Husky Energy **REPORT**

REPORT TITLE

HUSKY WHITE ROSE DEVELOPMENT PROJECT

New Drill Centre Construction and Operations Program

Environmental Assessment Amendment:

Construction of Protective Flowline Rock Berms

SUBMITTED TO

Canada-Newfoundland and Labrador Offshore Petroleum Board

5th Floor, TD Place

140 Water Street

St. John's, NL

A1C 6H6

SUBMITTED BY

Husky Energy

235 Water Street, Suite 901

St. John's, NL

A1C 1B6

COMMENTS IF APPLICABLE

This is a revision to the amendment to our original environmental assessment entitled Husky White Rose Development Project: New Drill Centre Construction and Operations Program Environmental Assessment.

Signature:				August 6, 2009
Full Name and Title:	**Dave Taylor, Environmental Consultant**	**Francine Wight, Environment Lead**	**Don Williams, HSEQ Manager**	
	Reviewed By	Reviewed By	Accepted or Approved By	Acceptance or Approval Date

		HDMS No.:	**004064452**	Report No.:	**WR-HSE-RP-1087**	Version No:	**2**

HUSKY WHITE ROSE DEVELOPMENT PROJECT

NEW DRILL CENTRE CONSTRUCTION AND OPERATIONS PROGRAM ENVIRONMENTAL ASSESSMENT AMENDMENT: CONSTRUCTION OF PROTECTIVE FLOWLINE ROCK BERMS

Prepared by

LGL Limited
environmental research associates
388 Kenmount Rd.
P.O. Box 13248, Stn. A, St. John's, NL
A1B 4A5
(709) 754-1992

Prepared for

Husky Energy
235 Water Street, Suite 901
St. John's, NL
A1C 1B6

August 2009
SA1030

Suggested format for citation:

LGL Limited. 2009. Husky White Rose Development Project - New Drill Centre Construction and Operations Program Environmental Assessment Amendment: Construction of Protective Flowline Rock Berms. LGL Rep. SA1030. Rep. by LGL Limited, St. John's, NL, for Husky Oil Operations Ltd., St. John's, NL. 55 p.

Table of Contents

Page

List of Figures

Page

List of Tables

Page

1.0 Introduction

Husky Oil Operations Limited (Husky) is proposing to construct rock berms (the Project) to serve as protection for flowlines in the vicinity of the Southern Drill Centre (SDC) and the North Amethyst Drill Centre (NADC). The protection will increase environmental safety by safeguarding against accidental release of hydrocarbons due to flowline damage. These drill centres are located in the southern portion of the White Rose Field located on the Grand Banks offshore Newfoundland approximately 350 km east-southeast of St. John's. (Figure 1.1).

The environmental assessment (EA) of the Husky White Rose Development Project: New Drill Centre Construction and Operations Program (New Drill Centre EA and Addendum) was completed in 2007 (LGL 2006, 2007a). The locations of the proposed rock berms are within the Project Area defined in LGL (2007a). This description and assessment of the proposed berm construction activities is considered to be an amendment of the drill centre EA and Addendum (LGL 2006, 2007a). Therefore, the Project Area defined in LGL (2007a) will be used for this Amendment although much of the focus will be on the small portion of the Project Area where the proposed berm construction will occur (i.e., southeastern portion of the Project Area).

The Project will require a Project Development Authorization pursuant to Section 138 (1) (b) of the Canada-Newfoundland Atlantic Accord Implementation Act and Section 134 (1) (a) of the Canada-Newfoundland and Labrador Atlantic Accord Implementation Newfoundland and Labrador Act.

There is no federal funding for this Project. Federal lands are involved and they are administered by the C-NLOPB, a federal-provincial agency operating under the *Canada-Newfoundland & Labrador Atlantic Accord Acts*.

Technical advice received from the C-NLOPB, other federal agencies, and certain stakeholders consulted by Husky will guide the preparation of this amendment of the New Drill Centre EA and Addendum LGL (2006, 2007a). All recommendations from regulatory agencies as well as mitigative measures that were documented during the original reviews of the Husky White Rose Development Project: New Drill Centre Construction & Operations Program Environmental Assessment and Addendum will be applied to the activities described in this Amendment to minimize effects on the environment. The Project Description is an accurate reflection of the Proponent's current level of knowledge.

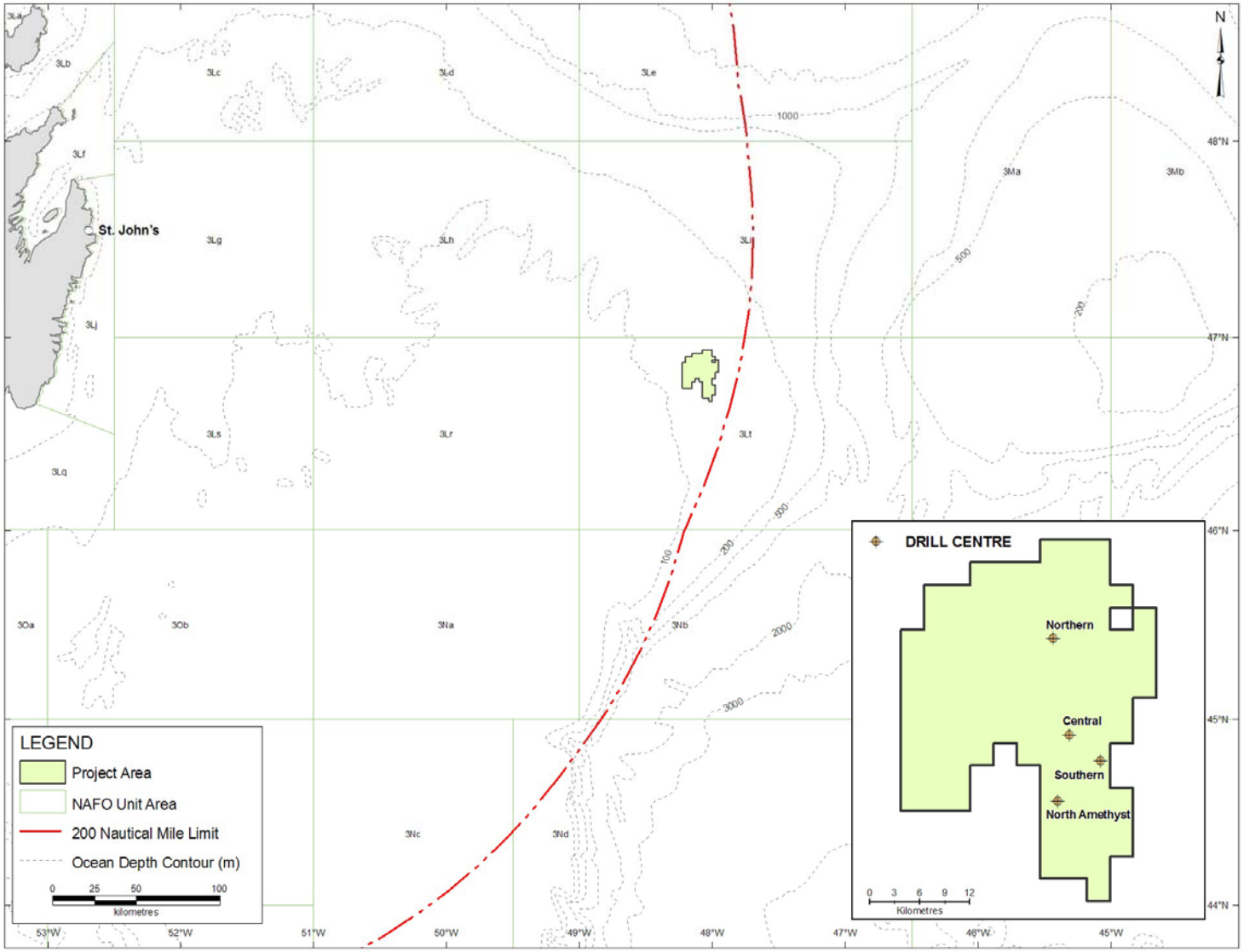

Figure 1.1. Locations of Project Area and Drill Centres.

2.0 The Proponent

Headquartered in Calgary, Alberta, Husky (the Operator) is a Canadian-based integrated energy company serving global customers, committed to maximizing returns to its shareholders in an ethical and socially responsible way, through the dedicated effort of its people. It is involved in:

- Exploration and development of crude oil and natural gas,
- Production, purchase, transportation, refining and marketing of crude oil, natural gas and natural gas liquids and sulfur, and
- Transportation and marketing of refined products.

The Operator is the management and operating company for the Operator's seven Significant Discovery Areas (SDA) and eleven Exploration Licenses, offshore Newfoundland.

2.1 Operator Contacts

Operator contacts concerning this application are provided below.

Don Williams
HSEQ Manager
Husky Oil Operations Limited
Suite 901, Scotia Center
235 Water Street
St. John's, NL
A1C 1B6
Phone: (709) 724-3900; Fax: (709) 724-3993
Don.Williams@huskyenergy.com

Francine Wight
Environment Lead
Husky Oil Operations Limited
Suite 901, Scotia Centre
235 Water Street
St. John's, Newfoundland
A1C 1B6
Phone: (709) 724-3900; Fax: (709) 724-3993
Francine.Wight@huskyenergy.com

3.0 Project Description

During late summer/early fall 2009, Husky plans to construct two rock berms to protect flowlines in the vicinity of the SDC and the NADC located in the southern part of the White Rose Field (Figures 1.1 and 3.1), and thereby increase environmental safety by safeguarding against accidental release of hydrocarbons due to flowline damage. At a later date, Husky may also construct rock berms over existing flowlines in the vicinity of the Central Drill Centre (CDC) and the Northern Drill Centre (NDC). Other drill centres that may be developed over the next several years, including the South White Rose Extension and the West White Rose Extension, may also be subject to flowline protection berms in the vicinity of new and existing drill centres. This amendment pertains to only the two berms to be constructed in 2009 as final decisions on the need for and design of any additional berms have not yet been made.

3.1 Name and Location of Proposed Project

The official name of the Project is the Husky White Rose Development Project: New Drill Centre Construction & Operations Program Environmental Assessment Amendment: Construction of Protective Flowline Rock Berms. All proposed activities will occur within the Project Area defined in the New Drill Centre EA Addendum (LGL 2007a).

3.2 Alternative Means within Project

The alternative to constructing the rock berms as means of protection for flowlines is to use polyurethane sheathing. However, rock placement is more effective and provides a more complex surface area which has the additional benefit of providing habitat for marine biota.

In summary, rock placement was chosen as a protective means based on the following rationale:

- Rock placement is already a proven protection method on the Grand Banks;
- Rock placement allows flexibility for future drilling operations at the North Amethyst drill centre; and
- Rock placement provides the flexibility to add additional protection to existing drill centres.

3.3 Canada-Newfoundland and Labrador Benefits

Consistent with the legislative requirements of the *Canada Newfoundland Atlantic Accord Implementation* acts, Husky Oil Operations Limited is committed to enhancing the business opportunities for Canada and Newfoundland and Labrador as outlined in the Company's Canada-Newfoundland and Labrador Benefits G/L outlined in the Benefits Plan.

Consequently, Husky will utilize the services of Newfoundland and Labrador and other Canadian companies and personnel wherever possible.

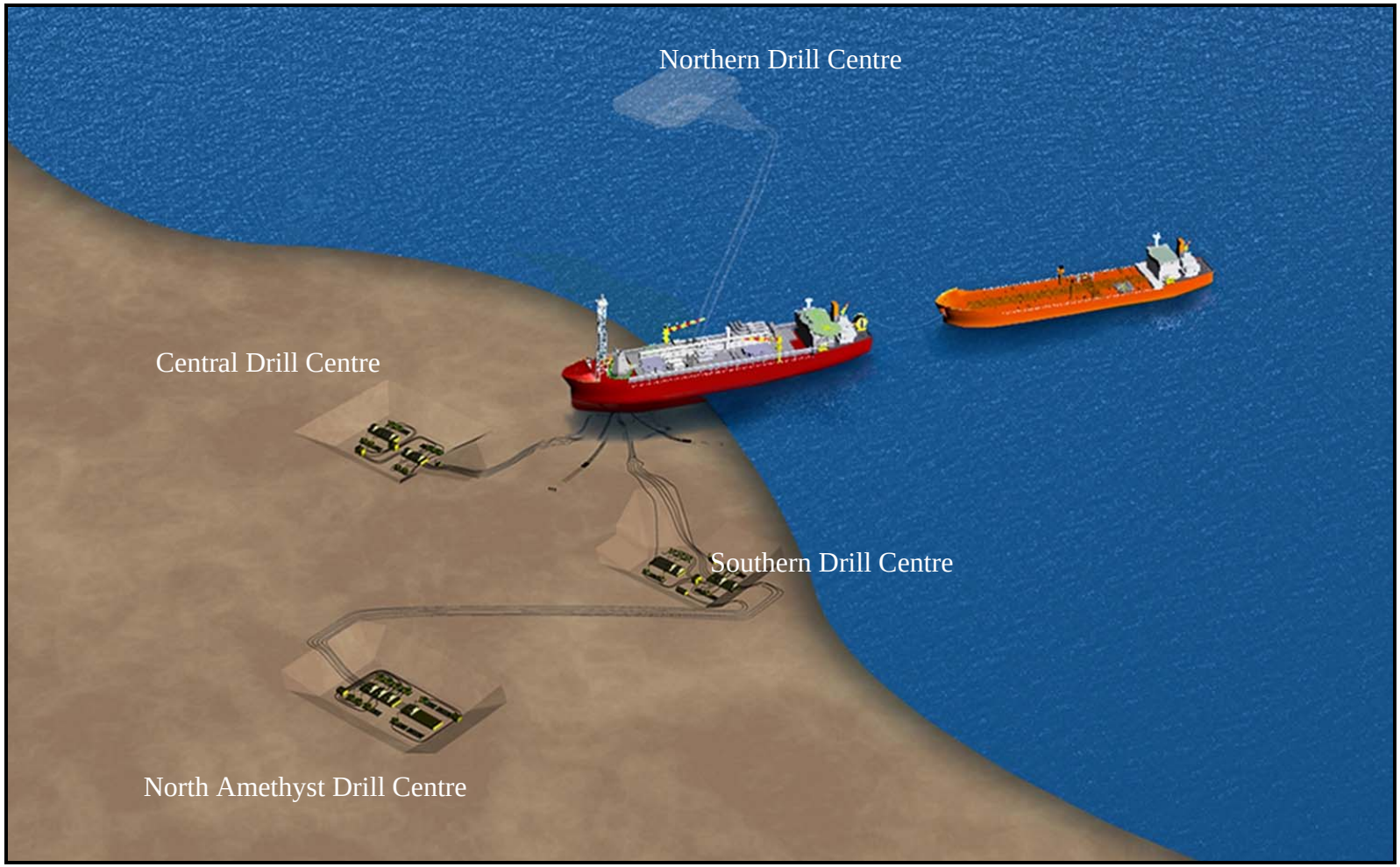

Figure 3.1. Conceptual Illustration Showing Flowlines Tying North Amethyst Drill Centre to Southern Drill Centre.

3.4 Personnel

The work associated with this Project Description will be managed by Husky's SeaRose Tie-back Project Manager located in St. John's. The management team that supports the SeaRose Tie-back Project Manager includes the Installation Manager, the Installation Team and Husky onshore operations personnel as required including the Drilling and Completion Manager, Subsurface Manager, Production Operations Manager, Logistics Manager, Administration Manager, HSEQ Manager, and the Regulatory Affairs and Administration Manager.

Offshore, the work will be conducted by a contracted vessel specifically designed to conduct the program. The vessels scope and daily activities will be managed by the SeaRose Tie-back Project team in St. John's.

Logistical support, as required by the Tie-back Project team will be managed through Husky's Logistics Team, made up of a Logistics Lead and supporting Coordinators. The Logistics Coordinator manages supply vessels, helicopters, and materials movement activities for Husky's East Coast operations. Crew changes and re-supply on the rock placement vessel will be done when the vessel comes to shore to pick up rock staged at the Bay Bulls Marine Terminal.

3.5 Offshore Equipment

3.5.1 Construction of Rock Berms

The rock will be placed using a Dynamically Positioned (DP) rock placement vessel. This vessel will have an onboard material handling system that will deliver the rock to the vessel's controlled delivery system. This system is typically a fall pipe which will be positioned to desired height above the area where the rock is to be placed. The lower fall pipe end positioning is controlled by a Remotely Operated Vehicle (ROV) which will be equipped with cameras and survey equipment to verify *in situ* positioning of the placed rock.

3.6 Logistics Support

3.6.1 Marine Support Vessels

There are no support vessels planned for this project.

3.6.2 Helicopter Support

There is no helicopter support planned for this project.

3.6.3 Shorebase Facilities

The Project will be managed and operational decisions will continue to be made from Husky Oil Operations Limited's existing Regional Office in St. John's at Suite 901, 235 Water Street. The Bay Bulls Marine Terminal will support Project activity including re-supply of the rock placement vessel and staging for the rock that will be used for flowline protection. During the Project, the rock placement vessel could make up to 25 trips to shore to pick up rock.

The primary communications link between the vessel and the Project Operations office in St. John's will be via a dedicated C-Band satellite service. Details on communications systems are outlined in the Husky East Coast Emergency Response Plan currently on file with the C-NLOPB.

3.7 Project Components/Structures/Activities

In the vicinity of the SDC and NADC (Figure 3.1), flowlines require protection from dropped objects and Mobile Offshore Drilling Unit (MODU) operations. The flowline protection limits are determined by MODU mooring patterns. Rock berm length will be approximately 885 m at the NADC and 570 m at SDC. The berm will be about 1.5 to 2.5 m in height with stable sloping sides, and the width at the base will vary from 18 m to 32 m, depending on the configuration and routing of the flowlines.

It is estimated that approximately 36,000 to 56,000 m^2 of natural sea bottom will be covered by the rock berms. However, for the purposes of the effects assessment in this document the "worst case" estimate – 56,000 m^2 is assumed. Consideration is currently being given to the construction of similarly sized rock berms for flowlines of existing and other new drill centres at some later time but this has not yet been finalized. The size of the rock to be used will vary from 25 mm to 200 mm. The rock graduations specified for the rock berms are

- 25 to 50 mm diameter;
- 90 to 130 mm diameter;
- 150 to 175 mm diameter; and
- Maximum of 200 mm diameter.

The unwashed rock will be processed by a crusher thereby removing any clumps of mud that may have been adhering to the rock.

An engineering drawing that provides some general information on the proposed rock berms is provided in Figure 3.2. Some of the details may change slightly but these changes will not affect this assessment.

Construction of the protective rock berms is proposed for August to November, 2009.

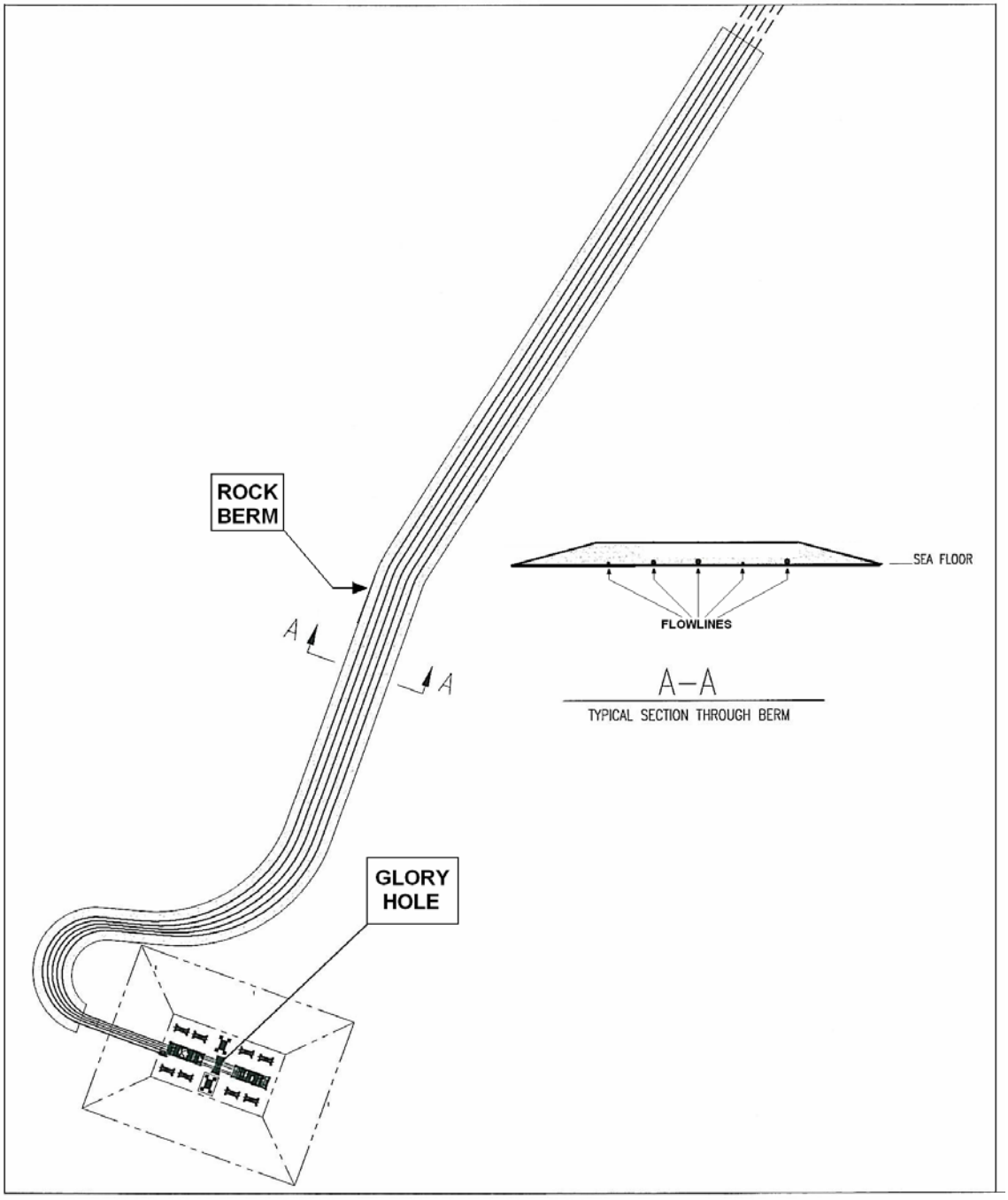

Figure 3.2. Schematic Indicating General Characteristics of Proposed Rock Berms.

3.8 Description of Waste Discharges and Treatments

Waste discharges during the proposed activities will include grey and black water, ballast water, bilge water, deck drainage, and air emissions. All vessels associated with the Project will be MARPOL-compliant. Details are provided in the following sections.

3.8.1 Air Emissions

The air emissions from Project activities will be those from the rock placement vessel engines which will be within the range of emissions from typical marine vessels on the Grand Banks such as fishing vessels and offshore supply vessels. There will also be air emissions from two excavators operating on the stern of the rock placement vessel.

3.8.2 Grey and Black Water

Grey and black water produced on the rock placement vessel will be treated in compliance with MARPOL requirements.

3.8.3 Bilge Water

Bilge water for the rock placement vessel will be treated in compliance with MARPOL requirements.

3.8.4 Ballast Water

Water used for stability purposes in the rock placement vessel is stored in dedicated closed system tanks and does not contain any oil under normal circumstances.

3.8.5 Garbage

All trash and garbage, including organic waste from galleys, will be containerized and transported to shore for disposal in approved landfills. Combustible waste such as oil rags and paint cans will be placed in hazardous materials containers for transport to shore.

3.9 Accidental Events

In the unlikely event of an accidental release of hydrocarbons during the rock berm construction, Husky and its contractor will implement measures outlined in Section 8 of the New Drill Centre EA and Addendum (LGL 2006, 2007a). All potential residual effects of accidental releases of hydrocarbons to the marine environment were assessed in the New Drill Centre EA and Addendum (LGL 2006, 2007a) and predicted to be not significant to the VECs. The assessment results in that EA also apply to this Project.

3.10 Project Site Information

3.10.1 Environmental Features

The Project has the potential to affect macroinvertebrate and fish habitat, macroinvertebrates and fishes, commercial fisheries and certain Species at Risk. Effects may originate from the physical covering of existing bottom substrate, emissions and discharges, both routine and accidental. There are no known special or unique areas in the Project Area. Descriptions of the physical and biological environments of the Project Area are included in the New Drill Centre EA and Addendum (LGL 2006, 2007a). As with the previous EAs, a valued ecosystem component (VEC) approach is used in this EA Amendment. The VECs in the area that are most relevant to the proposed Project include macroinvertebrate and fish habitat, macroinvertebrates and fishes, commercial fisheries, and *Species at Risk Act* (*SARA)* species (including COSEWIC-listed species). Seabirds, marine mammals and sea turtles will not likely be directly affected by the primary activity of rock covering natural substrate. Effects on VECs including cumulative effects (within the Project and with existing and planned projects) are also assessed in the Amendment. The focus is on any sensitive species, areas and times, including *SARA* species.

4.0 Physical Environment

The physical environment of the Project Area (e.g., geochemical, climate, physical oceanography, extremes and ice) is described in the New Drill Centre EA and Addendum (Section 4 in both LGL 2006, 2007a). This documentation included a detailed report (Oceans Limited 2005) describing climate, wind and physical oceanography of the Project Area and surrounding vicinity and was provided in Appendix 1 of LGL (2006).

Other recent environmental assessments also provide updated information on the physical environment which is relevant to this EA Amendment. These include Petro-Canada's Jeanne d'Arc Basin Exploration Drilling Program EA (Christian 2008) the StatoilHydro seismic and exploration and appraisal/delineation drilling EAs (LGL 2008a,b), and the Husky Delineation/Exploration Drilling EA (LGL 2007b).

4.1 Geochemical

The New Drill Centre EA and Addendum (LGL 2006, 2007a) discussed the geochemical characteristics of the Project Area. The following section provides information on the physical and chemical characteristics of the surficial sediment likely to be affected by the installation of the rock berms in the vicinities of SDC and NADC.

4.1.1 Physical and Chemical Characteristics of Surficial Sediment in Project Area

The physical and chemical characteristics of sediments on the Grand Banks were described in the White Rose Comprehensive Study and Supplement, and Baseline Characterization Data Report (Husky 2000, 2001a,b). Sediments were discussed in terms of particle size, trace metals, and hydrocarbons. In general, the Grand Banks sediments are relatively pristine, particularly compared to some inshore areas.

A full baseline EEM characterization study was conducted on the White Rose field in 2000. The Husky EEM program was implemented in 2004 and there are now sediment chemistry data from the 2004, 2005, 2006 and 2008 sampling programs in the Significant Development Area. The New Drill Centre EA and Addendum included discussion of sediment analysis results from the 2004 and 2005 sampling programs. Subsection 7.2.1 of the EA for the Husky Delineation/Exploration Drilling Program for Jeanne d'Arc Basin Area, 2008-2017 (LGL 2007b) discusses the physical and chemical characteristics of sediment collected during the 2006 EEM sampling program. Data from the 2008 EEM sampling program (Husky 2009) are presented in this amendment in various sections describing sediments and biota.

4.1.2 Physical and Chemical Characteristics of Surficial Sediment at Rock Berm Locations

For the purposes of this Addendum, selected EEM sediment stations are used to describe the sediment that will be covered by the rock berms. Transect Station 14 and Drill Centre Stations S1, S2 and S5 are used to represent the sediment that will be covered proximate to SDC. Transect Station 18, Drill Centre

Stations SS3 and SS4, and four new stations introduced in 2008 (NA1 to NA4) are used to represent the sediment that will be covered proximate to NADC. All representative stations are located within three kilometres of where the berms will be constructed. Results of sediment analyses are presented in Table 4.1 (Stations 14, 18, S1, S2, S5, NA1, NA2, NA3, NA4 in 2008 (Husky 2009); Stations SS3, SS4 in 2004 (Husky 2005)).

The surficial sediment at each rock berm location will consist predominantly of sand (Table 4.1). Chemical analyses of sediments collected in the vicinity of where the NASDC rock berm will be constructed indicate relatively pristine conditions. Sediments collected in the vicinity of where the SDC rock berm will be constructed have slightly higher concentrations of some hydrocarbons (e.g., $>C_{10}$-C_{21}) and elements (e.g., barium, iron). None of the rock berm location sediments were deemed toxic by Microtox testing.

4.2 Climate

A discussion of aspects of the Project Area climate was provided in the New Drill Centre EA and Addendum (LGL 2006, 2007a). Appendix 1 of LGL (2006) contains a detailed report by Oceans Limited (2005) that describes the climate of the Project Area. Environmental assessments prepared more recently (e.g., LGL 2007b, 2008a,b; Christian 2008) also provide detailed discussions of climate which include the Project Area of this Amendment.

4.3 Physical Oceanography

A discussion of aspects of the Project Area physical oceanography was provided in the New Drill Centre EA and Addendum (LGL 2006, 2007a). Appendix 1 of LGL (2006) contains a detailed report by Oceans Limited (2005) that describes the physical oceanography of the Project Area. Environmental assessments prepared more recently (e.g., LGL 2007b, 2008a,b; Christian 2008) also provide detailed discussions of physical oceanography which include the Project Area of this Amendment.

4.4 Extremes

A discussion of aspects of the Project Area wind and wave extremes was provided in the New Drill Centre EA and Addendum (LGL 2006, 2007a). Appendix 1 of LGL (2006) contains a detailed report by Oceans Limited (2005) that describes the wind and wave extremes of the Project Area. Environmental assessments prepared more recently (e.g., LGL 2007b, 2008a,b; Christian 2008) also provide detailed discussions of extremes which include the Project Area of this Amendment.

4.5 Ice

A discussion of ice and icebergs within the Project Area was provided in the New Drill Centre EA and Addendum (LGL 2006, 2007a). Environmental assessments prepared more recently (e.g., LGL 2007b, 2008a,b; Christian 2008) also provide detailed discussions of ice which include the Project Area of this Amendment.

Table 4.1. Results of Analyses of Representative Sediment Samples, 2004 and 2008 EEM Programs.

Parameter	Sediment Station										
	SDC Rock Berm				NADC Rock Berm						
	14[a]	S1[a]	S2[a]	S5[a]	NA1[a]	NA2[a]	NA3[a]	NA4[a]	18[a]	SS3[b]	SS4[b]
% Gravel	0.30	0.10	1.00	1.20	2.10	0.60	1.30	0.50	0.30	1.00	0.40
% Sand	98.62	98.20	97.80	97.00	96.55	98.10	97.70	98.00	98.60	97.32	98.03-98.23
% Silt	0.35	0.72	0.74	1.08	0.25	0.59	0.16	0.80	0.30	1.20	0.48-0.80
% Clay	0.73	0.58	0.46	0.72	1.10	0.71	0.84	0.71	0.80	0.48	0.77-0.89
Total inorganic carbon (TIC) (g/kg)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.6	1.2	<0.3	<0.3-0.4
Total organic carbon (TOC) (g/kg)	0.7	1.2	0.9	0.9	0.8	1.0	0.9	0.9	0.8	1.0	0.8-1.0
Total petrogenic hydrocarbons (TPH) (mg/kg)	bd	bd	bd	bd	bd	bd	bd	bd	bd	bd	bd
$>C_{10}$-C_{21} (mg/kg)	4.5	39.0	14.0	160.0	0.8	1.7	1.4	2.1	0.8	1.24-1.42	0.79-2.73
$>C_{21}$-$<C_{32}$ (mg/kg)	0.5	1.2	0.7	1.8	1.4	0.7	0.8	0.7	0.5	<0.25-0.4	<0.25
Polycyclic aromatic hydrocarbons (PAH) (mg/kg)	bd	bd	bd	bd	bd	bd	bd	bd	bd	bd	bd
Mercury (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium (mg/kg)	<0.050	<0.050	0.050	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.07-0.08	<0.05-0.06
Total aluminum (mg/kg)	8,700	9,000	8,500	8,600	8,700	7,000-8,500	8,700	9,700	8,900	7,300-7,700	6,700-7,500
Total antimony (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Total arsenic (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Total barium (mg/kg)	210	630	410	790	170	170	170	220	160	140-150	150-170
Total beryllium (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Total cadmium (mg/kg)	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15		
Total chromium (mg/kg)	3.4	4.1	4.3	4.5	4.0	3.7-4.0	3.6	4.3	3.8	4.0	3.0-4.0
Total cobalt (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total copper (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Total iron (mg/kg)	1,300	2,000	1,600	2,100	1,700	1,500-1,800	1,800	2,100	2,000	1,300-1,500	970-1,300
Total lead (mg/kg)	3.0	3.8	2.9	5.9	2.9	2.6-2.7	2.5	3.0	2.5	2.4-2.5	2.3-4.0
Total lithium (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Total manganese (mg/kg)	36	59	43	68	52	39-50	48	64	70	36-45	22-30
Total molybdenum (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Total nickel (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Total selenium (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Total strontium (mg/kg)	49	55	54	58	50	45-48	47	54	45	43-46	50-51
Total thallium (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.1	0.1

Parameter	Sediment Station										
	SDC Rock Berm				NADC Rock Berm						
	14[a]	**S1[a]**	**S2[a]**	**S5[a]**	**NA1[a]**	**NA2[a]**	**NA3[a]**	**NA4[a]**	**18[a]**	**SS3[b]**	**SS4[b]**
Total tin (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Total uranium (mg/kg)	0.21	0.23	0.21	0.24	0.21	0.20-0.22	0.22	0.26	0.31	0.20	0.20
Total vanadium (mg/kg)	4.9	6.7	5.8	7.0	6.3	5.7-6.2	5.8	7.0	6.4	5.0	5.0-6.0
Total zinc (mg/kg)	<5.0	7.0	5.3	7.0	7.0	7.0-7.2	11.0	6.3	6.7	6.0-8.0	7.0-8.0
Sulphur (%)	0.03	0.04	0.03	0.06	0.03	0.04	0.03	0.03	0.03		
Microtox Test	Non-toxic	Non-toxic	Non-toxic	Non-toxic	Non-toxic	Non-toxic	Non-toxic	Non-toxic	Non-toxic	Non-toxic	Non-toxic

Sources: Husky 2005, 2009.

Notes: [a] denotes samples collected in 2008

[b] denotes samples collected in 2004

"bd" denotes below analytical laboratory detection limits

5.0 Biological Environment

The biological environment of the Project Area is described in the New Drill Centre EA and Addendum (Section 5 in both LGL 2006, 2007a). Information is provided for plankton, macroinvertebrate and fish habitat, macroinvertebrates and fishes, commercial fisheries, seabirds, marine mammals, sea turtles, Species at Risk and sensitive/special areas.

Other recent environmental assessments also provide updated information on the biological environment which is relevant to this Amendment. These include the Husky Delineation/Exploration Drilling EA (LGL 2007b), the Petro-Canada Jeanne d'Arc Basin Exploration Drilling Program EA (Christian 2008), and the StatoilHydro seismic and exploration and appraisal/delineation drilling EAs (LGL 2008a,b).

New information pertaining to macroinvertebrate and fish habitat, macroinvertebrates and fishes, commercial fisheries and Species at Risk is provided in this section of the Amendment. Considering the nature of the activities associated with rock berm construction, these are the ecosystem components most likely to be affected. Background information on seabirds, marine mammals and sea turtles provided in the New Drill Centre EA and Addendum (LGL 2006, 2007a), as well as in other recent EAs that included the same area is relevant to the rock berm construction activities and will not be repeated in this Amendment.

5.1 Macroinvertebrate and Fish Habitat

The Project Area occurs entirely on the shelf with a relatively homogenous gravel/sand substrate and water depths ranging between 100 and 200 m. Gross classifications of Project Area habitats include benthic, demersal and pelagic, each of which can be divided into finer classifications. While only some of the macroinvertebrates and fishes occurring in each of these habitats are important to the commercial fisheries prosecuted in the area, many are ecologically important. Section 4.1 includes a physical and chemical description of surficial sediments that are probably representative of substrate conditions at the two proposed rock berm locations (i.e., predominately sand with relatively lower hydrocarbon and elemental concentrations at the NADC location). Water depth at both rock berm locations is less than 150 m.

5.1.1 Benthic Habitat

5.1.1.1 Benthos in Project Area

Benthos includes plants (flora) and animals that live in (infauna) or on (epifauna) the sea bottom. The marine benthos is quite diverse, including micro- and macroalgae, invertebrates such as polychaete worms, molluscs and crustaceans, and certain fish species (e.g., flatfish). The composition of the benthic community is highly related to substrate type and water depth. The benthos is obviously a very important component of the benthic habitat and represents important food sources for both lower and higher trophic animal species.

Epibenthic invertebrate species caught during the White Rose baseline characterization program in 2000 included snow crab, Iceland scallop, toad crab, various echinoderms and sponges (Husky 2000, 2001b). Benthic infauna collected during the same program was dominated by polychaetes which accounted for about 80% of the organisms in the samples. Other infauna included molluscs, crustaceans and echinoderms.

Results of 2001 site surveys at Gros Morne and Trepassey drill sites indicated abundant benthos including echinoderms (sand dollars, sea urchins, sea stars, and brittle stars), molluscs (bivalves and gastropods), and crustaceans (crabs). These are the animals expected to be associated with primarily sandy substrate with occasional gravel, cobble and shell detritus (Fugro Jacques GeoSurveys Inc. 2002a,b).

Based on sediment sampling during the Husky EEM program in 2004, 2005, 2006 and 2008, polychaetes continue to dominate the benthic infauna (~75% of all invertebrates) proximate to the White Rose Development Area (Husky 2005, 2006, 2007, 2009). Bivalves also accounted for a large proportion of the total number of invertebrates in the 2004 and 2005 sediment samples.

The infauna determined from 200 grab samples collected during a three-year trawling impact study (1993 to 1995) near White Rose has been described by Kenchington et al. (2001). The sediment samples contained 246 taxa (species or species groups), primarily polychaetes, crustaceans, echinoderms and molluscs. The biomass was dominated by propeller clams (*Cyrtodaria siliqua*) and sand dollars (*Echinarachnius parma*). The brittlestar *Ophiura sarsi*, the bivalve *Macoma calcarea*, and the sea urchin *Strongylocentrotus pallidus* also contributed substantially to the biomass collected. Abundance was dominated by the polychaetes *Prionospio steenstrupi* and the mollusc *Macoma calcarea*. Other species that were relatively abundant included the polychaetes *Chaetozone setosa*, *Spio filicornis*, and *Nothria conchylega*, the amphipod *Priscillina armata*, and the sand dollar.

5.1.1.2 Benthos at Rock Berm Locations

Benthic analyses were conducted on sediment samples assumed to be representative of surficial substrate at the proposed rock berm locations. They correspond to those used for physical and chemical analyses and described in Section 4.1.2. In terms of abundance, benthos at all stations was dominated by annelids (i.e., polychaetes and oligochaetes) and pelecypods (bivalve molluscs) (Table 5.1), reflecting results of benthic analyses at other locations within the Project Area.

5.1.1.3 Deep-water Corals

Deep-water corals (also referred to as cold water corals) are common in certain areas of Atlantic Canada. They are found primarily below the 200 m depth along the edge of the continental slope, in canyons or in channels between banks. Some soft corals are common in shallower areas on the continental shelf (Mortensen et al. 2006). It is noteworthy that the comprehensive Environmental Studies Research Fund (ESRF) summary report on deep-water corals and their habitats off Atlantic

Table 5.1. Results of Benthic Analyses (number of individuals) of Representative Sediment Samples, 2004 and 2008 EEM Programs.

Biota Group	Sediment Station										
	SDC Rock Berm				NADC Rock Berm						
	14[a]	S1[a]	S2[a]	S5[a]	NA1[a]	NA2[a]	NA3[a]	NA4[a]	18[a]	SS3[b]	SS4[b]
Cnidaria		2/0	1/1	8/1							
Porifera		1/0								5/0	1/0
Hydrozoa										4/1	3/3
Polychaeta	229/225	312/259	261/215	204/252	263/262	342/391	244/196	180/353	325/447	177/269	292/217
Oligochaeta	47/99	64/70	27/48	18/16	56/57	24/30	53/37	24/49	22/19	38/37	40/44
Nemertean	0/4	4/2	1/2	1/0	1/1			1/0	1/0		
Turbellaria											
Cirripedia		4/0		0/54							
Cumacea								2/0	0/1	0/2	2/0
Decapoda											
Copepod	0/1	1/1	0/2				4/0		2/0		
Isopoda	1/1	2/0		1/0	2/0	1/1	1/0	0/1			
Tanaidacea	1/3	1/0	1/4		7/7	3/4	14/6	7/16	15/25	5/7	4/3
Amphipoda	3/1	19/9	7/6	6/2	7/0	7/11	1/7	7/7	7/2	9/8	3/5
Ostracoda										2/0	3/3
Gastropoda	1/2	3/2	0/1		0/2	0/2		1/0		1/0	0/2
Pelecypoda	36/27	53/36	14/29	41/62	40/27	27/30	34/45	50/44	22/40	39/57	30/28
Echinoidea	2/2	1/0			3/4	2/5	1/6	2/2	4/4	4/5	4/3
Stelleroidea				2/0						0/1	0/1
Ophiuroidea	2/2	3/1	1/3		1/0	4/3	1/0	8/11	0/1	0/1	1/1
Hemichordata	0/3	0/2	0/2		1/0		2/0	1/3			
Ascidacea											
Pisces		1/0						0/1		5/0	1/0
TOTALS	**322/370**	**468/384**	**313/313**	**281/387**	**381/360**	**410/478**	**356/297**	**283/487**	**398/539**	**278/383**	**379/307**

Sources: Husky 2005, 2009.

Notes: [a] Denotes samples collected in 2008.
[b] Denotes samples collected in 2004.
Two replicate samples analyzed for each station.

Canada (Mortensen et al. 2006) was made possible through the financial support of the oil and gas industry.

The distribution of deep-water corals is patchy and influenced by several environmental factors including substrate, temperature, salinity and currents. The substrate largely determines which species can occur. For example, gorgonians (horny corals) are most common on cobble and boulder but some also have anchorage apparatus for attachment in soft sediments (Mortensen et al. 2006).

Deep-water corals are known to provide habitat for a variety of invertebrate and fish species. For example, redfish have been observed in close association with deep-water corals. Fisheries and Oceans Canada have recently created three conservation areas to protect deep-water corals from damage due to fishing activity: the Northeast Channel between Georges Bank and the southwest Scotian Shelf, the Gully on the southern Scotian Shelf, and the Stone Fence at the southern end of the Laurentian Channel. None of these areas occur within the New Drill Centre EA Study Area (see Mortensen et al. 2006).

Mortensen et al. (2006) present distribution maps of deep-water corals based on bycatch in DFO groundfish trawl surveys (1999-2001), fishery observer reports (2000-2001), and local ecological knowledge of Newfoundland fishermen. Mapped distributions within the Study Area include *Paragorgia arborea* (Bubble Gum Coral) on the upper slope region of the southern Flemish pass, *Primnoa resedaeformis* (Sea Corn) on the slope region of the northern part of the Study Area, and *Paramuricea* spp. (Black Coral) along the eastern slope region of the Tail of the Bank in the southern Study Area.

Deep-water corals should not be an issue during rock berm construction activities, as indicated in the New Drill Centre EA and Addendum (LGL 2006, 2007a).

5.1.2 Demersal and Pelagic Habitats

Other macroinvertebrate and fish species occur principally in the water column above the bottom substrate. Those that occur primarily in the lower water column and remain in association with the bottom are referred to as demersal species. Others that occur higher in the water column and have little or no association with the benthic habitat are referred to as pelagic species.

Demersal and pelagic macroinvertebrates likely occurring at the rock berm construction locations include crustacean (e.g., snow crab, shrimp) and cephalopod (e.g., squid) species. Demersal and pelagic fish species likely occurring at the rock berm construction locations include American plaice, sand lance and capelin.

5.2 Macroinvertebrates and Fishes

5.2.1 Species Occurrence

Based on recent EAs and associated documents that spatially included the Project Area (LGL 2006, 2007a,b, 2008a,b; Christian 2008) as well as analysis of recent Newfoundland and Labrador commercial landings data and DFO research vessel survey data, the following species have been identified as notable macroinvertebrates and fishes that likely occur at the proposed rock berm locations.

- Snow crab;
- Northern shrimp;
- American plaice;
- Thorny skate;
- Greenland halibut;
- Sand lance; and
- Capelin.

Figure 5.1 indicates locations and primary catches of DFO RV surveys conducted close to the Project Area in 2006 and 2007. The area which encompasses the Project Area is defined by the following corner coordinates:

47.00º N, 48.25ºW
47.00º N, 47.88ºW
46.63º N, 48.25ºW
46.63º N, 47.88ºW

Both RV survey tows indicated in Figure 5.1 are located at least 15 km from either proposed rock berm location.

In terms of weight, catches were dominated by shrimp (21.9%), unspecified invertebrates (19.7%), sand lance (12.0%), thorny skate (10.3%), American plaice (10.2%), capelin (7.1%), mailed sculpin (7.0%), Arctic eelpout (4.0%), male and female snow crab (3.1%), spotted wolfish (2.8%).

In terms of number, catches were dominated by capelin (36.5%), sand lance (33.6%), mailed sculpin (24.7%), American plaice (1.5%), unspecified cephalopods (0.6%), and Arctic alligatorfish.

A spotted wolfish was also reported in recent commercial catches within 25 km of the proposed berm locations. Numerous other macroinvertebrate and fish species also likely occur around SDC and NADC, including scallops, squids, and Atlantic cod.

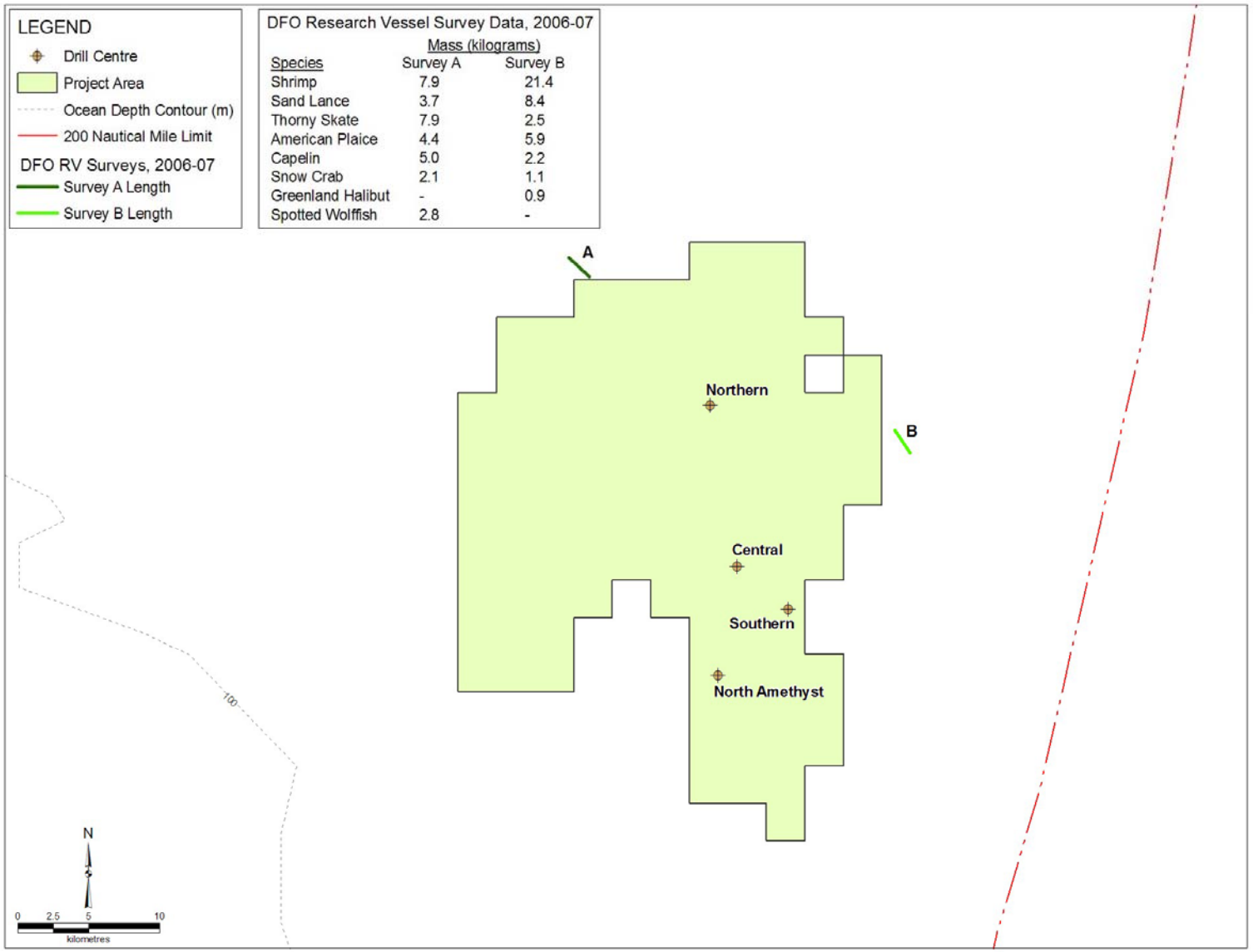

Figure 5.1. Locations and Primary Catches of DFO RV Surveys Conducted Close to the Project Area in 2006 and 2007.

5.2.2 Invertebrate and Fish Spawning

Ollerhead et al. (2004) mapped the spawning times and locations for ten commercially important fish and invertebrate species found on the Grand Banks. Mapping was based on data collected on DFO research surveys between 1965 and 2003. Ollerhead et al. (2004) identified spawning within the Project Area by Atlantic cod (May 1972-1997), American plaice (May and June 1987-1997) and northern shrimp which typically mates and extrudes during summer/early fall. It is reasonable to speculate that there is also spawning within the Project Area by other macroinvertebrates and fishes including snow crab (summer/early fall), scallops (summer/early fall), and sand lance (late fall). Both demersal and pelagic eggs likely occur at the proposed rock berm locations at particular times of the year, primarily during late spring, summer and early fall.

5.3 Commercial Fisheries

The Newfoundland and Labrador commercial fishery landings database for 2006 and 2007 was analysed for georeferenced catches within an area which encompasses the Project Area. It is the same area used for the DFO RV survey database analysis (see Section 5.2.1).

Figure 5.2 indicates the 2006 and 2007 catch locations within and proximate to the Project Area.

In 2006, the total reported weight of catches within the area and landed at Newfoundland and Labrador ports was 91.2 t. Snow crab represented essentially all of the catch weight, except for one reported spotted wolfish catch. Total value of the 2006 catches was about $193,000. In 2007, the total reported weight of catches within the area and landed at Newfoundland and Labrador ports was 183.2 t. Snow crab accounted for all 2007 catches which were valued at about $652,000. The only reported catch locations within the Project Area were in its northern region, well away from the proposed SDC berm.

5.4 Species at Risk

The *Species at Risk Act* (*SARA*) was assented to in December 2002 with certain provisions coming into force in June 2003 (e.g., independent assessments of species by COSEWIC and June 2004 and prohibitions against harming or harassing listed *endangered* or *threatened* species or damaging or destroying their critical habitat). The information provided in this subsection is current as of November 2008 on the websites for *SARA* (http://www.sararegistry.gc.ca/default_e.cfm) and COSEWIC (http://www.cosepac.gc.ca/index.htm).

The only species listed by the Government of Newfoundland and Labrador *Endangered Species Act* (*ESA*) that may occur in the area is the Ivory Gull (*Pagophila eburnean*) (http://www.env.gov.nl.ca/env/wildlife/wildlife_at_risk.htm).

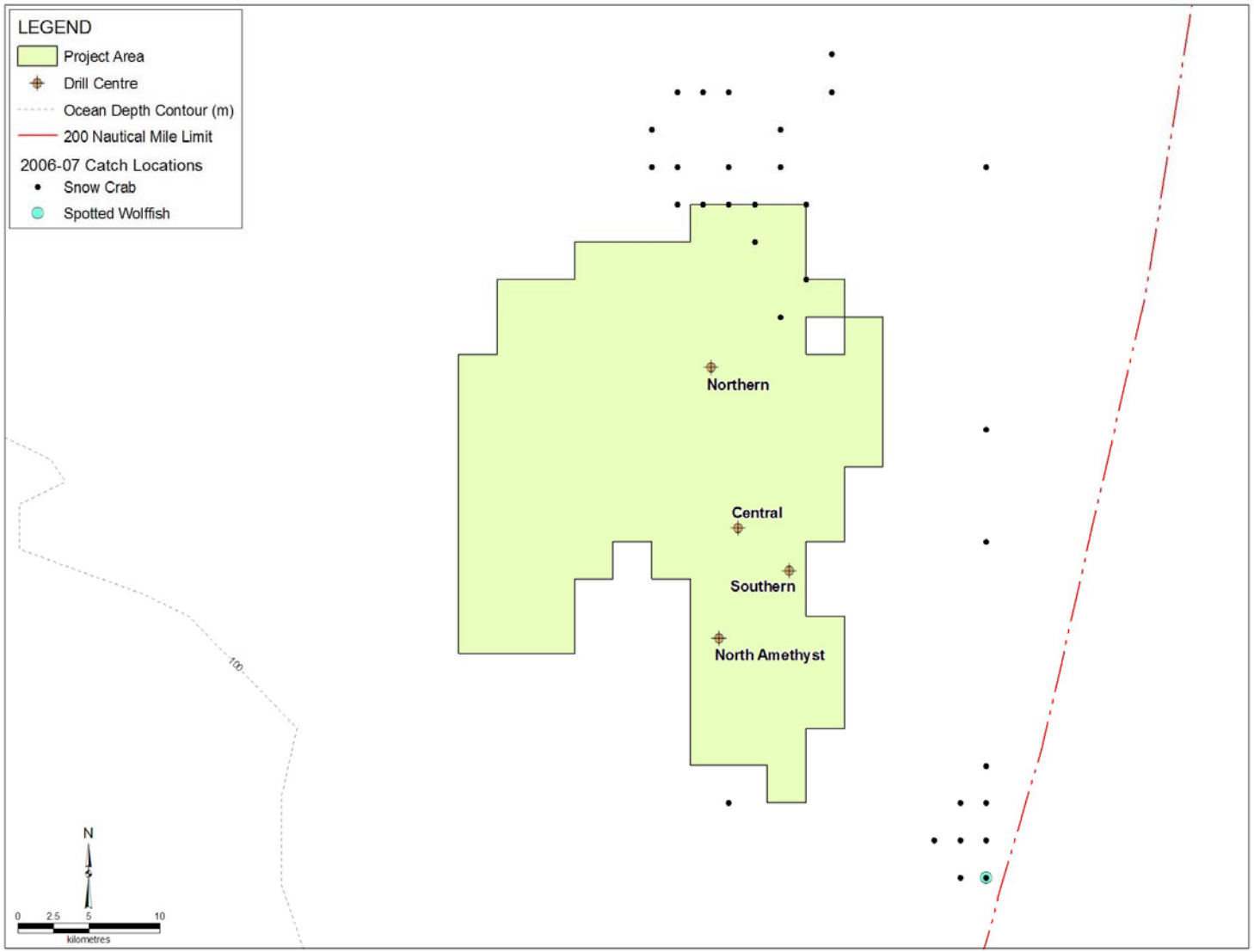

Figure 5.2. Georeferenced Catch Locations within and Proximate to the Project Area Reported in 2006 and 2007 NL Commercial Landings Database.

Species are listed under *SARA* on Schedules 1 to 3 with only those listed as *endangered* or *threatened* on Schedule I having immediate legal implications. Nonetheless, attention must be paid to all of the *SARA*-listed species because of their sensitivities to perturbation and the potential for status upgrades

Schedule 1 is the official list of wildlife Species at Risk in Canada. Once a species/population is listed, the measures to protect and recover it are implemented. The two cetacean species/populations, one sea turtle species, and two fish species/populations that are legally protected under *SARA* and have potential to occur in the Study Area are listed in Table 5.2. Atlantic wolffish (*Anarhichas lupus*), the Atlantic population of fin whales (*Balaenoptera physalus*), and Ivory Gull (*Pagophila eburnea*) are listed as *special concern* on Schedule 1 (Table 5.2). Schedules 2 and 3 of *SARA* identify species that were designated "at risk" by COSEWIC prior to October 1999 and must be reassessed using revised criteria before they can be considered for addition to Schedule 1. Species that potentially occur in the Study Area and are considered at risk but which have not received specific legal protection (i.e., proscribed penalties and legal requirement for recovery strategies and plans) under *SARA* are also listed in Table 5.2 as *endangered*, *threatened* or species of *special concern* under COSEWIC. Other non-*SARA* listed marine species which potentially occur in the Study Area and are listed by COSEWIC as *candidate* species are also included in Table 5.2.

Under *SARA*, a 'recovery strategy' and corresponding 'action plan' must be prepared for *endangered*, *threatened*, and *extirpated* species. A 'management plan' must be prepared for species listed as *special concern*. Recovery strategies have been prepared for four species currently listed as either *endangered* or *threatened* under Schedule 1: (1) North Atlantic right whale (Brown et al. 2009), (2) the leatherback sea turtle (ALTRT 2006), (3) the spotted wolffish (Kulka et al. 2007), and (4) the northern wolffish (Kulka et al. 2007). A management plan has also been prepared for the Atlantic wolffish (Kulka et al. 2007), currently listed as *special concern* on Schedule 1. Husky will monitor *SARA* issues through the Canadian Association of Petroleum Producers (CAPP), the law gazettes, the internet and communication with DFO and Environment Canada, and will adaptively manage any issues that may arise in the future. The company will comply with relevant regulations pertaining to *SARA* Recovery Strategies and Action Plans. Husky acknowledges the rarity of the species defined as "species at risk" and will continue to exercise due caution to minimize impacts on them during all of its operations. Husky also acknowledges the possibility of other marine species being listed as *endangered* or *threatened* on Schedule 1 during the course of the Project. Due caution will also be extended to any other species added to Schedule 1 during the life of this Project.

5.5 Areas of Special Sensitivity

There are not any identified areas of special sensitivity in the Project Area of the proposed rock berm construction Project.

Table 5.2. *SARA* Schedule 1 and COSEWIC-listed Marine Species that Potentially Occur in the Project Area.

Species		*SARA* Schedule 1[a]			COSEWIC[b]			
Common Name	**Scientific Name**	***Endangered***	***Threatened***	***Special Concern***	***Endangered***	***Threatened***	***Special Concern***	***Candidate***
Blue whale	*Balaenoptera musculus*	X			X			
North Atlantic right whale	*Eubalaena glacialis*	X			X			
Leatherback sea turtle	*Dermochelys coriacea*	X			X			
Ivory Gull	*Pagophila eburnea*	X			X			
Northern wolffish	*Anarhichas denticulatus*		X			X		
Spotted wolffish	*Anarhichas minor*		X			X		
Atlantic wolffish	*Anarhichas lupus*			X			X	
Fin whale (Atlantic population)	*Balaenoptera physalus*			X			X	
Atlantic cod (Newfoundland and Labrador population)	*Gadus morhua*				X			
Porbeagle shark	*Lamna nasus*				X			
White shark	*Carcharodon carcharias*				X			
Roundnose grenadier	*Coryphaenoides rupestris*				X			
Cusk	*Brosme brosme*					X		
Shortfin mako shark	*Isurus oxyrinchus*					X		
Sowerby's beaked whale	*Mesoplodon bidens*						X	
Harbour porpoise	*Phocoena phocoena*						X	
Killer whale (Northwest Atlantic/Eastern Arctic populations)	*Orcinus orca*						X	
Blue shark	*Prionace glauca*						X	
American eel	*Anguilla rostrata*						X	
Roughhead grenadier	*Macrourus berglax*						X	
Manx Shearwater	*Puffinus puffinus*							High priority
Bluefin tuna	*Thunnus thynnus*							High priority
Atlantic salmon	*Salmo salar*							High priority
Ocean pout	*Zoarces americanus*							High priority
Spiny eel	*Notacanthus chemnitzi*							Mid priority
Pollock	*Pollachius virens*							Mid priority
Blue hake	*Antimora rostrata*							Mid priority
Spinytail skate	*Bathyraja spinicauda*							Mid priority
Sperm whale	*Physeter macrocephalus*							Low priority
Hooded seal	*Cystophora cristata*							Low priority
Harp seal	*Phoca groenlandica*							Low priority

Sources: [a] *SARA* website (http://www.sararegistry.gc.ca/default_e.cfm) (as of 1 March 2009).
Notes: [b] COSEWIC website (http://www.cosepac.gc.ca/index.htm) (as of 1 March 2009).
[c] Also listed on Government of Newfoundland and Labrador *ESA.*

6.0 Effects Assessment Methodology

Two general types of effects are considered in this document:

1. Effects of the environment on the Project; and
2. Effects of the Project on the environment, particularly the biological environment.

Methods of effects assessment used here are comparable to those used in the Hibernia (Mobil 1985) and Terra Nova (Petro-Canada 1996a,b) EISs, White Rose Oilfield Development EA and Comprehensive Study, Husky White Rose Development Project: New Drill Centre Construction and Operations Program EA and Addendum (LGL 2006, 2007a), various Husky seismic and drilling EAs (e.g., LGL 2007b), and other East coast seismic and drilling EAs (e.g., LGL 2008a,b; Christian 2008). These documents conform to the *Canadian Environmental Assessment Act* (*CEAA*) and it's associated Responsible Authority's Guide and the CEA Agency Operational Policy Statement (OPS-EPO/5-2000) (CEA Agency 2000). Cumulative effects are incorporated within the procedures in accordance with *CEAA* (CEA Agency 1994) as adapted from Barnes and Davey (1999).

6.1 Scoping

Scoping of an assessment mainly includes determining the spatial and temporal extent of the assessment, selecting which components (i.e., sensitive and/or representative species or species-groups and associated habitats) of the ecosystem to assess, and which project activities to analyze. Scoping included the review of all relevant information on project activities and literature on the effects of these activities on the environment.

6.2 Consultations

Technical advice was received from the C-NLOPB, other federal agencies, and certain stakeholders (specifically the Fish, Food and Allied Workers Union and One Ocean) consulted by Husky and it helped to guide the preparation of this amendment of the New Drill Centre EA and Addendum LGL (2006, 2007a).

6.3 Valued Ecosystem Components (VECs)

The Valued Ecosystem Component (VEC) approach was used to focus the assessment on those biological resources of most potential concern and value to society.

VECs include the following groups:

- rare or threatened species or habitats (as defined by COSEWIC and *SARA*);
- species or habitats that are unique to an area, or are valued for their aesthetic properties;

- species that are harvested by people (e.g., commercial fish species); and
- species that have at least some potential to be affected by the Project.

VECs were identified based on the Hibernia EIS (Mobil 1985), the Terra Nova EIS (Petro-Canada 1996a,b), the White Rose Oilfield Development EA and Comprehensive Study and associated Supplement (Husky 2000, 2001a), various seismic and drilling EAs for proposed projects on the Grand Banks, Fisheries and Oceans Canada and Environment Canada comments on these documents, and consultations with stakeholders and regulators. The results of the White Rose issue scoping sessions, public and agency consultations, and Commission hearings were also considered in identifying the VECs for assessment.

The VECs are typically selected based upon expressed public comments related to social, cultural, economic, or aesthetic values and scientific community concerns. From a local perspective, most concern for offshore oil and gas activities is related to the fishery and the seabirds. National and international issues may include such groups as deep sea corals and marine mammals.

The VECs for the proposed rock berm construction Project include the following.

- Macroinvertebrate and Fish Habitat;
- Macroinvertebrates and Fishes;
- Commercial Fisheries; and
- Species at Risk (SAR).

Other VECs typically used for most environmental assessments of oil and gas industry offshore activities (i.e., seabirds, marine mammals and sea turtles) are not assessed in this Amendment because there is little chance of direct effect of berm building activities on them.

The following subsections provide brief descriptions of the VECs that will be used in this Amendment.

6.3.1 Macroinvertebrate and Fish Habitat VEC

'Fish habitat' includes both physical and biological components. In the broadest sense it includes water quality, plankton and benthos. Both plankton (phytoplankton and zooplankton) and benthos (epifauna and infauna) are integral components of fish habitat, and, hence, of the marine ecosystem. Phytoplankton is mostly responsible for the primary production in the Northwest Atlantic marine ecosystem and essentially all plankton species serve as food sources for a vast array of marine biota. Benthos, which includes macroalgae, also accounts for some primary production and plays a very important role in the cycling of organic material through the marine ecosystem. Benthos also serves as food sources for many marine biota. Plankton and benthos can be considered the basis of the marine ecosystem food web. This Amendment requires focus on the benthic aspect of fish habitat considering the nature of the proposed Project (i.e., coverage of bottom substrate with rock). The fish habitat VEC as it relates to key species is of prime concern from both a public and scientific perspective, at local, national and international scales.

6.3.2 Macroinvertebrate and Fish VEC

The macroinvertebrate and fish species previously identified in this Amendment (i.e., snow crab, shrimp, Atlantic cod, and wolffishes) are suitable examples to use in the effects assessment. For example, Atlantic cod is an important commercial and cultural species for which most data exist with respect to behaviour, life history, reproduction, etc., and therefore, is a good representative species for the fish VEC. The fish VEC is of prime concern from both a public and scientific perspective, at local, national and international scales.

6.3.3 Commercial Fishery VEC

The commercial fishery is a universally acknowledged important element in society, culture, economic and aesthetic environment of Newfoundland and Labrador. This VEC is of prime concern from both a public and scientific perspective, at local, national and international scales.

6.3.4 Species at Risk VEC

"Species at Risk" are those listed as *endangered*, *threatened* or *special concern* on either Schedule I of *SARA* or by COSEWIC. Also considered in this VEC are COSEWIC-listed candidate species.

6.4 Other Issues

Offshore air quality also has been given some consideration because it may affect water quality and animal and human health, albeit in very minor ways. Although the four VECs listed above represent very broad groups of organisms, consideration was given to individual species and life stages when data were sufficient and where warranted. In many cases, during effects analysis, species with similar life histories and sensitivities were grouped together.

6.5 Boundaries

Boundaries have been defined using CEA Agency (2003) as guidance.

6.5.1 Temporal

Since this document is an amendment to the New Drill Centre EA, effects of the routine activities associated with the construction of protective rock berms have been assessed 'year-round' for the period 2009-2020.

6.5.2 Spatial

The spatial boundaries described in the following subsections were used in this EA Amendment.

6.5.2.1 Project Area

This document is an amendment to the New Drill Centre EA; therefore, the Project Area used for the Amendment is the same as that used for the New Drill Centre EA (i.e., White Rose Operational Area (Figure 1.1)).

6.5.2.2 Study Area

Similarly, the Study Area used for the Amendment is the same as that used for the New Drill Centre EA. The Study Area boundary is based on the oil spill trajectory modeling conducted for the White Rose Oilfield Comprehensive Study (Husky 2000). Although the Study Area is very large relative to the Project Area, it is substantially smaller than the Regional Study Area of the Comprehensive Study. If not for the consideration of accidental events, the Study Area would be much reduced in size based on routine activities alone.

6.5.2.3 Affected Area

The Affected Area is the geographic extent of a specific potential effect on a species or species group. It varies according to the timing and type of project activity in question and the sensitivities of the species. Thus, there are more than one affected areas or geographic extents defined in this Amendment.

6.5.2.4 Regional Area

The Regional Area, based on convention established by numerous previous EAs for Newfoundland and Labrador waters, includes the Study Area and the Grand Banks.

6.6 Effects Assessment Procedures

The systematic assessment of the potential effects of the Project phase involved three major steps:

1. Preparation of interaction (between Project activities and the environment) matrices;
2. Identification and evaluation of potential effects including description of mitigation measures and residual effects; and
3. Determination of significance of residual effects, including evaluation of cumulative effects.

6.6.1 Identification and Evaluation of Effects

Interaction matrices identify all possible Project activities that could interact with any of the VECs. The matrices include times and places where interactions could occur. The interaction matrices are used only to identify potential interactions; they make no assumptions about the potential effects of the interactions. An interaction matrix is provided for each VEC.

Interactions were then evaluated for their potential to cause effects. In instances where the potential for an effect of an interaction was deemed impossible or extremely remote, these interactions were not considered further. In this way, the assessment could focus on key issues and the more substantive environmental effects.

An interaction was considered to be a potential effect if it could change the abundance or distribution of VECs, or change the prey species or habitats used by VECs. The potential for effect was assessed by considering:

- location and timing of the interaction;
- literature on similar interactions and associated effects (including the previous oil and gas EAs for Offshore Nova Scotia and Newfoundland);
- consultation with other experts (when necessary); and
- results of similar effects assessments.

When data were insufficient to allow certain or precise effects evaluations, predictions were made based on professional judgement. In such cases, the uncertainty is documented in the Amendment.

Effects were evaluated for the proposed rock berm construction with consideration of any mitigation measures that could reduce effects.

6.6.2 Classifying Anticipated Environmental Effects

The concept of classifying environmental effects simply means determining whether they are negative or positive. The following includes some of the key factors that are considered for determining negative environmental effects, as per the CEA Agency guidelines (CEA Agency 1994):

- negative effects on the health of biota;
- loss of rare or endangered species;
- reductions in biological diversity;
- loss or avoidance of critical/productive habitat;
- fragmentation of habitat or interruption of movement corridors and migration routes (It can be argued that while this is relevant for some terrestrial EAs, it is not relevant to the offshore where there are no confined corridors or routes.);
- transformation of natural landscapes;
- discharge of persistent and/or toxic chemicals;
- toxicity effects on human health;
- loss of, or detrimental change in, current use of lands and resources for traditional purposes;
- foreclosure of future resource use or production; and
- negative effects on human health or well-being.

6.6.3 Mitigation

Most effects, including any significant ones, can be mitigated by additions to or changes in equipment, operational procedures, timing of activities, or other measures. Mitigation measures appropriate for each effect predicted in the matrix were identified and the effects of various Project activities were then evaluated assuming that appropriate mitigation measures are applied. Effects predictions were made taking into consideration both standard and project-specific mitigations and can thus be considered "residual effects."

6.6.4 Application of Evaluation Criteria for Assessing Environmental Effects

Several criteria were taken into account when evaluating the nature and extent of environmental effects. These criteria include (CEA Agency 1994):

- magnitude;
- geographic extent;
- duration
- frequency;
- reversibility; and
- ecological, socio-cultural and economic context.

Magnitude describes the nature and extent of the environmental effect for each activity. Geographic extent refers to the specific area (km^2) potentially affected by the Project activity, which may vary depending on the activity and the relevant VEC. Duration and frequency describe how long and how often a project activity and/or environmental effect will occur. Reversibility refers to the ability of a VEC to return to an equal or improved condition at the end of the Project. The ecological, socio-cultural and economic context describes the current status of the area affected by the Project in terms of existing environmental effects. Results of the effects analyses of the Macroinvertebrate and Fish Habitat VEC, the Macroinvertebrate and Fish VEC and the Commercial Fishery VEC are described in the text only. An environmental effects assessment table is provided for each Species at Risk VEC component indicating the results of the effects analysis.

Magnitude is defined as:

Negligible	May create a measureable effect on individuals but would never approach the 10% value of the 'low' rating.
Low	Affects > 0 to 10 percent of individuals in the affected area (i.e., geographic extent). Effects can be outright mortality, sublethal or exclusion due to disturbance.

Medium	Affects >10 to 25 percent of individuals in the affected area (i.e., geographic extent). Effects can be outright mortality, sublethal or exclusion due to disturbance.
High	Affects more than 25 percent of individuals in the affected area (i.e., geographic extent). Effects can be outright mortality, sublethal or exclusion due to disturbance.

Geographic extent is defined as:

1	=	< 1 km^2
2	=	1 – 10 km^2
3	=	11 – 100 km^2
4	=	101 – 1,000 km^2
5	=	1,001 – 10,000 km^2
6	=	>10,000 km^2

Duration is defined as:

1	=	< 1 month
2	=	1 – 12 month
3	=	13 – 36 month
4	=	37 – 72 month
5	=	> 72 month

Short duration can be considered 12 months or less and medium duration can be defined as 13 to 36 months.

Frequency is defined as:

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

Reversibility (at population level) is defined as:

R	=	reversible
I	=	irreversible

Ecological, socio-cultural and economic context is defined as:

1 = relatively pristine area not negatively affected by human activity
2 = evidence of negative effects as a result of human activity

6.6.5 Cumulative Effects

Projects and activities considered in the cumulative effects assessment included:

- Within-project cumulative impacts, including other White Rose activities. For the most part, and unless otherwise indicated, within-project cumulative effects are fully integrated within this assessment;
- Hibernia and Terra Nova (other existing offshore oil developments);
- Other offshore oil exploration activity (seismic surveys and exploratory drilling).
- Commercial fisheries;
- Marine transportation (tankers, cargo ships, supply vessels, naval vessels, fishing vessel transits, etc.); and
- Hunting activities (marine birds and seals).

6.6.6 Integrated Residual Environmental Effects

Upon completion of the evaluation of environmental effects, the residual environmental effects (effects after project-specific mitigation measures are imposed) are assigned a rating of significance for the following:

- each project activity or accident scenario;
- cumulative effects of project activities within the Project; and
- cumulative effects of combined projects on the Grand Banks, in the Orphan Basin, and on the Labrador Shelf.

These ratings are presented in text for all VECs. Since all berm construction activities are actually included in the New Drill Centre EA (rock coverage of substrate essentially the same as glory hole excavation), and for the sake of document brevity, summary tables of residual effects presented in the New Drill Centre EA and Addendum are referred to in this Amendment. The last of these points considers all residual environmental effects, including project and other-project cumulative environmental effects. As such, this represents an integrated residual environmental effects evaluation.

The analysis and prediction of the significance of environmental effects, including cumulative environmental effects, encompasses the following:

- determination of the significance of residual environmental effects;
- establishment of the level of confidence for prediction; and

- evaluation of the scientific certainty and probability of occurrence of the residual impact prediction.

Ratings for level of confidence, probability of occurrence, and determination of scientific certainty associated with each prediction are also presented in the Amendment. The guidelines used to assess these ratings are discussed in detail in the sections below.

6.6.7 Significance Rating

Significant environmental effects are those that are considered to be of sufficient magnitude, duration, frequency, geographic extent, and/or reversibility to cause a change in the VEC that will alter its status or integrity beyond an acceptable level. Establishment of the criteria is based on professional judgement, but is transparent and repeatable. In this Amendment, a *significant* effect is defined as:

> *Having a high or medium magnitude for a duration greater than one year over a geographic extent greater than 100 km^2*

An effect can be considered *significant*, *not significant*, or *positive*. Significance tables presented in the New Drill Centre EA and Addendum will be referred to in the Amendment for the same reasons provided above regarding the summary tables of residual effects.

6.6.7.1 Level of Confidence

The significance of the residual environmental effects is based on a review of relevant literature, consultation with experts, and professional judgement. In some instances, making predictions of potential residual environmental effects is difficult due to the limitations of available data (for example, technical boundaries). Ratings are therefore provided to indicate, qualitatively, the level of confidence for each prediction.

6.6.7.2 Determination of Whether Predicted Environmental Effects are Likely to Occur

As per Husky (2000), the following criteria for the evaluation of the likelihood of predicted significant effects are used.

- probability of occurrence; and
- scientific certainty.

6.7 Monitoring/Follow-Up

Husky currently has an EEM program in place designed to measure effects from the variety of project activities.

6.8 Effects of the Environment on the Project

Effects of the physical environment on the Project include those caused by wind, ice, waves, and currents, particularly extreme events. These are referred to in Section 4.

Effects of the environment will be mitigated by state-of-the-art weather prediction, timing, selection of suitable vessels, equipment and personnel, and by adherence to Husky's HSE Plan. Effects of the environment on the Project are expected to be *not significant*.

7.0 Project Activities

General project activities were described in the Project Description in Section 3.0. The following subsections describe the potential zones of influence of specific project activities whose effects on the VECs are assessed in this Amendment. The activities assessed include:

- Coverage of natural substrate by rock;
- Noise produced by the Project;
- Presence of the rock placement vessel;
- Lights on the rock placement vessel;
- Liquid and solid wastes produced during the Project; and
- Atmospheric emissions produced during the Project.

7.1 Potential Affected Areas

The primary environmental concern regarding the routine activities associated with the Husky White Rose Development Project New Drill Centre Construction & Operations Program EA Amendment: Construction of Protective Flowline Rock Berms is the coverage of natural substrate (i.e., benthic habitat) and the resultant effects on benthos.

7.1.1 Rock Coverage of Natural Benthic Habitat

At most approximately 56,000 m^2 of seabed (~0.014% of the Project Area) will be covered by the two proposed rock berms. The anticipated duration of berm construction is 30 to 60 days, depending on any delays due to weather. Some of the sediment may be temporarily suspended in the lower water column during rock placement.

Construction of the rock berms may engender a Harmful Alteration Disruption or Destruction (HADD) of fish habitat, pursuant to the federal *Fisheries Act*. In order to compensate for the loss of fish habitat and its attendant fish productivity, Husky will be required to design and enact a compensation plan.

However, although as much as 56,000 m^2 of seabed will be covered by rock, the resultant berms will serve as deep water rock reefs in an area characterized as relatively homogeneous and low profile. The rock berms will add complexity and hard, stable substrate to the existing habitat.

Artificial marine reefs have been established and studied for over thirty years (Jensen 2002). The attraction of species assemblages to natural or artificial structures has not been fully explained although many hypotheses have been proposed. The practical implication of the 'reef effect' is a localized increase in density and activity of fish and invertebrate species (Vardaro et al. 2007). Studies have investigated reefs as shelters from predators (Soemarto 1960 *in* Vardaro et al. 2007), as a means for predators to concentrate smaller prey species (Kojima 1956 *in* Vardaro 2007), and as sites of increased reproductive success (Stephens and Pondella 2002). In deep water with low light conditions, an

assortment of red algae will grow on hard substrate and create numerous micro-habitats which are subsequently inhabited by a variety of marine biota. Even at depths where algal growth cannot occur, a succession of suspension-feeding invertebrates (e.g., sea anemones, sponges, corals) will colonize the rock berms and eventually attract mobile invertebrate and fish species (e.g., crabs, American plaice, wolffish). The eventual productivity on and within the rock berms will likely be equal to or possibly exceed the productivity of the original natural habitat. In fact, rock placement is a common form of habitat enhancement in both freshwater and marine environments.

7.1.2 Noise

The primary sources of noise during the construction of the berm will include the rock placement vessel and its associated equipment, and underwater rock collisions.

Underwater sound has the potential to affect marine animals in a variety of ways depending on source levels, duration of exposure, proximity of noise source, animal sensitivities, environmental conditions, and other factors. Marine mammals are generally believed to be the group most sensitive to underwater sound.

Some sound levels reported for various offshore drilling and VSP activities are provided in Table 7.1.

Table 7.1. Natural and Development-related Underwater Sound Levels.

Source	Broadband Sound Level (dB re 1 µPa[1])	Sound Levels at Dominant Frequencies	
		Frequency (Hz)	Level (dB re 1 µPa[1])
Ambient Noise			
Wind < 1.8 km/h	-	100	60
Wind 20.4-29.7 km/h	-	100	97
Wind 40.8-50.0 km/h	-	100	102
Heavy shipping	-	50	105
Light shipping	-	50	86
Remote shipping	-	50	81
TNT Explosion[a] 0.5 kg at 60 m	267	21	-
Seismic Airguns	216-259	50-100	-
VSP Array Peak source level	233	-	-
Depth Sounder	180+	12,000+	-
Semi-submersible Drill Rig	154	7-14, 29, 70	-
Drillship	174-185	to 600	-
Supply Boats (*Kigoriak*)	181	-	-
Large Tanker	186	100+, 125	177
Supertanker	190-205	70	175
Super Puma Helicopter at 300 m Above Sea Level			
Received level at sea surface	-	20, 50	105-110
Received levels at 3 to 18 m depth	-	-	65-70
[1] 3rd octave band level			

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

[a] Not a routine activity.

7.1.3 Presence of Rock Placement Vessel

After reaching the Southern part of the Project Area, the rock placement vessel will move within a two-kilometre radius of each drill centre and transit between the NADC and the SDC as required.

7.1.4 Lights

Lights will be used on the rock placement vessel to provide work area illumination. Lights under certain conditions have the potential to affect some bird species, particularly storm petrels, by attracting them to the rig. Lights might also attract other biota such as squid, fish and sea turtles.

7.1.5 Liquid and Solid Wastes

Some liquid and solid waste will be produced on the rock placement vessel over the duration of the berm construction.

7.1.6 Atmospheric Emissions

Atmospheric emissions will be produced by the rock placement vessel and associated equipment over the duration of the berm construction.

7.2 Potential Effects of Routine Activities

The following sections describe the potential interactions of the proposed Project routine activities with the VECs, identification and evaluation of potential effects of the routine activities on the VECs (including description of mitigation measures and residual effects), and determinations of significance of residual effects, including evaluation of cumulative effects.

Cumulative effects are considered for both within the rock berm construction Project and between the Project and other projects/activities occurring on the Grand Banks. These other projects/activities include existing oil development projects such as Hibernia, Terra Nova and White Rose, and other activities such as exploration, marine transportation, and fishing.

7.2.1 Macroinvertebrate and Fish Habitat VEC

Table 7.2 presents the potential interactions of the rock berm construction routine activities and the Macroinvertebrate and Fish Habitat VEC. The four components of fish habitat considered in this assessment include (1) water, (2) sediment, (3) plankton, and (4) benthos.

Table 7.2. Potential Interactions of Routine Activities and Macroinvertebrate and Fish Habitat VEC.

Valued Ecosystem Component: Macroinvertebrate and Fish Habitat				
Project Activity	**Habitat Components**			
	Water	**Sediment**	**Plankton**	**Benthos**
Coverage of benthic habitat	x	x		x
Noise			x	x
Presence of marine vessel				
Lights of marine vessel			x	
Liquid and solid wastes	x		x	
Atmospheric emissions	x		x	
Other projects/activities				
Hibernia	x	x	x	x
Terra Nova	x	x	x	x
White Rose	x	x	x	x
Exploration	x	x	x	x
Fisheries	x	x	x	x
Marine Transportation	x		x	x

7.2.1.1 Coverage of Benthic Habitat

Coverage of benthic habitat has the potential to interact with three of the four habitat components indicated in Table 7.2: water, sediment and benthos. As already indicated, a maximum of approximately 56,000 m^2 of natural benthic habitat will be covered by the rock used to construct the rock berms. At the same time, the rock berms will provide more complex surface area as well as interstitial spaces between rock particles to be used as habitat by invertebrate and fish biota. The locations where the two rock berms will be built are characterized by a homogeneous sandy substrate, a habitat type that appears widespread throughout much of the Project Area. The width of the berms will vary between 18 and 32 m; thus, biota displaced by installation of the rock will not have to move far to find habitat similar to that covered by the rock. The possibility of sediment suspension in the lower water column as a result of rock striking the bottom would be temporary. As noted previously, the anticipated areal extent of rock coverage represents only 0.014% of Project Area. If rock coverage area is added to the existing spoils site area (240,000 m^2) and the area of seven glory holes (34,300 m^2) indicated in the New Drill Centre EA (LGL 2006), the total area still only accounts for 0.083% of the Project Area.

Although the rock used to construct the berms will be unwashed, fines dispersion will be minimal. Firstly, the rock will be processed in a crusher, thereby removing any clumps of mud that may have been adhering to the rock. Secondly, the controlled 'downpipe' rock placement technique will minimize the dispersion of any residual fines still associated with the rock.
Mitigation measures that will be implemented during the Project to minimize effects of rock coverage of natural benthic habitat on macroinvertebrate and fish habitat include the following:

- Design rock berm to minimize the amount of areal coverage and still provide appropriate protection for the flowlines;

- Design rock berm to optimize its characteristics as a suitable complex habitat for invertebrates and fishes;
- Employment of a controlled 'downpipe' rock placement technique; and
- Minimize the time required to construct the rock berms.

Considering the relatively small area of coverage, the homogeneity of bottom substrate within the Project Area, the potential use of the berms as invertebrate and fish habitat, and the possible mitigation measures listed above, the *reversible negative* residual effects of rock coverage of natural benthic habitat on the Macroinvertebrate and Fish Habitat VEC are predicted to be *negligible to low* in magnitude over a duration of *>72 months* (when considering presence after construction) in a geographic area of *<1 km^2*. The frequency of the proposed rock berm construction Project is *<11 events/year* (see Table 7.6 in LGL 2006). Based on the ratings of these assessment criteria and with a *medium to high* level of confidence, the residual physical effects of rock coverage of natural benthic habitat on this VEC are predicted to be *not significant* (see Table 7.7 in LGL 2006)

7.2.1.2 Noise

Noise has the potential to interact with two of the four habitat components indicated in Table 7.2; plankton and benthos. In the New Drill Centre EA and Addendum, many noise types were assessed and all residual effects of exposure to noise on macroinvertebrate and fish habitat components were predicted to be *not significant*. Compared to potential noise produced by the proposed rock berm construction, many of the New Drill Centre EA noise types had higher energy levels and were produced for longer periods of time.

Considering this previous assessment of the effects of exposure to noise on habitat components and all attempts at minimizing the time required to construct the rock berms, the *reversible negative* residual effects of Project-related noise on the biotic components of the Macroinvertebrate and Fish Habitat VEC are predicted to be *negligible to low* in magnitude over a duration of *1 to 12 months* in a geographic area of *1 to 10 km^2*. The frequency of the proposed rock berm construction Project is *<11 events/year* (see Table 7.6 in LGL 2006). Based on the ratings of these assessment criteria and with a *medium to high* level of confidence, the residual physical effects of Project-related noise on this VEC are predicted to be *not significant* (see Table 7.7 in LGL 2006).

7.2.1.3 Lights of Marine Vessel

Vessel lighting has the potential to interact with one of the four habitat components (plankton) indicated in Table 7.2. Lights on the rock placement vessel may attract some plankton towards surface but any effects would be *negligible*. In fact, it is most likely that lights on the rock placement vessel will have a *neutral* effect on the Macroinvertebrate and Fish Habitat VEC (see Tables 7.6 and 7.7 *in* LGL 2006).

7.2.1.4 Liquid and Solid Wastes

Liquid and solid wastes have the potential to interact with two of the four habitat components (water and plankton) indicated in Table 7.2. However, release of liquid and solid wastes to the marine environment should be minimal. While much of the waste will be returned to shore, any that is intentionally released to the marine environment will be treated. Amounts of any liquid and solid wastes, including hydrocarbons, accidentally released to the marine environment should be minimal and have negligible effect on the habitat.

Considering the intention to return most liquid and solid wastes to shore and to treat any liquid wastes intentionally released to the marine environment, the *reversible negative* residual effects of Project-related liquid and solid wastes on the Macroinvertebrate and Fish Habitat VEC are predicted to be *negligible to low* in magnitude over a duration of *1 to 12 months* in a geographic area of *<1 km*^{2}. The frequency of the proposed rock berm construction Project is *<11 events/year* (see Table 7.6 in LGL 2006). Based on the ratings of these assessment criteria and with a *medium to high* level of confidence, the residual physical effects of Project-related liquid and solid wastes on this VEC are predicted to be *not significant* (see Table 7.7 in LGL 2006).

7.2.1.5 Atmospheric Emissions

Atmospheric emissions have the potential to interact with two of the four habitat components (water and plankton) indicated in Table 7.2. Atmospheric emissions produced by the rock dumping vessel are from the combustion of diesel fuel in reciprocating engines, and include greenhouse gases (GHGs) and Criteria Air Contaminants (CACs). Estimated emissions are supplied in tonnes per day. The sources of emissions that were taken into account were the excavators on the deck, the main engines and the thruster engines of the rock dumping vessel.

Greenhouse Gas Emissions (tonnes/day)

Source	CO_2	CH_4	N_2O
Excavator	0.8190	0.0000	0.0002
Vessel on DP	35.4900	0.0018	0.0104
Vessel in Transit	65.5200	0.0032	0.0192

Criteria Air Contaminants (tonnes/day)

Source	CO	NO_X	$PM_{2.5}$	PM_{10}	PMT	VOC
Excavator	0.0042	0.0160	0.0002	0.0002	0.0003	0.0004
Vessel on DP	0.1841	0.6930	0.0104	0.0107	0.0134	0.0177
Vessel in Transit	0.3398	1.2793	0.0191	0.0198	0.0248	0.0327

GHG emissions (Carbon dioxide (CO_2), methane (CH_4), and nitrogen dioxide (N_2O) produced by the rock dumping vessel are minimal compared to the emissions from Husky's existing offshore operation, and relative to the Province of Newfoundland and Canada as a whole. For comparative purposes, Husky's Sea Rose FPSO GHG emissions are approximately 600,000 tonnes/year, while Newfoundland and Labrador and Canada's emissions are in the order of 8,000,000 and 800,000,000 tonnes per year

respectively as stated on Environment Canada's website. GHG emissions and climate change would be considered a global issue not a local air quality concern.

Criteria Air Contaminants, especially NOx and VOCs, are smog and ozone precursors. Smog and ozone may have an impact on local air quality and on human health. However, the formation of smog and ozone from NOx and VOCs is a very complex phenomenon requiring relatively high atmospheric concentrations of both NOx and VOCs, as well as certain climate conditions including temperature and sunlight. Similar to GHGs, the NOx and VOC emissions from the rock dumping vessel are minimal relative to other sources and will not adversely affect local air quality.

To summarize the *reversible negative* residual effects of Project-related atmospheric emissions on the Macroinvertebrate and Fish Habitat VEC are predicted to be *negligible to low* in magnitude over a duration of *1 to 12 months* in a geographic area of *<1 km^2*. The frequency of the proposed rock berm construction Project is *<11 events/year* (see Table 7.6 in LGL 2006). Based on the ratings of these assessment criteria and with a *medium to high* level of confidence, the residual physical effects of Project-related atmospheric emissions on this VEC are predicted to be *not significant* (see Table 7.7 in LGL 2006).

7.2.1.6 Cumulative Effects

The proposed Project would make its greatest addition to cumulative effects with respect to impact on the macroinvertebrate and fish habitat. The rock berms will cover at most about 56,000 m^2 of natural benthic habitat. This area represents about 0.014% of the Project Area, a very small proportion. In addition, the substrate type being covered (predominately sand) is widespread throughout the Project Area. Area of rock coverage added to the area of glory hole excavation (~ 240,000 m^2) indicated in the New Drill Centre EA (LGL 2006) represents about 0.083% of the Project Area. Compared to other projects and activities on the Grand Banks (e.g., bottom trawling, drilling, glory hole excavation) the contribution of the proposed berm construction to the cumulative effects on habitat will be minimal and is predicted to be *not significant*.

7.2.2 Macroinvertebrate and Fish VEC

Table 7.3 presents the potential interactions of the rock berm construction routine activities and the Macroinvertebrate and Fish VEC. The four life stages of macroinvertebrates and fishes considered in this assessment include (1) egg and larvae, (2) juvenile, (3) adult pelagic, and (4) adult demersal/benthic.

7.2.2.1 Coverage of Benthic Habitat

Coverage of benthic habitat has the potential to interact with three of the four life stage components indicated in Table 7.3: egg/larva, juvenile and adult demersal/benthic.

Table 7.3. Potential Interactions of Routine Activities and Macroinvertebrate and Fish VEC.

Valued Ecosystem Component: Macroinvertebrates and Fishes				
Project Activity	**Macroinvertebrate/Fish Life Stage**			
	Egg/Larva	**Juvenile**	**Adult Pelagic**	**Adult Demersal/Benthic**
Coverage of benthic habitat	x	x		x
Noise	x	x	x	x
Presence of marine vessel				
Lights of marine vessel	x		x	
Liquid and solid wastes	x	x	x	x
Atmospheric emissions	x	x	x	x
Other projects/activities				
Hibernia	x	x	x	x
Terra Nova	x	x	x	x
White Rose	x	x	x	x
Exploration	x	x	x	x
Fisheries	x	x	x	x
Marine Transportation	x	x	x	x

The locations where the two rock berms will be built are characterized by benthic communities dominated by annelids and bivalves, a trend seen throughout much of the Project Area. The width of the berms will vary between 18 and 32 m, so macroinvertebrates and fishes displaced by installation of the rock will not have to move far to find habitat similar to that covered by the rock. The proposed rock berm locations do not appear to be unique areas important to particular life stages of any macroinvertebrates or fishes. Other areas adjacent to the berm areas could be used successfully by macroinvertebrates and fishes as spawning locations, nursery areas, feeding areas, etc. The anticipated areal extent of rock coverage represents only 0.014% of Project Area. If rock coverage area is added to the existing spoils site area (240,000 m^2) and the area of seven glory holes (34,300 m^2) indicated in the New Drill Centre EA (LGL 2006), the total area still only accounts for 0.083% of the Project Area.

Although the rock used to construct the berms will be unwashed, fines dispersion will be minimal. Firstly, the rock will be processed in a crusher, thereby removing any clumps of mud that may have been adhering to the rock. Secondly, the controlled 'downpipe' rock placement technique will minimize the dispersion of any residual fines still associated with the rock.

Mitigation measures that will be implemented during the Project to minimize effects of rock coverage of natural benthic habitat on macroinvertebrates and fishes include the following:

- Design of rock berm to minimize the amount of areal coverage and still provide appropriate protection for the flowlines;
- Employment of a controlled 'downpipe' rock placement technique;
- Minimization of the time required to construct the rock berms; and
- Recognition of the need for habitat compensation in consultation with DFO.

Considering the relatively small area of coverage, the homogeneity of bottom substrate within the Project Area, and the possible mitigation measures listed above, the *reversible negative* residual effects of rock coverage of natural benthic habitat on the Macroinvertebrate and Fish VEC are predicted to be *negligible to low* in magnitude over a duration of *>72 months* (when considering presence after construction) in a geographic area of *<1 km*^{2}. The frequency of the proposed rock berm construction Project is *<11 events/year* (see Table 7.9 in LGL 2006). Based on the ratings of these assessment criteria and with a *medium to high* level of confidence, the residual physical effects of rock coverage of natural benthic habitat on this VEC are predicted to be *not significant* (see Table 7.10 in LGL 2006).

7.2.2.2 Noise

Noise has the potential to interact with all four life stages indicated in Table 7.3. In the New Drill Centre EA and Addendum, many noise types were assessed and all residual effects of exposure to noise on macroinvertebrates and fish life stages were predicted to be *not significant*. Compared to potential noise produced by the proposed rock berm construction, many of the New Drill Centre EA noise types had higher energy levels and were produced for longer periods of time.

Considering this previous assessment of the effects of exposure to noise on macroinvertebrates and fishes, and all attempts at minimizing the time required to construct the rock berms, the *reversible negative* residual effects of Project-related noise on the Macroinvertebrate and Fish VEC are predicted to be *negligible to low* in magnitude over a duration of *1 to 12 months* in a geographic area of *1 to 10 km*^{2}. The frequency of the proposed rock berm construction Project is *<11 events/year* (see Table 7.9 in LGL 2006). Based on the ratings of these assessment criteria and with a *medium to high* level of confidence, the residual physical effects of Project-related noise on this VEC are predicted to be *not significant* (see Table 7.10 in LGL 2006).

7.2.2.3 Lights of Marine Vessel

Vessel lighting has the potential to interact with two of the four life stages indicated in Table 7.3. Lights on the rock placement vessel may attract some ichthyoplankton and pelagic macroinvertebrates and fishes towards surface but any effects would be *negligible* (see Tables 7.9 and 7.10 in LGL 2006).

7.2.2.4 Liquid and Solid Wastes

Liquid and solid wastes have the potential to interact with all four life stages indicated in Table 7.3. However, release of liquid and solid wastes to the marine environment should be minimal. While much of the waste will be returned to shore, any that is intentionally released to the marine environment will be treated. Amounts of any liquid and solid wastes, including hydrocarbons, accidentally released to the marine environment should be minimal and have negligible effect on macroinvertebrates and fishes.

Considering the intention to return most liquid and solid wastes to shore and to treat any liquid wastes intentionally released to the marine environment, the *reversible negative* residual effects of Project-related liquid and solid wastes on the Macroinvertebrate and Fish VEC are predicted to be *negligible to*

low in magnitude over a duration of *1 to 12 months* in a geographic area of *<1 km²*. The frequency of the proposed rock berm construction Project is *<11 events/year* (see Table 7.9 in LGL 2006). Based on the ratings of these assessment criteria and with a *medium to high* level of confidence, the residual physical effects of Project-related liquid and solid wastes on this VEC are predicted to be *not significant* (see Table 7.10 in LGL 2006).

7.2.2.5 Atmospheric Emissions

Atmospheric emissions have the potential to interact with all four life stages indicated in Table 7.3. Atmospheric emissions will be produced during the rock berm construction Project given the use of hydrocarbon-fuelled equipment during construction. The estimated emissions per day for the rock dumping vessel are given in Section 7.2.1.5. As the resulting emissions are extremely low and also considering the dilution factor and location of these emissions offshore, the impact to the marine environment should be minimal. As is the case with emissions, proper equipment maintenance can assist in minimizing emissions.

Considering the quick dispersion and dilution of atmospheric emissions, and the low amounts of emissions from this operation, the *reversible negative* residual effects of Project-related atmospheric emissions on the Macroinvertebrate and Fish VEC are predicted to be *negligible to low* in magnitude over a duration of *1 to 12 months* in a geographic area of *<1 km²*. The frequency of the proposed rock berm construction Project is *<11 events/year* (see Table 7.9 in LGL 2006). Based on the ratings of these assessment criteria and with a *medium to high* level of confidence, the residual physical effects of Project-related atmospheric emissions on this VEC are predicted to be *not significant* (see Table 7.10 in LGL 2006).

7.2.2.6 Cumulative Effects

As indicated in Subsection 7.2.1, rock berms will cover about 56,000 m^2 of natural benthic habitat. This area represents about 0.014% of the Project Area, a very small proportion. In addition, the substrate type being covered (predominately sand) is widespread throughout the Project Area. Area of rock coverage added to the area of glory hole excavation (~ 240,000 m^2) indicated in the New Drill Centre EA (LGL 2006) represents about 0.074% of the Project Area. Therefore, direct effects of the berm construction on populations of macroinvertebrates and fishes are negligible. Compared to other projects and activities on the Grand Banks (e.g., bottom trawling, oil and gas industry exploration and production, marine transportation), the contribution of the proposed berm construction to the cumulative effects on macroinvertebrates and fishes will be negligible and can be predicted to be *not significant*.

7.2.3 Commercial Fishery VEC

Table 7.4 presents the potential interactions of the rock berm construction routine activities and the Commercial Fishery VEC.

Table 7.4. Potential Interactions of Routine Activities and Commercial Fishery VEC.

Valued Ecosystem Component: Commercial Fishery			
Project Activity	**Commercial Fishery Components**		
	Fishing Gear/Vessels	**Access to Grounds**	**Catchability**
Coverage of benthic habitat			x
Noise			x
Presence of marine vessel			
Lights of marine vessel			
Liquid and solid wastes			x
Atmospheric emissions			x
Other projects/activities			
Hibernia	x	x	x
Terra Nova	x	x	x
White Rose	x	x	x
Exploration	x	x	x
Fisheries			
Marine Transportation	x	x	x

The three aspects or components of commercial fishing considered in this assessment are: (1) fishing gear and vessels (fouling or losing gear, vessel conflicts), (2) access to fishing grounds ("off limits" or unharvestable areas), and (3) fish "catchability" (issues related to scaring fish from a harvesting area or away from fishing gear).

This section concerns the activity of commercial harvesting (i.e. the process of catching fish for commercial sale), and not effects on fish habitat or on fish (other than catchability issues), since these effects have been assessed separately and were found to be *not significant*.

Fisheries science/research surveys (industry-led and DFO) are also included in this VEC because the effects pathways are the same (i.e., the surveys are conducted essentially by "fishing"), and because these surveys are concerned primarily with commercial stock status.

Many of the mitigations intended to minimize the effects of activities associated with the New Drill Centre EA on the commercial fishery are applicable to this Amendment since the proposed locations of the rock berms are within the Project Area used in the New Drill Centre EA.

7.2.3.1 Coverage of Benthic Habitat

Coverage of benthic habitat has the potential to interact with the catchability commercial fishery component but in a very indirect manner (Table 7.4). If the rock coverage has any effect on the macroinvertebrates and fishes, albeit slight, then the coverage also has the potential to affect catchability. Since the rock berms will be located within the Husky Safety Zone and the Safety Zone's effects have already been assessed in the New Drill Centre EA and Addendum, no interaction exists between rock coverage and the other two commercial fishery components (i.e., fishing gear and vessels, and access to grounds).

Considering that the residual effects of rock coverage on the Macroinvertebrate and Fish VEC have been predicted to be *not significant*, the residual effects of rock coverage on the Commercial Fishery VEC are also predicted to be *not significant* (see Tables 7.12 and 7.13 in LGL 2006).

7.2.3.2 Noise

Noise has the potential to interact with the catchability commercial fishery component, as indicated in Table 7.4. However, since the noise sources are inside the Safety Zone and a considerable distance from commercial catch locations reported in recent years, the *reversible negative* residual effects of Project-related noise on the catchability component of the Commercial Fishery VEC are predicted to be *negligible to low* in magnitude over a duration of *1 to 12 months* in a geographic area of *1 to 10 km*^{2}. The frequency of the proposed rock berm construction Project is *<11 events/year* (see Table 7.12 in LGL 2006). Based on the ratings of these assessment criteria and with a *medium to high* level of confidence, the residual physical effects of Project-related noise on this VEC are predicted to be *not significant* (see Table 7.13 in LGL 2006)

7.2.3.3 Liquid and Solid Wastes

Liquid and solid wastes have the potential to interact with the catchability commercial fishery component but in a very indirect manner (Table 7.4). If the wastes have any effect on the macroinvertebrates and fishes, albeit slight, then they also have the potential to affect catchability.

Considering that the residual effects of liquid and solid wastes on the Macroinvertebrate and Fish VEC have been predicted to be *not significant*, the residual effects of liquid and solid wastes on the Commercial Fishery VEC are also predicted to be *not significant* (see Tables 7.12 and 7.13 in LGL 2006)

7.2.3.4 Atmospheric Emissions

Atmospheric emissions have the potential to interact with the catchability commercial fishery component but in a very indirect manner (Table 7.4). If the emissions have any effect on the macroinvertebrates and fishes, albeit slight, then they also have the potential to affect catchability.

Considering that the residual effects of atmospheric emissions on the Macroinvertebrate and Fish VEC have been predicted to be *not significant*, the residual effects of the emissions on the Commercial Fishery VEC are also predicted to be *not significant* (see Tables 7.12 and 7.13 in LGL 2006).

7.2.3.5 Cumulative Effects

Berm construction will occur within the established Husky Safety Zone within which fishing is precluded. Additionally, the proposed Project is predicted to have little impact on macroinvertebrates and fishes and their habitats. Therefore, direct effects of the berm construction on commercial fisheries are negligible. Compared to other projects and activities on the Grand Banks (e.g., bottom trawling, oil

and gas industry exploration and production, marine transportation), the contribution of the proposed berm construction to the cumulative effects on commercial fisheries will be negligible and can be predicted to be *not significant*.

7.2.4 Species at Risk

Subsection 7.6.7 in the New Drill Centre EA (LGL 2006) provides a thorough analysis of the potential effects of numerous routine activities on those species currently listed as *endangered*, *threatened* or *special concern* on Schedule 1 of *SARA*. The activities associated with the proposed berm construction Project are the same as some of those activities associated with the New Drill Centre EA. The Schedule 1 *SARA* species are as follow:

- Blue whale;
- North Atlantic right whale;
- Leatherback sea turtle;
- Northern wolfish;
- Spotted wolfish;
- Atlantic wolfish;
- Ivory Gull; and
- Fin whale (Atlantic population).

Species listed by COSEWIC as *endangered*, *threatened*, *special concern*, and *candidate* (see Table 5.2) are also included in this assessment subsection. Fish, seabirds and marine mammal species are grouped for the purposes of the assessment of effects of routine activities on the Species at Risk VEC. The potential interactions between the routine activities and the Species at Risk are presented in Table 7.5.

Table 7.5. Potential Interactions of Routine Activities and Species at Risk VEC.

Valued Ecosystem Component: Species at Risk				
Project Activity	**Biota Group/Species**			
	Fishes	**Seabirds**	**Marine Mammals**	**Leatherback Sea Turtle**
Coverage of benthic habitat	x			
Noise	x	x	x	x
Presence of marine vessel			x	x
Lights of marine vessel	x	x	x	x
Liquid and solid wastes	x	x	x	x
Atmospheric emissions	x	x	x	x
Other projects/activities				
Hibernia	x	x	x	x
Terra Nova	x	x	x	x
White Rose	x	x	x	x
Exploration	x	x	x	x
Fisheries	x	x	x	x
Marine Transportation	x	x	x	x

7.2.4.1 Fishes

The potential interactions of Project routine activities and fishes of the Species at Risk VEC are indicated in Table 7.5. Rationale for the assessment is provided in Subsection 7.6.2 of the Husky White Rose Development Project: New Drill Centre Construction and Operations Program EA and Addendum (LGL 2006, 2007a) where effects of routine activities on the fish VEC are discussed. Possible mitigations to minimize any negative effects of these routine activities on the fishes of the Species at Risk VEC include the following:

- Minimization of coverage of the bottom substrate;
- Minimization of duration of berm construction
- Treatment of various liquid and solid wastes;
- Minimization of discharges;
- Optimal equipment design and maintenance; and
- Cleanup protocols.

Based on the range of ratings of magnitude (*negligible to medium*) geographic extent (*<1 to 1-10 km^2*) and duration (*1-12 months)* for routine activities that will potentially interact with fishes of the Species at Risk VEC (see Subsection 7.2.1 on Macroinvertebrate and Fish VEC), the *reversible* residual effects of the routine activities of the proposed berm construction Project on fishes of the Species at Risk VEC are predicted to be *not significant* (see Subsection 7.2.1 on Macroinvertebrate and Fish VEC) and are not expected to contravene the prohibitions of *SARA* (Sections 32(1), 33, 58(1). This is consistent with the predicted significance of effects on the fishes of the Species at Risk VEC in the New Drill Centre EA and Addendum (LGL 2006, 2007a).

7.2.4.2 Seabirds

The potential interactions of Project routine activities and seabirds of the Species at Risk VEC are indicated in Table 7.5. Rationale for the assessment is provided in Subsection 7.6.4 of the Husky White Rose Development Project: New Drill Centre Construction and Operations Program EA and Addendum (LGL 2006, 2007a) where effects of routine activities on the seabird VEC are discussed. Possible mitigations to minimize any negative effects of these routine activities on the seabirds of the Species at Risk VEC include the following:

- Release of stranded birds;
- Monitoring;
- Treatment of various liquid and solid wastes;
- Minimization of discharge;
- Optimal equipment design and maintenance;
- Safe handling practices; and
- Cleanup protocols.

Since a Seabird VEC was deemed unnecessary for this Amendment, refer to Tables 7.24 and 7.25 of the New Drill Centre EA Addendum (LGL 2007a) for the assessment and significance of routine Project activities on seabirds of the Species at Risk VEC. Based on the range of ratings of magnitude (*negligible to medium*), geographic extent (*<1 km^2 to 1-10 km^2*) and duration (*1-12 months*) for routine activities that will potentially interact with seabirds of the Species at Risk VEC (Table 7.24 in LGL 2007a), the *reversible* residual effects of the routine activities of the proposed berm construction Project on the seabirds of the Species at Risk VEC are predicted to be *not significant* (Table 7.25 in LGL 2007a) and are not expected to contravene the prohibitions of *SARA* (Sections 32(1), 33, 58(1).

7.2.4.3 Marine Mammals and Sea Turtles

The potential interactions of Project routine activities and marine mammals and sea turtles of the Species at Risk VEC are indicated in Table 7.5. Rationale for the assessment is provided in Subsections 7.6.5 and 7.6.6 of the Husky White Rose Development Project: New Drill Centre Construction and Operations Program EA and Addendum (LGL 2006, 2007a) where effects of routine activities on marine mammals and sea turtles are discussed. Possible mitigations to minimize any potential negative effects of these routine activities on the marine mammals ands sea turtles of the Species at Risk VEC include the following:

- Monitoring;
- Vessel avoidance of animal concentrations;
- Treatment of various liquid and solid wastes;
- Minimization of discharge;
- Optimal equipment design and maintenance;
- Safe handling practices; and
- Cleanup protocols.

Since Marine Mammal and Sea Turtle VECs were deemed unnecessary for this Amendment, refer to Tables 7.26 to 7.29 of the New Drill Centre EA Addendum (LGL 2007a) for the assessment and significance of routine Project activities on marine mammals and sea turtles of the Species at Risk VEC. Based on the range of ratings of magnitude (*negligible to medium*), geographic extent (*<1 km^2 to 1-10 km^2*) and duration (*1-12 months*) for routine activities that will potentially interact with marine mammals and sea turtles of the Species at Risk VEC (Tables 7.26 and 7.28 in LGL 2007a), the *reversible* residual effects of the routine activities of the proposed berm construction Project on the marine mammals and sea turtles of the Species at Risk VEC are predicted to be *not significant* (Tables 7.27 and 7.29 in LGL 2007a) and are not expected to contravene the prohibitions of *SARA* (Sections 32(1), 33, 58(1).

7.3 Accidental Events

In the unlikely event of an accidental release of hydrocarbons during the rock berm construction Project, Husky and its contractor will implement measures outlined in Section 8 of the New Drill Centre EA and Addendum (LGL 2006, 2007a). All potential residual effects of accidental releases of hydrocarbons to the marine environment were assessed in the New Drill Centre EA and Addendum (LGL 2006, 2007a) and predicted to be not significant to the VECs. The assessment results in that EA also apply to this Project.

8.0 Summary and Conclusions

8.1 Residual Effects of the Project

The predicted residual environmental effects of the Husky White Rose Development Project: New Drill Centre Construction & Operations Program Amendment: Construction of Protective Flowline Rock Berm on macroinvertebrate and fish habitat, macroinvertebrates and fishes, and commercial fisheries are assessed as *not significant*.

The predicted residual environmental effects of the routine activities of the Husky White Rose Development Project: New Drill Centre Construction & Operations Program Amendment: Construction of Protective Flowline Rock Berm on Species at Risk are assessed as *not significant* and are not expected to contravene the prohibitions of *SARA* (Sections 32(1), 33, 58(1).

In summary, after mitigation measures have been implemented, the overall predicted effects of the proposed Husky White Rose Development Project Centre Construction & Operations Program Amendment: Construction of Protective Flowline Rock Berm on the biophysical environment and the fishery are assessed as *not significant*. The capacity of renewable resources to meet present and future needs is not likely to be significantly affected by the proposed rock berm construction Project. In fact, the primary reason for the Project, protection from flowline damage, is itself a mitigation measure for operations at the Husky White Rose Development Project.

8.2 Cumulative Effects of the Project

Projects and activities considered in the cumulative effects assessment included:

- New Drill Centre Construction & Operations Program within-project cumulative impacts;
- Hibernia, Terra Nova, and White Rose (existing offshore oil developments);
- Other offshore oil exploration activity (seismic surveys and exploratory drilling);
- Commercial fisheries; and
- Marine transportation (tankers, cargo ships, supply vessels, naval vessels, fishing vessel transits, etc.).

Considering the limited scale of activities associated with the rock berm construction, little effect is added to the cumulative effects by the Project. The greatest impact of the proposed Project is likely the coverage of natural benthic habitat by the rock berms and that is minimal. As indicated in the Amendment, the anticipated area of rock coverage (i.e., ~ 56,000 m^2) represents a very small proportion of the Project Area (~ 0.014%). When the rock coverage area is added to the amount of bottom habitat predicted to be disturbed by glory hole excavation, the total still represents a small portion of the Project Area (i.e., 0.083%).

8.3 Monitoring and Follow-up

Husky's ongoing inspection and auditing programs will permit verification that the construction vessel has adequate environmental protection systems and practices in place commensurate with the potential effects of it operations.

All Project vessels will document and report any damaged fishing gear attributable to the Project and any damages demonstrably due to project activities will be subject to compensation pursuant to Husky policies.

Husky's ongoing EEM program for the field is the appropriate mechanism to integrate any of the effects of rock berm construction in the field. Verification of use of the berms by marine biota may be possible in the context of the regular facilities integrity monitoring program that will involve ROV inspections of the flowlines.

Husky recognizes that a HADD-associated habitat compensation program will be required in consultation with DFO.

9.0 Literature Cited

ALTRT (Atlantic Leatherback Turtle Recovery Team). 2006. Recovery strategy for leatherback turtle (*Dermochelys coriacea*) in Atlantic Canada. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa. vi + 45 p.

Barnes, J.L. and L.H. Davey. 1999. A practical approach to integrated cumulative environmental effects assessment to meet the requirements of the *Canadian Environmental Assessment Act*.

Brown, M.W., D. Fenton, K. Smedbol, C. Merriman, K. Robichaud-Leblanc, and J.D. Conway. 2009. Recovery Strategy for the North Atlantic Right Whale (*Eubalaena glacialis*) in Atlantic Canadian Waters [Final]. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada. vi + 66p.

CEA Agency. 1994. A reference guide for the *Canadian Environmental Assessment Act*, addressing cumulative environmental effects. Prepared by the Federal Environmental Assessment Review Office, November 1994.

CEA Agency. 2000. Preparing project descriptions under the Canadian Environmental Assessment Act. Canadian Environmental Assessment Agency Operational Policy Statement OPS –EPO/5-2000. 6 p.

CEA Agency. 2003. The process for defining the spatial boundary of a study area during an environmental assessment of offshore exploratory drilling projects. Canadian Environmental Assessment Agency Operational Policy Statement. 3 p.

www.acee-ceaa.gc.ca/013/0002/drilling_ops_e.htm [As viewed 4 March 2004.]

Christian, J.R. 2008. Environmental Assessment of Petro-Canada Jeanne d'Arc Basin Exploration Drilling Program, 2009-2017. LGL Rep. SA993. Prepared by LGL, St. John's, NL for Petro-Canada, St. John's, NL. 258 p. + Appendix.

Fugro Jacques Geosurveys Inc. 2002a. Site survey report, Gros Morne, Grand Banks of Newfoundland. C-NOPB Program #8926-H006-008E.

Fugro Jacques Geosurveys Inc. 2002b. Site survey report, Trepassey, Grand Banks of Newfoundland. C-NOPB Program #8926-H006-009E.

Husky. 2000. White Rose Oilfield Comprehensive Study. Report for Husky Oil Operations Ltd. St. John's, NF. 1011 p.

Husky. 2001a. White Rose Oilfield Comprehensive Study Supplemental Report. Submitted by Husky Oil Operations Limited, St. John's, NL. 265 p. + App.

Husky. 2001b. White Rose Baseline Characterization Data Report June 2001. Prepared by Jacques Whitford Environment Limited for Husky Oil Operations Limited, St. John's, NL. 109 p. + App.

Husky. 2005. White Rose Environmental Effects Monitoring Program 2004, Volume 1. June 2005.

Husky. 2006. White Rose Environmental Effects Monitoring Program 2005, Volume 1. March 2006.

Husky. 2007. White Rose Environmental Effects Monitoring Program 2006, Volume 1. March 2007.

Husky. 2009. White Rose Environmental Effects Monitoring Program 2008, Volumes 1 and 2. March 2009.

Jensen, A. 2002. Artificial Reefs of Europe: Perspective and Future. ICES Journal of Marine Science, 59: S3-S13.

Kenchington, E.L.R., J. Prena, K. Gilkinson, D.C. Gordon, K. MacIsaac, C. Bourbonnais, P. Schwinghamer, T.W. Rowell, D.L McKeown and W.P. Vass. 2001. Effects of Experimental Otter Trawling on the Macrofauna of a Sandy Bottom Ecosystem on the Grand Banks of Newfoundland. Can. J. Fish. Aquat. Sci. 58: 1043-1057.

Kulka, D., C. Hood and J. Huntington. 2007. Recovery strategy for Northern Wolffish (*Anarhichas denticulatus*) and Spotted Wolffish (*Anarhichas minor*), and Management Plan for Atlantic Wolffish (*Anarhichas lupus*) in Canada [Proposed]. Fisheries and Oceans Canada: Newfoundland and Labrador Region. St. John's, NL. x + 103 p.

LGL Limited. 2006. Husky White Rose Development Project: New Drill Centre Construction & Operations Program Environmental Assessment. LGL Rep. SA883. Rep. by LGL Limited, St. John's, NL, for Husky Energy Inc., Calgary, AB. 299 p. + App.

LGL Limited. 2007a. Husky White Rose Development Project: New Drill Centre Construction & Operations Program Environmental Assessment Addendum. LGL Rep. SA883a. Rep. By LGL Limited, St. John's, NL for Husky Energy Inc., Calgary, AB. 126 p. + App.

LGL Limited. 2007b. Husky Delineation/exploration Drilling Program for Jeanne d'Arc Basin Area, 2008-2017, Environmental Assessment. LGL Rep. SA935. Prepared by LGL, St. John's, NL, in association with Canning & Pitt Associates, Inc., Oceans Ltd., and PAL Environmental Services. Prepared for Husky Energy Inc., Calgary, AB. 231 p. + Appendices.

LGL Limited. 2008a. Environmental Assessment of StatoilHydro's Jeanne d'Arc Basin Area Seismic and Geohazard Program, 2008-2016. LGL Rep. SA947a. Rep. by LGL Limited, Canning & Pitt Associates Inc., and Oceans Ltd., St. John's, NL, for StatoilHydro Canada Ltd., St. John's, NL. 174 p. + appendices.

LGL Limited. 2008b. Environmental Assessment of StatoilHydro Canada Ltd. Exploration and Appraisal/Delineation Drilling Program for Offshore Newfoundland, 2008-2016. LGL Rep. SA947b. Rep. by LGL Limited, Canning & Pitt Associates Inc., and Oceans Ltd., St. John's, NL, for StatoilHydro Canada Ltd., St. John's, NL. 292 p. + appendices.

Mobil. 1985. Hibernia Development Project, Environmental Impact Statement. Volume IIIa: Biophysical Assessment. Mobil Oil Canada, Ltd. (Operator), Gulf Canada Resources Inc., Petro-Canada Inc., Chevron Canada Resources Ltd., and Columbia Gas Development of Canada Ltd. 258 p.

Mortensen, P., L. Buhl-Mortensen, S. Gass, D. C. Gordon, E. Kenchington, C. Bourbonnais, and K. Macsaac. 2006. Deep Water Corals in Atlantic Canada: A summary of ESRF-Funded Research (2001-2003), March 2006, Environmental Studies Research Funds Report No. 143. Calgary. 83 p.

Ollerhead, L.M.N., M.J. Morgan, D.A. Scruton, and B. Marrie. 2004. Mapping spawning times and locations for 10 commercially important fish species found on the Grand Banks of Newfoundland. Can. Tech. Rep. Fish. Aquat. Sci. 2522: iv + 45 p.

Oceans Ltd. 2005. Meteorology and oceanography of the Orphan Basin. Unpubl. Report. Submitted to LGL Limited, St. John's, NL. 153 p.

Petro-Canada. 1996a. Development Application Terra Nova Development Environmental Impact Statement. Prepared by Petro-Canada on behalf of Terra Nova Proponents: Petro-Canada, Mobil Oil Canada Properties, Husky Oil Operations Limited, Murphy Oil Company Ltd., and Mosbacher Operating Limited.

Petro-Canada. 1996b. Development Application Terra Nova Development Supplement A to the Application. Prepared by Petro-Canada on behalf of Terra Nova Proponents: Petro-Canada, Mobil Oil Canada Properties, Husky Oil Operations Limited, Murphy Oil Company Ltd., and Mosbacher Operating Limited. 82 p.

Stephens, J. and Daniel Pondella II. 2002. Larval productivity of a mature artificial reefs: the ichthyoplankton of King Harbour, California, 1974-1997. ICES Journal of Marine Science, 59: S51-S58.

Vardaro, M.F. 2007. A study of possible 'reef effects' caused by a long-term time-lapse camera in the deep North Pacific. Deep-Sea Research I, 54: 1231-1240.

Websites

SARA http://www.sararegistry.gc.ca/default_e.cfm
COSEWIC http://www.cosepac.gc.ca/index.htm