual environmental effects and the VC-specific thresholds for significance established in Section 5.3.2.

4.0 EXISTING CONDITIONS

The Project Area, LAA and RAA have been subject to previous and ongoing human activities, including offshore oil and gas activity, shipping, military exercises, scientific research and fishing.

The following VC-specific descriptions of existing conditions are primarily based on information from the Environmental Impact Statement (EIS) for the Shelburne Basin Venture Exploration Drilling Project (Stantec 2014) and supplemented with other survey information and information gathered via stakeholder engagements, noted below.

4.1 FISH AND FISH HABITAT

The following fish species are identified as potentially having eggs/larvae located on the Scotian Slope and in the vicinity of the Project Area: Acadian redfish *(Sebastes fasciatus)*, deepwater redfish (*Sebastes mentalla*), roundnose grenadier (*Coryphaenoides rupestris*), silver hake (*Merluccius bilinearis*), and witch flounder (*Glyptocephalus cynoglossus*). 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). Studies have however indicated that the eggs/larvae of the majority of fish species that may occur in the vicinity of the Cheshire well tend to be found on the banks of the Scotian Shelf and/or in nearshore waters, rather than on the Slope.

There are several species of commercial, recreational, or Aboriginal fisheries that may be present in the RAA including species which may be present in or migrate through the Project Area. One such species identified as important to Aboriginal fisheries includes the American eel (*Anguilla rostrata*). Mature American eels spawn in the Sargasso Sea and as they migrate back to North American coastal waters transform from transparent glass eels, into elvers which run into freshwater streams (peaking April to June in Nova Scotia). Elvers transform into yellow eels which spend years in freshwater streams and coastal areas before maturing into silver eels which then return to the Sargasso Sea to spawn.

A seabed survey conducted in 2014, as well as the pre-drilling ROV survey conducted in 2015 confirmed the absence of aggregations of habitat-forming coral concentrations, sponges or other sensitive or unique benthic habitat at the Cheshire wellsite. These surveys also verified the presence of a low-energy, Holocene mud and clay benthos.

ROV surveys conducted in October and November 2015 recorded the following benthic species (as identified by Stantec): brittle star (common), crinoid (feather star) (uncommon), sea cucumber (occasional), common sea stars (*Asterias rubens*) (uncommon), sea anemone (occasional), cup coral (uncommon), sea whip (uncommon), chimaera fish (uncommon), and unknown fish species were also occasionally observed. These observations were consistent with those noted during the 2014 seabed survey (Figure 2).

A total of 28 groundfish and pelagic fish species have been identified as Species of Conservation Interest (SOCI) that can be found in the RAA; however, none have been observed during the pre-drilling or post-incident ROV surveys at the Cheshire wellsite. Except for the roughhead grenadier (*Macrourus berglax*) and the roundnose grenadier, these SOCI fish species are typically not found at the depth at which the Cheshire wellsite and riser system are located and have low potential for occurrence in the Project Area.

The overall diversity and abundance of species is low within the Project Area.

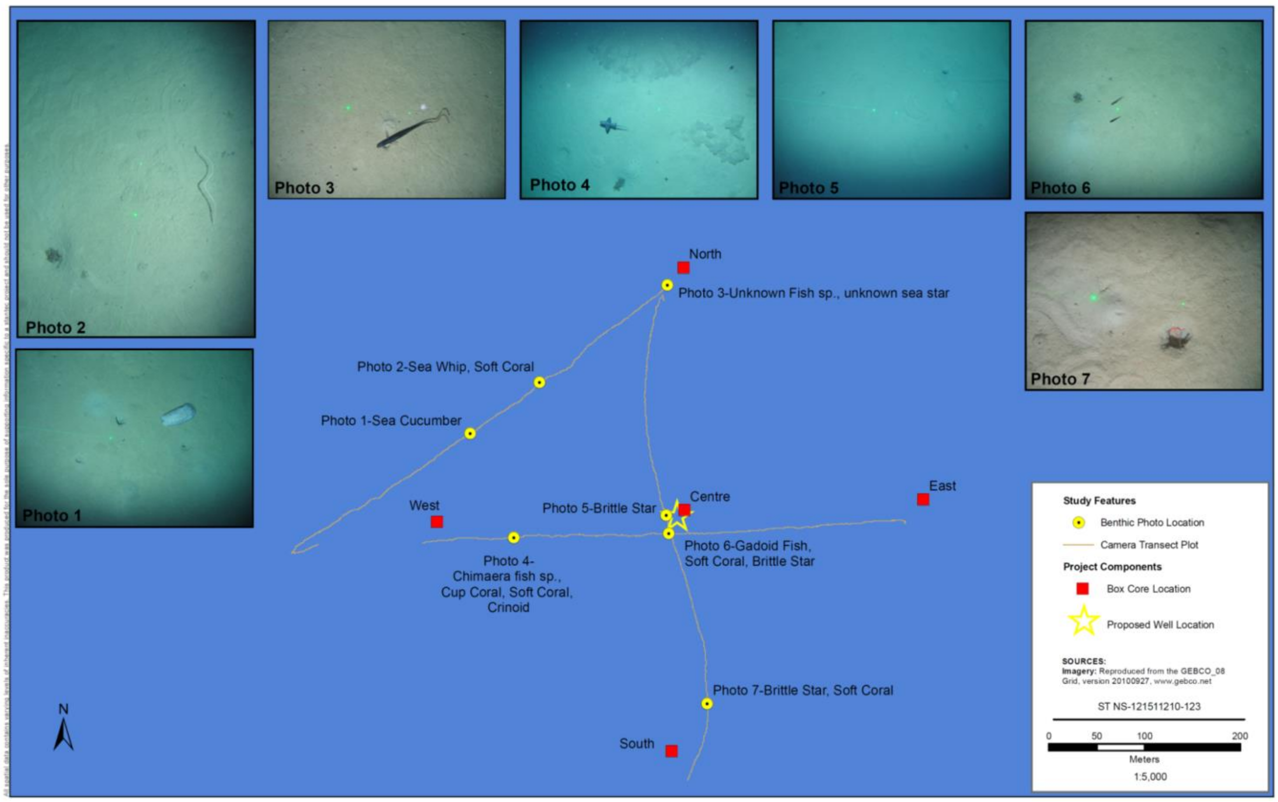

Figure 2 Benthic Species Observed during the 2014 Seabed Survey at Cheshire Wellsite

4.2 MARINE MAMMALS AND SEA TURTLES

Six species of mysticetes and ten species of odontocetes are 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. Five species of pinnipeds (seals) 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). Four species of sea turtles 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 Canadian waters. These species are known to occur in the vicinity of the Project Area primarily between April and December.

A total of 10 marine mammal and sea turtle SOCI have the potential to occur in the RAA including: blue whale *(Balaenoptera musculus),* fin whale *(Balaenoptera physalus),* humpback whale *(Megaptera novaeangliae),* North Atlantic right whale *(Eubalaena glacialis),* harbour porpoise *(Phocoena phocoena),* killer whale *(Orcinus orca),* Northern bottlenose whale *(Hyperoodon ampullatus),* Sowerby's beaked whale *(Mesoplodon bidens),* leatherback sea turtle *(Dermochelys coriacea),* and loggerhead sea turtle *(Caretta caretta)*. The list represents approximately half of the total marine mammal and sea turtle species that may occur in the RAA (Stantec 2014). No seal populations within the RAA are considered SOCI.

No critical habitat for marine mammals or sea turtle species has been designated within the Project Area or LAA, 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 63 km from the LAA and 227 km from the Cheshire wellsite) and critical habitat for the northern bottlenose whale has been identified in the Gully (approximately 244 km from the LAA and 297 km from the Cheshire wellsite), Shortland Canyon (approximately 301 km from the LAA and 353 km from the Cheshire wellsite) and Haldimand Canyon (approximately 335 km from the LAA and 387 km from the Cheshire wellsite). Although critical habitat has not yet been designated for the leatherback sea turtle within any of the spatial bounds of the Project, the leatherback and other sea turtle species are known to migrate through and forage along the Scotian Slope.

On February 26, 2016, a pod of approximately 30 unidentified dolphins were recorded 200 m off the bow of the IceMAX during drilling operations at the Cheshire wellsite.

4.3 MARINE BIRDS

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).

Six marine bird SOCI occur within the RAA for the Project: Ivory Gull (*Pagophila eburnea*), Piping Plover (*Charadrius melodus*), Roseate Tern (*Sterna dougallii*), Red Knot (*Calidris canutus*), Harlequin Duck (*Histrionicus histrionicus*), and Barrow's Goldeneye (*Bucephala islandica*). Critical habitat is identified for both Piping Plover and Roseate Tern within the RAA but does not occur within the LAA. Nine coastal important bird areas (IBAs) are present within the RAA; however no IBAs are present within the LAA or within the vicinity of the Cheshire well.

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.

According to the conditions of the Environment Canada - Canadian Wildlife Service permit obtained in support of the Shelburne Basin Venture Exploration Drilling Project, personnel onboard the IceMAX and associated supply and support vessels record stranded marine birds captured and released, and those found deceased. Migratory birds observed, captured and released around the vessels to date have included Leach's Storm Petrels, Dovekies, Thick-billed Murres, and Great Black-backed Gulls. Unidentified sparrow and swallow species have also been recorded by the IceMAX, presumably having sought refuge during transit from inshore.

4.4 SPECIAL AREAS

A small portion of the Scotian Slope Ecologically and Biologically Sensitive Area (EBSA) is overlapped by the Project Area. The next closest Special Areas are the Haddock Box and the Sambro Bank Sponge Conservation Area, which are located approximately 69 km north and 170 km north from the Cheshire wellsite, respectively. The Haddock Box is partially located within the LAA and the Sambro Bank Sponge Conservation Area is located entirely within the LAA; neither areas overlap with the Project Area.

The Scotian Slope EBSA occupies approximately 68 603 km^2 and is located on the Scotian Slope from Georges Bank to the Laurentian Channel. This 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).

4.5 COMMERCIAL FISHERIES

There is minimal commercial fishing effort within the LAA. The limited harvesting 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. This low level of commercial fishing activity was also noted within fisheries observation reports compiled during Project drilling in the area since October 2015.

4.6 CURRENT ABORIGINAL USE OF LANDS AND RESOURCES FOR TRADITIONAL PURPOSES

There are 144 communal commercial licences held by Aboriginal groups in the DFO Maritimes Region within the Western Scotian Shelf and Slope region. 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.

Membertou Geomatics Services (MGS) and Unama'ki Institute of Natural Resources (UINR) undertook a Traditional Use Study (TUS) in 2014 which provided information on Aboriginal fishing activities in the RAA. According to the TUS, 37 fish species, one mammal (seal), and nine invertebrate groups were identified as species harvested for food, social and ceremonial (FSC) purposes. The TUS findings indicated that no FSC fishing was reported in the vicinity of the Project Area. This low level of fishing activity within the Project Area was also confirmed at recent Shell engagements with Aboriginal fishers (Appendix A). However, the TUS also acknowledged that this should not indicate that FSC fisheries are not occurring in this area or that the area may not be accessed for future FSC fisheries. Lobster and herring were identified as currently being harvested within the LAA. 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). To be conservative, it is assumed that FSC fisheries could potentially occur in the Project Area, LAA, and RAA.

5.0 ENVIRONMENTAL EFFECTS ASSESSMENT

5.1 POTENTIAL INTERACTIONS AND ENVIRONMENTAL EFFECTS

Table 2 identifies potential interactions between the Project activities under consideration and each VC, and describes associated potential environmental effects.

Table 2 Potential Project-VC Interactions and Environmental Effects

VCs	Potential Project-VC Interactions (Denoted by "✓")				Description of Potential Environmental Effects
	Abandonment		Recovery		
	Of Riser	Of LMRP	Of Riser	Of LMRP	
Fish and Fish Habitat	✓	✓	✓	✓	• Abandonment of the riser and/or LMRP could cause: o a Change in Risk of Mortality or Physical Injury (particularly for benthic and demersal species) due to the potential release of toxic or harmful constituents as components of the riser and/or LMRP corrode and degrade over time. The buoyancy modules are considered to be chemically inert and do not contain any hazardous material; however the chemical breakdown of some other materials comprising the riser and LMRP is currently unknown. o a Change in Habitat Quality and Use (particularly for benthic and demersal species) due to the abandonment of a substantial amount of foreign anthropogenic material on the seabed, thereby permanently altering the benthic habitat. • Recovery of riser and/or LMRP could cause: o a Change in Risk of Mortality or Physical Injury (particularly for benthic and demersal species) due to direct physical disturbance associated with jetting/trenching into the seabed and the use of underwater cutting equipment. There is also potential for buoyancy modules on the riser to break apart, and small fragments could cause harm if ingested. o a Change in Habitat Quality and Use due to re-suspension of sediments during subsea excavation activities and underwater noise associated with operation of Project vessels and equipment, as well as routine waste discharges (*e.g.*, ballast water, deck drainage, sanitary discharges, food waste) from Project vessels.

Table 2 Potential Project-VC Interactions and Environmental Effects

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	Abandonment		Recovery		
	Of Riser	Of LMRP	Of Riser	Of LMRP	
Marine Mammals and Sea Turtles	✓		✓	✓	• Abandonment of the riser could cause: o a Change in Risk of Mortality or Physical Injury due to the low potential for entanglement in riser loops (given water depths). There is also potential for buoyancy modules on the riser to break apart, and small fragments could cause harm if ingested. • Recovery of riser and/or LMRP could cause: o a Change in Risk of Mortality or Physical Injury due to the risk of collision with Project vessels, as well as the potential for harm caused by ingestion of debris released during cutting of the riser. o a Change in Habitat Quality and Use due to re-suspension of sediments during subsea excavation activities and underwater noise associated with operation of Project vessels and equipment, as well as routine waste discharges (*e.g.*, ballast water, deck drainage, sanitary discharges, food waste) from Project vessels.
Marine Birds	✓		✓	✓	• Abandonment of the riser could cause: o a Change in Risk of Mortality or Physical Injury due to the potential for buoyancy modules on the riser to break apart, and small fragments could cause harm if ingested. o a Change in Habitat Quality and Use due to the potential for buoyancy modules to break apart and/or become loose and detach over time, in which case they could attract birds. Large pieces floating on the surface could serve as resting platforms and small fragments could be confused for a food source. • Recovery of riser and/or LMRP could cause: o a Change in Risk of Mortality or Physical Injury due to the presence and operation of Project vessels, which would increase the risks of potential exposure to residual contaminants in routine discharges (*e.g.*, bilge water, deck drainage), impacts with vessel structures, and disorientation and stranding as a result of artificial night lighting. There is also potential for harm caused by ingestion of debris released during cutting of the riser. o a Change in Habitat Quality and Use due to potential attraction to visual cues and routine discharges of sanitary and domestic waste associated with the presence and operation of Project vessels. There is also potential for marine birds to be deterred from areas subject to Project-related noise.

Table 2 Potential Project-VC Interactions and Environmental Effects

VCs	Potential Project-VC Interactions (Denoted by "✓")				Description of Potential Environmental Effects
	Abandonment		Recovery		
	Of Riser	Of LMRP	Of Riser	Of LMRP	

Special Areas	✓	✓	✓	✓	• Abandonment of the riser and/or LMRP could cause:
					  o a Change in Habitat Quality and Use for species within the Scotian Slope EBSA for the reasons described above with respect to the potential effects of this Project activity on the Fish and Fish Habitat, Marine Mammals and Sea Turtles, and Marine Birds VCs. The Project is not likely to interact substantively with any other Special Areas, given their distances from the Project Area.
					• Recovery of riser and/or LMRP could cause:
					  o a Change in Habitat Quality and Use for species within the Scotian Slope EBSA for the reasons described above with respect to the potential effects of this Project activity on the Fish and Fish Habitat, Marine Mammals and Sea Turtles, and Marine Birds VCs. The Project is not likely to interact substantively with any other Special Areas, given their distances from the Project Area.

Commercial Fisheries	✓	✓	✓	✓	• Abandonment of the riser and/or LMRP could cause:
					  o a Change in Availability of Fisheries Resources (*e.g.*, accessibility) due to the potential for buoyancy modules on the riser to break apart and/or become loose and detach over time, in which case they could pose a risk to commercial fishing vessels and gear.
					• Recovery of riser and/or LMRP could cause:
					  o a Change in Availability of Fisheries Resources (*e.g.*, accessibility) due to exclusion of fishers from a safety zone that may be established during Project activities. There is also potential for damage to commercial fishing gear caused by debris released during cutting of the riser.

Current Aboriginal Use of Lands and Resources for Traditional Purposes	✓	✓	✓	✓	• Abandonment of the riser and/or LMRP could cause:
					  o a Change in Traditional Use due to the potential for buoyancy modules on the riser to break apart and/or become loose and detach over time, in which case they could pose a risk to Aboriginal fishing vessels and gear.
					• Recovery of riser and/or LMRP could cause:
					  o a Change in Traditional Use due to potential exclusion of Aboriginal fishers from a safety zone that may be established during Project activities. There is also potential for damage to Aboriginal fishing gear caused by debris released during cutting of the riser.

5.2 MITIGATION

Implementation of the mitigation measures outlined below is proposed to reduce, eliminate and/or control potential adverse environmental effects that could arise as a result of the Project.

5.2.1 Mitigation Measures for Abandonment of the Riser and/or LMRP

If abandonment of the riser and/or LMRP is undertaken, Shell would compensate any Project-related damage to fishing gear in accordance with the *Compensation Guidelines with Respect to Damages Relating to Offshore Petroleum Activity* (C-NLOPB and CNSOPB 2002).

The location of the abandoned riser and/or LMRP would be published in Notices to Mariners for consideration by fishers and other marine users.

5.2.2 Mitigation Measures for Recovery of the Riser and/or LMRP

The following general mitigation measures are applicable to the recovery of the riser and/or LMRP.

- All operations would be required at a minimum to comply with Shell or contractor standards and with external regulatory standards. Shell would require contractors to demonstrate that they have in place an acceptable Health, Safety and Environment Management System, and that they are committed to its implementation. In the event that sub-contractors are used, the main contractor would be required to ensure that these sub-contractors also conform to the same standards and requirements.
- Project vessels would comply with the *Canada Shipping Act* and national and international regulations while at sea, Eastern Canadian Vessel Traffic Services Zone Regulations when operating in nearshore or harbour areas, and applicable Port Authority requirements when in a port.
- Project vessels would adhere to Annex I of the *International Convention for the Prevention of Pollution from Ships* (MARPOL 73/78), of which Canada has incorporated provisions under various sections of the *Canada Shipping Act* and its regulations. This would include managing routine waste discharges (*e.g.*, ballast water, deck drainage, sanitary discharges, food waste) in compliance with MARPOL.
- The transportation of any dangerous goods, waste dangerous goods or hazardous substances would occur in compliance with the *Transportation of Dangerous Goods Act* and its associated regulations.
- Wastes destined for onshore treatment, recycling and/or disposal would be managed in accordance with the Nova Scotia *Solid Waste-Resource Management Regulations* and would comply with any applicable federal and provincial waste requirements as well as municipal by-laws.

- Environmental, health and safety management of the recovery effort would follow procedures and requirements described in Shell's Health, Safety, Security, Environment and Social Performance (HSSE & SP) Control Framework and Corporate Standards.
- Shell and its contractors would have measures in place to reduce the potential for vessel collisions and any resulting spills. This includes:
  - all activities adhering to Annex I of the *International Convention for the Prevention of Pollution from Ships* (MARPOL 73/78).
  - adherence to standard navigation procedures, Transport Canada regulations and Canadian Coast Guard requirements.
  - special attention to activities presenting increased risks for marine traffic including loading and offloading, docking and extreme weather events.
- If stranded birds are found on Project vessels, they would 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 Canadian Wildlife Service (CWS). Activities would comply with the permit conditions for handling, documenting and reporting any stranded birds (or bird mortalities) to CWS during the Project activities. To differentiate between Wilson's Storm-Petrel and Leach's Storm-Petrel, photographs depicting their differences would be provided to crew members trained to check for and handle stranded birds.
- Project vessels would use existing shipping routes when travelling to and from the Project Area, adhere to standard navigation procedures, and reduce speeds to 18.5 km/hour (10 knots) within the Project Area.
- Shell has been engaging with First Nations organizations and Aboriginal and commercial fishers in regards to the riser since March 2016. An overview of the engagements to date can be found in Appendix A.
- Shell would communicate with Aboriginal and non-Aboriginal fishers before, during, and after Project activities. Details regarding the timing and location of Project activities would be published in Notices to Shipping and Notices to Mariners.
- Shell would continue to engage Aboriginal and non-Aboriginal fishers to share Project details as applicable and facilitate coordination of activities.
- Project-related damage to fishing gear, if any, would be compensated in accordance with the *Compensation Guidelines with Respect to Damages Relating to Offshore Petroleum Activity* (C-NLOPB and CNSOPB 2002).
- In the event that a vessel collision with a marine mammal or sea turtle occurs, Shell would contact the Marine Animal Response Society (MARS) or the Canadian Coast Guard to relay the incident information.
- Weather conditions would be monitored and Project activities would be suspended if weather becomes unsuitable.

- A safety zone may be established around Project vessels actively engaged in recovery activities in the Project Area.

In addition to the general mitigation measures discussed above, the following response-specific mitigation measures would be implemented to reduce potential Project-related adverse environmental effects if recovery of the riser and/or LMRP is undertaken:

- A detailed survey of the riser, identifying each joint individually, would be required prior to any recovery operation commencing. A cutting and recovery plan would be developed to appropriately manage the sequence.
- Prior to lifting, the ROV would be used to inspect the riser for damaged/loose modules, damaged pipework and other anomalies that could result in a dropped object, damage to the surface vessel(s), or the loss of buoyancy modules at sea.
- To prevent the riser from falling back to the seafloor a second sling would be attached immediately after liftoff, to reduce the chances of the slings slipping.
- To prevent potential damage to the recovery vessel from the swinging riser, regular maintenance and frequent inspections would be done prior to commencement of Project activities and on a regular basis for the duration of Project activities.

5.3 CHARACTERIZATION CRITERIA AND SIGNIFICANCE THRESHOLDS

5.3.1 Criteria for Characterizing Residual Environmental Effects

Table 3 defines broadly-applicable analysis criteria that are used in the assessment to support characterization of the nature and effect of residual environmental effects (*i.e.*, those environmental effects that remain after the proposed mitigation measures have been applied) on each VC.

Table 3 Criteria for Characterization of Residual Environmental Effects

Characterization	Description	Quantitative Measure of Definition of Qualitative Categories
Nature of Effect	The long-term trend of the residual effect	• **Positive (P)** – effect is beneficial relative to baseline • **Adverse (A)** – effect is detrimental relative to baseline • **Neutral (N)** – no net change relative to baseline
Magnitude	The expected degree or severity of the residual effect, in consideration of the proportion of the VC affected within the spatial boundaries and the relative effect	• **Negligible (N)** – no measurable change in species populations, habitat quality or quantity, or availability of/access to fisheries resources • **Low (L)** – measurable change that is within the range of natural variability and does not pose a risk to short-term viability of populations or fisheries • **Moderate (M)** – measurable change that may exceed natural variability but does not pose a risk to long-term viability of populations or fisheries

Table 3 Criteria for Characterization of Residual Environmental Effects

Characterization	Description	Quantitative Measure of Definition of Qualitative Categories
		• **High (H)** – measurable change that exceeds the limits of natural variability and may affect long-term viability of populations and/or fisheries
Geographic Extent	The geographic area or spatial scale over which an environmental effect is expected to occur	• **Project Area (PA)** – effects are restricted to the Project Area • **Local Assessment Area (LAA)** – effects are restricted to the LAA • **Regional Assessment Area (RAA)** – effects are restricted to the RAA
Duration	The length of time the residual effect is expected to persist, 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 throughout the entire duration of Project activities • **Long-term (LT)** – effect extends beyond the duration of Project activities
Frequency	How often the residual effect occurs, which 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 • **Continuous (C)** – effect occurs continuously
Reversibility	Whether or not the residual effect on the VC can return to its existing condition once the activity causing the disturbance ceases	• **Reversible (R)** – VC will recover to baseline conditions before or after completion of Project activities • **Irreversible (I)** – effect is permanent
Context	The influence of past and present human activities on the area in which the residual effect occurs	• **Undisturbed (U)** – effect occurs within a relatively pristine area that is unaffected or not adversely affected by past or present human activities • **Disturbed (D)** – effect occurs within a disturbed area that is affected or adversely affected by past or present human activities

5.3.2 Thresholds for Determining Significance

In consideration of the analysis criteria defined in Table 3, the thresholds described below have been established to define significant adverse residual environmental effects for each VC.

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 residual 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; or
- 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 Fisheries and Oceans Canada’s (DFO) *Fisheries Protection Policy Statement* (DFO 2013).

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 residual 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.

Marine Birds

For the purposes of this effects assessment, a significant adverse residual environmental effect on Marine Birds is defined as a residual 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.

Special Areas

For the purposes of this effects assessment, a significant adverse residual environmental effect on Special Areas is defined as a residual 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
- causes 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.

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 one or more of the following outcomes:

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

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; or
- unmitigated damage to fishing gear.

5.4 CHARACTERIZATION OF RESIDUAL ENVIRONMENTAL EFFECTS

Table 4 details the environmental effects assessment and prediction of residual environmental effects resulting from the potential Project-VC interactions identified in Table 2, including significance of those effects.

Table 4 Residual Environmental Effects Characteristics and Significance Determinations for Each VC

Potential Project Activities	Residual Environmental Effects	Residual Environmental Effects Characteristics (see Table 3 for definitions)							Notes	Significance (S= Significant; NS= Not Significant)
		Nature of Effect	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context		
Fish and Fish Habitat										
Abandonment of Riser and/or LMRP	Change in Risk of Mortality or Physical Injury	N-A[1]	N	PA[2]	LT	C	I	D	[1] The buoyancy modules on the riser are chemically inert. Abandonment of these riser components is therefore predicted to have a neutral effect of negligible magnitude with respect to a potential Change in Risk of Mortality or Physical Injury affecting fish. However, because information regarding chemical properties is not available for all components of the riser and LMRP, it is conservatively assumed for the purposes of this assessment that the materials in some of those components could release contaminants as they break down over time. Abandonment of some components of the riser and/or LMRP may therefore result in a highly localized Change in Risk of Mortality and Physical Injury for colonizing benthic organisms. It is expected that any contaminants would be released in very small quantities over a long period of time and would be quickly diluted in the ocean such that the magnitude of any resultant adverse effect would be negligible. The residual environmental impact resulting from seabed disturbance and sediment re-suspension would be low to negligible, as there is no expected seabed disturbance resulting from this operation.	NS
	Change in Habitat Quality and Use	P-A[3]	N-L	PA	LT	C	I	D	[2] Current measurements were taken in the area of the Cheshire wellsite on February 5 and March 7, 2016. The riser and LMRP are located at a water depth of approximately 2143 m. The bottom currents measured at 2100 m ranged from 4 cm/s to 13 cm/s and flowed towards the west. Overall, the currents were relatively weak (*i.e.*, less than 21 cm/s) throughout the water column, from 100 m to 2100 m. In consideration of these weak currents, residual environmental effects associated with re-suspended sediments would be primarily limited to the area of disturbance (*i.e.*, Project Area) and a very small portion of the surrounding LAA, immediately adjacent to the Project Area. [3] Refer to note 1 above. The potential release of contaminants from some components of the riser and/or LMRP could also result in a highly localized Change in Habitat Quality and Use for colonizing benthic organisms. It is expected that any contaminants would be released in very small quantities over a long period of time and would be quickly diluted in the ocean such that the magnitude of any resultant adverse effect would be negligible. The introduction of hard substrate with interstitial spaces may result in a positive Change in Habitat Quality and Use for some benthic and demersal species by enhancing the diversity of benthic habitat and creating an artificial 'reef effect' in an area otherwise generally devoid of hard substrate. The magnitude of such a positive effect is predicted to be low.	NS

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Table 4 Residual Environmental Effects Characteristics and Significance Determinations for Each VC

Potential Project Activities	Residual Environmental Effects	Residual Environmental Effects Characteristics (see Table 3 for definitions)							Notes	Significance (S= Significant; NS= Not Significant)
		Nature of Effect	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context		
Recovery of Riser and/or LMRP	Change in Risk of Mortality or Physical Injury	A	L-M[4]	PA	MT	C	R	D	[4] The magnitude of residual environmental effects is predicted to be low if only the riser is recovered and moderate if the LMRP is recovered with the riser or on its own. This is due to the relative increase in the extent of direct physical disturbance and sediment re-suspension possibly associated with jetting/trenching required for recovery of the LMRP compared with jetting/trenching for the recovery of the riser.	NS
	Change in Habitat Quality and Use	A	L-M[4]	LAA	LT	C	R	D		NS
Marine Mammals and Sea Turtles										
Abandonment of Riser and/or LMRP	Change in Risk of Mortality or Physical Injury	A[5]	L	PA	LT	S-C[6]	I	D	[5] The likelihood of the riser and/or LMRP contributing to a Change in Risk of Mortality or Physical Injury due to potential entanglement of marine mammals or sea turtles is considered low. The large loops of the riser on the seabed are likely too large to entangle marine mammals and sea turtles. Marine mammals that may be found in the Project Area would not likely be foraging on benthic species at depths of greater than 2000 m and more likely be feeding on pelagic species such as fish, squid or plankton. These prey species are likely to be higher up in the water column and greater than 6 m off the seabed. Sea turtles such as the endangered leatherback feed on jellyfish that are planktonic and also much higher in the water column. The likelihood of buoyancy modules on the riser breaking apart and/or becoming loose and detaching over time, thereby contributing to a Change in Risk of Mortality or Physical Injury affecting marine mammals and sea turtles, is also considered low. Any potential loss of buoyancy modules from the riser would be expected to occur incrementally and intermittently over several years, with individual modules/fragments released gradually as a result of the slow corrosion of threaded studs and/or degradation of the modules. The potential for the modules/fragments to interact with marine mammals and sea turtles is expected to be relatively low, particularly following dispersal of any fragments in the open ocean. [6] The frequency of the Change in Risk of Mortality or Physical Injury is sporadic with respect to buoyancy modules on the riser potentially breaking apart and/or becoming loose and detaching over time. The frequency of the Change in Risk of Mortality or Physical Injury is continuous with respect to potential entanglement of marine mammals and sea turtles. However, as indicated in note 5 above, the likelihood of either of those interactions occurring is considered low. [7] The loss of surficial debris may extend to the RAA. [8] Residual environmental effects associated with underwater excavation and the presence and operation of Project vessels are reversible. However, residual environmental effects associated with the loss of debris to the ocean are potentially irreversible, as the debris would persist in the marine environment indefinitely.	NS
Recovery of Riser and/or LMRP	Change in Risk of Mortality or Physical Injury	A	M	RAA[7]	LT	C	R-I[8]	D		NS
	Change in Habitat Quality and Use	A	M	RAA[7]	LT	C	R-I[8]	D		NS

Table 4 Residual Environmental Effects Characteristics and Significance Determinations for Each VC

Potential Project Activities	Residual Environmental Effects	Residual Environmental Effects Characteristics (see Table 3 for definitions)							Notes	Significance (S= Significant; NS= Not Significant)
		Nature of Effect	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context		
Marine Birds										
Abandonment of Riser and/or LMRP	Change in Risk of Mortality or Physical Injury	A[9]	L	PA	LT	S	I	D	[9] The likelihood of buoyancy modules on the riser breaking apart and/or becoming loose and detaching over time, thereby contributing to a Change in Risk of Mortality or Physical Injury or a Change in Habitat Quality and Use affecting marine birds, is considered low. Any potential loss of buoyancy modules from the riser would be expected to occur incrementally and intermittently over several years, with individual modules/fragments released gradually as a result of the slow corrosion of threaded studs and/or degradation of the modules. The potential for the modules/fragments to interact with marine birds would be relatively low, particularly following dispersal of any fragments in the open ocean. [10] The loss of surficial debris during recovery operations may extend to the RAA. [11] Residual environmental effects associated with underwater excavation and the presence and operation of Project vessels are reversible. However, residual environmental effects associated with the loss of debris to the ocean are potentially irreversible, as the debris would persist in the marine environment indefinitely.	NS
	Change in Habitat Quality and Use	A[9]	L	PA	LT	S	I	D		NS
Recovery of Riser and/or LMRP	Change in Risk of Mortality or Physical Injury	A	L	RAA[10]	LT	C	R-I[11]	D		NS
	Change in Habitat Quality and Use	A	M	RAA[10]	LT	C	R-I[11]	D		NS

Table 4 Residual Environmental Effects Characteristics and Significance Determinations for Each VC

Potential Project Activities	Residual Environmental Effects	Residual Environmental Effects Characteristics (see Table 3 for definitions)							Notes	Significance (S= Significant; NS= Not Significant)
		Nature of Effect	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context		
Special Areas										
Abandonment of Riser and/or LMRP	Change in Habitat Quality and Use	P-A[12]	N-L	PA	LT	S-C[13]	I	D	[12] The buoyancy modules on the riser are chemically inert. Abandonment of these riser components is therefore predicted to have a neutral effect of negligible magnitude with respect to a potential Change in Risk of Mortality or Physical Injury affecting fish. However, because information regarding chemical properties is not available for all components of the riser and LMRP, it is conservatively assumed for the purposes of this assessment that the materials in some of those components could release contaminants as they break down over time. Abandonment of some components of the riser and/or LMRP may therefore result in a highly localized Change in Risk of Mortality and Physical Injury for colonizing benthic organisms. It is expected that any contaminants would be released in very small quantities over a long period of time and would be quickly diluted in the ocean such that the magnitude of any resultant adverse effect would be negligible. The potential release of contaminants from some components of the riser and/or LMRP could also result in a highly localized Change in Habitat Quality and Use for colonizing benthic organisms. It is expected that any contaminants would be released in very small quantities over a long period of time and would be quickly diluted in the ocean such that the magnitude of any resultant adverse effect would be negligible. The introduction of hard substrate with interstitial spaces may result in a positive Change in Habitat Quality and Use for some benthic and demersal species by enhancing the diversity of benthic habitat and creating an artificial 'reef effect' in an area otherwise generally devoid of hard substrate. The magnitude of such a positive effect is predicted to be low. [13] The potential Change in Habitat Quality and Use associated with buoyancy modules potentially breaking apart and/or becoming loose and detaching over time would occur sporadically, whereas the potential Change in Habitat Quality and Use associated with the presence of the riser and/or LMRP on/in the seabed would occur continuously.	NS
Recovery of Riser and/or LMRP	Change in Habitat Quality and Use	A	L-M[14]	RAA[15]	LT	C	R-I[16]	D	[14] The magnitude of residual environmental effects is predicted to be low if only the riser is recovered and moderate if the LMRP is recovered with the riser or on its own. This is due to the relative increase in the extent of direct physical disturbance and sediment re-suspension possibly associated with jetting/trenching required for recovery of the LMRP compared with jetting/trenching for the recovery of the riser. [15] The loss of surficial debris may extend to the RAA. [16] Residual environmental effects associated with underwater excavation and the presence and operation of Project vessels are reversible. However, residual environmental effects associated with the loss of debris to the ocean are potentially irreversible, as the debris would persist in the marine environment indefinitely.	NS

Table 4 Residual Environmental Effects Characteristics and Significance Determinations for Each VC

Potential Project Activities	Residual Environmental Effects	Residual Environmental Effects Characteristics (see Table 3 for definitions)							Notes	Significance (S= Significant; NS= Not Significant)
		Nature of Effect	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context		
Commercial Fisheries										
Abandonment of Riser and/or LMRP	Change in Availability of Fisheries Resources	A[17]	L	PA	LT	S-C[18]	I	D	[17] The likelihood of buoyancy modules on the riser breaking apart and/or becoming loose and detaching over time, thereby contributing to a Change in Availability (*e.g.*, accessibility) of Fisheries Resources affecting commercial fisheries, is considered low. Any potential loss of buoyancy modules from the riser would be expected to occur incrementally and intermittently over several years, with individual modules/fragments released gradually as a result of the slow corrosion of thread studs and/or degradation of the modules. The potential for the modules/fragments to interact with commercial fisheries would be relatively low, particularly following dispersal of any fragments in the open ocean. The location of the abandoned riser and/or LMRP would be published in Notices to Mariners for consideration by fishers and other marine users. However, the presence of the abandoned riser and/or LMRP on/in the seabed is not expected to impede fishing activity since the depth of water in the Project Area (approximately 2143 m) precludes fishing with bottom-contact gear. [18] The potential Change in Accessibility of Fisheries Resources associated with buoyancy modules potentially breaking apart and/or becoming loose and detaching over time would occur sporadically, whereas the potential Change in Availability of Fisheries Resources associated with the presence of the riser and/or LMRP on/in the seabed would occur continuously. [19] The loss of surficial debris may extend to the RAA. [20] The debris field is expected to disperse relatively quickly in the open ocean, at which point its potential effects on commercial fishing activities are reversible.	NS
Recovery of Riser and/or LMRP	Change in Availability of Fisheries Resources	A	L	RAA[19]	LT	C	R[20]	D		NS

Table 4 Residual Environmental Effects Characteristics and Significance Determinations for Each VC

Potential Project Activities	Residual Environmental Effects	Residual Environmental Effects Characteristics (see Table 3 for definitions)							Notes	Significance (S= Significant; NS= Not Significant)
		Nature of Effect	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context		
Current Aboriginal Use of Lands and Resources for Traditional Purposes										
Abandonment of Riser and/or LMRP	Change in Traditional Use	A[21]	L	PA	LT	S-C[22]	I	D	[21] The likelihood of buoyancy modules on the riser breaking apart and/or becoming loose and detaching over time, thereby contributing to a Change in Traditional Use affecting Aboriginal fisheries, is considered low. Any potential loss of buoyancy modules from the riser would be expected to occur incrementally over several years, with individual modules/fragments released gradually as a result of the slow corrosion of threaded studs and/or degradation of the modules. The potential for the modules/fragments to interact with Aboriginal fisheries would be relatively low, particularly following dispersal of any fragments in the open ocean. The location of the abandoned riser and/or LMRP would be published in Notices to Mariners for consideration by fishers and other marine users. However, the presence of the abandoned riser and/or LMRP on/in the seabed is not expected to impede fishing activity since the depth of water in the Project Area (approximately 2143 m) precludes fishing with bottom-contact gear. [22] The potential Change in Traditional Use associated with buoyancy modules potentially breaking apart and/or becoming loose and detaching over time would occur sporadically, whereas the potential Change in Traditional Use associated with the presence of the riser and/or LMRP on/in the seabed would occur continuously. [23] The loss of surficial debris during recovery operations may extend to the RAA. [24] The debris field is expected to disperse relatively quickly in the open ocean, at which point its potential effects on Aboriginal fishing activities are reversible.	NS
Recovery of Riser and/or LMRP	Change in Traditional Use	A	L	RAA[23]	LT	C	R[24]	D		NS

6.0 ACCIDENTAL EVENTS

The greatest potential for an accidental event during the recovery of the riser and/or LMRP is a batch diesel spill in the marine environment, from one of the recovery vessels. This accidental event could directly or indirectly affect all of the VCs.

Potential accidental spills of diesel fuel from a Project-related recovery or support vessel would be responded to in a similar fashion to those spills modelled for the Shelburne Basin Venture Exploration Drilling Project, with concentrations of total dissolved aromatics affecting the immediate area with some surface oiling, but rapidly dispersed for the majority of spills that could be expected from vessel operations. Effects of a spill would be temporary and low in magnitude for the majority of marine resources, as diesel would rapidly spread to a thin surface layer and most of the diesel fuel would evaporate. Effects from any vessel-related spills on the marine VCs are not likely to be significant.

Shell is committed to responding to an offshore spill or other incident of any magnitude with a full complement of oil spill response tools and strategies. Response tools include remote sensing, aerial surveillance, and mechanical on-water recovery. Contingency plans in place for the Shelburne Basin Venture Exploration Drilling Project detail the associated practices and procedures for responding in all emergencies and would also be relevant and applicable for riser and/or LMRP response efforts. Accident prevention, proactive safety barrier management and emergency response procedures would significantly reduce the potential consequences of an accidental release and any associated potential environmental effects.

7.0 EFFECTS OF THE ENVIRONMENT

Potential effects of the environment on a project are typically a function of project design and environmental conditions that could affect the project. Aspects of the environment that could potentially affect riser and/or LMRP response activities include adverse weather conditions such as reduced visibility, high winds and waves.

Design standards for harsh weather conditions and standard operating procedures including the monitoring of meteorological conditions, stop-work procedures and safe work practices would reduce the risk of adverse effects of the environment on the response options under consideration. These factors are relevant to the response options discussed in this assessment.

In consideration of the adherence to the *Offshore Physical Environment Guidelines* and other mitigations the residual effects of the physical environment on potential Project activities are predicted to be not significant.

8.0 CUMULATIVE EFFECTS

This section of the assessment considers past, present and certain or reasonably foreseeable future physical activities with residual environmental effects that could interact cumulatively with the residual effects of the response options. The most significant proposed activities that may interact with the Project include Shell's proposed drilling program (past, present and future) as part of the Shelburne Basin Venture Exploration Drilling Project (including completion of drilling at Cheshire and Monterey Jack proposed for 2016) and BP's proposed Scotian Basin Exploration Drilling Project (scheduled to commence in 2018). The complete list of other physical activities for consideration in this cumulative effects assessment includes the following:

- Offshore gas development projects on the Scotian Shelf (*i.e.*, Sable Offshore Energy Project and Deep Panuke) (past, present and future)
- Commercial, Aboriginal and Recreational Fisheries (CRA) (past, present and future)
- Other ocean users, such as those conducting shipping, scientific research, and military activities (past, present and future) and existing infrastructure on the seafloor (*e.g.*, subsea cables)
- Shelburne Basin Venture Exploration Drilling Project (past, present and future)
- Scotian Basin Exploration Drilling Project (future)

Residual effects from the response options that could potentially interact with residual effects of these physical activities vary according to response option. The magnitude of residual environmental effects associated with abandonment of the riser and/or LMRP are negligible to low, with limited potential to result in cumulative environmental effects for fish and fish habitat within the Project footprint as a result of benthic disturbance associated with the Shelburne Basin Venture Exploration Drilling Project. There is also a low likelihood of buoyancy modules on the riser breaking apart and/or becoming loose and detaching over time thereby resulting in floating debris, potentially interacting with marine mammals and sea turtles, marine birds, commercial fisheries and traditional use. However, this effect would be sporadic over an extended period of time and not predicted to result in measurable effects that could overlap with effects of other projects and activities so as to result in cumulative environmental effects. No significant cumulative adverse environmental effects are therefore predicted to occur as a result of abandonment of the riser and/or the LMRP.

The recovery of the riser and/or LMRP are predicted to result in the following effects that could potentially interact cumulatively with residual effects of other physical activities:

- physical disturbance and re-suspension of benthic sediments and associated water column turbidity (Change in Habitat Quality and Use for Fish and Fish Habitat)

- underwater noise as a result of increased vessel traffic and underwater recovery operations (Change in Habitat Quality and Use for Fish and Fish Habitat; and Change in Habitat Quality and Use for Marine Mammals and Sea Turtles)
- introduction of floating debris to the marine environment (Change in Risk of Mortality or Physical Injury for Marine Mammals and Sea Turtles; Change in Risk of Mortality or Physical Injury for Marine Birds; Change in Habitat Quality and Use for Special Areas; Change in Availability (*e.g.*, accessibility) of Fisheries Resources; Change in Traditional Use)
- increased lighting as a result of increased vessel traffic (Change in Habitat Quality and Use for Marine Birds; Change in Risk of Mortality or Physical Injury for Marine Birds)
- potential establishment of a safety (exclusion) zone (Change in Availability (*e.g.*, accessibility) of Fisheries Resources; Change in Traditional Use).

As noted in Section 5.3.2, these interactions could result in residual adverse effects to Fish and Fish Habitat, Marine Mammals and Sea Turtles, Marine Birds, Special Areas (Scotian Slope EBSA), Commercial Fisheries, and Current Aboriginal Use of Lands and Resources for Traditional Purposes. The other physical activities listed above would result in residual adverse environmental effects to the same VCs, although residual effects would have limited spatial and/or temporal overlap with the effects of the removal and recovery response options, limiting the potential for cumulative effects. Of particular relevance for potential cumulative effects would be the residual effects predicted to overlap with the residual effects of Shell's current Shelburne Venture Exploration Drilling Project, including but not limited to drilling conducted to date for the Cheshire well, and future drilling at Cheshire and Monterey Jack where activities and residual effects (similar to the list above) could potentially overlap spatially and/or temporally with recovery options.

Predicted residual environmental effects associated with the recovery of the riser and/or LMRP could therefore potentially interact cumulatively with residual environmental effects from other physical activities to result in cumulative environmental effects on Fish and Fish Habitat, Marine Mammals and Sea Turtles, Marine Birds, Special Areas (Scotian Slope EBSA), Commercial Fisheries, and Current Aboriginal Use of Lands and Resources for Traditional Purposes. However, cumulative effects for all VCs are predicted to be not significant in recognition of the significance thresholds established for each VC (refer to Section 5.3.2) and the generally low magnitude of potential effects associated with Project activities.

9.0 SUMMARY AND CONCLUSIONS

Summaries of the residual environmental effects characteristics associated with each of the potential response activities (*i.e.*, Project activities) under consideration, as well as conclusions regarding the significance of residual adverse environmental effects, are provided below.

1) **Abandonment of the Riser and/or LMRP** consists of leaving the riser and/or LMRP in place (*i.e.*, laying on and/or embedded into the seafloor) indefinitely. Residual adverse environmental effects of this potential Project activity are predicted to be **not significant**. The following table summarizes the range of anticipated residual environmental effects characteristics for all VCs.

Table 5 Residual Environmental Effects Characteristics – Abandonment of the Riser and/or LMRP

Characterization Criteria	Residual Environmental Effects Characteristics	Explanation
Nature of Effects	Positive, Neutral and Adverse	Although most effects are generally expected to be adverse (*i.e.*, detrimental relative to baseline), the introduction of hard substrate may improve habitat quality for some benthic and demersal species.
Magnitude	Negligible to Low	Any measurable change in species populations or habitat quality or quantity is expected to be within the range of natural variability and to not pose a risk to short-term viability of populations.
Geographic Extent	Project Area to RAA	Effects would be limited to the Project footprint, except in the event that buoyancy modules on the riser break apart and/or become loose and detach over time thereby resulting in floating debris that may extend to the RAA.
Duration	Long-Term	Effects would extend beyond the duration of Project activities (*i.e.*, effects would be permanent).
Frequency	Sporadic to Continuous	Effects associated with buoyancy modules potentially breaking apart and/or becoming loose and detaching over time would occur sporadically, whereas effects associated with the presence of the riser and/or LMRP on/in the seabed would occur continuously for the duration specified above.
Reversibility	Irreversible to reversible	Effects associated with the presence of the riser and/or LMRP on/in the seabed would only be reversible upon removal of the riser and/or LMRP, which is not being considered within the scope of this potential Project activity. Effects associated with the debris field are considered reversible for the Commercial Fisheries and Current Aboriginal Use of Lands and Resources for Traditional Purposes VCs only (and irreversible for the remaining VCs).

2) **Recovery of the Riser and/or LMRP** will likely include underwater cutting of the riser into smaller segments, excavation via trenching/jetting into the seabed, and slinging and lifting the riser and/or LMRP to the surface and onto a recovery vessel. Residual adverse environmental effects of this potential Project activity are predicted to be **not significant**. The following table summarizes the range of anticipated residual environmental effects characteristics for all VCs.

Table 6 Residual Environmental Effects Characteristics – Recovery of the Riser and/or LMRP

Characterization Criteria	Residual Environmental Effects Characteristics	Explanation
Nature of Effects	Adverse	Effect is detrimental relative to baseline.
Magnitude	Low to Moderate	Depending on the VC under consideration and which component(s) is/are recovered (*i.e.*, riser and/or LMRP), the magnitude varies from a measurable change that is within the range of natural variability and does not pose a risk to short-term viability of populations or fisheries to a measurable change that may exceed natural variability but does not pose a risk to long-term viability of populations or fisheries.
Geographic Extent	LAA to RAA	Re-suspended sediments, underwater noise, and effects associated with the presence and operation of Project vessels would extend beyond the Project footprint to the LAA, and substantial amounts of debris could rise to the surface and be lost to the RAA.
Duration	Medium-Term to Long-Term	Effects associated with excavation, cutting, slinging and lifting, and the presence and operation of Project vessels would extend through the duration of Project activities (*i.e.*, approximately ≥ 6 months), whereas effects associated with the potential loss of surficial debris to the marine environment would extend for an indeterminate amount of time beyond the duration of Project activities.
Frequency	Continuous	Effects would occur continuously for the durations specified above.
Reversibility	Reversible to Irreversible	VCs would recover to baseline conditions before or after completion of Project activities, except in the case of environmental effects related to the loss of surficial debris to the marine environment (which would persist for an indeterminate amount of time).

With the exception of the potential loss of surficial debris to the open ocean associated with abandonment and recovery of the riser and/or LMRP, residual environmental effects are generally anticipated to be localized to the LAA and Project Area. Effects associated with direct physical disturbance would be limited to an area that is not known to contain any unique, high-value or vulnerable habitats, species or commercial or Aboriginal fisheries resources. Seabed

ROV surveys conducted at the Cheshire wellsite have confirmed the absence of aggregations of habitat-forming coral concentrations, sponges or other sensitive or unique benthic habitat. No portion of the LAA has been designated under SARA as critical habitat for any species.

In conclusion, with implementation of the mitigation measures proposed in Section 5.2, the Project is not likely to result in significant adverse residual environmental effects, including cumulative effects.

10.0 REFERENCES

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APPENDIX A

Aboriginal and Commercial Fishers Riser Incident Engagement Log

April 20, 2016
Fisheries Advisory Committee (FAC)
Halifax – CNSOPB Offices

- Brief Overview of the Riser System (riser 101)
- Summary of Riser Incident
- Riser Options Assessment
- Buoyancy Modules Update
- Q&A/ Feedback for Shell
- Next Steps

April 21, 2016
Assembly of Nova Scotia Mi'kmaq Chiefs/KMKNO
Millbrook – KMKNO Offices

- Brief Overview of the Riser System (riser 101)
- Summary of Riser Incident
- Riser Options Assessment
- Buoyancy Modules Update
- Q&A/ Feedback for Shell
- Next Steps

May 18, 2016
Mi'gmawe'l Tplu'taqnn Incorporated (MTI)
Fredericton – Delta Hotel

- Brief Overview of the Riser System (riser 101)
- Summary of Riser Incident
- Riser Options Assessment
- Buoyancy Modules Update
- Q&A/Feedback for Shell
- Next Steps

May 18, 2016
Woodstock and St. Mary's Maliseet First Nations
Fredericton – St. Mary's Band Office

- Brief Overview of the Riser System (riser 101)
- Summary of Riser Incident
- Riser Options Assessment
- Buoyancy Modules Update
- Q&A/Feedback for Shell
- Next Steps

June 22, 2016
Fisheries Advisory Committee (FAC)
Halifax – CNSOPB Offices

- Riser Incident Summary
- Results of Riser Investigation: Key Findings and Corrective Actions
- Q&A

THE SHELBURNE BASIN VENTURE EXPLORATION DRILLING PROJECT: ENVIRONMENTAL REVIEW OF RISER/LOWER MARINE RISER PACKAGE RESPONSE OPTIONS

- Riser Options: Environmental Review
- Feedback for Shell
- Next Steps

June 23, 2016
Assembly of Nova Scotia Mi'kmaq Chiefs/KMKNO
Halifax – Shell Offices

- Riser Incident Summary
- Results of Riser Investigation: Key Findings and Corrective Actions
- Q&A
- Riser Options: Environmental Review
- Feedback for Shell
- Next Steps

Upcoming Meetings:

- Fisheries Advisory Committee (FAC): September 21, 2016 in Halifax, Nova Scotia
- Assembly of Nova Scotia Mi'kmaq Chiefs: September 22, 2016 in Truro, Nova Scotia
- New Brunswick First Nations: October 4, 2016 in Fredericton, New Brunswick