Deep Panuke Offshore Gas Development

Comprehensive Study Report

EnCana™

October 2002

DEEP PANUKE OFFSHORE GAS DEVELOPMENT

COMPREHENSIVE STUDY REPORT

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EXECUTIVE SUMMARY

EnCana Corporation (EnCana) proposes to develop the Deep Panuke Offshore Gas Development Project (the Project). The Project is intended to develop a significant natural gas reservoir located offshore on the Scotian Shelf, approximately 175 km southeast of Goldboro, Nova Scotia (NS), and 250 km southeast of Halifax. The Project will enable EnCana to exercise its rights under, and obtain economic benefit from, the licences issued to it under the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act* and *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation (Nova Scotia) Act*. The proximity of the Deep Panuke discovery to existing infrastructure serving growing energy markets in Canada and the United States is one of the foundations of the Project.

This document is the Comprehensive Study Report (CSR) required for this Project under the *Canadian Environmental Assessment Act* (*CEAA*). The Responsible Authorities (RAs) for this Project include: the Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) (lead RA); the National Energy Board; Fisheries and Oceans Canada; Industry Canada; and Environment Canada.

The preparation of the CSR was delegated to EnCana pursuant to Section 17 of the *CEAA*. The CSR has been prepared to meet the environmental assessment requirements under the *CEAA* and the scope of the assessment prepared for the Project under a Memorandum of Understanding (MOU) between the RAs, the Canadian Environmental Assessment Agency (CEA Agency) and the Province of Nova Scotia.

The CSR is based on a series of documents filed in an application with the CNSOPB referred to collectively as the Development Plan Application (DPA). The DPA, while not critical to reading and understanding the CSR, contains additional detail that may interest some readers. The DPA comprises six volumes, as follows:

- Project Summary (DPA Volume 1);
- Development Plan (DPA Volume 2);
- Canada-Nova Scotia Benefits Plan (DPA Volume 3);
- Environmental Impact Statement (EIS) (DPA Volume 4);
- Socio-Economic Impact Statement (SEIS) (DPA Volume 5); and
- Public Consultation Report (PCR) (DPA Volume 6).

In accordance with the MOU and scope of the environmental assessment, EnCana submitted a draft CSR, in addition to the DPA documents, to the signatory parties and the public for review and comment. The CNSOPB, as lead RA, coordinated comments from the RAs and Expert Federal Authorities, as well as comments from the public. The Nova Scotia Department of Environment and Labour (NSDEL) coordinated provincial comments and provided them to the CNSOPB. These comments were forwarded to EnCana for consideration in the preparation of a revised CSR. A response document (Addendum 1) was prepared to respond specifically to these comments and was filed with the CNSOPB in September 2002 as a supporting document to the DPA. The CSR has been revised in consideration of these comments. This CSR is based on the analysis presented in the EIS (DPA Volume 4) and SEIS (DPA Volume 5) and updated as necessary to reflect Project updates and comments received during the review of the DPA and draft CSR.

Current Project design consists of three bottom-founded platforms in a water depth of approximately 40 m. The wellhead platform will be dedicated to dry wellheads, the wellhead control system, and production manifolds. The production platform will contain all power generation and processing equipment; this equipment is designed to process 400 MMscfd of natural gas at peak production with turndown capabilities as the Deep Panuke field declines. A third platform, the accommodations (utility/quarters) platform, will contain utilities, a helicopter landing pad, refueling station and crew accommodations. The three platforms will be interconnected by pedestrian/service bridges.

The gas processing system will consist of equipment necessary for separation, measurement, dehydration, and hydrocarbon dew point control. Deep Panuke is considered to be a sour gas reserve with raw gas containing approximately 0.2% hydrogen sulphide (H_2S). Gas sweetening equipment will, therefore, also be required. Full gas processing will be conducted offshore through application of an amine unit to remove H_2S and carbon dioxide (CO_2) (acid gas). The acid gas will be injected under compression to a dedicated disposal well in an approved geological formation. Condensate produced during offshore processing will be consumed on the production platform as the primary fuel; any surplus condensate will be injected into a disposal well.

Market-ready gas will be produced offshore and transported via subsea pipeline to Goldboro, Nova Scotia to an interconnection with the Maritimes & Northeast Pipeline (M&NP) main transmission pipeline for transport to markets in Canada and the Northeast United States. EnCana's onshore facilities will consist of the physical components necessary for interconnection of EnCana's natural gas pipeline with M&NP facilities. The production life of the Project is anticipated to be 11.5 years, with a design life of 25 years. A description of the Project including reservoir description, Project components, Project activities and schedule are presented in Section 2. Alternatives to the described Project, and alternative means of carrying out the Project, are presented in Section 2.10.

The capital cost of Project construction is estimated to be $1.1 billion. The annual operating cost of the Project is estimated to be $60 million, of which just over $31 million will be material purchasing. Project development is anticipated to involve 2,805 person years of work (approximately 3,787 short term jobs of which 40% are estimated to accrue to Nova Scotians). The production phase is estimated to generate an average of 3,159 person years of employment over the life of the Project (approximately 312 jobs, 91% of which are estimated to accrue to Nova Scotians). Regional and local economic benefits are presented in Section 7.2.

It is anticipated that the proposed Project will produce minor routine emissions and discharges typical of other oil and gas projects currently proposed and/or operating in the Canadian offshore including: air emissions from power generation and routine flaring; drilling waste; produced water; deck drainage; sewage; noise; and light. EnCana will strive to reduce all wastes and discharges in order to promote efficient operation. EnCana will ensure compliance with all applicable regulations and company standards for discharge limits including those specified in the Offshore Waste Treatment Guidelines (NEB *et al.* 1996, and updates). Routine Project emissions and discharges are described in Section 2.7, with atmospheric emissions and produced water dispersion modeling results presented in Appendix C.

EnCana has reviewed the various potential malfunctions and accidental events that may occur during the Project including platform spills, malfunction of the acid gas management system, blowouts and pipeline ruptures. Spill risk has been modeled to determine the probability and extent of such events. EnCana has incorporated design features and procedures to virtually eliminate or minimize the risk of major releases. EnCana will also develop and implement safety, spill response and contingency plans to reduce adverse environmental effects in the unlikely event of such incidents. Potential accidents and malfunctions, spill risk and probability, and spill release behavior are presented in Section 3. Emergency response and contingency planning commitments are described in Section 4 and Appendix D.

The biophysical impact assessment (Section 6) focuses on environmental issues of greatest concern, known as Valued Environmental Components (VECs). An issues scoping process was undertaken to identify VECs most appropriate for this assessment. This scoping included: stakeholder consultation; regulatory issues and guidelines; research; and professional judgement of the Study Team.

As a key component of Project planning and assessment, EnCana has conducted an extensive program of public consultation with stakeholder groups, and discussions with First Nations and Aboriginal groups. This program and ongoing initiatives are summarized in Section 5. The objectives of this program are to: provide information about the Project in a timely fashion; provide opportunities for identification of issues and concerns; seek technical advice; and develop mutually beneficial relationships throughout the life of the Project. The public consultation program focused on key stakeholder groups including: regulatory agencies; local municipalities and regional development authorities; nearshore fishing interests; offshore fishing interests; residents and businesses in the Guysborough County area; scientists; environmental non-governmental organizations; and the general public. Dialogue with several First Nations and Aboriginal organizations has also been initiated to determine Project related issues and concerns among their members. Issues and concerns identified through the consultation and discussion process have been considered in Project planning, design and the impact assessment.

The following VECs were selected for the assessment:

- Air Quality;
- Marine Water Quality;
- Marine Benthos;
- Marine Fish;
- Marine Mammals (Whales and Seals);
- Marine Related Birds
- Sable Island; and
- Onshore Environment.

Impact assessment methodology including issues scoping and VEC selection rationale is described in Section 6.2. Potential Project interactions, assessment boundaries, evaluation criteria, impact analysis, mitigative measures and proposed monitoring are presented for each VEC in Section 6.3.

EnCana is committed to a high level of environmental protection through Project design and mitigation measures. Some of these key voluntary environmental management features proposed for the Project include:

- injection of waste acid gas into a secure geological formation to greatly reduce potential atmospheric emissions of greenhouse gases and sulphur compounds;
- a target for dispersed oil in produced water discharges lower than regulatory requirements;
- no marine discharge of non-aqueous drill muds and associated cuttings;
- energy conservation measures including waste heat recovery and use of produced condensate for offshore power generation;
- the use of an existing offshore pipeline corridor;
- a pipeline designed to minimize interference with fishing activity;
- no nearshore pipeline construction during the lobster fishing season (April 19 to June 20) which also covers the period when the endangered Roseate Tern typically prospects for nests and lays eggs on nearby Country Island (May 1 – June 20);
- routing of the onshore portion of pipeline to avoid sensitive areas such as wetlands and major stream crossings; and
- implementing codes of practice for environmentally sensitive areas - Sable Island, Country Island and the Gully.

Table 9.1 in Section 9 summarizes commitments made by EnCana in its DPA and CSR to ensure there will be no significant adverse residual environmental effects as a result of the Deep Panuke Project. EnCana will also implement several environmental management documents such as: Environmental Management Plan; Environmental Protection Plans; Environmental Effects Monitoring Plan; Waste Management Plan; Chemical Management Plan; Spill Response Plan; Alert/Emergency Response Contingency Plan; Fisheries Compensation Plan; and Decommissioning Plan.

In general, any potential adverse environmental effects from routine Project activities will be short-term, highly localized, and/or of low magnitude. Non-significant adverse effects include: impacts on air quality from routine air emissions; impacts on water quality from routine effluents; temporary disturbance to benthic habitat from WBM drill waste discharges and pipeline installation; and minor habitat loss and disturbance associated with installation of the onshore pipeline and facilities. These effects can be effectively mitigated to non-significant levels through the application of technically and economically feasible measures, standard offshore oil and gas industry procedures, and adherence to regulatory guidelines. Section 4 and Appendix D contain information on EnCana's environmental management framework and outlines for environmental plans. Appendix E contains environmental codes of practice adopted by EnCana for Sable Island, the Gully, and Country Island. The effects from routine Project construction, operation and decommissioning activities are therefore predicted to be not significant for all VECs.

In the unlikely event of a well blowout or piping break resulting in the release of large amounts of raw gas or acid gas, significant adverse effects on air quality may occur. Such an event could have health and safety consequences for platform workers and passengers on vessels downwind. Design prevention measures, rendering such an event extremely unlikely, and emergency response contingency planning, will further reduce the likelihood that workers or others would be seriously affected by emissions. In general, spill modeling indicates that accidental releases of hydrocarbon from the Project will dissipate quickly without widespread effects; for example, a spill from a blowout would not reach Sable Island.

The socio-economic impact assessment focuses on socio-economic issues of greatest concern: the economy; environment; infrastructure; and social factors. These issues are considered for each of the potentially affected geographical areas, including: the Halifax Regional Municipality (HRM); service and landfall communities; and the offshore area. Mitigation is proposed where appropriate, to reduce potential adverse socio-economic effects.

The proposed Project will bring significant benefits to the economy of Nova Scotia, specifically 3,220 direct and indirect jobs and a $154 million contribution to household income during development. The Project will also bring considerable socio-economic benefits to HRM. It is not considered likely that the Project will cause significant adverse socio-economic effects, provided proposed mitigation measures noted in this report are implemented. To enhance the benefits that may accrue, particularly to the landfall areas and service communities, EnCana will establish a procedure to notify the municipalities, Chambers of Commerce and appropriate regional development authorities, prior to and during the construction period, of the products and services that are required.

Effects of the environment on the Project are not considered to be significant. Project facilities will be designed and installed based on the appropriate environmental design criteria to ensure the safety and the integrity of these facilities during severe environmental conditions. Monitoring and/or contingency planning will also serve to minimize any adverse effects.

In conclusion, the Deep Panuke Project is not likely to cause significant adverse environmental effects. The Project will contribute to the development of the offshore oil and gas industry in Atlantic Canada by establishing a viable facility and operation that will reduce adverse environmental effects to acceptable levels through the use of technically and economically feasible design and mitigation measures.

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1 INTRODUCTION

This Comprehensive Study Report (CSR) describes the potential environmental and socio-economic effects of the Deep Panuke Offshore Gas Development Project (the Project) proposed by EnCana Corporation (EnCana). The proposed Project is intended to develop a significant natural gas reservoir located approximately 175 km southeast of Goldboro, Nova Scotia and 250 km southeast of Halifax, Nova Scotia on the Scotian Shelf.

The preparation of the CSR was delegated to EnCana pursuant to Section 17 of the *Canadian Environmental Assessment Act* (*CEAA*). The CSR has been prepared to meet the environmental assessment requirements and the scope of the assessment for the Project under the *CEAA*. The CSR is based on more detailed information contained in a series of documents filed in an application with the Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) referred to collectively as the Development Plan Application (DPA). In particular, the following documents have been used in support of this CSR:

- Project Summary (DPA Volume 1);
- Development Plan (DPA Volume 2);
- Canada-Nova Scotia Benefits Plan (DPA Volume 3);
- Environmental Impact Statement (EIS) (DPA Volume 4);
- Socio-Economic Impact Statement (SEIS) (DPA Volume 5);
- Public Consultation Report (PCR) (DPA Volume 6); and
- Responses to Comments from Regulatory and Public Review (Addendum 1).

This CSR will allow for full review and decision making by the federal Minister of Environment under the *CEAA* and the Responsible Authorities identified in Section 1.3. While the CSR can be read as a stand alone document, the DPA documents, including Addendum 1, provide additional supporting detail and background information. References to these documents are presented as applicable throughout the CSR.

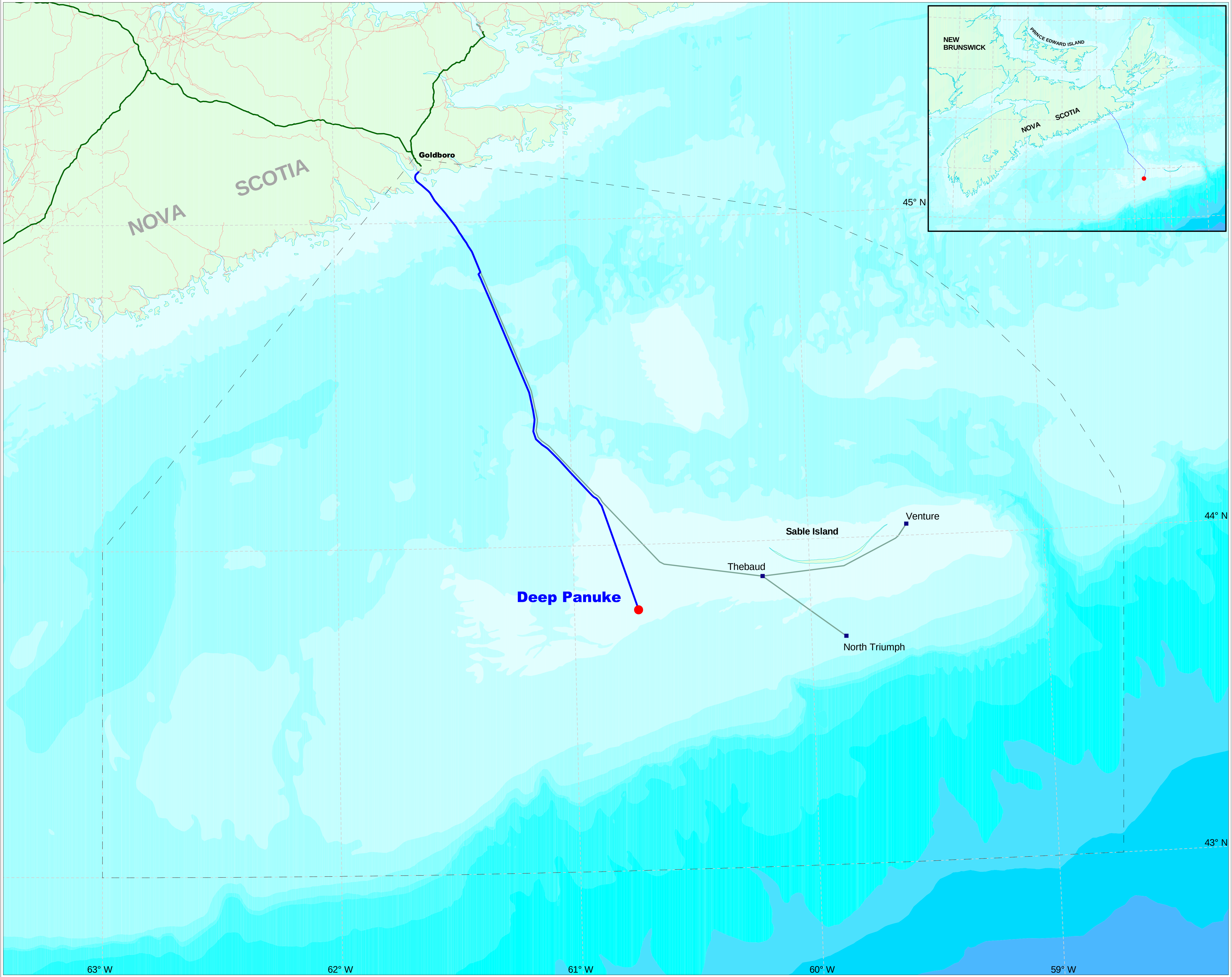
1.1 Project Overview

In 1996 PanCanadian Energy Corporation (now EnCana) purchased a 50% interest in and became the operator of the Cohasset Project near Sable Island. While producing oil from the Cohasset Project, PanCanadian was also conducting exploration drilling in the area. In February of 2000, PanCanadian announced the discovery of a potentially significant natural gas reservoir in the Deep Panuke location (Figure 1.1). Further delineation drilling results led PanCanadian to initiate preparation of the DPA which was submitted to the CNSOPB, the body that regulates offshore development projects for Nova Scotia. The Deep Panuke gas pool is located on Production Licence 2902, in which EnCana holds a 100% working interest.

Figure 1.1

Deep Panuke Project

Location Map & Study Area



EnCana Proposed Pipeline Route

Bathymetry
0 - 50
51 - 100
101 - 200
201 - 400
401 - 500
501 - 1000
1001 - 2000
2001 - 3000
3001 - 3500
3501 - 4000
4001 - 4500
4501 - 5000
5001 - 5500

Environmental Assessment Study Area

N

0 20 40 60
Kilometres

Map Parameters
Projection: Universal Transverse Mercator (UTM)
Zone: 20
Datum: NAD 83
Scale: 1:1,250,000
Grid: Lat/Long 1°
Project No: NSD15999

x:\projects\NovaScotia\NSD15999\av_projects\panuke_working.apr

Current Project design consists of three bottom-founded platforms in a water depth of approximately 40 metres (m). A wellhead platform will be dedicated to dry wellheads, the wellhead control system, and production manifolds. The production platform will contain all power generation and processing equipment. A third platform, the accommodations (utility/quarters) platform, will be used for utilities, a helicopter landing pad, a refueling station and crew accommodations. The three platforms will be interconnected by pedestrian/service bridges.

The gas processing system will consist of equipment necessary for separation, measurement, dehydration, and hydrocarbon dew point control. Deep Panuke is considered to be a sour gas reserve with raw gas containing approximately 0.2% hydrogen sulphide (H_2S). Gas sweetening equipment will, therefore, also be required. EnCana is applying for full processing to be conducted offshore through application of an amine unit to remove H_2S and carbon dioxide (CO_2) (acid gas). The acid gas will be injected under compression to a dedicated disposal well in an approved geological formation. Condensate produced during offshore processing will be used on the production platform as the primary fuel; any surplus condensate will be injected into the disposal well.

The production life of the Project is anticipated to be 11.5 years, with a design life of 25 years. Market-ready gas will be transported via subsea pipeline to Goldboro, Nova Scotia to an interconnection with the Maritimes & Northeast Pipeline (M&NP) main transmission pipeline for further transport to markets in Canada and the Northeast United States. EnCana's onshore facilities will consist of the physical components necessary for interconnection of EnCana's natural gas pipeline with M&NP's facilities. The onshore portion of the pipeline is expected to be approximately 3 to 4 km in length. The onshore facility will likely include metering and quality monitoring equipment, pressure control facilities, temporary pig receiver facilities, a supervisory control and data acquisition (SCADA) system and a small building required for SCADA and metering. The area of this facility is estimated to be 50 m x 40 m. An access road will be required, which will run parallel to the pipeline.

Refer to Section 2 for a more detailed description of the Project.

1.2 Purpose and Need for the Project

The primary purpose of the Project is to allow EnCana to exercise its rights under, and obtain economic benefits from, the licences issued to it under the *Canada-Nova Scotia Offshore Petroleum Resources Accord Act* and *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation (Nova Scotia) Act (*Accords Acts). By recovering the value of the reserves that EnCana has obtained the right to produce under the Accord Acts, it can provide a return to its shareholders on the capital invested in the Project. The value of the Deep Panuke reserves will be obtained by exploiting the opportunity presented by the considerable and growing demand for natural gas and other forms of energy in markets in Canada and the United States. The proximity of the Deep Panuke discovery to existing infrastructure serving these growing energy markets is one of the foundations of the Project. The Project will contribute to the development of the offshore oil and gas industry in Atlantic Canada by establishing the second pipeline between the offshore gas fields located on the Scotian Shelf and the Nova Scotia mainland. The Project will, therefore, provide further opportunity for Nova Scotians, and other Canadians, to participate in, and benefit from, the offshore oil and gas industry, thereby contributing to the economies of Nova Scotia and Canada.

1.3 Regulatory and Planning Context

The CNSOPB regulates oil and gas activities under the Accord Acts, and specifically requires proponents to file a DPA for development projects. Development of offshore oil and gas is subject to environmental assessment under the *CEAA*. The CNSOPB and National Energy Board (NEB) also require an environmental assessment as part of the approval process. Amendments to the *Federal Authorities Regulations* in January 2001 designated the CNSOPB as a Federal Authority (FA) under the *CEAA*. The CNSOPB is a Responsible Authority (RA) under the *CEAA* review process, and is designated as the lead RA for the Project.

A Project Description was filed with the Canadian Environmental Assessment Agency (CEA Agency), the CNSOPB, and the NEB on July 23, 2001 (PanCanadian 2001a) to initiate provisions of the *Federal Coordination Regulations* pursuant to the *CEAA.* Application of the *Federal Coordination Regulations* process under the *CEAA* requires federal departments with decision making responsibility (under *CEAA*) or “specialist or expert information or knowledge” to declare their interest in the project. The following lists the Federal Authorities and their record of determination resulting from the *Federal Coordination Regulations* process:

- CNSOPB (likely to require an environmental assessment; grants interest in land under the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act* and the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation (Nova Scotia) Act*, therefore a CEAA Section 5(1)(c) trigger);
- Fisheries and Oceans Canada (DFO) (likely to require an environmental assessment; authorization required under Section 35(2) of the *Fisheries Act*);
- Environment Canada (in possession of specialist-expert information or knowledge, additional information required to determine if a Disposal at Sea permit under Part 7 of the *Canadian Environmental Protection Act* is required);
- NEB (likely to require an environmental assessment; Certificate required under Section 52 of the *National Energy Board Act* related to the pipelines);

- Industry Canada (likely to require an environmental assessment; approval required under Section 5(1)(f) of the *Radiocommunication Act*);
- Transport Canada (in possession of specialist-expert information or knowledge);
- Human Resources Development Canada (not likely to require an environmental assessment);
- Department of National Defence – Maritime Forces Atlantic (in possession of specialist-expert information or knowledge);
- Health Canada (in possession of specialist-expert information or knowledge); and
- Canadian Customs and Revenue Agency (not likely to require an environmental assessment).

Applicable provincial approvals may include permits and licences under the Nova Scotia *Pipeline Act*. Registration under the *Environmental Assessment Regulations* under the Nova Scotia *Environment Act* is required for oil and gas pipelines greater than 5 km in length. Other provincial and municipal permits may also be required.

In addition to regulatory requirements, the Project will also have regard to the numerous applicable federal and provincial guidelines. The specific relevance of these regulations, policies and guidelines to the Project is discussed throughout the CSR and in detail throughout the EIS (DPA Volume 4) and SEIS (DPA Volume 5).

The RAs (CNSOPB, NEB, DFO, Industry Canada, and Environment Canada), along with the CEA Agency, and the Province of Nova Scotia (represented by the Nova Scotia Department of Environment and Labour (NSDEL)) have negotiated a Memorandum of Understanding (MOU) (December, 2001) (CNSOPB *et al.* 2001a) (Appendix A). The purpose of this MOU is to ensure the interests of federal and provincial government departments and agencies are included in the environmental assessment and to coordinate their respective environmental assessment processes and responsibilities. The MOU describes the agreement of the parties to the MOU to delegate the preparation of the CSR to EnCana. To this end, the signatory parties to the MOU also prepared a scoping document (December 18, 2001; revised February 15, 2002) (CNSOPB *et al.* 2001b) (Appendix B) outlining issues to be addressed in this CSR.

In accordance with the MOU and scoping document, EnCana submitted a draft CSR to the signatory parties for review and comment. The CNSOPB, as lead RA, coordinated comments from the RAs and Expert Federal Authorities. The NSDEL coordinated provincial comments and provided them to the CNSOPB. All comments were forwarded to EnCana for consideration in the preparation of a revised CSR. EnCana's response to these comments comprise Addendum 1. The CSR will be reviewed by the signatory parties to ensure its completeness in consideration of their respective legislative requirements. Once the parties are satisfied the CSR is complete, the CSR will be forwarded to the federal Minister of Environment and the CEA Agency. The CEA Agency will invite public comment on the CSR in accordance with Section 22 of the *CEAA*. Notices of regulatory public hearing by the CNSOPB and NEB will be published after the final CSR is submitted to the federal Minister of Environment. Notices of the commencement of regulatory public hearings by the Province will be published after the final CSR is submitted to the provincial Minister of Environment and Labour. Once the federal Minister of Environment takes the decision pursuant to Section 23(a) of the *CEAA*, the CNSOPB agrees the CSR will form part of the DPA filed by EnCana under the DPA approval process (CNSOPB *et al*. 2001a).

1.4 Scope of the Assessment

The Scope of the Environmental Assessment (CNSOPB *et al*. 2001b) outlines the requirements for the assessment of the Deep Panuke Project. Table 1.1 identifies where each of the scoping requirements is addressed in the CSR and other supporting documents, as applicable.

Table 1.1 Document Concordance with Scope of the Environmental Assessment (CNSOPB *et al*. 2001b)

	Applicable Reference
Scope of the Project Undertakings proposed by the proponent, or likely to be carried out in relation to the physical works proposed by the proponent	
Construction, Operation and Decommissioning of: Three new bottom-founded platform(s) accommodating gas processing system, power generation, utilities, helipad, refueling station and crew accommodations.	CSR, Section 2
An offshore gas processing system including: separation, measurement, dehydration and hydrocarbon dew point control equipment; and full acid gas processing.	CSR, Sections 2.3.1, 2.4.1
A subsea gas pipeline from the platform to the coastline and an onshore portion to Goldsboro, NS.	CSR, Sections 2.2.2, 2.3.2, 2.5
Onshore facilities including: metering and quality monitoring equipment, pressure control facilities and pig launcher/receiver facilities, and associated buildings.	CSR, Sections 2.2.4, 2.3.3, 2.4.4, 2.5
Ancillary undertakings in relation to the physical works described above, including pipeline installation and construction, development and injection well drilling, subsea gathering lines, vessel and helicopter support, communications equipment, work and lay-down areas, access roads, and transportation and installation of onshore infrastructure.	CSR, Section 2
B. Factors to be Considered The following factors as described in subsections 16(1) and (2) of the CEAA will be considered during the assessment	
Environmental effects of the project, including malfunctions and accidents, and any cumulative effects that are likely to result from the project in combination with other projects that will be carried out	CSR, Sections 6.3, 7.3, 7.4 EIS, Sections 6, 8 SEIS, Sections 6 and 7
The significance of the environmental effects, considered in the context of sustainable development principles	CSR, Sections 6.3, 7.3, 7.4 EIS, Section 6 SEIS, Sections 6, 7
Comments from the public	CSR, Section 5 EIS, Section 4 SEIS, Sections 5, 7 PCR, Section 6 Addendum 1

Table 1.1 Document Concordance with Scope of the Environmental Assessment (CNSOPB *et al*. 2001b)

	Applicable Reference
Measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects, considered in a hierarchical sequence with a clear priority on avoidance of adverse environmental effects	CSR, Sections 5, 6.3, 7.3 and Table 9.1 EIS, Section 6.3 SEIS, Sections 6 and 7
Need for the Project and alternatives to the Project	CSR, Sections 1.2, 2.10
The purpose of the project	CSR, Section 1.2
Alternative means of carrying out the project that are technically and economically feasible and the environmental effects of any such alternative, considered in the context of sustainable development principles, best management practices and compliance with applicable legislation	CSR, Section 2.10.2
The need for, and the requirements of, any follow-up program in respect of the project	CSR, Sections 6.3, 7.3 and Table 9.1 EIS, Section 6
The capacity of renewable resources that are likely to be significantly affected by the project to meet the needs of the present and those of the future	CSR, Section 6.3 EIS, Section 6
C. Scope of Factors to be Considered The environmental assessment will consider the potential effects of the proposed project within spatial and temporal boundaries that encompass the periods and areas during and within which the proposed project may potentially interact with, and have an effect on, components of the environment. These boundaries will vary with the issues and factors considered (*i.e.*, ocean currents, wind conditions and species migration patterns), and will include, but are not limited to, the following:	
Major Environments	
Offshore marine physical, biological and chemical environment	CSR, Section 6.1 EIS, Sections 5.1, 5.2
Coastal and nearshore physical, biological and chemical environment (*e.g.*, inter-tidal communities, aquaculture)	CSR, Section 6.1 EIS, Sections 5.1, 5.2 SEIS, Section 4.2
Onshore aquatic and terrestrial environments	CSR, Sections 6.1.3, 6.3.8 EIS, Section 5.3
Atmospheric environment	CSR, Sections 6.1.1.2, 6.3.1 EIS, Section 5.1.2
Geologic environment (*i.e.*, geomorphology, marine sediments, and sediment quality)	CSR, Section 6.1.1 EIS, Section 5.1.5
Ecosystem Components (Candidate VECs to be considered in all relevant environments):	
Air quality	CSR, Sections 6.1.1.2, 6.3.1 EIS, Sections 6.1
Water quality	CSR, Sections 6.1.1.4, 6.3.2 EIS, Sections 6.2
Sediment quality	CSR, Sections 6.1.1.5, 6.3.3 EIS, Sections 6.2
Soil capability and quality	EIS, Sections 6.1.3, 6.3.8
Fish and fish habitat	CSR, Sections 6.1.3, 6.3.4, 6.3.8 EIS, Sections 6.2, 6.3, 6.7
Mammals	CSR, Sections 6.1, 6.3.5, 6.3.8 EIS, Sections 6.4, 6.6, 6.7
Archaeological and heritage resources	CSR, Section 7.3 SEIS, Section 7
Benthos	CSR, Sections 6.1.2.1, 6.3.3 EIS, Sections 6.2

Table 1.1 Document Concordance with Scope of the Environmental Assessment (CNSOPB *et al.* 2001b)

	Applicable Reference
Vegetation (terrestrial and marine)	CSR, Sections 6.1, 6.3.3, 6.3.7 EIS, Sections 5.2.1, 5.2.7, 5.3.3, 5.3.5,
Plankton	CSR, Sections 6.1.2, 6.3.4 EIS, Section 6.3
Amphibians and Reptiles	CSR, Sections 6.1.2, 6.1.3, 6.3.8 EIS, Sections 5.2.4, 5.3.4, 6.7
Birds and bird habitat	CSR, Sections 6.1.2, 6.1.3, 6.3.6, 6.3.7, 6.3.8 EIS, Sections 5.3.4, 6.5, 6.6, 6.7
Special Places (Sable Island, the Gully and other environmentally sensitive or protected areas)	CSR, Sections 6.1.2.6, 6.3.7 EIS, Sections 5.2.5, 5.2.6, 6.5, 6.6
Species at risk	CSR, Sections 6.1.4, 6.3 EIS, Sections 5.2, 5.3, 6.3, 6.4, 6.5, 6.6, 6.7
Groundwater resources	CSR, Section 6.1.3 EIS, Section 5.3.2.3
Surface water resources	CSR, Sections 6.1.3, 6.3.8 EIS, Sections 5.3.5, 5.3.6, 6.8
Wetlands and wetland functions	CSR, Sections 6.1.3, 6.3.8 EIS, Sections 5.3.5, 6.7, 8.3.7
Socioeconomic Components:	
Land use (parks and other recreational uses, forestry, agriculture, mineral tenures, gravel resources, landfills, proximity to residential areas, future development plans, access management, and crossing of contaminated areas)	CSR, Sections 7.2, 7.3 SEIS, Sections 4.4.1.4, 7.2.4.1, 7.4.4.1
Public health and safety (project emissions and effluents, radio wave emissions, noise, dust, pipeline integrity, fire, water supplies, sewage treatment)	CSR, Sections 7.2, 7.3 EIS, Sections 2.3.3.11, 2.5, 3, 9 SEIS, Sections 7.4.4.5, 7.5.4.2
Use of marine resources (commercial fisheries and fisheries exclusion zones, aquaculture, commercial and recreational navigation, oil and gas, communications and submarine cables, maritime defense, marine science and technology)	CSR, Sections 7.2.6, 7.3.5 EIS, Section 2.3.5 SEIS, Sections 4.3.2, 4.6, 7.4.1.6, 7.5
Mi'kmaq interests (hunting and traditional or commercial fishing, cultural sites)	CSR, Sections 5.3, 7.2, 7.3 EIS, Section 5.3 SEIS, Sections 4.3.2.4, 4.4.1.1, 7.4.4
Project Activities (possible causes of environmental effects):	
Normal and fugitive air emissions	CSR, Section 2.7 EIS, Section 2.5.1
Marine discharges (*e.g.*, produced water, drill fluids and cuttings, biocides, grey water, black water, galley waste)	CSR, Section 2.7 EIS, Sections 2.5.4, 2.5.5
Acid gas injection	CSR, Section 2.4.1.4
Offshore storage and use of condensate	CSR, Section 2.4.1
Electromagnetic emissions (radio)	CSR, Section 2.7.2 SEIS, Section 7.5.4.2
Noise (underwater and atmospheric)	CSR, Section 2.7.2 EIS, Section 2.5.2
Onshore waste disposal	CSR, Section 2.7 EIS, Section 2.5.6
Erosion and sedimentation	CSR, Section 6.3.8 EIS, Section 7.7
Vessel Traffic	CSR, Section 2.4.2

Table 1.1 Document Concordance with Scope of the Environmental Assessment (CNSOPB *et al*. 2001b)	
	Applicable Reference
	EIS, Section 2.4.2
Aircraft Activity	CSR, Section 2.4.2 EIS, Section 2.4.2
Dredging/trenching/blasting and dredge material disposal	CSR, Section 2.3 EIS, Sections 2.3.2, 2.2.2
Malfunctions and accidental events (*e.g.*, spills or leaks of hydrocarbons or chemicals, blowouts)	CSR, Sections 3, 6.3, 7.3 EIS, Sections 3, 6.1.4.4, 6.2.4.4, 6.3.4.4, 6.4.4.4, 6.5.4.4, 6.6.4.4, 6.7.4.4
Environmental Influences (factors which could affect the project design or operation):	
Meteorology and oceanography (*e.g.*, extreme winds, waves, currents and precipitation, fog, freezing spray)	CSR, Section 8 EIS, Sections 5.1.1, 5.1.3, 7
Seismic activity	CSR, Section 8.6 EIS, Section 7.6
Ice climate	CSR, Sections 8.2, 8.3 EIS, Sections 5.1.1.6, 5.1.3.3, 7.2, 7.3
Corrosion	CSR, Sections 2.3.2, 8.8 EIS, Section 7.8
Sinkholes	CSR, Section 6.1.3 EIS, Section 5.3.2.1
Key EIS = Environmental Impact Statement PCR = Public Consultation Report SEIS = Socioeconomic Impact Statement	

1.5 Project Study Area

The study area boundary for the CSR (Figure 1.1) was defined to encompass all areas within which most Project-environment interactions could reasonably be expected to occur. Areas of environmental or socio-economic concern were included within this study area where it was reasonable to do so, including Middle, Sable Island, Western, and Emerald Banks and sensitive areas such as Sable Island and the Gully.

The study area boundaries were also determined in recognition of assessment boundaries established for previous offshore development projects (*i.e.*, Cohasset Project and Sable Offshore Energy Project (SOEP)). The Deep Panuke study area falls entirely within the study area previously assessed for these two projects.

It is impossible, however, to set a single study area boundary to accurately reflect the spatial characteristics of all Project-environment interactions. More specific spatial and temporal assessment boundaries are included in the biophysical and socio-economic impact assessment (Section 6 and 7) with regard to valued environmental and socio-economic components.

2 PROJECT DESCRIPTION

This section provides an overview of the technical and operational considerations related to the Deep Panuke Project. A detailed description of the Project's technical aspects is contained in the Development Plan (DPA Volume 2) that has been submitted to the CNSOPB.

2.1 Reservoir Description

The Deep Panuke Project will produce natural gas from a porous carbonate reservoir located 3,500-4,000 m below the seafloor. The reservoir occurs in the margin of the carbonate platform (Abenaki formation) (refer to Figure 2.1) which formed along the East Coast of North America during the opening of the Atlantic Ocean in the Middle to Late Jurassic, approximately 170 to 128 million years ago. The Deep Panuke gas pool was discovered by PanCanadian (now EnCana) drilling in 1998. Additional drilling in the Abenaki formation in 1999 and 2000 confirmed the presence of a significant gas accumulation. A detailed geological and geophysical description of the reservoir is contained in the Development Plan (DPA Volume 2).

Deep Panuke raw gas is very lean (*i.e.*, with low volumes of associated gas liquids) and contains low levels of carbon dioxide (CO_2) (approximately 3.6%). The raw gas contains hydrogen sulphide (H_2S) and is therefore referred to as "sour gas". H_2S concentration in the raw gas is expected to be approximately 0.2% or 2,000 parts per million (ppm), and is not expected to exceed 46.1 kgmole/hr (equivalent of approximately 2,200 ppm at a production rate of 11.3×10^6 m^3/day (400 MMscfd) sales gas).

The components of the Deep Panuke raw gas are as follows:

- Aromatics: Deep Panuke raw gas contains low levels of benzene, toluene, ethyl benzene, and xylene commonly known as BTEX. BTEX concentration in the raw gas is expected to be 0.14 mole% or 1,400 ppm.
- Trace Elements: The presence of mercury in the raw gas was analyzed by Cold Vapour Atomic Fluorescence method during well testing. Deep Panuke raw gas contains very low levels of mercury (Hg), measured at an average concentration of 0.18 $\mu g/m^3$ (microgram/m^3).
- Metals: A metal analysis by method ASTM D5185 was conducted on a number of samples of produced condensate and heavy metals, such as barium, vanadium; and lead concentrations were less than the detection limit.

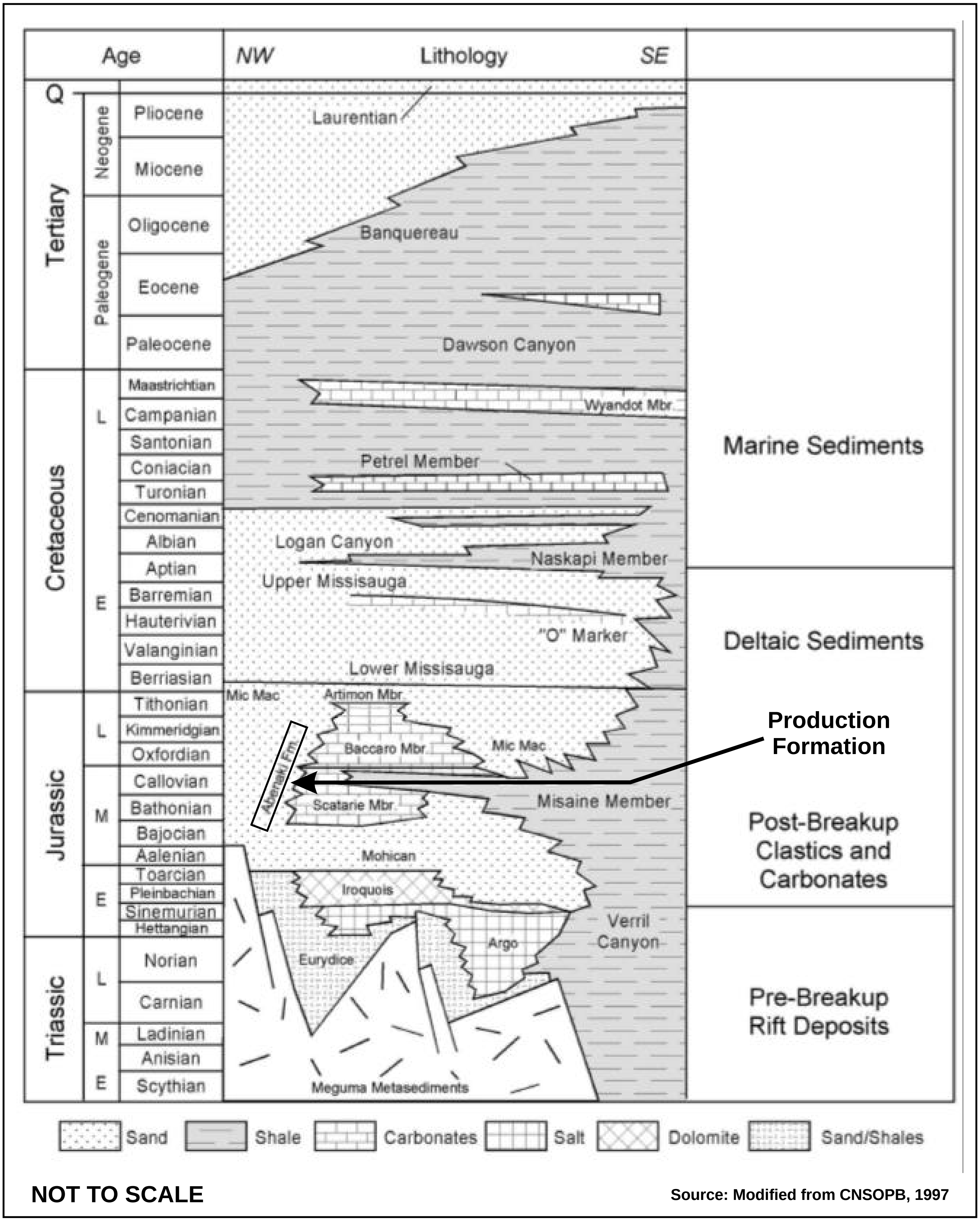


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Figure 2.1 Generalized Stratigraphy of the Scotian Shelf

Potential Radioactive Components: The presence of radon, a Naturally Occurring Radioactive Material (NORM), was measured during well testing by an RDA 200 Radon Detector. Deep Panuke raw gas contains very low levels of radon (Rn), averaging 52.3 Bq/m^3, equivalent to 1.4 pCi/Litre (Conversion factor: 1Bq = 27.027 pCi).

The following sections describe the process by which EnCana proposes to develop this reservoir and produce market-ready gas.

2.2 Project Infrastructure Components

The main Project infrastructure components include three bottom-founded offshore steel platforms (including wellhead, production, and utilities/quarters (accommodations) platforms) interconnecting bridges, and a subsea pipeline to transport sweet natural gas to the onshore infrastructure. The wellhead platform is centered at 43°47'57"N and 60°43'45"W. A simplified site plan is presented as Figure 2.2.

2.2.1 Offshore Platforms

Wellhead Platform

The wellhead platform will be used for dry wellheads and production and test manifolds. The wellhead platform will be connected to the processing platform via a pedestrian/service system bridge with associated piping to transport gas from the wellhead to the production platform and utilities (*i.e.*, water, air, nitrogen, *etc.*) back to the wellhead platform.

The wellhead platform will have six production wells and one injection well (all new wells). EnCana investigated the re-use of two suspended delineation wells (H-08 and M-79A). However, the evaluation determined that the technical and associated commercial risks to convert these wells were unacceptable. The existing suspended wells would have to be converted to subsea producers by re-entering the old wellbore to clean-up tubulars, running a completion string and installing a subsea production tree. This tree would have been tied back to the platforms using a subsea flowline and control umbilicals. In addition to the potential for very high operating costs associated with converted wells, the technical risks associated with corrosion of tubulars and re-entry of wells not originally designed as long-term producing wells, led EnCana to the determination not to re-use the existing wells.

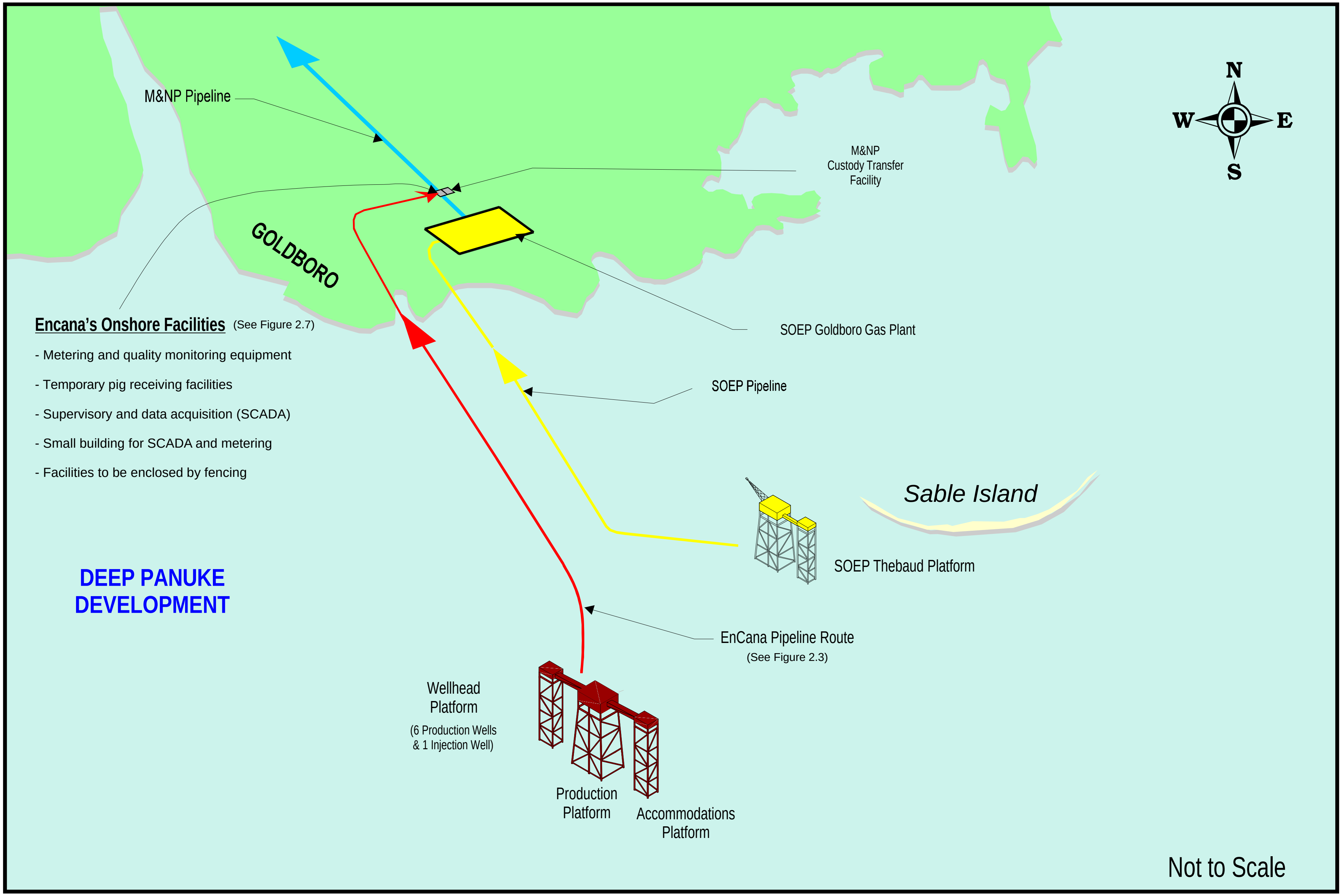

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Figure 2.2 Proposed Project Components

Based on work carried out during the Front End Engineering Design (FEED) study, it appears to be technically and economically feasible to inject both acid gas and surplus condensate together into the same injection well. Therefore, only one injection well will be required for the Project. All wells for the Project, both production and injection, will be located on the wellhead platform.

Production Platform

The production platform is the largest of the three platforms and will contain all power generation and processing equipment to separate, measure, sweeten, dehydrate, dewpoint control, and compress the raw gas. Equipment to handle acid gas (waste gas, primarily H_2S and CO_2, generated during gas sweetening), condensate (liquids removed from raw gas during processing), and water will also be installed on the production platform. The processing facility will be designed to produce 11.3 x 10^6 m^3/day (400 MMscfd), with turndown capability to 1.7 x 10^6 m^3/day (60 MMscfd), to continue production as the Deep Panuke field declines. The market-ready gas pipeline will be designed to transport 12.7 x 10^6 m^3/day (450 MMscfd) with compression. No other expansion capacity is being incorporated into the Project.

Utilities and Quarters Platform

The accommodations (utility/quarters) platform will include living quarters which can accommodate 68 offshore personnel, along with the necessary utilities, control room, emergency power generation, and associated safety systems. A helicopter deck with refueling facilities will be located on the platform.

2.2.2 Subsea Equipment

As previously noted, the two existing subsea wells will not be re-used as a part of the Project. As a result, the only subsea equipment for the Project will be the pipeline and an associated subsea isolation valve (SSIV) assembly located on the pipeline within 500 m from the platform.

2.2.3 Offshore Pipeline

EnCana proposes to transport market-ready gas from the offshore processing facility to Goldboro, Nova Scotia via a subsea pipeline. The pipeline will have a nominal diameter of 610 mm (24 inch).

The subsea pipeline will be designed in accordance with the *Nova Scotia Offshore Petroleum Installation Regulations*. Steel pipe, coated with concrete to reduce buoyancy and improve on-bottom stability, will be installed on the bottom of the ocean by a pipelay vessel. Non-destructive testing will be carried out on the vessel.

The pipeline will be trenched, buried and/or directionally drilled where the water depth is less than 85 m. This requirement is for pipeline protection and stability in the nearshore area. This will also reduce span correction and reduce the potential for sediment scour to the pipeline. The pipeline will be designed to withstand impacts from conventional mobile fishing gear in accordance with the Det Norske Veritas (DNV) Guideline No. 13, Interference Between Trawl Gear and Pipelines, September, 1997.

The proposed offshore pipeline route (together with some alternatives to be investigated during detailed design) is presented on Figure 2.3. Details of the pipeline route are noted in Figure 2.4 and Figure 2.5. The main criteria for selection of the proposed pipeline route were to minimize effects to fisheries (in accordance with the provincial Energy Strategy), the seabed geology and topography. Other criteria included length of pipeline free span, soil properties (ability to trench the seabed), cost and ease of laying the pipeline, and rocky outcrops on seabed. Specifically, the following criteria were used to determine the proposed pipeline route:

- Minimize the environmental effects, seabed disturbance, and effects to fisheries due to the installation and operation of the new pipeline.
- Minimize the pipeline route length where possible while still satisfying all other route criteria.
- Minimize the number of subsea pipeline and cable crossings. Where crossings are unavoidable, routing of the pipeline shall, where possible, have a crossing angle of greater than 30°.
- Consideration shall be given to any known future pipelines.
- Consideration shall be given to concerns raised by the Municipality and fishing interests.
- The pipeline route shall be such that "normal" pipelay operations (pipelay vessel) are not precluded and appropriate minimum horizontal radius of curvature (to be defined during detailed design, dependent on the pipeline size and water depth) could be kept.
- Consideration shall be given to the approaches near the new wellhead jacket (which may be installed in advance of the pipeline installation) to ensure compliance with safety and layout requirements.
- The shore approach routing shall be such to enable shore pull systems to be as simple as possible. Due consideration shall be made of the existing Sable Offshore Energy Project (SOEP) pipeline in the close confines of the harbour.
- Within the limits of the lay corridor and SOEP pipeline proximity requirements, route selection shall minimize potential pre-lay works (pre-sweeping, etc.) and post-lay rectification requirements for freespans.

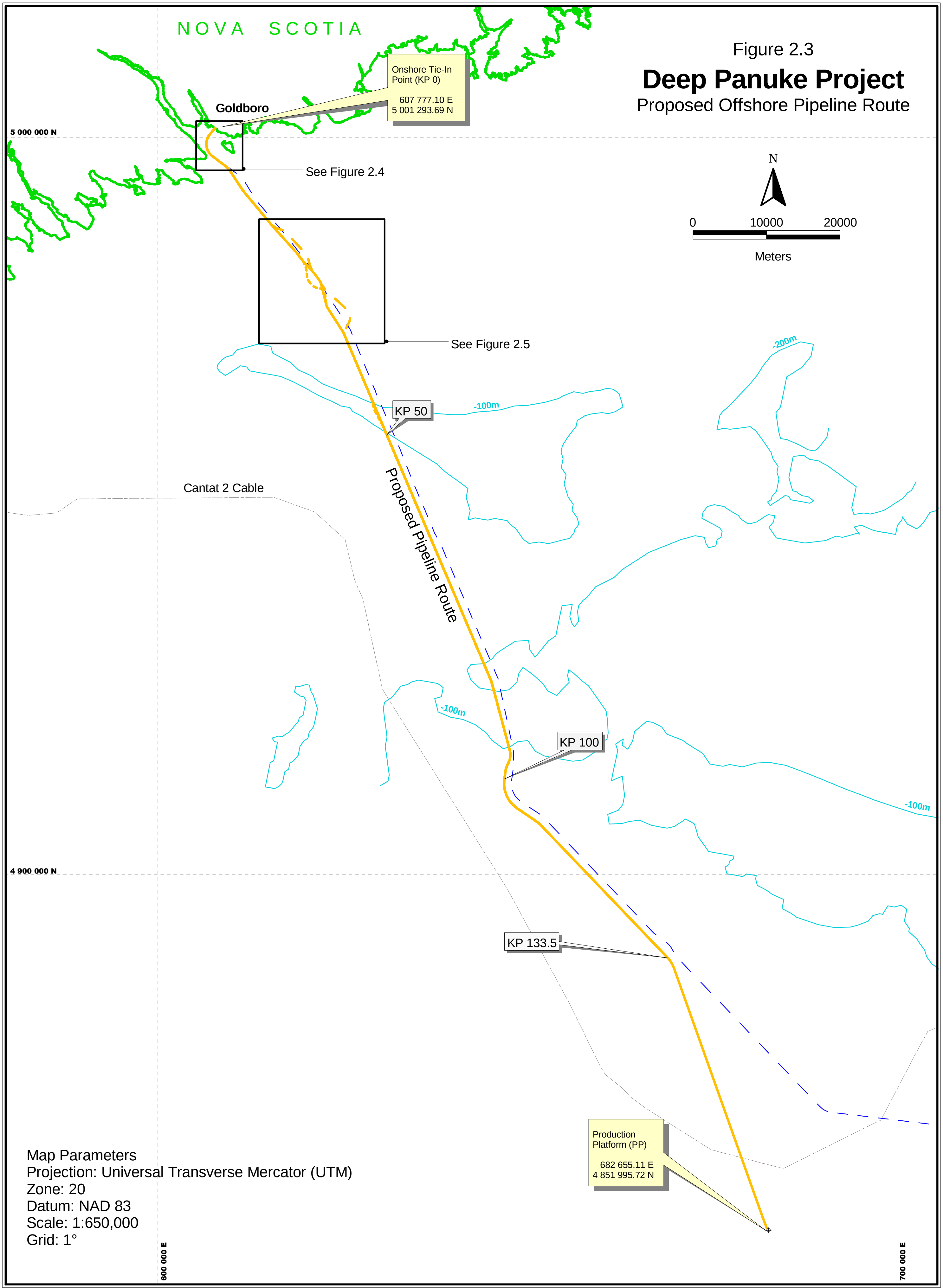

Figure 2.3
Deep Panuke Project
Proposed Offshore Pipeline Route
NOVA SCOTIA
Goldboro
Onshore Tie-In Point (KP 0)
607 777.10 E
5 001 293.69 N
5 000 000 N
See Figure 2.4
See Figure 2.5
N
0
10000
20000
Meters
-200m
-100m
KP 50
Cantat 2 Cable
Proposed Pipeline Route
-100m
KP 100
-100m
4 900 000 N
KP 133.5
Production Platform (PP)
682 655.11 E
4 851 995.72 N
Map Parameters
Projection: Universal Transverse Mercator (UTM)
Zone: 20
Datum: NAD 83
Scale: 1:650,000
Grid: 1°
600 000 E
700 000 E

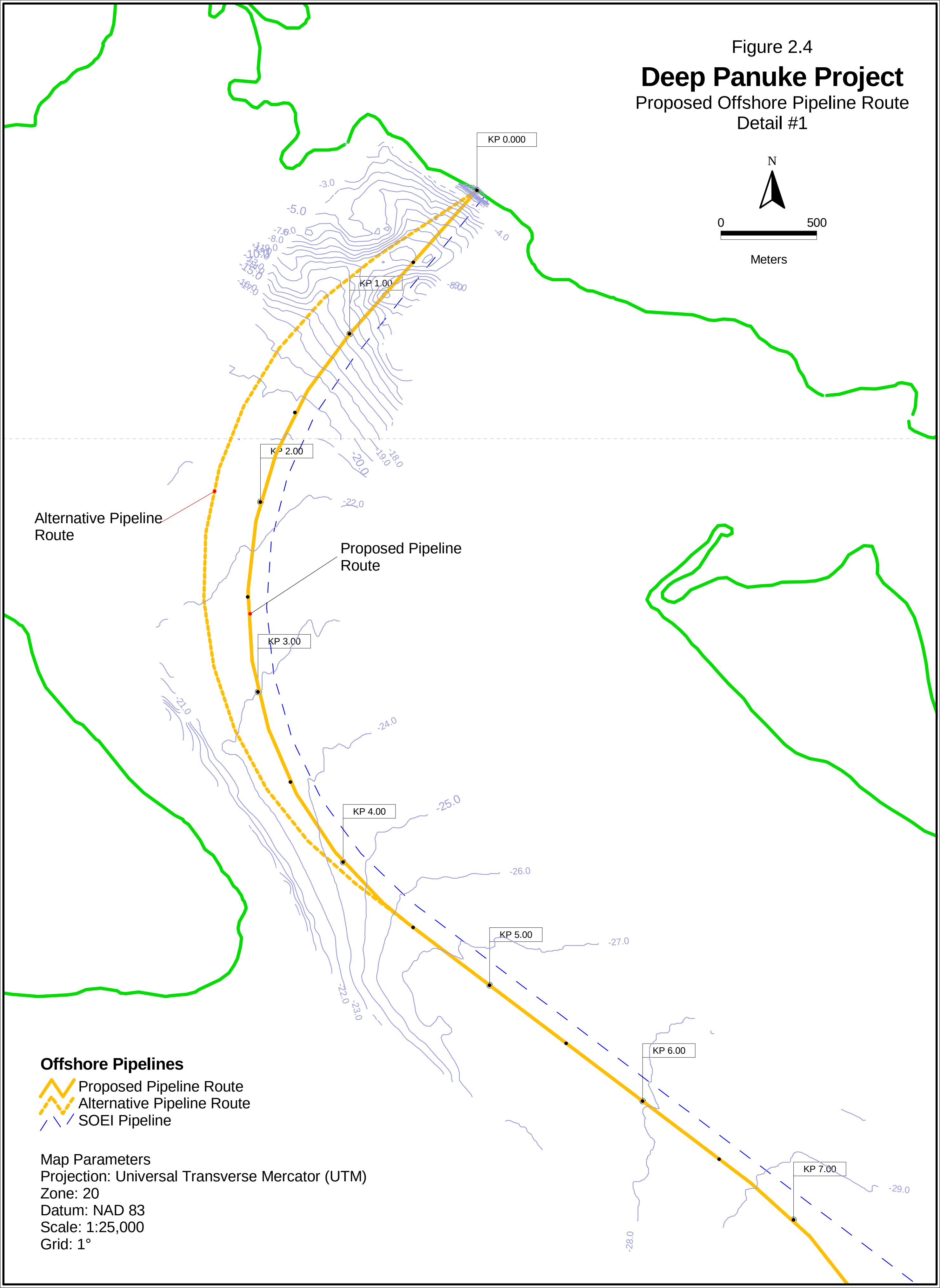

Figure 2.4
Deep Panuke Project
Proposed Offshore Pipeline Route
Detail #1
N
0
500
Meters
KP 0.000
KP 1.00
KP 2.00
KP 3.00
KP 4.00
KP 5.00
KP 6.00
KP 7.00
Alternative Pipeline Route
Proposed Pipeline Route
-3.0
-5.0
-4.0
-20.0
-22.0
-21.0
-24.0
-25.0
-26.0
-27.0
-23.0
-28.0
-29.0
Offshore Pipelines
Proposed Pipeline Route
Alternative Pipeline Route
SOEI Pipeline
Map Parameters
Projection: Universal Transverse Mercator (UTM)
Zone: 20
Datum: NAD 83
Scale: 1:25,000
Grid: 1°

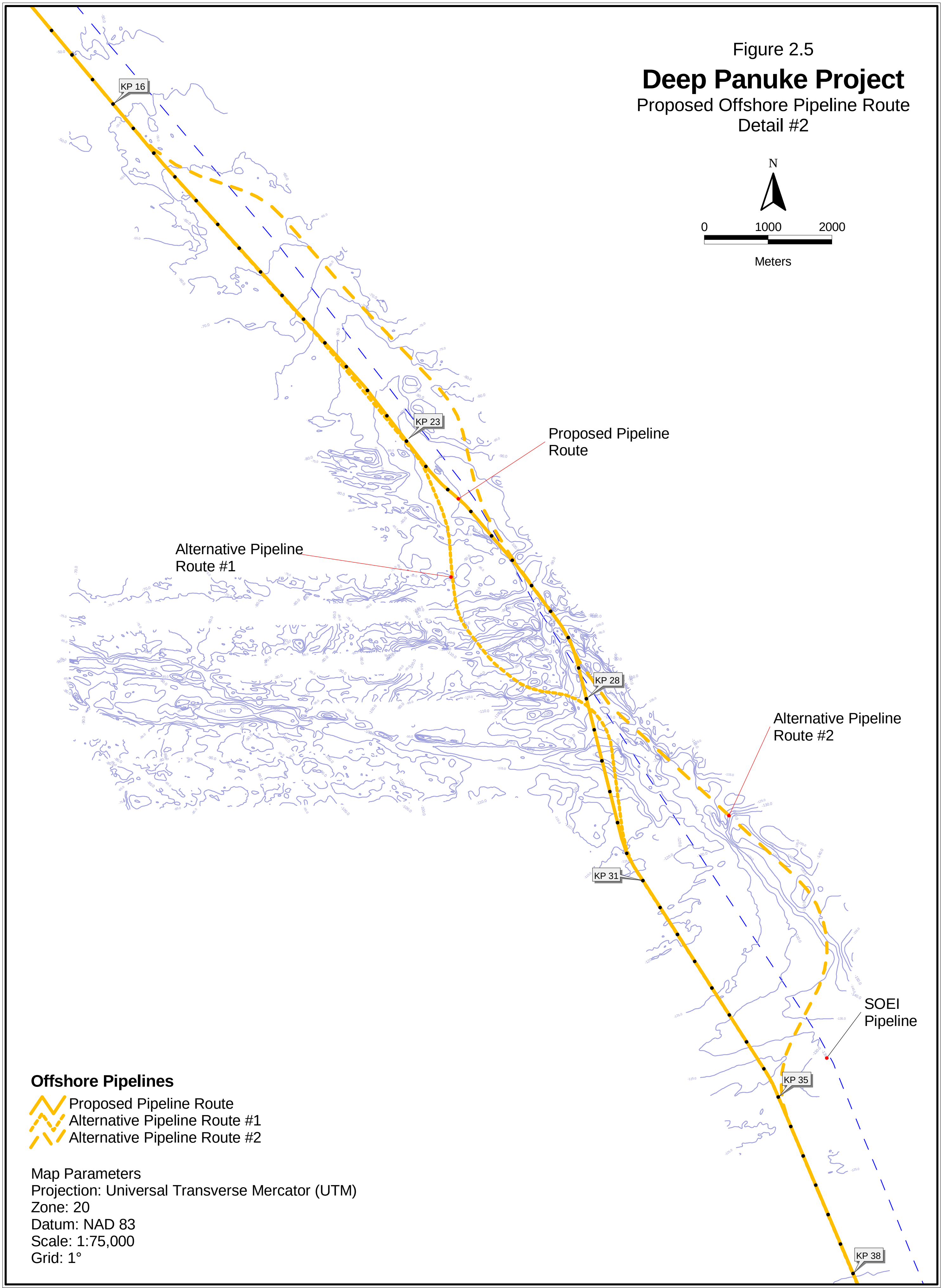

Figure 2.5

Deep Panuke Project

Proposed Offshore Pipeline Route

Detail #2

The proposed offshore pipeline route extends 175 km and closely follows the existing SOEP gas pipeline. The route starts at the landing site in Goldboro, approximately 50 m northwest of the existing SOEP gas pipeline, at KP0 (landfall point). The proposed route then extends southwest paralleling the SOEP pipeline, with a separation of approximately 100 m to KP1.5. At KP1.5, the route deviates to the east until the route is on a southeast heading (heading 127°). At approximately KP8.3, the separation between the SOEP pipeline and the route is increased to a minimum of 500 m.

The Deep Panuke route continues paralleling the SOEP pipeline between KP7.2 to KP23.7. Between this area, minor deviations are necessary to avoid areas of rock outcrop. The route between KP8.1 to KP23.7 has a minimum separation from the SOEP pipeline of 300 m. Currently, at KP25.3, the route crosses the existing SOEP pipeline to allow passage through the extensive rock outcrop. The pipeline route follows along the eastern side of the SOEP pipeline at a separation of approximately 100 m to 150 m to KP27.6, where the route crosses back over the SOEP pipeline.

Between KP27.6 and KP30.5, the route runs south-south-east through an area of steep gullies, until it rejoins the original proposed route, heading south-east and paralleling the SOEP pipeline at a separation of 1,000 m.

The pipeline route continues on a southeast heading (with the exception of some minor route deviations) paralleling the SOEP pipeline to KP96, where the route deviates east of a steep slope (>12°). At this location, the separation between the SOEP pipeline and the Deep Panuke route is a minimum of 450 m. After this deviation, the pipeline then rejoins the original proposed route and again parallels the SOEP pipeline at a separation of 1,000 m.

At KP102.3, the pipeline is routed alongside (west of) the Brindal Basin, remaining parallel to the SOEP pipeline, with a separation of 1,000 m. The route remains on a heading of south-west and paralleling the SOEP pipeline until it reaches KP133.5, where the pipeline diverts due south-east until it reaches the Deep Panuke platform at KP175.

2.2.4 Onshore Pipeline and Facilities

EnCana's onshore facilities will consist only of the physical components necessary for interconnection of EnCana's pipeline with Maritime & Northeast Pipeline's (M&NP) facilities. EnCana's pipeline will tie into the M&NP transmission main at Goldboro, Nova Scotia, downstream of the SOEP gas processing plant. The onshore pipeline will be located within the pipeline corridor indicated on Figure 2.6.

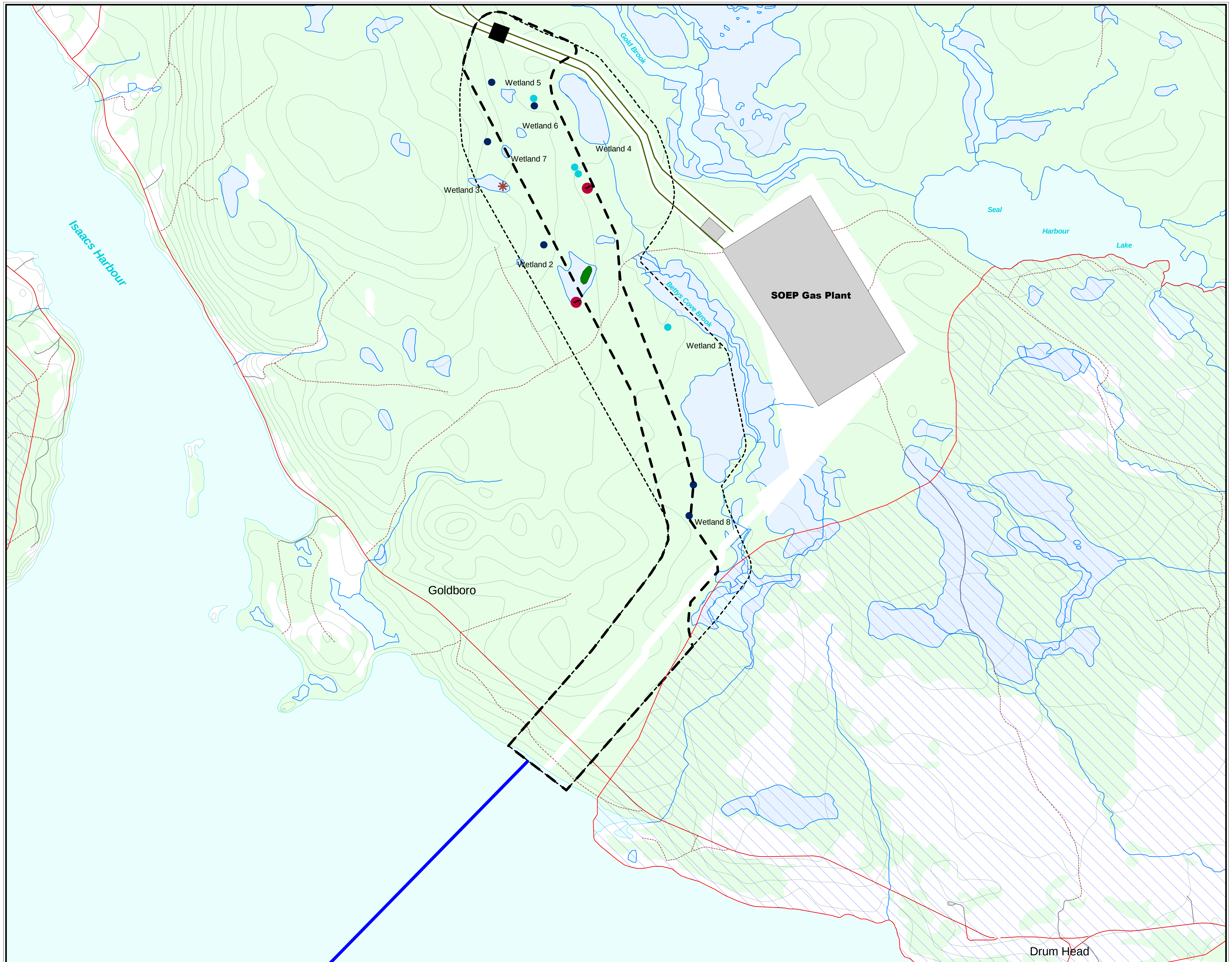

Figure 2.6

Deep Panuke Project

Proposed Onshore
Pipeline Corridor

EnCana
- Onshore Study Area
- Proposed Onshore Pipeline Corridor
- EnCana Proposed Offshore Pipeline Route

Existing Pipeline
- M&NP Pipeline

Terrestrial Features
- Small Stream
- Small Stream - (Intermittent / Subsurface)
- Good Four-toed Salamander Habitat
- Wetland
- Deer Wintering Area
- Geocaulon lividum Distribution
- Geocaulon lividum (~29 Stems)

Topographic Features

Land Cover
- Watercourse
- Waterbody
- No Cover
- Forested

Roads
- Major
- Minor
- Service/Track
- Abandoned

N

0 500

Metres

Map Parameters
Projection: Universal Transverse Mercator (UTM)
Zone: 20
Datum: NAD 83
Scale: 1:15,000
Project Number: NSD15999

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The onshore portion of the pipeline will be approximately 3 to 4 km in length. Design criteria for the onshore pipeline include the following:

- consideration of physical features such as rock outcrops;
- minimizing environmental effects through avoidance of:
    - wetlands;
    - Bettys Cove Brook; and
    - Deer Wintering Areas;
- minimizing pipeline length;
- consideration of pipelay restriction, such as minimum horizontal radius of curvature;
- minimizing effects on landowners' properties through which the pipeline will run; and
- ensure best use of industrial park land consistent with the Municipality's conceptual plan for the park.

The environmental constraints on the pipeline route and expected mitigation measures to manage these constraints will be included in the Request for Quote for the onshore pipeline installation package. Additionally, onshore environmental constraints will be considered in the Project's Onshore Construction Environmental Protection Plan (EPP).

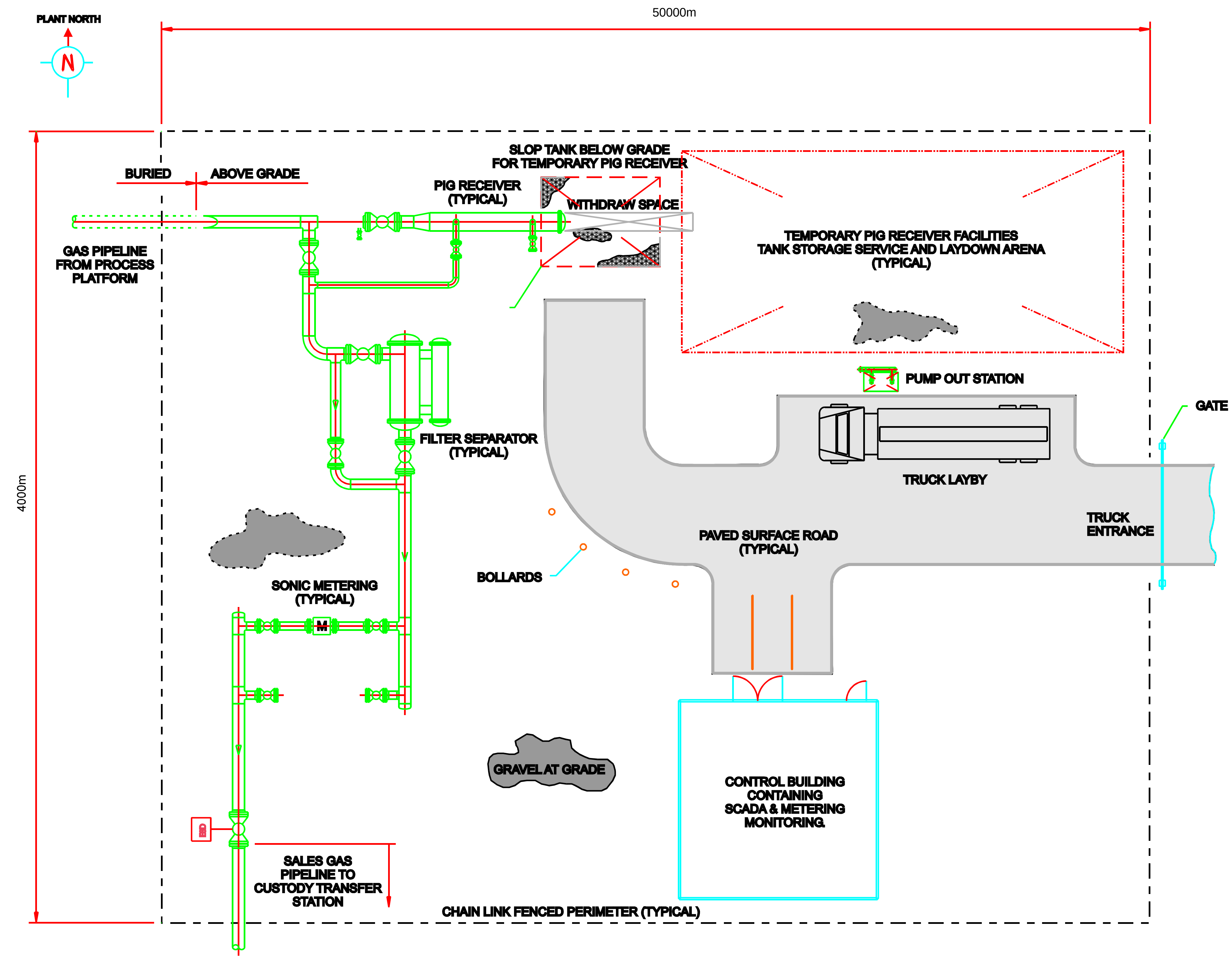
The onshore facility may include metering and quality monitoring equipment, temporary pig receiver facilities, a supervisory control and data acquisition (SCADA) system and a small building required for SCADA and metering. The area of the facility is estimated to be 50 m x 40 m, and it is anticipated that the facility will be sited within or close to land to be allocated to M&NP for custody transfer at the tie-in point to the existing transmission pipeline. An access road will be required which will run parallel to the new pipeline. The final location of the onshore facilities will depend on the final pipeline routing and access, as well as environmental, socioeconomic and engineering constraints. When additional survey work is completed, EnCana will consult with the owners of the Goldboro Industrial Park to determine the location of the onshore facilities, as well as the onshore pipeline route.

Although layout of the onshore facilities is not complete at this time, Figure 2.7 is a plot plan for typical onshore facilities that would be required for a development, such as the Deep Panuke Project.

Figure 2.7

Deep Panuke Project

Plot Plan, Typical Onshore Facilities



LEGEND

- CHAIN LINK FENCE
- PIPING ABOVE GROUND
- PIPING BELOW GROUND
- ESD VALVE
- BALL VALVE

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2.3 Construction and Installation

2.3.1 Offshore Production Facilities

The Project aims to maximize onshore construction, completion, and commissioning and to minimize offshore hook-up and commissioning. Each topsides element will be designed such that it can be installed with a single offshore lift. As far as practical, all items of equipment will be skid-mounted and will arrive on site 100% complete, fully tested and commissioned.

Various individual construction sites at existing fabrication yards will be employed during the construction phase of the Project. The individual elements of the Project will be divided as follows:

- production platform topsides;
- utilities/quarters platform topsides;
- wellhead platform topsides;
- jackets;
- bridges; and
- flare.

Construction

The general method of construction for the structures will be based on preparation and sub-assembly of components at existing facilities, mainly in specialized shops and in protected environments, and final assembly close to the point of loadout for sea transportation.

The wellhead, production and utilities/quarters jackets will be fabricated onshore at existing fabrication yards and barged to the offshore location for installation on the seafloor. Piles driven into the seabed will secure the new jackets. Pile driving is expected to take a total of 4 to 7 days to complete, but may be conducted intermittently over a longer period of time. Integrated decks will also be fabricated onshore, barged to the offshore location, and installed. A heavy lift vessel will be required for installation of the jackets and topsides.

The construction philosophy for the topsides will, in general, be based on a pancake-build philosophy. (This is the term given to describe the method of completing the various levels of the topsides, stacking one deck on top of the other, after having placed the equipment on each level). The decks will be constructed from pre-fabricated plate girders, rolled sections and pre-rolled tubulars. The intent is to maximize opportunities for equipment installation and the subsequent erection of pipework, cable trays and support steel prior to deck stacking operations.

Mechanical completion will denote the completion of all construction work, inspection and static testing prior to dynamic testing and start-up with power and fluids. The mechanical completion work to be carried out at the fabrication yard prior to transport to site includes the following:

- All “tagged” equipment will be located, installed, connected and tested.
- All piping systems will be installed, non-destructive testing (NDT) completed, pressure tested, flushed, dried and reinstated.
- All chemical cleaning will be complete.
- All oil flushing will be complete.
- All electrical systems will be installed and tested.
- All instrumentation systems will be installed and tested.
- All leak testing will be complete.

Installation

Installation activities cover the transportation and installation of the components of the offshore platforms; namely jackets, piles and the topsides elements including bridges and flares. The installation scope also includes the pipelay activities, which are detailed in Section 2.3.2.

The size of the platform components dictate that they must be lifted into position and secured offshore with a dedicated heavy lift vessel (HLV). The production platform topsides must be installed using semi-submersible twin crane heavy lift vessels (SSCV) that are capable of lifting such a structure. The environmental conditions offshore Eastern Canada can be severe and the installation season may be considered from April to September.

The completed components of each platform will be transported from the construction site to the offshore location on dedicated flat top barges. A typical transportation sequence for each barge spread is as follows:

- mobilization of the cargo barge to fabrication yard;
- installation of support grillage, loadout and sea fastening of the fabricated components;
- towing of cargo barge and fabricated structures to the installation site;
- lifting and installation of the component;
- towing of the cargo barge to cleaning yard/home port; and
- demobilization of tug and cargo barge.

The installation of the facilities at the offshore location is a complex exercise that may be affected by adverse weather. The technical complexities can largely be mitigated by an experienced installation contractor.

Installation will be in accordance with Deep Panuke Installation Manuals providing full details of the sequence and content of each operation. The following summarizes the typical scope and strategy required to execute a major offshore installation activity:

Preparation Activities

- Deliver jacket, deck and piles rigging to the nominated fabrication yard for pre-installation; and
- mobilize cargo barge to platform fabrication yard.

Installation Activities

- Mobilize HLV to the offshore and perform sea trials;
- tow jacket and topsides cargo barges to the offshore site;
- lift and set the jacket on the seabed, perform level survey and de-rig;
- lift, stab and drive the piles to the target penetration;
- grout pile sleeve connections;
- survey and cut jacket legs ready to receive topsides, remove rigging platform and perform miscellaneous jacket completions;
- lift, install and de-rig platform in accordance with installation procedures;
- weld deck to jacket and perform testing of the welds; and
- demobilize from offshore location.

Hook-Up

It is intended that the platforms be commissioned as fully as possible onshore. Thus, the likely offshore hook-up scope will be limited to the final tie-in of such items as:

- jacket-topsides interface weld out;
- flare structure;
- removal of temporary steelwork;
- 610 mm diameter pipeline riser;
- seawater lift pumps and caissons;
- installation of bridges and linking services;
- equipment alignment checks; and
- final commissioning activities.

The hook-up phase will be supported from the Project office in Halifax and the existing Halifax supply base. A flotel (floating accommodation barge) will be on station at the offshore location during the major hook-up activities, providing accommodation and essential services.

2.3.2 Subsea Pipeline

A proposed pipeline corridor has been selected as described in Section 2.2.3 and shown on Figure 2.3; refinement of the proposed pipeline route will be completed during detailed design. The following paragraphs describe the methods to be used for pipeline installation.

Landfall Preparation

Well in advance of the installation vessel arrival on site, the landfall will be prepared to receive the pipeline. The landfall will consist of a conventional open cut trench construction and a nearshore dredged section (or possibly a directionally drilled section in the nearshore).

The landfall area will be graded in preparation for the pipeline and pull-in winch and reels. It is anticipated that due to the soil conditions at the site, some blasting will be required in the low tide area, prior to the installation of the winch. Blasting is currently proposed in the nearshore and is likely to be required in some local areas within 300 to 500 m of the shoreline only. Blasting requirements will be refined during the detailed design phase after the nearshore geotechnical survey has been performed. Blasting will require approval from DFO and will be conducted in accordance with the Guidelines for Use of Explosives in or Near Canadian Fisheries Waters (Wright and Hopky 1998). Blasting activities will also comply with the *General Blasting Regulations* made pursuant to the Nova Scotia *Occupational Health and Safety Act*.

It is anticipated that the pull-in arrangement will consist of a single linear winch of 300-tonne minimum capacity, tied back to either a temporary pile or block anchor. Final details and operational procedures will be confirmed once a sub-contract has been placed for the work and a detailed site and soil inspection has been performed.

Once the pipeline has been pulled in, the trench will be mechanically backfilled to ensure cover depth and protection. The remaining landfall site will be restored.

Nearshore Pre-Lay

Prior to the arrival of the pipelay vessel, the pipeline route, for a distance approximately 1 km from the shoreline, will be pre-dredged. Floating equipment will be used that is capable of digging glacial till, and additional localized drilling and blasting may be required close to the shoreline. Upon completion of the pipeline pull-in operation, this section will be mechanically backfilled. Silt curtains will be used during dredging. Fisheries interests will be notified well in advance of pipelay operations using the Notice to Mariners and by direct contact with key fisheries representatives. Local fishing vessels will be used to carry out environmental compliance monitoring (*i.e.*, turbidity measurements) during dredging or as chase boats during pipelay operations (if required).

Directional Drilling

A review of the alternatives for the installation of the nearshore pipeline has identified directional drilling as a potential method for bringing the pipeline ashore. Horizontal directional drilling (HDD) would require drilling a nominal 910 mm (36”) diameter hole from the shore to an offshore tie-in point approximately 1 km offshore (KP1). Using this method, the pipeline could be pulled from the pipelay vessel at KP1 through the drilled hole to the shore. Alternatively, the pipeline could be prepared onshore, and pushed from the shore out to the breakout point at KP1. The onshore component of the pipeline from this point to the M&NP pipeline would be installed in the conventional manner described in Section 2.3.3.

HDD employs a large self-contained onshore drilling machine, including power and support facilities, which are brought to the onshore site in containerized modules. The drilling system is established on a prepared (level and graded) site near the shore. The drill is anchored into the bedrock to provide a secure footing for drilling at a downward angle into the bedrock. The drill is guided along a predetermined curved pathway beneath the seabed to emerge at KP1. This hole would reach a depth of approximately 25 m below the seafloor.

Typically, a pilot hole is drilled to a point short of breakout and the hole opened to the proper diameter. This confines the cuttings and mud to the hole and onshore mud re-circulation tanks. Once the diameter of the hole has been achieved, the hole is completed by breaking out onto the seafloor. This minimizes the release of drilling fluids (water based mud consisting of freshwater and bentonite) into the marine environment. On break out, in the order of 1-3 m^3 of drilling mud may be released from the hole. This mud has a high specific gravity and accumulates around the breakout point in a relatively small area.

During the drilling program approximately 25 m^3/day of freshwater is required for mixing with the drilling mud (bentonite). This water would be sourced through drilled wells or an approved surface water supply. This water is recycled throughout the drilling program through the onshore drilling fluid treatment equipment. Drill cuttings and mud are collected on-site and mud is recycled during drilling.

The onshore drilling operation runs seven days per week and 24 hours per day. The equipment has exterior lighting to illuminate the work site at night. The mechanical equipment is enclosed in sound isolated containers to reduce off-site noise impacts.

Potential environmental impacts from directional drilling may include noise and illumination of the drill site during the drilling program and a limited release of water and bentonite during the breakout at KP1. Preliminary indications are that cuttings, which are separated from the mud, may be used as onsite fill as required at the end of the Project. Any acid rock and drainage which might be encountered would be handled in accordance with the EPP.

An analysis of the HDD option will compare potential environmental effects and costs of this method against those of seabed dredging and conventional pipe laying procedures for the nearshore installation. These aspects of the nearshore installation alternatives are currently under review and evaluation.

Pre-Lay and As-Laid Surveys

An independent survey vessel with full workclass remotely operated vehicle (ROV) will be mobilized to undertake surveys and provide pipeline installation assistance. Just prior to the mobilization of the pipeline installation spread, the survey vessel will be mobilized and will conduct a pre-lay survey of the pipeline route.

During the pipeline installation, the survey vessel will perform pre-lay and as-laid surveys and will provide installation assistance and touchdown monitoring during critical operations. Such operations are anticipated to be laying through boulder fields, laying through bedrock outcropping and during pipeline crossings.

Upon completion of the pipeline laydown, the survey vessel will complete the as-laid survey. The as-laid survey will also provide a visual survey of the pipeline.

Pipeline Pull-in

Prior to the arrival of the pipelay vessel, the pull-in cable will be pre-installed in the dredged channel and buoyed off at a convenient point offshore.

Once the pipelay vessel is on location, the pull-in cable will be recovered by one of the supporting anchor handling vessels and will be transferred to the pipelay vessel. Once the pipelay vessel has recovered the cable, it will be connected to the pipeline pull-in head.

The lay-vessel will arrive on site with a "string" of pipe on the firing line with the pipeline lay-down head at the top of the lay-vessel ramp. The linear winch will pull the pipeline onto the beach as the lay-barge simultaneously welds further sections of pipe onto the string. This process is continuous until the pipeline end has reached the designated point. The winch will then retain tension on the pipeline pull-in head while the pipelay vessel "lays away" from the shore pull location. The winch will retain tension on the head until sufficient pipe has been laid on the seabed to provide enough "hold back" tension to allow the pull-in cable to be released.

There are a very limited number of pipelay vessels capable of installing the subsea pipeline. The final selection of the pipelay vessel will be based on technical capability, availability, and cost. The nominated vessel will set up at the beach pull location approximately 1 km from landfall and the pipeline will be pulled onto the beach as described above.

Once the pipeline has been pulled-in, the vessel will "lay away" and continue along the pipeline route. During regions of complex lay, such as through the rocky outcrop, the dedicated survey vessel will assist with laying operation. The survey vessel will perform touchdown monitoring using an ROV and will check the route ahead of the pipelay vessel.

Pipelay

The installation method will be to "S-Lay" the pipeline from a conventional pipelay vessel. The actual vessel to be used cannot be nominated at this time and may be either a conventional pipelay vessel, which is controlled by the use of anchors, or a dynamically positioned vessel, which is controlled by the use of thrusters located at the bow and stern. A typical anchored vessel has 12 anchors each weighing 25 tonnes, connected to individual anchor winches by 3 in (7.6 cm) diameter cable. Anchors are positioned using a separate anchor-handling vessel. Once on station, the anchor-handling vessel lowers the anchor to the seabed using a winch. The anchor locations may extend up to 1 km from the pipelay vessel. Part of the anchor cable contacts the seabed as the vessel moves forward; the extent of this contact depends on water depth and cable tension. Each anchor would cover an area on the seafloor of approximately 4 m wide by 4 m long. An anchor handling plan including avoidance of sensitive areas (*e.g.*, inshore lobster and scallop habitat) where practical and use of midline cable buoys where complete avoidance is not practical, will reduce impact to the marine benthos should an anchor pipelay vessel be used.

While laying in close proximity to the SOEP pipeline, an exclusion zone will be set up to eliminate the risk of damage. In addition, where the anchor cables cross the SOEP pipeline, a buoy will be placed on the anchor cable. In the unlikely event the anchor cable breaks, the buoy will prevent the cable from falling onto or damaging the SOEP pipeline.

As the pipelay vessel approaches the crossing locations, the dedicated survey vessel will place a number of subsea acoustic transponders at the extremes of the crossing corridor. The pipelay vessel will then place transponders on the pipe prior to and leading up to the crossing location. These transponders will advise the position of the pipeline in relation to the crossing corridor. This system enables the pipelay vessel to make an accurate crossing and enable any changes in the pipeline heading to take place well in advance of the actual crossing. If deemed necessary, touchdown monitoring by the survey vessel will be carried out during the crossing operations.

Upon completion of the crossing, the survey vessel will undertake an ROV video survey of the crossing and will remove the transponders from the crossings and pipeline.

The pipeline will be sealed with a temporary "head" at the end of the pipe and laid down adjacent to the platform location.

Pipeline Stabilization

In order to stabilize the pipeline on the seabed, concrete weight coating will have been applied prior to delivery of the pipe to the pipelay vessel. It is foreseen that the pipeline will be buried in the zones where the water depth is less than 85 m. This will be performed using subsea trenching equipment, which will trench the pipeline to a depth of approximately 2 m so that after the soil has backfilled, there will be approximately 1 m of cover. The pipeline will be trenched and backfilled within 1 km of the shoreline.

There are two main methods that may be used to form the trench for pipeline burial. The first option is to use a towed plough. In this method, the plough is deployed from a host vessel and lowered over the pipeline. The pipeline is raised into the chassis of the plough and the shares are closed below the pipeline. As the plough moves forward, under control of the host vessel, it forms a V-shaped trench into which the pipeline is lowered. The second option is to use a self propelled subsea digging tool. This type of machine is positioned over the pipeline and moves forward without touching it. Hydraulic digging arms are used to form the trench underneath the pipeline. Additionally, strong jets of water may be used to fluidize the loose material under the pipeline, to ensure that the pipe is lowered as far as possible into the V-shaped trench. For either option, natural backfill of soil from the steep sides of the trench will cover the pipeline. Loose sand particles will start to cover within a few minutes; denser material will take longer. The design has conservatively allowed for the pipe to be partially buried for up to one year before the soil completely fills the trench. A follow-up program will be designed, in consultation with Environment Canada, to allow verification of natural backfilling of sediment to the trenches. If natural backfilling has not occurred within one year of trenching, other backfilling options will be implemented or a disposal at sea permit will be sought.

In the rock outcrop area, where trenching may not be possible, the option to stabilize the pipeline with rock will be investigated during detailed design. Additionally, span rectification using rock may be performed in any locations where high stress in the pipeline would otherwise occur due to excessive undulations in the seabed. The source of this rock will likely be onshore from an existing rock quarry, such as that in Mulgrave, NS.

Applicable regulatory authorities (*e.g.*, Environment Canada, DFO) are being consulted with respect to specific permitting requirements (if any) associated with the pipeline installation.

Hydrostatic Testing

The pipeline will be hydrostatically tested during commissioning using treated seawater which will be drawn from a location near the landing site in Goldboro. All the water introduced into the line shall be thoroughly filtered to 50 microns. During pipeline filling, cleaning, gauging and hydrostatic testing, chemical inhibition package(s) will be continuously injected into the seawater. It is anticipated that the time required to fill the pipeline and these operations will be less than ten days. The chemical inhibition package may include: dye to aid in the detection of leaks; a biocide to control marine organisms and sulphate reducing bacteria; a corrosion inhibitor; and a dissolved oxygen scavenger to minimize corrosion on the interior of the pipeline. During the filling cycle, some spillage of this water may occur at the pig receiving station offshore. This occurs when excess hydrostatic water is required to push the pig into the pig receiver at the end of the pipeline.

It is necessary to treat the seawater introduced into the pipeline with corrosion inhibitors and biocides as these chemicals protect the interior surface of the pipeline. The time between the installation of the pipeline and its commissioning into service may be up to one year which exceeds the time window allowed for leaving untreated seawater in the pipeline. Leaving untreated seawater in the pipeline for more than one month can establish conditions which permit corrosion to occur at a later stage in the life of the pipeline. The introduction of treatment chemicals is a safety measure for the prevention of corrosion over the life span of the pipeline.

The proposed method of discharging the hydrostatic water incorporates pigging from the shore using a temporary air compressor station onshore to push the pig and hydrostatic water through the pipeline for discharge at the production platform. At the production platform, a temporary line will direct the hydrostatic discharge water to the cooling water discharge caisson where the hydrostatic test water will be mixed with the seawater before discharge into the marine environment. The use of compressed air onshore provides some degree of variability in rate at which the hydrostatic water can be discharged. The compressed air used to dry the pipeline will be purged using nitrogen. A nitrogen charge of approximately 5 to 6 psi will be left in the pipeline. The nitrogen will be vented during commissioning of the overall facility with “First Gas”.

A study has been identified to optimize the method of discharge of hydrostatic water from the pipeline and to identify the chemicals best suited for application and discharge into the environment. This is a one time only discharge. It is estimated that the pipeline will contain approximately 47,000 m^3 of hydrostatic test water and that the pipeline will be emptied over an estimated period of 4 to 5 days. The discharge rate will be approximately 470 m^3/hr. The seawater discharge from the platform is estimated to be 3050 m^3/hr. Therefore, there will be a 7:1 (approximate) dilution of the hydrostatic test water with the cooling water prior to discharge.

The chemicals to be used in this application will be screened through the Offshore Chemical Selection Guidelines (NEB *et al.* 1999), selected from a list of chemicals approved for use in Canada. Since the installation program for the pipeline is still under development and a supplier has not yet been selected, the definitive treatment chemicals cannot be specified.

A study, consisting of two components, will be undertaken to assess the impact of the selected chemicals discharged into the environment. A toxicity bioassay program (first study component), will be undertaken prior to discharging these compounds. The bioassay will employ samples of the proposed chemical diluted in seawater to emulate the mixtures of chemicals and concentrations proposed for the hydrostatic test program. The results will be applied in a plume dispersion model (second study component) to confirm that there will be minimal impact to the marine environment around the platform. Prior to undertaking this study, the parameters and scope of the bioassay study will be discussed with Environment Canada and DFO.

The onshore section of the pipeline will also require hydrostatic testing, which may be conducted concurrently with the offshore section of the pipeline as discussed above, using the same seawater source and treatment chemicals.

Should the schedule of the onshore section of the pipeline installation be changed, then a separate hydrostatic test might be required. Under this circumstance, the hydrostatic test water could be left in the onshore pipeline until the offshore testing is completed and the hydrostatic test water discharged with the offshore hydrostatic test water.

Should circumstances require separate testing and it became necessary to discharge the hydrostatic test water from the onshore pipeline, this water would have to be removed in tankers and taken to an approved waste treatment facility for disposal. Because of the environmental and cost considerations, this option would only be considered under exceptional circumstances.

2.3.3 Onshore Facilities and Pipeline

The onshore pipeline will be constructed and installed according to applicable design codes (*e.g.*, CSA Z662-99 Oil and Gas Pipeline Systems), regulatory requirements (*e.g.*, *Onshore Pipeline Regulations*, 1999), and industry standards. Other onshore facilities will include metering and quality monitoring equipment, temporary pig receiver facilities, a SCADA system and a small building required for SCADA and metering.

The construction and installation of all onshore activities will be in accordance with CSA Z662-99. An outline and description of installation of typical onshore facilities (excluding pipelines) is as follows:

- tie into the M&NP transmission pipeline, install tie-in facilities (*e.g.*, metering, *etc.*), carry out a hydrostatic test, and isolate these facilities;
- lay out onshore sections of piping and associated works (*e.g.*, aboveground piping, temporary pig receiver);
- line fill, clean and gauge onshore sections of piping and associated works;
- test onshore sections of piping and associated works;
- connect piping to the M&NP facilities;
- dewater, and dry onshore sections of piping and associated works; and
- perform tie-ins to the pipeline.

A proposed onshore pipeline corridor has been selected as shown in Figure 2.6. The final pipeline route will be determined in consultation with the Municipality and in accordance with the design criteria as listed in Section 2.2.4.

In general, the installation of the onshore pipeline will use the “spread” method as detailed below. Due to the relatively short length of pipeline to be installed, only a single spread (*i.e.*, one set of crew for each activity) will be required. The detailed make-up of the spread will depend on the particular construction contractor, their equipment and the nature of terrain, but in general, the following teams could operate along each spread:

- survey crew;
- special crew to locate existing services;

- working width preparation crew;
- fencing crew;
- top soil stripping crew;
- field bending crew;
- welding crew;
- inspection crew;
- coating crew;
- trenching crew;
- lower and lay crew;
- backfill crew;
- reinstatement crew;
- hydrotesting crew; and
- precommissioning crew.

In addition, special crews for such operations as road and water crossings will operate as necessary.

The working width for construction activities will typically be a 25 m wide right-of-way (RoW) along with a 25 m wide temporary work room (TWR), as necessary. The working width, a combination of permanent RoW and TWR, will be acquired in consultation with the affected landowners. When special crossing techniques are being applied (*e.g.*, at road and stream crossings), an increased working width is required to facilitate the passing of crews and extra spoil storage. For the pipeline installation at landfall, the total working width required for equipment and laydown is approximately 100 m.

Within the working width, the centreline of the pipeline will be pegged and then trees and shrubs removed. Wherever possible, established trees are worked around. Ditches are flumed by installing pipes and ramped over with subsoil to give a continuous "running track".

Stumps and debris in the way of the trench will be removed and disposed of during the clearing operation. Holes remaining after stumps have been removed will be filled with suitable material and compacted. Clearing operations performed with bulldozers will be confined to the working width and will comply will all environmental permit conditions.

Topsoil will then be striped across the working area and stored at one side. An area of the working width adjacent to the stored topsoil will be designated as a running track for vehicle movements.

The pipes are transported to the working width from the pipe dumps and laid out on wooden sleepers (skids) along a line parallel to the proposed trench. Gaps are left in the strung pipeline to permit access across the working width. Where the pipeline route negotiates changes in direction, factory manufactured bends will be installed or, if the change of direction is less severe, bends can be fabricated in the field. The pipeline sections will then be welded together and all welds will be subjected to radiographic inspection, with detected faults being repaired or cut out.

The open end of the pipeline section will be capped at night to prevent any material from infilling the pipe and/or the ingress of small animals.

The welds and any other areas of bare pipe are then coated so as to form a continuous protective coating. Prior to installation in the trench the coating is checked to ensure it has not been damaged.

A trench, nominally 300 to 600 mm wider than the pipe diameter and deep enough to provide the minimum covers, will be excavated to allow the pipeline to be buried. In rock areas where grading the bottom of the trench is difficult, a bed of sand at least l00 mm thick is provided for the pipeline to settle on. Where the pipeline has to cross an existing pipeline, the trench depth will be increased to allow a gap to exist between the two pipelines. The ultimate depth of cover will be determined by design codes and local site conditions and is affected by land usage, pipe restraint and safety considerations (*i.e.*, third-party effects). It is anticipated that the depth of cover will typically be in the range of 1 m; however, it could be a minimum of 600 mm due to design constraints (such as crossing an existing pipeline).

The pipeline is lowered into the trench using side-boom tractors and extreme care is taken to avoid damaging the pipeline coating. The trench is then backfilled with subsoil, which is graded to avoid damage to the pipeline coating. Approximately l50 mm of graded subsoil will be placed around the pipeline. This soil, with a maximum particle size of approximately 6 mm, is compacted by hand in order that the pipe can gain strength from the backfill and to reduce future settlement.

The remaining subsoil is then returned to the trench. On steep inclines, “anti-scour” devices, called water stops, are placed underground across the trench to minimize any potential erosion problems caused by surface water runoff. Sand bags or bentonite plugs are often used. Other typical erosion control measures include the use of diversion ditches, erosion control blankets, and berms on steep slopes. For detail on the hydrostatic testing, refer to Section 2.3.2.

Prior to testing of the line, the working width is restored. The area is sub-soiled using a deep restored line cultivator to alleviate any compaction, and the stored topsoil will then be regraded over the disturbed land. Unless specifically required for further protection, the restoration fences are also removed. The RoW will be seeded and allowed to revegetate. Debris will be transported to an approved disposal site.

The requirement for onshore blasting will not be known until the geotechnical survey slated for the fall of 2002 is completed. If blasting is required, blasting activities will comply with the *General Blasting*

Regulations made pursuant to the Nova Scotia *Occupational Health and Safety Act*. Blasting will also be conducted in accordance with the Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters (Wright and Hopky 1998).

A temporary pipeline supply base will also be required, prior to and during offshore pipeline installation. A waterfront site of approximately 15 to 40 ha will be required, including wharfage with sufficient water depth, close proximity to the pipeline route, and good access to road or railway systems. The site will likely include warehouse space, repair and maintenance facilities, offices, and a pipe-coating and laydown yard. A wharf approximately 300 m long would be needed to enable simultaneous loading and unloading of pipe supply barges and supply vessels. This existing facility will be similar to the Sheet Harbour facilities used during the SOEP Tier I.

2.3.4 Development Well Construction

Development wells will include six production wells and one injection well, which will be located on the wellhead platform. A jack-up drilling unit will be used to drill the wells from the wellhead platform. A jack-up drilling unit is a mobile offshore drilling unit (MODU) that has legs that can be jacked up or down. Once towed to the site, the legs are jacked down until they are in contact with the seafloor, then the rig platform is elevated until it is approximately 25 m above the water surface. A jack-up drilling unit will be positioned beside the new wellhead platform to drill the development wells required for the Project. The jack-up drilling unit will remain on location during drilling and completion operations and then be removed. Development well construction is expected to take approximately 450 days in total to complete.

The normal drilling program for all Deep Panuke wells involve conventional hole and casing/pipe sizes. All casing designs are based on CNSOPB *Offshore Petroleum Drilling Regulations*. Additional information on casing design and drilling program is contained in the Development Plan (DPA Volume 2).

For the new wells drilled from the platform, the conductor pipe (first string of pipe) will be set approximately 75 m below the seafloor using the “Drill and Drive” procedure. The “Drill and Drive” procedure is used to set conductors on platforms where the seabed is unconsolidated and would wash away if the conductors were drilled into place. In addition, the driving of conductors becomes an efficient method to install conductors on a platform (compared to exploration), since the conductors are guided to the seabed through the jacket. The transfer of energy applied to the surface is effectively transmitted to the bottom of the pipe to allow penetration into the soil.

The soil plug on the inside of the driven pipe is removed by drilling and washing the soil back to surface using seawater. Viscosifiers (polymers) may be added to the seawater to help with the washing of the soil. This soil is discharged overboard at the seabed. The amount of soil removed is equal to the volume inside of the 610 mm conductor pipe.

The conductor pipes will be installed after the wellhead platform has been installed and will serve as the primary weather barrier to take environmental loading and protect the inner strings of casing (length of pipe). The conductors also take the surface loading implied by the other strings of casing that are returned to surface in the pressure-containing wellhead located on the platform. All wells will set surface casing into the Wyandot member (refer to Figure 2.1) at approximately 900 m below the seafloor in the general direction that the bottom of the well will be located (refer to Figure 2.8).

For the production wells drilled into the Abenaki formation, once the surface casing is set in the Wyandot, the intermediate hole section will be drilled. The blow-out preventers (BOPs) will be installed (similarly with the injection well) and the well will be drilled to just above the Abenaki formation (3,450 m TVD). The well will be directionally drilled to correctly position the wellpath to enter the reservoir in the desired location. A production casing string will be set at this point. Additional equipment will be installed in preparation for Annular Velocity Control (AVC) drilling techniques, and the main hole section will be drilled through the productive interval of the carbonate reef. A liner (string of pipe) will be installed in this main section that will be drilled as a near-horizontal wellbore through the top of the Abenaki formation. In similar fashion to the injection well, the production well would be completed with a downhole packer (plus other ancillary downhole equipment), production tubing, surface controlled subsurface safety valve, a tubing hanger and a production tree. Once all hydrostatic tests and function tests are performed, the injection and production wells will be ready for operation.

It is currently planned to inject the surplus condensate with the acid gas into the one injection well that will be drilled from the new wellhead platform. Injection pumps on the main production platform will be used to pump the condensate down the well at the required pressures for injection into the downhole disposal zone.

The injection well for condensate and acid gas will be drilled into a porous and permeable zone. The impermeable shales located directly above the potential intake zone will prevent any migration of injected acid gas or condensate. The selected zone will be capable of containing the entire acid gas and surplus condensate volumes that will be produced over the life of the Project. The zone will be selected to ensure no breach of injection fluids to surface, either through another wellbore or annulus, or through a fracture within the rock. This zone will also ensure that existing and future wells in the area will not be compromised by this injection well. Suitable formations for disposal of acid gas and condensate are currently being investigated. This zone will be located in either the lower part of the Logan Canyon, the "P" sands or in the Missasauga sands.

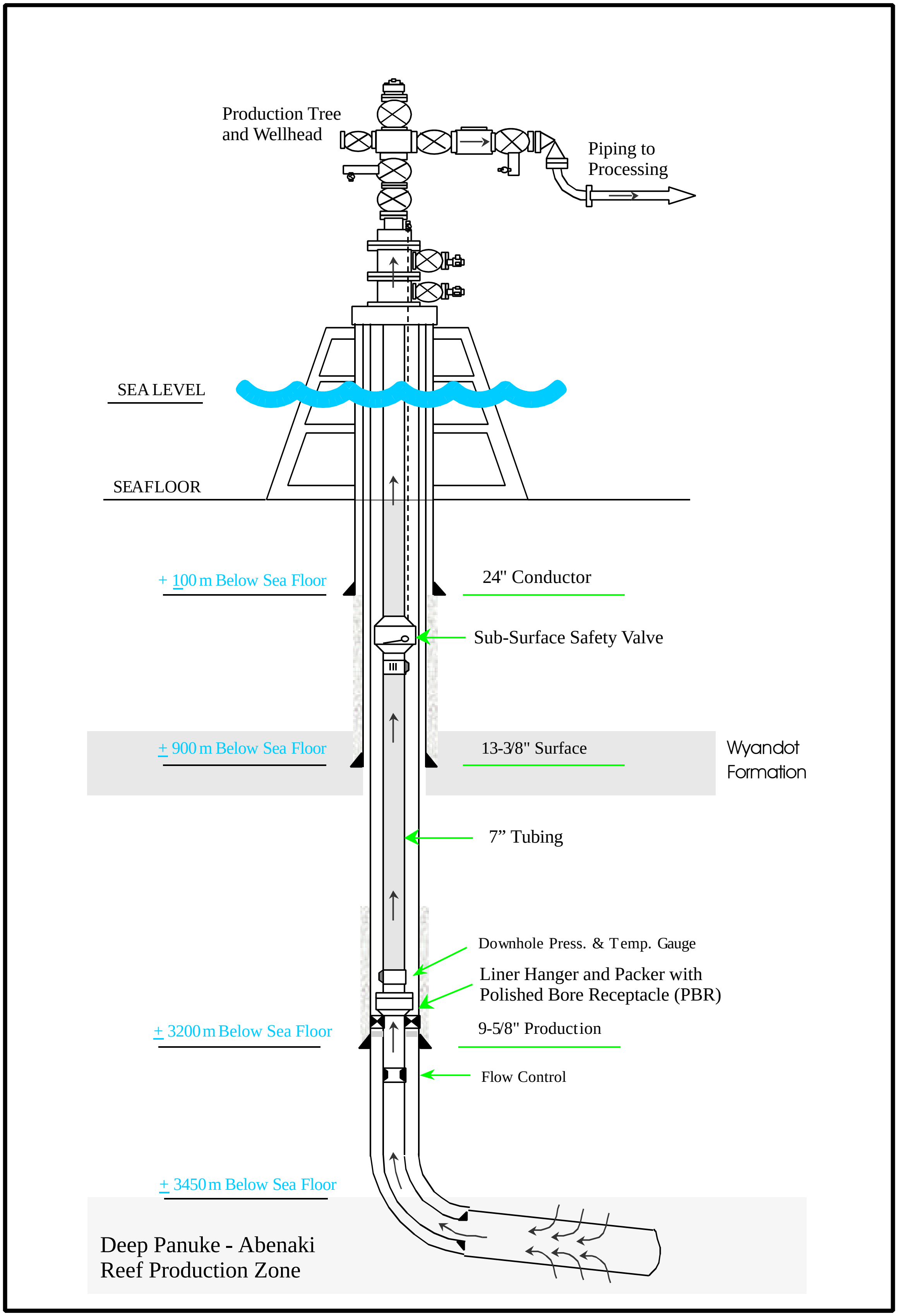

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Figure 2.8 Typical Production Well Schematic

Figure 2.9 provides a schematic of the injection system. The injection well will likely be drilled using a 216 mm bit and a 245 mm x 178 mm casing string. The well will then be completed as an injector using a downhole packer (internal barrier), 89 mm injection tubing string, a surface controlled subsurface safety valve (fail-safe closed emergency internal barrier), a tubing hanger and injection tree (internal surface barriers).

Water-based muds (WBM) and oil-based muds in the form of synthetic oil-based muds (SBM) or enhanced mineral oil-based muds (EMOBM) will likely be used in development drilling. These muds are used to protect and clean the drill hole, for overbalancing formation pressures, and for bringing cuttings to the surface. The selection of the drilling fluid is based on factors, such as the hole angle, the formation types drilled (*e.g.*, mudstone, sandstone, clays), and the time of exposure. An ongoing borehold stability study will provide additional information on the critical parameters that outline the selection process.

Oil-based muds can have a base fluid of either synthetic oil (for SBM) or enhanced mineral oil (for EMOBM). WBM is a suspension of solids and dissolved material in a carrier base fluid of water (refer to Table 2.1 for typical constituents). WBM tends to be used for wells that exhibit little deviation or do not encounter difficult geology. SBM/EMOBM increases the cohesiveness of the mud associated with cuttings and provides superior formation inhibition for improved drilling efficiency.

Table 2.1 Typical Composition of Drilling Muds for Deep Panuke

Water Based Mud (Seawater Gel Mud Type)	**Oil Based Mud (Synthetic Based Mud or Enhanced Mineral Oil-Based Mud)**
Barite	Base Fluid[1]
Bentonite	Water
Potassium Chloride (KCl)	Emulsifiers
Polymers	Calcium Chloride
Water	Lime
Glycol	Barite
Soda Ash/Sodium Bicarbonate/Lime	Fluid Loss Additive
Caustic Soda	Oil Wetter
Salt (Sodium Chloride or Calcium Chloride)	Viscosifiers

[1]Base fluid will be Enhanced Mineral Oil (as in EMOBM) or Synthetic Based Mineral Oil (as in SBM).

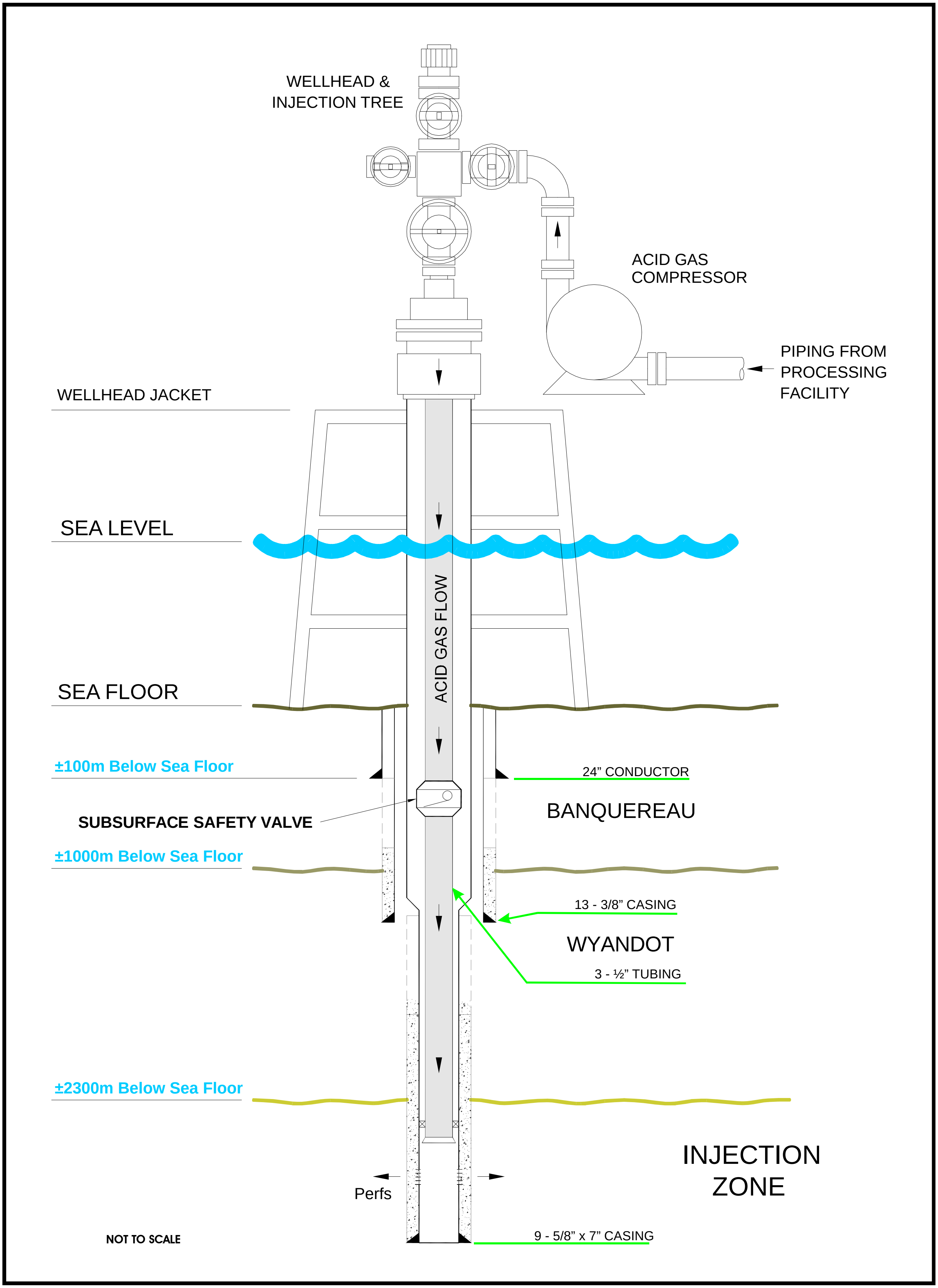

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Figure 2.9 Typical Acid Gas Injection Well Schematic

There are three hole sections for each well (as previously noted) below the 610 mm conductor, each of which has different mud-type requirements: surface hole section (from seabed (± 75 m below the sea floor (BSF)) to the Wyandot formation (± 900 m true vertical depth [TVD] (BSF)), intermediate hole section (from the Wyandot formation to the top of Abenaki formation), and the main hole section (from the top of the Abenaki formation to the production zone (± 3400 m TVD BSF)).

WBM will be used to drill the surface hole for several reasons. The hole angles of the top sections will likely not be extremely high so the inhibition provided by SBM/EMOBM is not required. The hole section drills very quickly, so again the higher level of inhibition is not required. But most importantly, the potential for surface (seafloor) break-through of the drilling fluid while drilling this hole section is fairly significant. From an environmental and economic perspective, this break-through would be unacceptable. For the intermediate section, WBM or SBM/EMOBM will be used. The drilling fluid for the intermediate hole will be selected based primarily on hole angle, formation types drilled, and time of exposure. The selection of the drilling fluid will be finalized during detailed design. Finally, for the main hole section, WBM will be used in case Annular Velocity Control (AVC) drilling with total mud losses is required.

EnCana intends to use WBM where it is technically practical, and only use SBM/EMOBM where hole conditions (*e.g.*, higher hole angles for longer reach directionally drilled wells) otherwise warrant. However, it seems very unlikely that WBM can be used for the intermediate hole sections for all wells.

During drilling, the mud is circulated down the drillpipe from the drilling unit to the bottom of the wellbore and returned to the drilling unit in the annular space (between drillpipe and open hole/casing) carrying the cuttings from the well. Each hole section of a wellbore requires different fluid properties for the mud. Thus after each hole section, the mud is modified or changed out. WBM that is no longer required will be disposed of overboard, along with WBM cuttings, in accordance with the Offshore Waste Treatment Guidelines (OWTG) (NEB *et al.* 1996, and updates). If SBM/EMOBM is used, it is returned to the shore base for reconditioning or disposal. SBM/EMOBM cuttings will not be discharged overboard, but instead will be disposed of by one of the following practices:

- injection into a disposal zone, through either annular injection or a dedicated well; or
- onshore treatment and disposal through skip-and-ship methods at an approved facility.

Refer to Section 2.7.4 for further information on drill waste management.

During well testing and cleanup, the reservoir gases and liquid are processed on a small scale temporary process unit on the drilling rig and gas and liquid products burned using the flare on the drill rig. These tests are conducted prior to and separate from the production process.

Through the life of the field, workovers will be required in the wellbores. These workovers will require various pieces of equipment to be sent offshore to perform downhole work. Completions brines may be used during these processes. These brines would be composed of water and a salt formulation kept in suspension using a viscosifier (polymer).

2.4 Operations

2.4.1 Production

Production facilities will be operated to optimize production, while maintaining environmental protection and high safety standards and minimizing environmental impact. The production facilities will be staffed on a 24-hour basis. Facility maintenance and inspection requirements will be managed through a maintenance management system that will incorporate proactive and predictive methods, as well as intelligent condition monitoring techniques.

Production facilities will consist of equipment for separation, metering, amine sweetening, acid gas injection, dehydration, hydrocarbon dewpoint control, produced water treatment and disposal, condensate treatment for fuel, surplus condensate injection, compression, and utilities. A simplified process flow diagram is presented as Figure 2.10.

All production and treatment facilities are located offshore. The sales gas entering the export pipeline will be "on specification" gas meeting the hydrocarbon dewpoint and water content requirements for the M&NP pipeline. As a result, there is no onshore treatment (such as glycol recovery) required. Onshore facilities are related to metering and isolation valve requirements only.

2.4.1.1 Separation

The well fluids will be processed through the production or test separator for separation of the gas, condensate, and water.

2.4.1.2 Metering

The production and test separator's individual streams are metered for reservoir management purposes as per CNSOPB regulations.

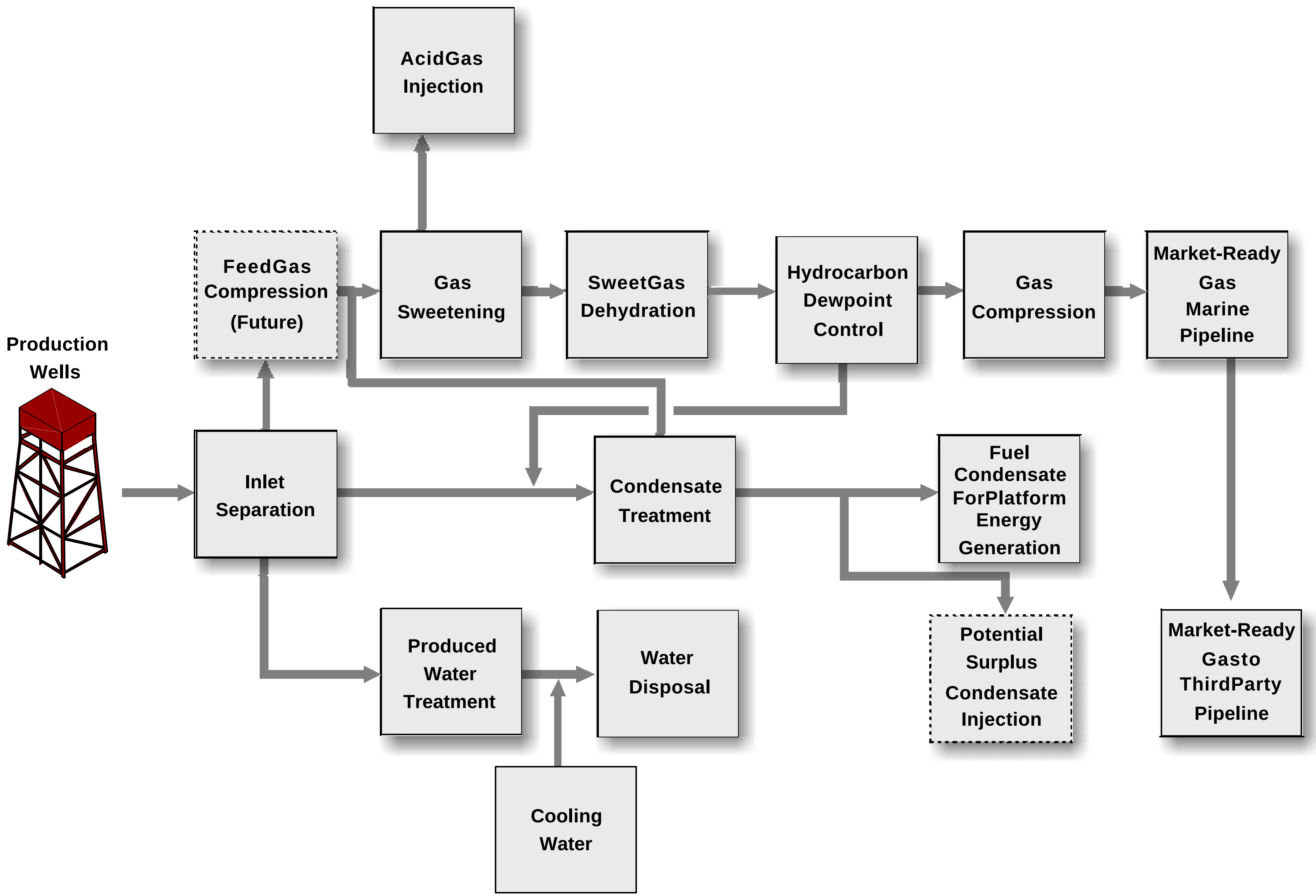

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Figure2.10 SimplifiedProcessFlowDiagram

2.4.1.3 Amine Sweetening

The amine sweetening system is designed to remove the H_2S contained in the raw gas. The removal of the H_2S and CO_2 from raw gas results in a waste acid gas stream predominantly containing H_2S and CO_2.

While the Deep Panuke gas contains up to 3.6 mole% CO_2 and approximately 2,000 ppm H_2S, the amine sweetening unit is designed to be fed with gas that contains up to 3,000 ppm H_2S and up to 3.7 mole% CO_2. The sales gas specification requires the H_2S content to be a maximum of 6 mg/m^3 (approximately 4 ppm) and 3.0 mole% CO_2. The current design basis unit outlet is for an H_2S level of 2 ppm and CO_2 at 2.8 mole%.

The amine-sweetening unit is based on physical absorption using a solvent to absorb the impurities (H_2S and CO_2). The solvent is then regenerated via heating to release the absorbed impurities. The process is cyclic, in which the amine is continuously circulated through the absorber/contactor to pick up the impurities, then routed to a regenerator to release the impurities. A brief description of the process follows.

The rich gas (high H_2S and CO_2) from the amine feed filter coalescer is fed to the amine feed gas superheater, where approximately 4^{o}C superheat is added to the gas. The heated gas is then fed into the amine contactor and contacted with a lean amine solution fed into the contactor by the second stage amine pump. The treated gas leaves the top of the column and the rich amine leaves the bottom of the column. The liquid is then flashed across a level control valve into the flash gas drum. The gas flashed off is routed to the stabilizer overhead compressor to join with main process gas flow. The rich amine from the flash gas drum is fed via level control through the rich amine filter and the amine regenerator feed/effluent exchanger to the regeneration tower.

The sour gases are driven off from the amine in the regenerator tower. The overheads from the regenerator column are cooled in the regenerator overhead condenser, and then the vapour and liquid are separated in the reflux drum. The acid gas is fed via pressure control to the acid gas injection compressor unit. The cooled liquid is fed back into the regeneration column by the regenerator reflux pump via level control from the reflux drum. Liquid is fed from the bottom tray of the regenerator into the reboiler. The rate of liquid and vapour return depends on the flow of heating medium through the reboiler, which is controlled to achieve the desired regenerator overhead temperature, thereby giving a suitable lean amine product.

The lean amine stream is taken from the bottom of the column, and through the regenerator feed/effluent exchanger and the lean amine cooler into the lean amine surge drum. The lean amine flowrate through both exchangers is determined by a control valve positioned upstream of the cooler based on the level of liquid in the regenerator column.

Lean amine is fed from the surge drum to the first stage amine pump feeding the second stage amine pump, the lean amine cartridge filter, and charcoal filter. The flow through the second stage amine pump is via flow control to the amine contactor. The remaining "slipstream flow" through the cartridge filter and charcoal filter is the remaining capacity of the first stage amine pump. A bypass around the filters is provided for start-up, *etc.*, when the slipstream flow is high as flow to the contactor and absorber is low.

Residual waste not removed during the amine sweetening process (CO_2, H_2S) remains in the sales gas, which is sent to market. The amine-sweetening unit is a closed loop system.

The amine solvent used in the sweetening unit will either be Methyldiethanolamine (MDEA), or a sterically hindered version of MDEA, which will improve the selectivity between H_2S and CO_2 absorption. The cyclic process can result in a build up of impurities in the amine solvent over time. If the amine solvent requires a change, whether complete or partial (dilute out the impurities), it is removed from the process and shipped to shore for reclaiming (manufacturer to clean and recycle).

2.4.1.4 Acid Gas Injection

Acid gas from the amine regenerator is compressed to approximately 15,000 kPa using a multistage compressor. Water condensing between the compression stages is recycled back to processing facilities. The compressed acid gas is injected into a suitable, subsurface reservoir. Table 2.2 describes the design flow and composition for the acid gas injection system. Figure 2.9 provides a schematic of the injection system.

Refer to Section 2.3.4 for details on the injection well.

Table 2.2 Acid Gas Injection System – Composition and Flow

Description	Design Data
Mass Flow (kg/h)	12180
STD Gas Flow (m^3/hr)	7325
Molar Flow (kgmole/hr	307
Pressure (kPa)	200
Temperature (C)	45
Component Mass Fraction (%)	
CO_2	78.02
H_2S	17.30
Cl^+	1.41
H_2O	3.24
Note: The flow represents the total feed to the acid gas management system including acid gas from the amine system and H_2S removed from the condensate fuel.	

2.4.1.5 Dehydration

Sweet gas from the amine-sweetening unit contains water which must be removed. The gas dehydration unit is a liquid desiccant process utilizing a solvent to absorb the water. The solvent, triethylene glycol (TEG), is then regenerated via heating to release the absorbed water. The process is cyclic in which the TEG is continuously circulated through the absorber/contactor to pick up the water then routed to a regenerator to release the water. A brief description of the process follows.

Treated gas from the amine unit is routed to the TEG system for dehydration. The gas is first routed to the TEG contactor, in which the incoming gas flows counter current to the lean TEG. The lean TEG absorbs the entrained water in the gas stream and reduces the water content of the gas.

The rich TEG leaving the contactor cools the regenerator overheads and is routed to the TEG flash drum. The flashed gas from the flash drum is routed to the flare. The flash drum liquids then pass through the TEG charcoal filter (to remove trace hydrocarbons) and the TEG filter (to remove charcoal) before being heated in the TEG regenerator feed/effluent heat exchanger before entering the regenerator.

The bottoms of the regenerator are heated to remove the water from the rich TEG. A small amount of stripping gas is used to enhance the water removal of the regenerator. The regenerator overheads are cooled for tower top temperature control, with the overhead gas stream being routed to the flare boom. The gas stream is partially condensed by cooling within the flare system.

The water removed from the sweet gas dehydration process is removed from the top of the TEG regenerator in the overhead gas stream and routed to the low-pressure (LP) flare header. A large portion of the water in the overhead gas stream will condense in the flare piping or drum. The flare drum liquids will be pumped into either the inlet or test separators and the water portion of the liquids in these separators is routed to the produced water treating facilities. Non-condensable hydrocarbons will be flared.

The lean glycol leaves the regenerator column, enters the TEG surge drum, then is cooled in the TEG regenerator feed/effluent heat exchanger. The lean TEG is further cooled in the lean TEG cooler (cooling medium cooler) before entering the TEG contactor.

The dry gas from the TEG contactor passes through a coalescer to reclaim any entrained TEG leaving the contactor in the overhead gas stream. The TEG is returned to the flash drum. The dehydration process is a closed loop system. The circulating TEG builds up contaminants, primarily salts. Once the levels build to a point, the risk of corrosion and or deposits increase to the point where removal of some/all the TEG is required and new TEG added. Rate of build up varies with the feed quality, so it is difficult to predict how long before this happens.

Spent TEG has no measurable H_2S and will be disposed of at an approved facility.

2.4.1.6 Hydrocarbon Dewpoint Control

Sweet gas from the TEG system is cooled via the Joules-Thompson (JT) effect by dropping the pressure of the gas. A portion of the gas stream condenses (condensate) and is then separated. This step is necessary to satisfy pipeline gas specification requirements.

2.4.1.7 Produced Water Treatment and Disposal

Formation water removed with raw gas and separated during the initial stages of processing is called produced water. This water contains residual hydrocarbons and other contaminants that must be removed to acceptable levels prior to ocean discharge. Produced water was not available for testing when the Deep Panuke discovery was made. The information on the constituents in produced water was derived through water chemistry modeling of water from the nearby Musquodoboit formation and interpreted by EnCana's geo-chemists for application to the Deep Panuke design.

Table 2.3 summarizes the produced water chemistry from the Musquodoboit Wildcat drill stem tests (Temp. 120°C, 37 Mpa, CO_2 3.5% (gas), H_2S 2,000 ppm (gas), Density 1.067 (96,933 mg/L TDS).

Table 2.3 Produced Water Chemistry from Musquodoboit Drill Stem Test

Property	Average	Property	Average	Property	Average
Ca ions	5,070	CaCO3 ions	1.11 e-5	MgOH ions	0.05
Mg ions	523	CaHCO3 ions	0.085	MgSO4 ions	5.37 e-4
Na ions	26,050	CaOH ions	0.012	NaCl ions	0.08
Cl ions	54,688	CaSO4 ions	0.003	NaCO3 ions	5
SO4 ions	1,871	H_2CO3 ions	0.11	NaHCO3 ions	0.003
HCO3 ions	781	CO3 ions	0.024	Na2CO3 ions	2.95 e-8
H ions	0.014	HS ions	22.6	NaSO4 ions	1440
OH ions	0.0035	S ions	1.23 e-9	NaHS ions	6.36 e-5
Ba ions	5.3	HSO4 ions	0.73	SrOH ions	1.42 e-4
Sr ions	395	KCl ions	0.02	SrCO3 ions	1.2 e-7
H_2S ions	0.015	KCO3 ions	0.02	SrHCO3 ions	149
BaCO3 ions	1.04 e-10	KHSO4 ions	8.5 e-6	SrSO4 ions	2.97 e-5

Table 2.3 Produced Water Chemistry from Musquodoboit Drill Stem Test					
Property	**Average**	**Property**	**Average**	**Property**	**Average**
BaHCO3 ions	2.1	KSO4 ions	95.6	$CaCl_2$ ions	0.006
BaOH ions	1.5 e-6	MgCO3 ions	4.6 e-7	pH	4.94
BaSO4 ions	1.32 e-7	MgHCO3 ions	58.3		
All units are in mg/L, with the exception of pH.					

It is appropriate to use the Musquodoboit formation water sample as a surrogate because the Musquodoboit well was drilled close to the Deep Panuke reservoir structure. It was drilled into a similar formation which, based on EnCana's interpretation of seismic data and exploration drilling results, appears to be a continuous connection at a deep formation level to Deep Panuke. Therefore, it would have similar formation water. Formation water from the Deep Panuke reservoir will be collected during drilling of the production wells and submitted for chemical analysis. The produced water treatment and disposal system will then be reviewed to ensure the system addresses the specific constituents found in the Project's formation water.

Table 2.4 predicts the produced water production rates as indicated by the current production profile.

Table 2.4 Produced Water Production Rates			
Year	**Cumulative Water Production**	**Water Production Rates**	
	(m^3)	**(m^3/day)**	**(m^3/hr)**
0	39,069	107	4.5
1	303,183	724	30.2
2	666,898	996	41.5
3	1,059,170	1075	44.8
4	1,346,411	787	32.8
5	1,564,535	598	24.9
6	1,730,362	454	18.9
7	1,857,557	348	14.5
8	1,958,034	275	11.5
9	2,033,020	205	8.6
10	2,094,427	168	7.0

Treated produced water will be discharged overboard according to the OWTG (NEB *et al.* 1996, and updates). The following is a brief description of the treatment process.

Water from the inlet separator, test separator, condensate stabilizer surge drum, and stabilizer feed filter coalescers is commingled together and routed directly into the produced water feed drum. Water from other LP vessels is typically routed to the closed drains header, which is routed to the LP flare drum. Liquids from the LP and high-pressure (HP) flare drums are routed to either the inlet or test separators.

The function of the water feed drum is to hold produced water until sufficient volume is available to route to the hydrocyclones. The small amount of gas from this drum is routed to the flare. At the start of the field life, the water rates are anticipated to be very low, such that batch processing in the hydrocyclones is likely. As the water rates increase, the flow will be continuous.

The hydrocyclones will remove all but trace amounts of liquid hydrocarbons. The hydrocyclones oil outlet is routed to the closed drains. The water is continuously routed to cartridge-style produced water polishers to further reduce trace amounts of liquid hydrocarbons.

The water is then heated in the produced water stripper feed preheater prior to entering the produced water stripper. The amount of heat will be adjusted to aid in the H_2S removal capabilities of the stripper tower. The produced water stripper tower is a packed counter current gas/liquid stripping column in which sweet fuel gas flows upwards counter current to the water to remove H_2S. The gas from the stripper is routed to the acid gas injection compressor. The flow to the stripper column will change dramatically over the field life. It may be necessary to provide flow via recycle, or process in batches, during low flow periods.

Preliminary indication suggests that the produced water stripper will be a packed counter-current gas/liquid stripping column in which sweet fuel gas flow upwards counter-current to the water to remove H_2S to a concentration of 1 to 2 ppm. A similar approach, although using steam as a heat and vapour source, is used in land-based gas plants and/or refineries. Offshore platforms typically do not have steam, so sweet gas is used for stripping and either a pre-heater or a reboiler is used to heat the water. A brief description of this application can be found in the Fractionation and Absorption section of the *Gas Processors Suppliers Association Engineering Data Book*.

The water outlet of the stripper is then sampled for oil and H_2S and routed overboard. No waste gases from the stripping unit will be flared. The waste gas from the produced water stripper will be routed to the acid gas injection compressor for injection. This will be the normal mode of operation. The plant does have the capability to divert the produced water stripper gas to the flare boom in the event of a malfunction of the acid gas injection well. If the produced water stripper gas were flared, it would be approximately 350 kg/h of 20.1 MW gas containing 2.0 mole% H_2S.

The concentration of amine in the produced water will typically be in the range of 40 to 75 ppm. The ppm range in the first year only could be as high as 400 to 500 ppm due to the relatively small amount of produced water. The concentration of triethylene glycol (TEG) remaining in produced water will typically be in the range of 30 to 60 ppm. Again, the ppm range in the first year only could be as high as 350 to 400 ppm. This is a worst case scenario as it is calculated on the basis that all the amine and TEG process losses are routed to the produced water. There is no treatment for metals.

The concentrations of amine and TEG in produced water at the outlet to the sea are below those concentrations which would impact marine species. Studies on the eco-toxicity of methyldiethanolamine and TEG, undertaken by the manufacturers, indicate that these substances are of low toxicity to fish and invertebrates in the concentrations present in the produced water discharge and that these substances are readily bio-degradeable (Woodburn and Stott, undated). Discharge concentrations will be approximately 100 and 10,000 times (respectively for methyldiethanolamine and TEG) lower than the acute lethal limits (LC50).

Currently the design envisages online oil monitors backed up with platform-based laboratory facilities for verification of produced water measurements.

The produced water will be routed overboard via the discharge caisson, where it will mix with approximately 3,050 m^3/hr of seawater.

2.4.1.8 Condensate Treatment for Fuel

Recovered condensate will be used on the production platform as the primary fuel. In order to minimize air emissions, the residual H_2S in the condensate is removed by heat in the condensate stabilizer. The H_2S thus released is recycled back to the raw gas stream for removal by the amine solution. Condensate will be used as fuel over the life of the Project and will be supplemented with natural gas as necessary to maintain adequate fuel levels.

Condensate production is based on the production profile for the Project. The production profile has been calculated for a range of reservoir gas compositions. The intent is that the platform will be designed for the entire possible range. One end of the range indicates no surplus of condensate (*i.e.*, maximum use of all condensate produced with shortfall made up with fuel gas). The other end of the range (surplus case) projects a surplus for the first number of years as per Table 2.5.

Table 2.5 Surplus Condensate		
Year	**Surplus Case**	
	Production (m3/day)	**Surplus (m3/day)**
0	392.4	143.8
1	397.7	147.4
2	398.6	148.3
3	382.6	101.0
4	281.8	37.7
5	218.6	11.8

Beyond Year 5, the produced condensate will be used as fuel and the shortfall made up with fuel gas.

It is not envisioned that the gas composition will vary dramatically outside the design range, but there will be emphasis to keep the platform production rates maximized (enhanced reserves and/or additional reserves). As such, the prediction of surplus condensate is subject to change if the gas production does not decline as forecasted.

The design basis for the Project includes the injection of surplus condensate along with acid gas via an injection well. The probability of the acid gas injection well malfunctioning and becoming inoperable is very low (<1%). Any maintenance work for the well would be scheduled during planned shutdowns. If the injection well becomes unavailable at any time, additional condensate can be consumed through the operation of "spare" fired turbine equipment or spare compressor. As well, the production could also be turned down to reduce the amount of condensate produced, and as a result, to reduce the condensate surplus (*i.e.*, reducing the plant rate to match fuel consumption with production). There is no capability to flare condensate with this Project.

The production platform will have some minimal storage for condensate. This storage amount, approximately 55 m^3, represents approximately five hours of consumption at full rate. The intention of this amount is to cover periodic production upsets with enough time to allow for short term troubleshooting and/or swinging fuel from condensate to either fuel gas or diesel. The storage tank is a pressure vessel that is pressured with inert gas with excess pressure routed to the flare.

2.4.1.9 Compression

The sales gas is compressed on the platform for delivery to shore. The expected sales gas discharge pressure on the platform is 13,000 kPa requiring a maximum of approximately 18 MW compression power. To account for the declining reservoir pressure in later years, a maximum of approximately 9 MW of feed gas compression is anticipated. The compressor system is expected to consist of three units, two in sales gas service and one in feed gas service.

2.4.1.10 Utilities

Electrical power generation for the Project platforms will be provided by multiple redundant tri-fuel turbine generating sets. For the first production start up, sufficient quantity of diesel will be available for power generation. Battery back-up will be provided for essential services.

Condensate will be used as platform fuel. Fuel gas will be used as a supplemental fuel source, as condensate production declines. Cooling water for process and utility systems will be done via an indirect seawater/cooling medium system. Seawater will be pumped through a filter then a heat exchanger. The exchanger will cool a mixture of ethylene glycol and water (cooling medium). The cooling medium will then be distributed to the equipment and the plant requiring cooling.

During construction and installation, deck drainage will be discharged overboard. Deck drainage water might contain traces of petroleum hydrocarbons, such as lube oils, helicopter fuel, and diesel fuel. Every effort will be made to prevent chemical contamination on decks, which could be entrained into deck drainage. Storage areas for totes containing chemicals and petroleum products will have secondary containment to prevent discharge onto deck surfaces.

During the operation phase, deck drainage will be collected and treated according to the OWTG (NEB *et al.* 1996, and updates). Drainage from equipment areas on platforms will be directed through a header system to a collection tank to an oil/water separator treatment unit on the production platform. Petroleum hydrocarbons and sludge in the oil/water separator will be transferred into containers for shipment to shore for disposal. The water from the oil/water separator will be treated using cartridge-style water polishers and tested prior to discharge to ensure compliance with the discharge criteria of 15 mg/L or less. The deck drainage system does have overflows to permit water to be routed directly overboard in the event of a deluge event or rain water in excess of the design condition.

Emergency power will be provided by a diesel engine as per CNSOPB regulations. The platform design requires the use of diesel fuel for emergency situations (emergency generators, firewater pumps), for certain start up scenarios (*i.e.*, when buy back gas is not available), and for certain maintenance scenarios (*i.e.*, power generators when no buy back gas is available). Currently, the facility has two 75 m^3 diesel tanks.

The transfer of diesel from ships to these two tanks will occur via loading hose. Bulk transfer/hose-handling procedures will be outlined in the EPP.

2.4.1.11 Relief, Fire Protection and Safety Systems

Safety systems and devices will be designed to meet Project standards and the requirements of all applicable standards and codes and local regulations, including:

- API B31.3 – Piping,
- API 14C – Cause and Effects;
- API 520, 521 – PSV's/Rupture Discs;
- IEC 61508 – Functional Safety System;
- ANSI/ISA-84.01-1996 – Safety Instrumented Systems;
- NFPA 72E – Automatic Fire Detectors; and
- NORSOK-1-002 – Safety and Automation System.

In all instances, local regulations will be met unless exceptions are sought for alternatives that will provide an equivalent level of safety.

The principal elements of the relief and blowdown system include the pressure relief devices, flare piping system, flare separator, flare boom and the flare system. The flare will be located on a 70 m flare boom installed at 45 degrees from the production platform. This configuration will place the flare tip at an elevation of approximately 50 m above the weather deck and 50 m outboard of the platform, approximately 92 m above the sea surface. The flare design will be refined during detailed design. Application of all relevant codes will be followed for the system design. The system will be designed considering blocked discharges, fire exposure, tube rupture, control valve failure, thermal expansion and utility failures.

The Project will include an inert gas system. Inert gas is necessary for commissioning and start-up exercises, as well as ongoing operations. The inert gas may also be used as a blanketing or purging gas to displace hydrocarbon vapours and reduce the risk of explosion and fire.

Instrument air will be used in the instrumentation and control systems. A breathing air system will be included in the design of the Project. Breathing air will be required for emergency purposes and for routine maintenance activities.

Refer to Section 2.9 for more information on environmental and safety protection systems.

2.4.2 Support and Servicing

Supply vessels and helicopters will be used to supply personnel, fuel, food, well construction equipment and other materials required to maintain production, construction, and well construction operations. Typically, helicopters will be used for regular crew changes, visits from regulatory agencies, service personnel and other visitors that need to be transported to and from the offshore facilities.

2.4.2.1 Support Vessels

Supply vessels will be used to provide the platform operations with materials. Supply vessels will hold liquid drill mud, drill water, potable water, barite (weighting material), fuel, cement, bentonite (fresh water gel), drill pipe, casing and various equipment necessary for well construction operations, production operations and construction. It is anticipated that supply vessels will make periodic round trips from a dockside shorebase in Nova Scotia to the platform operation between two and four times a week during normal operations. It is anticipated that there will be approximately six trips a week during construction and heavy maintenance periods. In addition, a standby vessel is required near the platform at all times as per CNSOPB regulations.

2.4.2.2 Helicopters

Personnel will be transported to and from the offshore facilities via helicopters from the heliport located at the Halifax International Airport. During pipelay and heavy lift activities, the frequency of helicopter activity is estimated to be two to three trips per week. During hook-up and commissioning, the frequency is estimated to be seven to ten trips per week. The frequency will reduce to approximately six to ten flights per month during operations. These helicopters are used primarily to transport crew members, company personnel and service personnel. In some cases, small equipment and parts are transported via air transportation.

2.4.3 Project Safety Zones

EnCana will consult with the appropriate regulatory authorities to develop a safety zone around the Deep Panuke facilities in accordance with the *Nova Scotia Offshore Petroleum Drilling Regulations* and the *Nova Scotia Offshore Area Petroleum Production and Conservation Regulations*. This zone will most likely be a 500 m zone around the perimeter of each of the three jackets and also take into account a temporary 500 m overlap from the drilling rig when it is on location. A Notice to Mariners will be issued and appropriate mariner charts will be updated for the installations through the Canadian Hydrographic Service.

Standard operating procedures would be developed to lessen the risk of collisions between ships and Project infrastructure. These would include, but are not limited to, the following:

- presence of structures and safety zones would be indicated on nautical charts;
- Coast Guard Notice to Mariners would apply during construction; and
- radio operators would notify approaching vessels of the presence of the structures. The distance at which mariners would be notified would be dependent on a number of factors, including the direction and speed of the approaching vessel and weather conditions.

Although there are no regulations under the CNSOPB that provide a similar safety zone around a pipelaying vessel, EnCana will be issuing a Notice to Mariners with regard to this temporary construction activity. Mariners will be informed as to the status of the pipelaying operation and the vessels taking part in the activity. The pipeline's design takes into consideration fishing activity in the area so that once the pipeline is laid, there will be no restrictions with regard to safety zones over the pipeline. As with the installation, the Canadian Hydrographic Service (CHS) charts will be updated for the pipeline through the CHS.

Details of these procedures will be developed as part of the standard operating procedures for the Project. In addition, EnCana has an Alert/Emergency Response Contingency Plan (AERCP) on file with the CNSOPB (refer to Section 4). One aspect of this Plan is collision avoidance and procedures for communication with vessels. Standard procedure for collision avoidance is to determine the current location, direction of travel and speed of the approaching vessel and then to track the vessel if the direction of travel is towards the platform. EnCana will contact all vessels in the vicinity of the platforms to inform them of Project operations and explain the 500 m safety zone surrounding the platform. The AERCP would also address response to the unlikely event of a collision.

2.4.4 Onshore Facilities

In addition to the onshore pipeline, other onshore facilities will include metering and quality monitoring equipment, temporary pig receiver facilities, a SCADA system, and a small building required for SCADA and metering. Periodic mechanical, electrical, instrumentation and general housekeeping maintenance will be performed. For example, valves, piping, or general lighting will require routine maintenance. Site visits will take place on a weekly basis.

EnCana will take care to avoid use of invasive species in post-construction revegetation efforts and will place a clear priority on the use of native species. Vegetation on the pipeline RoW and around above-ground facilities will be cut periodically using mechanical means.

2.5 Decommissioning and Abandonment

The production life of the Project is anticipated to be 11.5 years, with a design life of 25 years. Facility life could be extended beyond 25 years with appropriate technical and maintenance activities in the event reserve productivity or additional reserves prolong the life of the Project.

The following facilities will require decommissioning and abandonment:

- production platform;
- wellhead platform;
- utilities and quarters platform;
- production and injection wells;
- subsea pipeline;
- onshore pipeline; and
- onshore facilities.

Decommissioning and abandonment of these facilities will be performed in accordance with the regulatory requirements applicable at the time of such activities. An action plan for decommissioning will be submitted to the appropriate authorities for approval prior to commencement of decommissioning and abandonment activities.

Requirements for eventual removal of facilities will be taken into account during the design. Abandonment of the offshore platforms and jackets is currently anticipated to include cutting off the jacket legs and/or piles below the seafloor and transporting the jackets and platforms to a suitable site for recovery and disposal. The potential presence of contaminants that could be encountered during recovery and transportation of the facilities will be taken into account. Potential reuse of the platforms and jackets will be considered on an economic basis.

Wells and pipelines will be abandoned in compliance with applicable drilling and offshore regulations and according to standard industry practices.

Onshore facilities will be removed and the land restored in accordance with applicable regulations. Buried onshore pipelines will be flushed, capped and abandoned in place. The onshore pipeline RoW will be allowed to return to its natural vegetated state by natural succession. Any aboveground structures associated with onshore pipelines will be removed. A Decommissioning Plan will be developed for the Project, which will provide detailed procedures for decommissioning onshore facilities.

2.6 Project Schedule

The Project completed the FEED study as of June 30, 2002. This initial phase of the Project will be followed by detailed engineering and procurement. Subsequent onshore fabrication at existing facilities will occur prior to installation offshore.

The onshore pipeline and facilities will be installed over a four-month period prior to the summer of 2005. The schedule of the pipeline installation and associated clearing will be finalized in keeping with the overall Project timelines and also with mitigation measures for onshore construction as outlined in Section 6 of the CSR.

Offshore installation will begin with the wellhead platform being installed in late spring/early summer 2004. The offshore pipeline will be installed in the summer of 2004. The utilities/quarters platform and production platform will be installed during summer 2005.

In terms of the pile driving associated with the Project, there are a total of sixteen piles to be driven. There are four piles for the wellhead platform and each will take approximately four to six hours to drive within an overall period of approximately one to two days. This is also the case for the utilities/quarters platform, which also has four piles. There are eight piles for the production platform and each will take approximately four to six hours to drive within an overall period of approximately two to three days.

Development well construction is expected to take approximately 450 days in total to complete. The pipeline tie-ins will be carried out during summer 2005. Commissioning for the Project will take place the fall of 2005. First gas is anticipated to be produced in the fall of 2005.

Mitigation measures with respect to timing of construction activities for the Project will be followed to the extent possible, unless there are vendor/supplier constraints which affect schedule. Where vendor/supplier constraints conflict with mitigation measures described herein, EnCana will work with applicable regulators in order to minimize environmental effects.

2.7 Emissions and Discharges

EnCana will adhere to the OWTG (NEB *et al.* 1996, and updates) and all applicable regulations for emissions and waste management. Where no standards exist, best industry practice will be adopted where feasible. EnCana will minimize, to the extent practical, both the volumes of wastes being discharged and the concentration of contaminants entering the environment. A Waste Management Plan (WMP) will be developed for the Project that will address all phases of the Project including construction, installation, operation, decommissioning, and abandonment. The goal of this plan is to minimize offshore wastes, discharges, and emissions and identify appropriate mitigative measures.

Estimated quantities of wastes, discharges, and emissions that will be generated for both the construction/installation/drilling and production/operation phases of the Project are summarized in Table 2.6. The table also includes summary descriptions of the characteristics of the waste discharges and disposal procedures to meet regulatory compliance standards.

2.7.1 Air Emissions

There will be a wide range of sources and types of air emissions during routine Project construction and operation, including:

- exhaust from supply and stand-by vessels;
- short-term flaring of the produced fluid from production wells during clean-up;
- exhaust from machinery on the platform (*e.g.*, gas turbines);
- fugitive emissions (*e.g.*, emission of volatile organic compounds from valves, filter changeouts, storage of hydrocarbons, *etc*.);
- emissions associated with processing operations including continuous flaring for processing by-products from TEG and produced water treatment systems; and
- flaring of the full acid gas stream during routine maintenance of the acid gas management system (approximately 2% of operating time).

The gas vented from the TEG regenerator must be continuously flared to prevent emissions of aromatic hydrocarbons (BTEX) from the system. If the produced water stripping unit is required to remove residual H_2S prior to disposal, the waste gas from this unit will be injected into the acid gas disposal well. The maximum waste gas flow rate is 326 m^3/hr (<0.1% of the feed gas rate).

Refer to Appendix C for details on the atmospheric modeling undertaken for their Project. Further information on routine air emissions, including generation rates, is presented in Table 2.6 and Section 6.3.1. Information on air emissions during malfunctions and accidental events is provided in Section 6.3.1.

Table 2.6 Routine Project Emissions/Effluents

Type	Emission/Effluent	Estimated Quantity	Characteristics	Disposal Standard
		Construction/Installation/Drilling		
Atmospheric Emissions	Generator, engine and utilities exhausts	Temporary, minor	CO_2, SO_2, NO_x, TSP	Atmospheric emissions will comply with the *Air Quality Regulations* (Nova Scotia *Environment Act*) and Ambient Air Quality Objectives (*CEPA*).
	Flaring during well testing and completion	Expected ~1/2 day per production well, unless otherwise required by operating requirements.	Possible NOx, CH_4, TSP, SO_2, CO_2, TPH, H_2S	Compliance with CNSOPB *Production and Conservation Regulations* (Section 32), *Air Quality Regulations* (Nova Scotia *Environment Act*) and Ambient Air Quality Objectives (*CEPA*).
Drill Waste Discharges	WBM	Bulk surface release of approximately 1075 m^3 of WBM for production well; 685 m^3 for injection well. WBM on cuttings is expected to be 182 m^3 for each production well and 120 m^3 for injection well.	Typical constituents include: barite, bentonite, KCl, polymers, $NaHCO_3$, lime, caustic soda, salt, and water	WBM will be disposed overboard.[1, 2]
	WBM associated cuttings	Approximately 412 m^3 of WBM associated cuttings discharged at the surface for each new production well to be drilled; 270 m^3 for injection well.	Rock cuttings coated with WBM	WBM associated cuttings will be disposed overboard.[1, 2]
	SBM/EMOBM	SBM/EMOBM will not be discharged overboard.	Typical constituents include: oil base fluid, water, emulsifier, CaCl, lime, barite, oil wetter, fluid loss additive, viscosoifiers	Unused or spent SBM/EMOBM will be returned to shore for storage and re-use at a later date.
	SBM/EMOBM associated cuttings	Associated cuttings will not be discharged overboard.	Rock cuttings covered with SBM/EMOBM	Injected into a suitable zone either through a dedicated well or annular injection or the cuttings will be skipped and shipped.

Table 2.6 Routine Project Emissions/Effluents

Type	Emission/Effluent	Estimated Quantity	Characteristics	Disposal Standard
		Construction/Installation/Drilling		
Drill Waste Discharges (cont'd)	Completion brine	Approximately 300 m^3 of completion brine will be discharged at the surface for each new production well to be drilled; 300 m^3 for injection well.	Water-based brine, possibly viscosifiers	Completion fluid will be discharged overboard as permitted by the CNSOPB.[1]
Liquid Effluent for Ocean Discharge	Sanitary and food waste	Maximum capacity of the facility during operation is approximately 68 persons with an estimated volume of 20 L per person per day; amounts will increase during construction phase with increased presence of vessels and crews.	Macerated food, grey water and sanitary waste	Sanitary and food waste will be macerated to a particle size of 6 mm or less prior to ocean discharge.[1]
	Deck drainage	As generated	Possible oily water with some particulate matter	Roof drainage will be directed overboard.[1] Deck drainage will be treated to reduce its oil concentration to meet regulatory requirements ocean discharge.[1]
	Bilge/ballast water (Construction/ Support vessels)	As required	Water with hydrocarbons	Bilge/ballast water will be treated as necessary to reduce its oil concentration to 15 mg/L or less prior to ocean discharge.[1]
	Bilge/ballast water (Platform installation)	No discharge during installation or operation.	Biocide and corrosion inhibitor in water will be sealed into jacket legs	At decommissioning of the platform, water in the jacket legs will be tested to determine disposal alternatives.
	Hydrostatic test fluids (Pipeline commissioning water)	47,000 m^3 (one time only, over a 4-5 day period)	Seawater containing biocide and corrosion inhibitors	The discharge of hydrotest fluids will require pre-approval from Environment Canada.
Solid Waste	Miscellaneous solid wastes (transported to shore)	As required	Construction materials, broken equipment components, packaging and shipping materials, damaged containers and general debris and refuse associated with construction	Wastes will be sorted and disposed according to local regulatory regime of the shore base, including the Nova Scotia *Solid Waste-Resource Management Regulations* and municipal requirements. Metals will be salvaged.

Table 2.6 Routine Project Emissions/Effluents

Type	Emission/Effluent	Estimated Quantity	Characteristics	Disposal Standard
			Production/Operation	
Air Emissions	Flaring (continuous)	refer to Table 6.13	H_2S, SO_2, NO_x, CO_2	Atmospheric emissions will comply with the *Air Quality Regulations* (Nova Scotia *Environment Act*) and Ambient Air Quality Objectives (*CEPA*).
	Flaring (acid gas during routine maintenance)	refer to Table 6.13	H_2S, SO_2, NO_x, CO_2	Atmospheric emissions will comply with the *Air Quality Regulations* (Nova Scotia *Environment Act*) and Ambient Air Quality Objectives (*CEPA*).
	Power Generation	refer to Table 6.13	SO_2, NO_x, CO_2	Atmospheric emissions will comply with the *Air Quality Regulations* (Nova Scotia *Environment Act*) and Ambient Air Quality Objectives (*CEPA*).
Liquid Effluent for Ocean Discharge	Produced water	refer to Table 2.4	Hydrocarbon, H_2S in water (sour water)	Produced water will be treated to a target dispersed oil concentration of 25 mg/L (30-day weighted average). The OWTG specify a 30-day weighted average of 30 mg/L.[1]
	Cooling water	3,050 m^3/h	Chlorinated water; temperature 20EC above ambient (before mixing in caisson)	Mixed with produced water before discharge. Total residual free chlorine in cooling water will not normally exceed 0.25 ppm.
	Deck drainage	Pump capacity is 150 m^3/h	Rain and deluge water, may contain oily water with some particulates	Roof drainage flows directly overboard as permitted by CNSOPB guidelines.[1] Deck drainage will be treated to reduce hydrocarbons to <15 mg/L.[1]
	Bilge/ballast water	As required	Water with hydrocarbons	Bilge/ballast water will be treated as necessary to reduce oil concentration to 15 mg/L or less prior to ocean discharge.1
	Well treatment fluids/ Well completion and workover fluids	As required	Well completion fluids have similar properties to WBM	Fluids will be treated to an oil concentration of 40 mg/L or less prior to discharge.[1]

Table 2.6 Routine Project Emissions/Effluents

Type	Emission/Effluent	Estimated Quantity	Characteristics	Disposal Standard
			Production/Operation	
Liquid Effluent for Ocean Discharge (cont'd)	Sanitary and food waste	Operational complement is estimated to be 30-40 persons. Maximum capacity of the facility is approximately 68 persons with an estimated volume of 20 L per person per day.	Macerated food, grey water and sanitary waste	Sanitary and food waste will be macerated to a particle size of 6 mm or less prior to ocean discharge.[1]
	Water for testing fire control systems	As required	Excess deck drainage water	Discharged overboard without treatment.[1]
	Desalination brine	13 m^3/hr	Estimated salinity of 35-40 ppt	Discharged overboard without treatment.[1]
Hazardous Liquids for Onshore Disposal	Waste production fluids and by-products	As required	Waste residues in the production system including oily sludge, scale, filters and filter residues and chemical wastes	Hazardous wastes will be accumulated in suitable containers and placed in appropriate shipping containers for return to shore for disposal and collected by licenced waste haulers. Provincial regulations for the storage, disposal, transport and management of used oil products will be followed as well as the *Transportation of Dangerous Goods Act* as applicable.
Solid Waste	Miscellaneous solid waste (transported to shore)	As required	Domestic solid waste and non-hazardous solids such as packing material	Wastes will be sorted and disposed according to local regulatory regime of the shorebase, including the Nova Scotia *Solid Waste-Resource Management Regulations* and other municipal requirements.

References:

1. Offshore Waste Treatment Guidelines (NEB *et al*. 1996, and updates)
2. Canada-Nova Scotia Offshore Petroleum Board Policy on Oil Based Muds (effective January 1, 2000) (CNSOPB 2000a)

2.7.1.1 Air Pollutants

The following describes criteria air pollutants (*i.e.*, regulated by federal guidelines or provincial limits) emitted by the Project, although some may be emitted in minor amounts and may not necessarily result in the effects described below unless otherwise indicated in Section 6.3.1.

Nitrogen Oxides

Nitrogen oxides are produced in most combustion processes, and almost entirely made up of nitric oxide (NO) and nitrogen dioxide (NO_2). Together, they are often referred to as NO_x. NO_2 is an orange to reddish gas that is corrosive and irritating. Most NO_2 in the atmosphere is formed by the oxidation of NO, which is emitted directly by combustion processes, particularly those at high temperature and pressure, such as diesel engines. NO_2 is the regulated form of NO_x. NO is a colourless gas with no direct effects on health or vegetation at ambient levels. The levels of NO and NO_2, and the ratio of the two gases, together with the presence of hydrocarbons and sunlight are the most important factors in the formation of ground-level ozone and other oxidants. Further oxidation, and combination with water in the atmosphere, forms part of “acid rain”.

Generally NO_2 constitutes 5 to 10% of the initial total emissions of NO_x, and the conversion of the majority of NO occurs after emission to the atmosphere. Emissions information on boilers usually refers only to total NOx, partly because the conversion rate of NO to NO_2 is somewhat site specific. Different methods are acceptable to regulatory authorities in the assessment of NO_x effects, the mostly widely accepted being either the use of a conservative conversion rate such as 30%, or the use of the ozone limiting method.

The ozone limiting method is fundamentally more accurate then the assumption of a fixed conversion rate. It assumes that some NO_2 is emitted directly from the stack and that additional NO_2 is formed in the atmosphere by the direct mole for mole oxidation of NO by O_3. If the ozone is unlimited, all of the NO is assumed to convert to NO_2. If, as is the norm, the ozone is limited, the conversion of NO will be limited by the amount of O_3. The assumption is usually made (*e.g.* US EPA, Alberta, Ontario) that initially 10% of the emitted NO_x is NO_2. The level of ozone is taken from real-time monitoring data.

For this Project, nitrogen oxides are produced primarily in the generation of power for electrical loads and compressors. It is estimated that the compression load of 27 MW and electrical load of 8 MW will be met through the use of multiple combustion turbines.

Sulphur Dioxide

Sulphur dioxide (SO_2) is a colourless gas with a distinctive pungent sulphur odour. It is produced in combustion processes by the oxidation of sulphur in the fuel. SO_2 can, at high enough concentrations, cause damage to vegetation and health effects through the respiratory system. SO_2 can also be further oxidized and combines with water to form the sulphuric acid component of "acid rain."

This Project incorporates a sulphur management system that removes H_2S from the gas stream and injects it into a disposal well. In the event of maintenance requiring downtime, or a malfunction of the acid gas injection system, the gas stream will be redirected to the flare which will result in the emission of SO_2.

Total Suspended Particulate Matter

Total suspended particulate matter (TSP) is a measure of the particles in the atmosphere that are too small to settle out quickly, but remain suspended for significant periods of time. Generally, this means particles with an aerodynamic diameter of less than 44 µm. TSP is produced by mechanical processes, such as the abrasion of vehicle tires on unpaved roads, and by combustion processes. Most particulate matter formed by combustion is either mineral ash from the fuel, or hydrocarbons formed by incomplete combustion.

This Project will result in construction-related emissions of particulate matter for the onshore facilities; these emissions will be similar in type and scale to those created by other medium to large sized construction projects. Offshore, the vessel exhausts will contain some particulate matter; these emissions are no more critical than those of similar vessels in everyday operation.

Fine and Respirable Particulate Matter

Although TSP is an excellent measure of the loading of particulate matter in the air, it does not necessarily reflect the health risks of the particulate matter. Large aerodynamic particles are trapped by the upper airways, and do not enter the lungs. Smaller diameter particles make their way to the lungs, and may become lodged there. Over the past few years, greater concern with regard to these fine particles has led to research resulting in new sampling methods and criteria. In June, 2000, the Canadian Council of Ministers of the Environment (CCME) adopted in principle Canada Wide Standards for particulate matter. Although these standards are not yet applicable, they will be relevant in the future. These standards provide for a proposed PM2.5 standard of 30 $\mu g/m^3$ for the fine (<2.5 µm) particulate fraction, with the current objective of meeting the standard by 2010. It should be noted that TSP includes the PM2.5 fraction; if the TSP reading is less than 30 $\mu g/m^3$, the PM2.5 standard is attained, likely by a considerable margin. The fine particulate matter is discussed for completeness; however, the total emissions of particulate matter from the Project activities are low, and this is not considered to be a critical issue.

Hydrogen Sulphide

H_2S is a colourless, poisonous gas with a characteristic odour of rotten eggs at low concentrations. Humans are particularly sensitive to the odour of H_2S at low concentrations; however, the gas causes rapid fatiguing of the olfactory system at higher concentrations. Environmental exposures are generally to the noxious odours. At higher exposures, such as in industrial operations, low concentrations can result in eye irritation and respiratory system irritation, and higher concentrations can result in asphyxia. H_2S is a by-product of decomposition of sulphur-containing organic material, and is associated with certain natural gas deposits, including this Project. H_2S has been safely managed in the natural gas resource sector and the acid gas management system for this Project is designed to remove and eliminate the H_2S from the gas stream. In the event of a failure of the injection system and the extinguishing of the flare, there may be a brief period of controlled H_2S emissions to atmosphere from this Project. In the event of the much less probable scenario of a blowout of the injection well, there will be a release of H_2S to the environment. In the event of a blowout from a production well, H_2S will be released as a component of the raw gas.

2.7.1.2 Air Emissions Modeling

In order to predict the dispersion and subsequent effect of air emissions from the Project, a simulation was conducted using a mathematical computer model of atmospheric transport. This method provides quantitative results and enables direct comparison of the simulated project effects with regulatory criteria. For certain sources where the quantitative releases are too difficult to predict, an assessment has been made based on the relative likelihood of releases, and the potential consequences. Modeling results and environmental effects associated with significant air emissions are presented in Appendix C and Section 6.3.1.

2.7.2 Noise Emissions

2.7.2.1 Offshore Noise

Noise emissions will mainly be generated during pile driving, blasting, and drilling operations. Other noise generating activities will include ship and air traffic during transport of materials and personnel to offshore facilities.

The sea is a naturally noisy environment. Natural ambient noise is often related to sea state. Ambient noise tends to increase with increasing wind speed and wave height (Table 2.7). In many areas, shipping is a major contributor to ambient noise. Table 2.7 presents examples of underwater noise levels for ambient noise, non-Project-related noise, and noise emissions anticipated to be generated by Project activities.

Table 2.7 Natural and Development Related Underwater Noise Levels

Source	Broadband Noise Level (dB re 1 FPa[1])	Source Levels at Dominant Frequencies	
		Hz	Noise Level dB re 1 FPa[1]
Ambient Noise			
Sea state[2] (SS) 0	-	100	60
SS 3	-	100	97
SS 5	-	100	102
Surf noise	-	100-700	
Non-Project Related Noise			
Fishing trawler	191	-	-
Commercial freighter	172	-	-
Project Related Noise			
Pile driving at SS 3 (1 km distance)	131-135	-	-
Drilling from bottom-founded structures (*e.g.*, jack-up drill rig)	-	5	119-127
Supply boats	170-180	100	174
Helicopter (Sikorsky @ 305 m above water)	105	-	-

Note: Standard units for underwater sound use a reference pressure of 1 FPa. Therefore underwater sound pressure levels are given in dB re 1 FPa.
[1]1/3 octave band level
[2]SS 0 = glassy, wind<1.8 km/h; SS 3 = small whitecaps, wind 20.4 to 29.7 km/h; SS 5 = mod. waves, some spray, wind 40.8 to 60.0 km/h
Source: Richardson *et al.* 1995; SOEI 1997 (IR 3.13)

2.7.2.2 Onshore and Nearshore Noise

EnCana anticipates some blasting will be required in the nearshore area for pipeline installation. The extent of blasting required will not be known until after the detailed design phase. Onshore noise will be limited primarily to construction of the pipeline and other onshore facilities. This noise will be similar to common construction projects involving large machinery. Table 2.8 lists the noise outputs of commonly used construction machinery (May 1978). Construction equipment generally has outputs ranging from 68-105 dBA. When assessing noise levels in air, measurements are based on the response of human hearing. The filtering applied to noise levels based on human hearing responses is known as A-weighting. Airborne noise is therefore reported in units of dBA. The level of noise will vary according to the type and level of construction activity. Standard operations of onshore facilities are not anticipated to generate audible noise off facility property. Periodic noise will be generated during RoW maintenance, associated with mechanical vegetation cutting and vehicle access.

Table 2.8 Typical Construction Equipment Noise

Equipment Powered By Internal Combustion Engines	Noise Level dBA at 4.5 m
Earth Moving	
Compactors (Rollers)	72-75
Front Loaders	72-85
Backhoes	72-94
Tractors	76-96
Scrapers, Graders	80-94
Materials Handling	
Cranes (Moveable)	75-86
Cranes (Derrick)	86-88
Stationary	
Pumps	68-72
Generators	72-82
Compressors	75-86
Impact Equipment	
Jack Hammers and Rock Drills	82-98
Impact Pile Drivers (Peaks)	95-105
Source: May 1978	

NSDEL has established the following criteria for the provincial Guideline for Environmental Noise Measurement and Assessment (NSDOE 1989) with respect to sensitive receptors (*e.g.*, residential areas, schools, *etc.*):

- An L_{eq} of 65 dBA between 0700 to 1800 hours;
- An L_{eq} of 60 dBA between 1900 to 2300 hours; and
- An L_{eq} of 55 dBA between 2300 to 0700 hours.

The Equivalent Sound Level (L_{eq}) is a logarithmic average of noise levels due to all sources of noise in a given area over a stated period of time.

2.7.3 Electromagnetic Emissions

Light

Light emissions will include navigation lights and warning lights. Working areas will be illuminated with floodlights. The helipad will be floodlit and have omnidirectional guidance lights. These lights are necessary for navigation safety and worker safety. Other potential light sources are flares and lights from vessels and helicopters.

Electronic and Magnetic Fields

The Deep Panuke Project will include electrical devices including generators, transformers, and high voltage cables. These devices can produce electric and magnetic fields (EMF). EMF is ubiquitous at home and in the workplace at varying levels. The significance of EMF to human health is a subject of debate, and the effects of exposure are unclear. Electrical devices which might generate EMF aboard the Project platforms will be designed and shielded to minimize worker exposure. EMF levels around electrical devices will be measured to ensure compliance with health and safety standards such as those established by the American Conference of Governmental Industrial Hygienists for Monitoring Radiation and Magnetic Fields (ACGIH 2001).

Radiofrequency and Microwave Radiation

Radiofrequency and microwave radiation (RF radiation) is part of the electromagnetic spectrum below the frequency of visible light and above the frequency produced by high-voltage electrical devices. Regulations have been established to limit the exposure of workers to RF fields to safe levels in relation to well understood heating effects (*i.e.*, microwaves). Sources of RF radiation on facilities like the Deep Panuke platforms could consist of radar antenna, wireless radio telecommunication devices and microwave communication devices. Any such RF producing devices being considered for the Project will be designed and constructed to meet the relevant safety guidelines and standards (ACGIH 2001 and Health Canada's Safety Code 6) and will be monitored during commissioning and operations to ensure that worker health and safety is protected.

2.7.4 Drill Waste Discharges

Use of Drill Muds

All drilling fluids (mud) go through a cyclic process during the drilling of a well. Prior to drilling a specific hole section, the required type of mud must be prepared. It is either prepared onshore and brought to the rig, or the required base products are brought to the rig and it is prepared onboard. Once the mud is ready for use, the drilling may begin for that hole section. The following describes the simple cycle that all drilling fluids follow:

1. The mud is pumped down the drillpipe to the bit on the bottom.
2. The mud comes out the bit and picks up the cuttings that the bit has produced and carries these cuttings back to the rig on the outside of the drillpipe.
3. Once back on the drilling rig, the cuttings (solid materials) are separated from the mud using solids control equipment. Linear vibrating shakers plus periodic use of centrifuges are the main components of the solids control equipment used to separate solids (cuttings from the wellbore) from the drilling mud.
4. The mud returns to the original tanks for any minor modifications (additional products) before starting the cycle again.
5. The cycle continues until the hole section reaches final depth.

Once the final depth of the hole section is achieved, the mud is cleaned for re-use on the next hole section or it is removed from the rig to allow for the next drilling fluid for the subsequent operation. Bulk mud releases will be minimized through batch drilling. Only WBM will be released overboard during mud releases, since SBM/EMOBM and associated cuttings will not be released overboard in the Project.

Typically, a conventional well would be installed as follows:

1. Drill and case the surface hole, then change the mud system and drilling tools.
2. Drill and case the intermediate hole section, then change the mud system and drilling tools.
3. Drill and case the main hole section.
4. Clean up the well and install the completion.
5. Move to the next well and repeat the process.

Batch drilling is a process that the Project team is hoping to employ for all hole sections. For a batch drilling process, all wells would have their surface holes drilled sequentially. The mud system and drilling tools would then be changed out after the surface holes for all wells were completed. The next hole section would then be drilled for all wells, again with the mud system and drilling tools changed out after that section for all wells was completed. This process would continue until all wells were completed. As a result, the mud change out occurs after each section of a well in completed for all wells, instead of after each section of each well.

Batch drilling cannot always be utilized for several reasons. For example, all material may not arrive in time to drill all sections of holes at the same time (*i.e.,* material for three complete wells may arrive, but not material for all surface sections). There are also issues related to reservoir uncertainty. Completing the first well before moving on to drill the second well may be preferential to increase the understanding of the reservoir risks and to allow for adjustments before completing the drilling program.

SBM/EMOBM will not typically be disposed of after a well is completed; instead it is removed from the rig to shore for further cleaning and storage until the next use. Typically, the more costly SBM/EMOBM provides for faster and more efficient drilling than WBM, and it can be effectively re-used for several wells since it may be kept in storage for long periods of time without significant degradation.
EnCana screens all chemicals used in both the WBM and SBM/EMOBM as per the Offshore Chemical Selection Guidelines (NEB *et al.* 1999).

Drill Waste Disposal Requirements

Spent WBM and associated drill cuttings will be discharged in accordance with the OWTG (NEB *et al.* 1996, and updates). EnCana intends to use WBM where it is technically practical, and only use SBM/EMOBM where hole conditions otherwise warrant. If SBM/EMOBM is used, it is returned to the shore base for reconditioning or disposal. SBM/EMOBM cuttings will not be discharged overboard, but instead will be disposed of with one of the following practices:

- injection into a disposal zone, through either annular injection or a dedicated well; or
- onshore treatment and disposal through skip-and-ship methods at an approved facility.

Cuttings that are sent to shore for disposal will follow strict manifesting and comply with all applicable TDG regulations. The cuttings will be loaded into containers and lifted to a supply vessel for transit to EnCana's Supply Base facilities. A waste contractor will then take the containers to a NSDEL-approved disposal facility for remediation. Transfer of these wastes will be outlined in the EPP.

There are currently two onshore facilities for cuttings disposal in Nova Scotia that have been approved by NSDEL. One facility in Dartmouth, NS uses a thermal desorption unit to remove hydrocarbons from the cuttings. The second facility in Antigonish, NS uses bio-remediation techniques to break down the hydrocarbons in the cuttings. EnCana has not selected a waste disposal facility for the Deep Panuke Project at this time.

The exact volumes of mud (SBM/EMOBM) to be used during drilling will be confirmed during detailed design. Since the Project will not discharge any SBM/EMOBM cuttings overboard, the scenario that has been modeled is “all wells drilled using WBMs with overboard discharge of cuttings” as listed in Table 2.9; it also assumes batch drilling could not be utilized and all sections of all wells are drilled utilizing WBM. The most likely scenario involves drilling several of the intermediate sections with a WBM (with overboard discharge of cuttings) and then drilling the remaining wells using SBM/EMOBM (with no overboard discharge of cuttings).

The conservative case scenario of eight wells using WBM for all hole sections has been modeled with results presented in Section 6.3.3.

Drill Waste Discharge Behavior and Modeling

When cuttings and mud are discharged, the fine materials in the discharge form a turbidity plume near the sea surface, but the bulk of the material (cuttings) drops to the seabed with the fine materials being stripped from the plume as it descends. The cuttings form a pile on the seabed near the discharge point, which, over the period of drilling, usually assumes an elliptical shape with the major axis defined by the dominant currents and their variability. The ultimate size of the cuttings pile depends on the type of mud, volume of the cuttings and mud, depth and subsequent reworking by waves and currents. In high energy environments, like the Deep Panuke site, cuttings and fine particles and associated metals, such as barium, are more likely to disperse (refer to Section 6.3.3).

Table 2.9 Deep Panuke Potential Drilling Waste Discharge Summary

	Each Production Well	Total for 6 Production Wells	Injection Well	'Other' Well	Total Discharges
Surface release of WBM associated cuttings (m^3)	412	2472	270	412	3154
Surface release of WBM on cuttings (m^3)	182	1092	120	182	1394
Surface release of WBM (bulk mud release) (m^3)	1075	6450	685	1075	8210
Surface release of completion fluid (m^3)	300	1800	300	300	2400

Notes:

All volumes are approximations that represent each well's cutting discharges.

Using a conservative approach to dispersion modeling, it is assumed six new production wells, one injection well and one "other" well will be drilled using WBM with overboard discharge. See rationale located below in Drill Waste Discharge and Modeling of Section 2.7.4. This provides a worst-case model using overboard discharge of all cuttings which assumes WBM usage for all hole sections for all wells.

The completion fluid is a brine that will be used for clean-out purposes.

There will be no release of cuttings at the seafloor since the drill and drive procedure will be used for all conductors. Seawater from gel sweeps will be used to clean the 30 m^3 of cuttings from each conductor with an additional 14 m^3 of mud discharged on those cuttings. the bulk dump of WBM after all conductors are set will be approximately 250 m^3.

Oceanographic plume modeling for discharge of mud and cuttings at sea was conducted for surface discharge of WBM which is considered to be conservative since WBM likely cannot be used for all sections of all wells. See Section 2.3.4 for further details. The modeling of drill mud and cuttings discharges is based on the following assumed operational processes and volumes shown in Table 2.9.

- As previously noted, a total of seven wells (six production and one injection) will be drilled for the Project. However, since previous modeling for the Project included a total of eight wells, this conservative modeling is utilized for the assessment of drill mud and cuttings.

- The structural, conductor sections (assumed diameter of 762 mm) are obtained through the use of a drill and drive method with limited use of muds. Seawater from gel sweeps will be used to clean the 30 m^3 of cuttings from each conductor with an additional 14 m^3 of mud discharged on those cuttings. the bulk dump of WBM after all conductors are set will be approximately 250 m^3.

- The 445 mm and 216 mm holes of each well will be drilled using WBM, with cuttings and mud brought to the surface via the riser for processing and discharge at the surface. The total cuttings volume is estimated to be 228 m^3 with a mud content of an additional 101 m^3. The bulk release of WBM after the hole sections are completed is expected to total approximately 775 m^3; this may be reduced through batch drilling or AVC drilling, if encountered.

- For modeling purposes, the 311 mm hole of each well was assumed to be drilled using WBM. Cuttings are estimated to be 184 m^3 with mud volumes on those cuttings of 81 m^3. The bulk release of WBM after the hole sections are completed is expected to total approximately 300 m^3; this may be reduced through batch drilling or AVC drilling, if encountered.

- Each completion phase (178 mm hole) will have completion fluids of approximately 300 m^3 released at the sea surface. These fluid will be used for cleaning the hole prior to installing the production tubing and equipment.

Modeling results of ocean disposal of drill waste discharges are presented in Section 6.3.3.

If SBM/EMOBM is required for the intermediate hole section, the cuttings will be transported to shore in skips for disposal (if skip and ship operations are selected), or disposed of by injection. Onshore disposal options for drill waste include bioremediation or low temperature thermal desorption (LTTD). EnCana will select an NSDEL-approved treatment facility in Nova Scotia for onshore disposal of drill wastes as required.

2.7.5 Effluent Discharges

2.7.5.1 Produced Water

Produced water management is described in Section 2.4.1.7 and Table 2.4. Treated produced water will be discharged overboard according to the OWTG (NEB *et al.* 1996, and updates). Refer to Appendix C for results of produced water dispersion modeling.

2.7.5.2 Cooling Water

The cooling system will use seawater to indirectly cool a circulating medium (40% ethylene glycol, 60% water (volume)) solution. The flow of seawater at the maximum design water temperature of 15^{o}C is 3,050 m^3/hr. The seawater discharge temperature at those conditions will be approximately 33^{o}C. This is all at maximum cooling conditions.

The seawater is treated with chlorine generated by a sodium hypochlorite generator to prevent/reduce the growth of marine biological growth. The design chlorine concentration at the seawater lift pump inlet is 2 ppm (1 ppm during normal operation with an increase during periods of high larval mussel concentration). The residual free chlorine concentration at the outlet will normally be below 0.25 ppm.

2.7.5.3 Deck Drainage

During construction and installation, prior to operation of the drains system, deck drainage will be discharged overboard. Deck drainage water might contain traces of petroleum hydrocarbons, such as lube oils, helicopter fuel, and diesel fuel. Every effort will be made to prevent chemical contamination on decks, which could be entrained into deck drainage. Storage areas for totes containing chemicals and petroleum products will have secondary containment to prevent discharge onto deck surfaces.

During the operation phase, deck drainage will be collected and treated according to the OWTG (NEB *et al.* 1996, and updates). Drainage from equipment areas on platforms will be directed through a header system to a collection tank to an oil/water separator treatment unit on the production platform. Petroleum hydrocarbons and sludge in the oil/water separator will be transferred into containers for shipment to shore for disposal. The water from the oil/water separator will be treated using cartridge-style water polishers and tested prior to discharge to ensure compliance with the discharge criteria of 15 mg/L or less. The deck drainage system does have overflows to permit water to be routed directly overboard in the event of a deluge event or rain water in excess of the design condition.

Any spills of petroleum products (or other chemicals) will be cleaned up immediately and reported. Oil absorbent pads and "oil dry" compounds will be available, at all times, in spill kits located at strategic sites on the platforms, to remove petroleum products from deck surfaces. The used absorbent materials and any other oily wastes will be placed in sealed containers and returned to shore for treatment and disposal at an approved waste management facility.

EnCana will develop a Spill Response Plan for the Project (refer to Appendix D) that will be submitted to the regulators for review and approval. It is the responsibility of all EnCana employees and contractors to report any accidents, incidents or spills to the Offshore Installation Manager for immediate action. The standby vessel in the field will also be tasked as part of their regular duties to observe and report any spills from the facilities.

2.7.5.4 Other Ocean Discharges

Other ocean discharges (*e.g.*, bilge/ballast, sanitary/food waste/testing waters, etc.) are summarized in Table 2.6 for the construction and operations phases of the Project. Those wastes, which are identified in the OWTG (NEB *et al.* 1996, and updates) and other regulations, are included along with the compliance standard. Each waste stream will be treated or managed to make sure the discharges comply with the respective regulatory limits and EnCana's environmental protection policies.

2.7.6 Naturally Occuring Radioactive Material (NORM)

Naturally occurring radioactive material (NORM) originating in geological oil and gas formations is typically brought to the surface in produced water. As the water approaches the surface, temperature and pressure changes cause radioactive elements to precipitate out of solution. Radium (scale), radon (gas) and their decay products are typically the radioactive elements of concern in petroleum production and gas processing. There is a low probability of NORM contamination during the Deep Panuke Project, both for radon or radium products since analysis has shown that the Deep Panuke gas has a low concentration of both radon and ethane/propane fractions. EnCana has a quality management plan for NORM. Periodic surveys of gamma radiation will be conducted. Appropriate response procedures will also be in place should NORM contamination be identified.

2.7.7 Non-Hazardous Solid Wastes

Potential sources and management of solid waste are summarized in Table 2.6. Solid waste management will be based on principles of reduction, re-use, recovery and recycling where practical and according to law. Solid waste will be segregated into appropriate categories (*e.g.*, recyclables, cardboard, refuse, scrap metal) at the source on the facility, transported to shore in containers appropriate for each waste type and treated or disposed of in accordance with the Provincial *Solid Waste-Resource Management Regulations*.

2.8 Hazardous Materials and Waste

Hazardous materials will be used on the Project facilities. EnCana will adhere to all applicable federal and provincial codes and regulations for the handling and transport of hazardous materials, including Workplace Hazardous Materials Information System (WHMIS) and the *Transportation of Dangerous Goods* (TDG) *Act* and Regulations.

All drilling and production chemicals/substances used by EnCana offshore must be approved under the Offshore Chemical Selection Guidelines (NEB *et al.* 1999) before they can be shipped offshore. The goal of these guidelines is to reduce or eliminate the use of any chemical that is known to be hazardous to human health and the environment. The guidelines accomplish this by using a decision-tree system. If a chemical is not located on these lists, then a hazard analysis is undertaken on the chemical and submitted to the CNSOPB for consideration. Also, all chemicals sent offshore will comply with WHMIS and TDG Regulations, as appropriate.

All staff working on Project facilities that will be required to handle, store and dispose of hazardous materials will be appropriately trained. Hazardous materials anticipated to be used throughout the life of the Project include, but are not limited to:

- drilling fluids;
- amines;
- glycols;
- methanol;
- corrosion inhibitors;
- scale inhibitors;
- paints and solvents;
- industrial cleaners;
- lubricating oils and fuels (aviation fuel, diesel fuel);
- anti-foams (often hydrocarbon-based);
- biocides for marine growth inhibitors; and
- radioactive (drilling) source.

EnCana will strive to reduce the need to dispose of any chemicals onshore; however, when the need arises, hazardous waste will be transported to shore for appropriate treatment and disposal. Transportation and storage of the wastes will comply with the Nova Scotia *Dangerous Goods Management Regulations* and *Transportation of Dangerous Goods Act* and Regulations. Only provincially licenced haulers will be used. Onshore wastes will be handled, treated, and disposed of at approved waste handling facilities.

A WHMIS program will be in place and all employees will be WHMIS-trained. A WMP will be in place to guide all activities related to hazardous waste storage transport and disposal. A NSDEL approved hazardous waste contractor will be selected for the disposal of hazardous wastes and will be regularly audited by EnCana personnel for compliance with regulations and the WMP.

2.9 Environmental and Safety Protection Systems

2.9.1 Equipment Inspection and Maintenance

All Project equipment will meet the requirements of industry standards, and be certified as being safe and fit for its intended use. Purchase orders for such equipment will be suitably monitored during the manufacturing and testing processes for strict compliance to these standards and to all applicable regulations as set out by the CNSOPB. Where required, the Certifying Authority (CA) may provide additional surveillance. Once installed, equipment will be operated and maintained in accordance with documented processes and procedures. EnCana will submit inspection and monitoring programs, a maintenance program and a weight control program to the CA for approval. These regular inspection and maintenance programs will ensure continued equipment reliability and integrity. Necessary critical spares will be maintained should equipment change-out be required. Subsea inspection programs allow for regular monitoring of critical subsea components such as pipelines.

As part of the maintenance of the Certificate of Fitness for a given installation (*e.g.*, wellhead platform, production platform), the CA is required to conduct inspections and surveys during the operation phase of the Project (Annual Surveys). These surveys will verify that installations are being operated in accordance with the approved programs noted above and provide further assurance that safety and protection of the environment are being upheld.

2.9.2 Pipeline Leak Prevention

The pipeline design philosophy, in accordance with CNSOPB regulations, incorporates designs for: internal pressure containment; dropped objects protection; fatigue; spanning; and hook, pull or snag loads due to fishing activities. The pipeline will be designed to withstand impacts from conventional mobile fishing gear in accordance with the Det Norske Veritas (DNV) Guideline No. 13, Interference Between Trawl Gear and Pipelines, September, 1997. During the operational phase, inspections are carried out as part of the Annual Survey to ensure that the pipeline integrity is maintained.

Environmental and safety protection systems, such as leak detection and emergency shutdown (ESD) valves, will be provided on the natural gas pipeline to shore. The pipeline has a shutdown valve and check valve onshore to prevent gas from backing up. The check valves could take about 30 seconds to close in the event of pipeline rupture. A subsea isolation valve (SSIV) assembly at approximately 500 m from the platform would also take approximately 30 seconds to close in the event of a pipeline rupture. The volume of gas that would be released before the export compressors are shut down is therefore reduced.

Leak detection for the pipeline will be carried out by the use of mass balancing. This method uses process conditions at either end of the pipeline along with gas composition to calculate the mass entering the pipeline and exiting it. The M&NP custody transfer meter along with onshore instruments would be utilized to gather flow, temperature and pressure measurements. Similarly on the platform, the flow, temperature, and pressure will be used in conjunction with the gas composition to calculate the mass entering the pipeline. The onshore measurements along with the offshore gas composition will be used to calculate the mass exiting the pipeline. The mass entering and exiting the pipeline will be used to detect leaks. The method of mass balance is considered acceptable, since it is a single pipeline and not a series of pipes or a distribution system for which algorithm applications are more suitable.

There will also be monitoring of the pipeline pressure for control purposes such that the maximum allowable operating pressure is not exceeded.

2.9.3 Blowout Prevention Safeguards

There are many safeguards in place to prevent blowouts or uncontrolled releases of hydrocarbons during the various stages of a wellbore's life cycle. The equipment used to drill, complete and workover a wellbore are essentially the same regardless of whether it is an injection or production well. Also, there is a separate set of permanently installed equipment that is used during the production or injection phase of the life cycle.

The objective during the drilling of the well is to provide a wellbore through the selected reservoir interval in the safest and most efficient manner. Several strings of pipe (casing) are set at increasingly deeper depths to achieve this goal. The first section of pipe, the conductor, is set to approximately 75 m below the seafloor with no well control or blow-out prevention equipment. It is anticipated for Deep Panuke that this large pipe is driven using a pile-driving hammer ("drill and drive"). For the next hole section (surface hole), a large diverter assembly is installed on top of the conductor pipe. This provides a means to divert any shallow gas that may be encountered over the side of the rig in a controlled manner until the mud weight can be increased to control the flow. The probability of encountering shallow gas during this hole section is unlikely since the rig is positioned to avoid any seismic shallow gas anomalies based on a shallow seismic survey.

Once the surface section has been drilled and cased, blowout preventers (BOPs) are installed which can withstand/holdback the reservoir pressures expected during the drilling process should a well control incident occur. The primary method of well control is the hydrostatic pressure exerted by the column of mud in the wellbore. The density of the mud that is used to drill the hole section is tailored to ensure that the ingress of wellbore hydrocarbons is prohibited. If the density of this fluid is too low a "kick" occurs by which an amount of reservoir fluid enters the wellbore. As soon as this kick is detected, the well is shut in and monitored to determine the conditions surrounding the kick. The BOPs are used to shut in the well. Once the well is shut in, the mud is circulated to bring the reservoir fluids to surface. The hydrocarbons are vented or burnt at the flare in a controlled manner. The density of the mud is increased the appropriate amount and the drilling process may begin again.

These blowout prevention safeguards are well-known operational procedures for which standard industry practices are in place. EnCana's Well Control Manual deals with these types of situations and is constantly updated based on the most recent technological innovations. All personnel are trained on a continuous basis and exercises and drills are routinely performed during operations on the drilling rig.

During the production or injection life of a well, there are several safety measures in place to insure no uncontrolled release of hydrocarbons occur. The primary prevention mechanism within an offshore wellbore is the surface controlled subsurface safety valve (SC-SSSV). The fail-close valve has a control line to surface that is constantly pressured to keep the valve open. In the case of an accident, the ESD procedure would have the valve close as soon as the hydraulic pressure is removed from the line. All reservoir fluids are contained within the production or injection tree on top of the wellhead. This tree (series of fail-close surface valves) is connected to the tubing string within the wellbore that is used to transport the fluids to or from the reservoir. The SC-SSSV is an integral part of the tubing string usually located at a depth below the seafloor. At the bottom of the tubing string, a production packer is placed between the tubing and casing to prevent migration of reservoir fluids in the annulus (space between the tubing and casing). This equipment provides a fit for purpose design conduit for the fluids to be removed from or injected into the reservoir.

2.10 Project Alternatives

2.10.1 Alternatives to the Project

In reviewing other possible development alternatives, EnCana was guided by the economics associated with using existing infrastructure. Taking advantage of the existing M&NP system will allow EnCana to proceed with an economically viable Project as soon as possible. Each of the liquefied natural gas (LNG), compressed natural gas (CNG) and electric power generation alternatives would require the construction of substantial new infrastructure, in addition to the infrastructure described in Section 2.2, affecting both the timing and economics of the Deep Panuke Project. Accordingly, these alternatives to the Project were determined to be uneconomic as compared to the Project design chosen and described herein.

2.10.2 Alternative Means of Carrying Out the Project

Several concepts were originally identified as potential development alternatives for the Deep Panuke Project. Each of these options was evaluated against a list of criteria to arrive at a preferred development concept.

As a precursor to the formal evaluation of various development alternatives against selected evaluation criteria, it was necessary to outline a central development concept by which the Project would be guided. The development concept for Deep Panuke is that the Project will, because of its reserve size, take advantage of pre-existing infrastructure to the maximum extent possible. EnCana has made conditional commercial arrangements to transport up to 11.3 x 10^6 m^3/day (400 MMBtu/d) of Deep Panuke gas on the M&NP system, specifying delivery at Goldboro. Accordingly, development alternatives which will not allow EnCana to take advantage of the infrastructure installed by M&NP were not evaluated against the criteria outlined below because they were determined to be not economically feasible. Examples of development options which fell outside the Project's central development concept (and hence were determined not to be economically feasible) are alternatives involving landfall sites other than Goldboro, and the use of technologies requiring substantial new infrastructure such as LNG or CNG technologies, which would be alternatives to this Project. With this central concept in mind, the following development alternatives were evaluated:

- substructure type;
- topside type;
- total number of platforms;
- re-use of the existing Panuke platform;
- processing location;
- acid gas handling;
- produced water disposal;
- condensate handling; and
- SBM/EMOBM drill cuttings disposal.

The decision to proceed with the preferred development option described herein was based on evaluation of the various alternatives described above against the following criteria (the Evaluation Criteria):

- technical suitability (including operational factors);
- costs;
- commercial risk;
- concept deliverability;
- safety; and
- environmental impact.

Although each alternative was evaluated using the Evaluation Criteria, the relevance and contribution of each criterion varied depending on the alternative under consideration. For example, although the capital cost to provide a separate platform for accommodations was considerable, it was determined that it was an acceptable cost opposed to the increased safety risk associated with including the personnel accommodations on the production platform.

If an alternative was deemed to be technically and economically not feasible, a further assessment of the alternative, including concept deliverability, safety and environmental factors, was not considered. If alternatives are considered technically and economically feasible, they are addressed in the CSR.

2.10.2.1 Substructure Type

Substructure alternatives investigated included steel semi-submersible hulls, concrete gravity based systems (GBS), large and medium sized jack-ups, and steel jackets. The evaluation of these alternatives against the Evaluation Criteria is summarized in Table 2.10.

The steel semi-submersible hull was eliminated based on technical suitability as this concept has not been proven in the harsh/shallow water environment prevalent at the Deep Panuke site. The mooring and riser design would be technically very challenging and the concept lacked favourable experience with a steel semi-submersible as a gas production platform.

The other four options (GBS, large jack-ups, small jack-ups and jackets) were primarily compared on the basis of technical suitability, cost and commercial risk; the environment and safety impact for the four options were not significantly different. The GBS structure was rejected due to higher commercial risk imposed by a single source supplier and cost, thus it was determined to be not economically feasible.

The large jack-up alternative was also rejected as not economically feasible based on higher cost and increased commercial risk. There is limited experience worldwide with large jack-ups of this scale operating as a gas production platform. The experience of the large jack-up alternative indicates significant risks associated with cost and schedule overruns.

Table 2.10 Substructure Development Alternatives

Alternative	Technical Suitability	Cost	Commercial Risk	Technically and Economically Feasible	Concept Deliverability	Safety	Environmental Impact
Jacket	• proven for Deep Panuke site conditions	• lowest	• lowest – competitive procurement • best estimate of offshore hook-up costs	• yes	• best	• no specific concern	• local seabed disturbance and pile driving required
Steel Semi-Submersible Hull	• technical concerns related to riser design and mooring, adjacent to other platforms and riser design • lack of experience in shallow/harsh conditions • only one semi in use for gas production (deeper water)	• 10% higher than jacket option	• greater than jacket	• no			
Concrete GBS	• gravity based system (GBS) widely used – six examples in water this shallow • inshore topside analysis avoids large crane requirement • condensate storage is free	• most expensive by approximately $100 MM	• single source of supply could lead to high costs	• no			
Medium Size Jack-Up	• no semi-submersible crane vessel (SSCV) required • co-location of facilities is required due to jack-up size • Foundation concerns • size required pushes the proven technology envelope	• 10% higher costs than jacket option	• higher contract management risk • installation problems possible (Siri and Harding) • same risks as larger jack-ups • offshore hook-up costs high potential to exceed jacket HUC (SSVC)	• no			
Large Jack-Up	• co-location of all facilities on a single deck • no SSCV required • some concerns regarding installation and challenge of blast loading on a triangular deck	• 15% higher than jacket option	• significant risk of cost overruns (*e.g.*, Elgin) • offshore HUC could be significant • only one jack-up of this scale operating (Elgin)	• no			

The initial screening study showed that the capital cost for mid-sized jack-ups and jacket options were very close in cost. Upon further investigation of the concept deliverability, it was found that similar jack-up projects had experienced significant delays associated with transportation and hook-up, demonstrating the actual cost of a jack-up option to be 10% higher than the jackets option. The size of the production platform topsides would be a novel solution since it would be one of the largest applications of this technology for the harsh environment at Deep Panuke. Therefore, the mid-size jack-up option was rejected for technical and economic reasons.

In summary, conventional steel jackets were selected as the preferred development alternative based on economics and technical feasibility.

2.10.2.2 Topside Type

The production platform topsides will be configured as an integrated deck, installed offshore in a single lift by a twin crane semi-submersible crane vessel (SSCV).

The feasibility of an alternative approach to the production platform topside design, based on splitting the deck into a number of discrete modules, was investigated during the FEED study. Initially this was seen as offering a number of potential benefits to the Project including more heavy lift contractors to choose from, and cost. The utility/quarters and wellhead platforms were not investigated for modularization because the deck size does not limit the number of heavy lift contractors to choose from.

Several modularization scenarios were considered with the following options studied in depth:

- two large modules consisting of a separation/gas treatment and a utilities/gas compression module with additional power generation and waste heat recovery skids on the top deck;
- four medium sized modules consisting of a separation module, utilities module, gas treatment and gas compression modules with additional power generation and waste heat recovery skids on the top deck; and
- six small modules consisting of one separation, one utilities, two gas treatment and two gas compression modules.

The results of the topside type alternatives analysis is summarised in Table 2.11.

The production platform modularization study determined that the difference in offshore installation costs of the various options is small. Although the day rates for the smaller installation vessels capable of installing the medium and smaller modules is lower, this is outweighed by the increased offshore installation time and thus increased exposure to weather downtime in the harsh offshore environment of the Scotian Shelf.

Table 2.11 Topside Development Alternatives

Alternative	Technical Suitability	Cost	Commercial Risk	Technically and Economically Feasible	Concept Deliverability	Safety	Environmental Impact
Integrated Deck	• most technically suitable alternative	• lowest	• requires one of two heavy lift vessels in the world	• yes	• best control over schedule	• minimum time required for offshore hook-up	• least number of vessels required resulting in less emissions
Two Large Modules	• modular decks result in less efficient deck layout and are more costly • construction complexity is increased	• increased mobilization costs • installation vessels have lower day rate but more weather downtime expected due to Deep Panuke site conditions • increased offshore hook-up costs and commissioning • not as cost effective as four module option	• multiple contractors means increased management efforts and risk of delays (slowest yard dictates pace) – more logistics • more installation vessels available than integrated deck • multiple yards increase weather delays for transport/load out • no "extra" installation contractor to bid the job	• no			
Four Medium Modules	• similar to two large modules	• increased mobilization costs • installation vessels have lower day rate but more weather downtime expected due to Deep Panuke site conditions • increased offshore hook-up costs and commissioning • costs of four modules were 20% higher (capital and hook-up, and commissioning) than integrated deck	• multiple contractors means increased management efforts and risk of delays (slowest yard dictates pace) – more logistics • more installation vessels available than integrated deck • multiple yards increase weather delays for transport/load out • allows one extra installation contractor to bid the job	• no			

Table 2.11 Topside Development Alternatives

Alternative	Technical Suitability	Cost	Commercial Risk	Technically and Economically Feasible	Concept Deliverability	Safety	Environmental Impact
Six Small Modules	• similar to two large modules	• increased mobilization costs • installation vessels have lower day rate but more weather downtime expected due to Deep Panuke site conditions • increased offshore hook-up and commissioning • not as cost effective as a four module option	• multiple contractors means increased management efforts and risk of delays (slowest yard dictates pace) – more logistics • more installation vessels available than integrated deck • multiple yards increase weather delays for transport/load out	• no			
Two or Three Modular Combination at an Integration Site Onshore	• similar to two large modules	• two module option has increase Project cost of 20% • three module option has costs greater than two module cost	• multiple contractors means increased management efforts and risk of delays (slowest yard dictates pace) – more logistics • multiple yards increase weather delays for transport/load out	• no			

Integrated decks are more technically suitable alternatives than modular decks. Modularization offers a less efficient platform layout with increased pipework, cabling, and support steelwork resulting in a heavier and more costly platform. Modularization will result in a more complex onshore construction program and logistics with increased number of vessels to transport the platform components. The difference in hook-up and commissioning costs is significant with respect to offshore person-hours and other associated costs. The increased number of vessels presents some additional safety risks and, due to the increased emissions associated with a larger number of vessels, a less desirable environmental alternative (although not significantly so).

Although modularization would increase the number of fabrication yards worldwide capable of constructing the deck, it also increases the cost of the Project and presents a schedule risk due to weather-related delays associated with transportation and load out from multiple fabrication yards. The four module option was considered to offer the most advantages, although after considering all the findings, this option would have cost approximately 20% more than the integrated deck solution selected for the development plan.

A further modularization study was performed to investigate the feasibility of a jacket substructure supporting two or three modules that would be built separately, and subsequently brought together at an integration site to be welded into a single deck structure. The study proved that this alternative would cost approximately 20% more than the single integrated deck solution and also presented a schedule risk.

In summary, after consideration of the additional costs and the increased effort for offshore hook-up and commissioning associated with modularization, it was determined that modularization was not economically and technically feasible.

2.10.2.3 Total Number of Platforms

Various platform layout scenarios were evaluated to determine the best option for the Project. The best option consists of three separate platforms – a production platform (PP), a utility/quarters platform (UQP) and a wellhead platform (WP). However, combinations of these individual platforms are technically and economically feasible, and were evaluated. The alternatives evaluated included the following:

- Case 1: separate PP, UQP and WP;
- Case 2: a combined PP/UQP and a separate WP; and
- Case 3: a combined PP/WP and a separate UQP.

Although each of Cases 1, 2 and 3 were analyzed using the Evaluation Criteria as shown by Table 2.12, the primary design consideration during the development of platform layouts is safety of personnel, including the segregation of hazardous and non-hazardous areas. The option selection process utilized the As Low As Reasonably Practicable (ALARP) principle to analyze the relative safety of the three cases considered.

The safety risk associated with the utility/quarters location was determined by carrying out a risk assessment. Full Quantitative Risk Assessment uses detailed information about the installation, together with generic equipment failure data (flanges, valves, compressors, *etc.*), to estimate the following safety risk parameters:

- PLL (Potential Loss of Life): Represents the number of statistical fatalities likely to occur on an installation per year;
- IRPA (Individual Risk Per Annum): Represents the probability of an individual becoming a statistical fatality in a period of one year; and
- TRIF (Temporary Refuge Impairment Frequency): Represents the probability that the Temporary Refuge (TR) is impaired (together with associated life support and evacuation systems) in a period of one year.

A separate quarters platform (Cases 1 and 3) is the safest option because personnel are further removed from hazards such as a blowout, riser/pipeline releases, and process topsides releases that could result in fires/explosions, or releases of H_2S gas. While the costs of co-located living quarters would be significantly lower ($28 MM) than separating these two functions, the increased safety risk dictated that a separate UQP become the preferred option.

In terms of environmental impact, there is little difference between the two or three-platform options. For the three-platform option, the offshore footprint of the Project is larger and therefore, there is a greater impact to the benthic community and a larger exclusion (safety) zone. However, the environmental impact is still considered insignificant.

Case 3, combining the PP and the WP, was discarded due to the concept deliverability criteria, reduced drilling and installation flexibility, as well as safety. As a result, the preferred development alternative for Deep Panuke was based on three separate platforms (Case 1).

Table 2.12 Total Number of Platforms Development Alternatives

Alternative	Technical Suitability	Cost	Commercial Risk	Technically and Economically Feasible	Concept Deliverability	Safety	Environmental Impact
Three Separate Platforms: Living Quarters/Utilities, Processing and Wellhead Platforms	• equivalent	• approximately $28 MM more expensive ($15 - $38 MM range)	• higher than co-location due to load out/transport risk and offshore hook-up and commissioning	• yes	• equivalent	• much lower risk to offshore personnel than either of the two platform options	• greater number of platforms will create a minor increase in disturbance to the benthic environment • relatively larger exclusion (safety) zone
Two Platforms: Co-located Living Quarters on Production Facilities (single platform) and separate wellhead	• equivalent	• lowest cost	• lower than three separate platform case	• yes	• equivalent	• higher risk to offshore personnel	• less disturbance to benthic environment than three platforms • smaller exclusion zone than three platforms
Two Platforms: Co-located Production Facilities and Wellheads (single platform) and separate quarters	• reduced drilling and installation flexibility	• lower than separate living quarters and processing platform	• lower than three separate platform case	• yes	• reduced drilling and installation flexibility	• low risk to offshore personnel	• less disturbance to benthic environment than three platforms • smaller exclusion zone than three platforms

2.10.2.4 Re-Use of Existing Platform

The existing Panuke structure, bridge-connected to the main production platform, was investigated for use as the wellhead platform. The Panuke platform was designed for the Cohasset Project and installed in 1991. It contains five well slots from which the original Deep Panuke discovery well (PP-3C) and the first delineation well (PI-1A/B) were drilled. These wells were suspended during the first phase of decommissioning of the Cohasset Project with the intention to use them in the Deep Panuke Project. The ability to use these wells as Project development wells was a key driver behind the evaluation of the Panuke platform re-use. An evaluation was also conducted to determine whether refurbishing the platform was more cost-effective than building a new platform.

An evaluation of the existing two wellbores at the Panuke platform was performed and concluded that PP-3C would have to be re-drilled and PI-1B would require downhole modifications.

A platform inspection program was implemented during the summer of 2001 to investigate the structural adequacy of the Panuke platform as the Project wellhead platform. It was concluded that the jacket was acceptable for re-use; however, the deck would have to be either removed and replaced with a new one or modified offshore. The modifications would reduce the topside weight to accommodate the bridge weight from the production platform and outfit the required facilities for Deep Panuke.

The Panuke platform experiences excessive movement during storm conditions, creating a concern as to how the piping connections would accommodate relatively large differential movements between the two adjacent platforms.

Following the preliminary analysis of the technical suitability of re-using the existing Panuke platform, the two alternatives, re-use of the Panuke platform and use of a new wellhead platform, were compared using the Evaluation Criteria. This analysis is summarised in Table 2.13.

As Table 2.13 indicates, installation of a new wellhead platform is the most suitable technical solution. The clear deciding factor in the analysis was the relative safety and environmental risk of re-using the Panuke platform as compared to the installation of a new platform. Installation of a new platform removes the concern regarding the excessive movement of the Panuke platform, and the associated concerns in regard to the pipe connections that would exist between the production platform and the Panuke platform. In summary, in consideration of safety, environmental and technical factors, the re-use of the existing Panuke platform was rejected as an alternative.

Table 2.13 Re-Use of Existing Platform Development Alternatives

Alternative	Technical Suitability	Cost	Commercial Risk	Technically and Economically Feasible	Concept Deliverability	Safety	Environmental Impact
New Wellhead Platform	• design and installation of a new fit-for-purpose wellhead is the best technical solution	• additional cost of a new platform and well(s)	• delivery of new wellhead platform presents some commercial risk	• yes	• equivalent	• no specific concerns	• more disturbance to benthic environment than re-use of existing platform • new fishing and vessel exclusion (safety) zone
Re-use of Existing Panuke Platform for Wellhead	• only five drilling slots available for Project development • concern with excessive movement of Panuke platform • major offshore modifications required	• more cost effective (in terms of drilling) as it allows re-use of an existing wellbore(s) • Panuke platform will require modifications/upgrade offshore and therefore accommodations vessel will be required	• very low, but does not balance off the risk of re-drilling new well(s) • offshore construction could negate the cost advantage • EnCana only owns 50% of the platform	• yes	• equivalent	• concerns about excessive movement related to pipeline connections and platform connections	• risk of potential spill due to excessive movement related to pipeline connections • re-use of platform results in less disturbance to benthic environment than a new platform • fishers and vessels accustomed to existing exclusion zone at Panuke

2.10.2.5 Processing Location

The Project involves offshore processing such that market-ready natural gas will be transported to shore in a subsea pipeline. The decision to process raw gas offshore was based on an analysis using the Evaluation Criteria. This analysis is summarised in Table 2.14. The alternatives analyzed are as follows:

- offshore processing;
- onshore processing; and
- an intermediate case.

The preferred case for development is offshore processing. Offshore processing involves gas sweetening, acid gas injection, TEG dehydration, dewpointing, gas compression, produced water treatment and disposal, and condensate treatment/usage for platform fuel offshore. Market-ready natural gas is shipped to shore in a subsea pipeline.

The onshore processing alternative is based on minimally treating the gas such that the gas and condensate could be transported, in a common multiphase pipeline, for processing onshore. Onshore processing still involves offshore treatment including dehydrating the gas, and separating the water from the condensate so that the pipeline may be operated free of water. The removal of water is necessary for corrosion control and hydrate prevention.

The third processing alternative reviewed involved the intermediate case. The intermediate case requires dehydration and H_2S removal offshore, transportation to shore in a multiphase pipeline, with separation, dewpointing, and condensate treatment occurring onshore. As the study of the intermediate case progressed, it was realised that the condensate must also be treated offshore for H_2S removal since the pipeline and the onshore facility are designed for sweet service. As a result of this finding, the intermediate case was rejected since treating the condensate offshore required the same facilities as full offshore processing plus, additional, duplicative facilities onshore. There is no technical or economic advantage in recombining the gas and condensate for multiphase transport since duplicate facilities for condensate separation and treatment would be required onshore. Accordingly, the intermediate case was rejected based on technical and economical suitability considerations.

Table 2.14 Location of Processing Development Alternatives

Alternative	Technical Suitability	Cost	Commercial Risk	Technically and Economically Feasible	Concept Deliverability	Safety	Environmental Impact
Offshore Processing	• best technical solution (H_2S and condensate removal at source to produce natural gas)	• slightly lower cost than onshore processing • handling condensate offshore improves economic feasibility	• no specific concerns	• yes	• equivalent	• deals with H_2S at source thereby minimizing safety risk related to unnecessary transportation	• deals with H_2S at source, thereby minimizing environmental risk related to unnecessary transportation • fewer sensitive environmental receptors and potential impacts with regard to offshore sulphur emissions
Onshore Processing	• higher risk than offshore processing associated with pipeline integrity	• slightly higher cost than offshore processing	• substantial risk to Project economics should pipeline corrode and be out of service for an extended period of time • increased risk to Project economics due to pipeline integrity concerns	• yes	• equivalent	• transports H_2S from offshore to populated area (increased safety risks)	• greater number of sensitive environmental receptors and potential impacts onshore with regard to sulphur emissions • increased corrosion risk associated with transmission of H_2S in a 175 km pipeline increases risk of gas release
Intermediate Case	• duplication of some facilities onshore and offshore	• highest – must duplicate elements of processing offshore and onshore	• no specific concern	• no			

While proven and effective mitigation measures to address these environmental and safety concerns exist, EnCana's preferred approach for this Project is to deal with the sour gas at source to minimize the potential for risk to the environment. The environmental evaluation of onshore processing determined that handling the sour gas onshore increases the potential impact on the onshore environment through acidic deposition, storage of elemental sulphur, and stack emissions. In general, there are many more environmental receptors onshore that are sensitive to potential acidification from routine and fugitive sulphur emissions (*e.g.*, freshwater habitat, soils) than offshore, with buffering capacity provided by the marine environment.

For onshore processing, additional safety and human health risk of handling sour gas onshore near populated areas was also considered. The probability of a large-scale accidental release of sour gas from a processing facility is remote, but is nevertheless a serious concern. While the oil and gas industry has a proven ability to handle sour gas in populated areas, EnCana believes the most prudent approach for the Project, when an economic choice is presented, is to keep sour gas away from populated areas thereby minimizing risk.

Onshore processing also presents operational and pipeline integrity concerns due to difficulties that may be encountered in guaranteeing that water will not enter the export pipeline. Hydrocarbons and H_2S, in the presence of water, can form hydrates. Also, water and H_2S, can cause localised internal corrosion, which results in a pipeline integrity risk. The pipeline integrity risk can be reduced with the use of corrosion inhibitors to manage localised corrosion created by H_2S and water. While the corrosion inhibitors reduce the pipeline risk to an acceptable level in an onshore environment, the risk is still a significant concern given the length of the subsea pipeline and potentially prolonged downtime for the Project. Internally coating the pipeline was investigated to decrease this risk of corrosion; however, increased costs associated with "cladding" a pipeline make onshore processing not economically feasible when the cost criterion is applied.

Condensate being used as a primary fuel also improves the economic feasibility of offshore processing. Condensate as the primary fuel maximizes the amount of sales gas sent to shore for sale, while minimizing associated capital costs for dealing with condensate.

Finally, an important consideration that supports the selection of offshore processing as the preferred option is the pipeline to shore transporting sweet gas. Based on the production profile for the Deep Panuke Project, the maximum production rate will likely drop after three to four years. With a sweet pipeline to shore, other projects that are developed after the Deep Panuke Project may be able to utilize the surplus capacity in EnCana's sweet pipeline to bring their gas to shore. The increasing surplus capacity in EnCana's pipeline may allow another project, with marginal economics, to be developed by using existing infrastructure and, at the same time, minimize the proliferation of facilities in Goldboro.
In summary, offshore processing was selected as the preferred option based on the following:

- treating and disposing of sour gas as close to source as possible (and keeping acid gas away from populated areas which minimizes risk);
- offshore injection of acid gas minimizes environmental impact;
- reduced risk related to pipeline integrity in an offshore environment with the removal of both water and H_2S offshore;
- handling condensate offshore improves economic feasibility of the Project; and
- a sweet gas pipeline to shore may potentially be used by other offshore producers as EnCana's production declines.

2.10.2.6 Acid Gas Handling

As a result of adopting offshore processing, removal of H_2S from the inlet gas stream results in a concentrated waste stream to be handled offshore. The FEED study investigated four options for handling acid gas offshore including flaring, seawater scrubbing, offshore sulphur recovery, and acid gas injection. The alternative chosen for the Project is the acid gas injection technology. A summary of the investigation is included below and summarised in Table 2.15.

Flaring acid gas consists of directing the acid gas stream to a flare system for incineration and emission to the atmosphere. Although flaring is a relatively low-cost option, the SO_2 resulting from the incineration process can be scavenged from the air by rain or may oxidise further to sulphate particles which can contribute to acidic deposition. In this situation the amount of SO_2 released is within air quality guidelines, though long term emissions may be of concern with regard to federal/provincial agreements to reduce acid rain. This alternative was, however, ruled out because other economic alternatives are available.

The seawater scrubbing option consists of an incinerator and a scrubber. The unit accepts acid gas from the incinerator that has converted the H_2S to SO_2. The SO_2 is subsequently removed by seawater absorption in a packed column. The acid gas leaving the incinerator flows up the column contacting the seawater countercurrently. The spent seawater flows by gravity to a mixing device, where it is combined with other plant discharge water (cooling water, produced water, *etc.*) and returned to the ocean.

Table 2.15 Acid Gas Handling Development Alternatives

Alternative	Technical Suitability	Cost	Commercial Risk	Technically and Economically Feasible	Concept Deliverability	Safety	Environmental Impact
Acid gas injection	• proven technology • used extensively in Western Canada – EnCana has existing installations	• approximately $26 MM	• costs may be higher than anticipated due to drilling difficulties	• yes	• intermediate risk – specialized equipment has long lead delivery but can be purchased in Canada	• incremental risk over flaring due to handling of high pressure acid gas	• significantly reduces air emissions and marine discharges compared with other options
Flaring	• proven technology • used worldwide	• approximately $1 MM • fuel gas required to ensure efficient operation	• not applicable	• yes	• least risk – equipment is readily available in Canada	• some risk associated with handling acid gas	• highest air emissions
Seawater scrubber	• relatively new technology for offshore – two offshore facilities exist	• approximately $13 MM • requires 90% less fuel gas than flaring to ensure efficient operation	• not applicable	• yes	• greatest risk – equipment is long lead delivery and will likely be purchased internationally	• incremental risk over flaring due to the handling of low pH effluent	• higher marine discharges compared with other options, lower air emissions compared with flaring
Offshore sulphur recovery	• offshore footprint required makes option uneconomical	• very high	• not applicable	• no			

The seawater scrubbing technology is successfully used in many facilities world wide, including two offshore facilities, although the offshore facilities are recently constructed and do not have an established performance record. The seawater scrubbing option has a substantially lower capital cost when compared to acid gas injection. Although an environmental review of this technology showed no significant impact to the environment, there were a number of atmospheric emissions and marine discharges that were relatively higher than the other acid gas management options. The seawater scrubbing option also had associated marine discharges (lower pH, chemical oxygen demand) not present with the other options. The seawater scrubber was rejected based on lack of performance data and higher atmospheric/marine emissions.

Offshore sulphur recovery was considered as an alternative for acid gas handling. After preliminary review of the option, it was determined that it was not economically feasible due to the size of the platform required for the process.

Injecting acid gas into a reservoir is based on technology commonly used in gas and oilfield developments, including existing EnCana facilities. Compressors are used to inject the gas into the reservoir through a disposal well. In general, acid gas injection minimizes both air emissions and marine discharges using proven technology. In addition to minimizing SO_2 emissions, acid gas injection also minimizes CO_2 emissions through injection, compared with the other options. Refer to Section 6.3.1 for further information on reduced greenhouse gas emissions associated with acid gas injection.

In summary, acid gas injection was selected as the preferred development alternative due to the established track record of the technology even though it is the most costly option. Acid gas injection also offers important environmental benefits through minimization of atmospheric emissions and marine discharges.

2.10.2.7 Produced Water Disposal

EnCana identified four potential alternatives for produced water disposal on the Deep Panuke Project. These alternatives were treatment and discharge overboard, injection into a dedicated well, simultaneous injection into the condensate/acid gas injection well, and injection into the annular space of an existing well. Although all four alternatives were identified as technically feasible, each carries different types and levels of risk to the Project (further information provided in Table 2.16). After a thorough review of the alternatives, the treatment and discharge overboard option was deemed the best technical and commercial option.

Treatment and discharge overboard is a proven technology that is used worldwide in offshore oil and gas facilities, including offshore Nova Scotia. The treatment technology proposed for the Project will ensure that the prescribed CNSOPB limits for produced water discharge are met and exceeded.

Table 2.16 Produced Water Disposal Alternatives

Alternative	Technical Suitability	Cost	Commercial Risk	Technically and Economically Feasible	Concept Deliverability	Safety	Environmental Impact
Treatment and disposal overboard	• proven technology • currently used worldwide in offshore oil and gas facilities • meets published CNSOPB guidelines	• base case for capital costs • annual operating costs for environmental monitoring	• no significant concerns	• yes	• no significant concerns	• no significant concerns	• EIS concludes no significant impact to the environment • water will be treated and disposed according to existing regulations
Injection into dedicated well	• proven technology onshore • injection zone has been identified • will require duplication of overboard equipment in case well goes down	• additional capital cost is ~$23MM • significant additional operational costs for well interventions, injection chemicals	• significant uncertainty related to reservoir characteristics and acceptance of produced water flow (will not be confirmed until well is drilled)	• technically feasible • not economically feasible			
Simultaneous injection into condensate and acid gas injection well	• concept is technically feasible, but has significant risk • if problems occur, will shutdown acid gas injection	• similar to base case for capital costs since acid gas/condensate injection well • operational costs are similar to dedicated injection well, assuming streams are compatible	• although concept is technically feasible, it is not recommended due to phase separation, hydrates and corrosion • significant potential risk of Project shut down if ability to inject acid gas is sacrificed.	• yes, however commercial and technical risk are too high to make this alternative acceptable	• technical issues related reservoir suitability and mixing the streams	• potential risk to workers from high pressure water injection lines	• injection of produced water reduces potential marine interactions from operations phase • if acid gas injection well goes down, then acid gas would have to be flared until a rig could workover the well (5 months) • same comment for condensate

Table 2.16 Produced Water Disposal Alternatives

Alternative	Technical Suitability	Cost	Commercial Risk	Technically and Economically Feasible	Concept Deliverability	Safety	Environmental Impact
Injection into an annulus	• concept is technically feasible, but has significant technical risks • if corrosion problem occurs, will shut down a producer well	• additional capital cost over base case is ~$2MM for injection equipment, additional piping, and wellhead modifications • additional operational costs for injection chemicals (~$18MM)	• potential risk of shut-down of production well that is being injected into (corrosion) • uncertainty with regard to a suitable injection zone (cannot be confirmed until well is drilled) • no workovers possible • multiple wells must be prepared	• yes, however commercial and technical risk are too high to make this alternative acceptable	• technical issues related to corrosion on producer well and selection of a suitable injection zone	• potential risk to workers from high pressure water injection lines	• injection of produced water reduces potential marine interactions from operations phase

Produced water injection into a dedicated well is a proven technology on offshore oil developments (used for reservoir pressure maintenance). This option, while environmentally attractive, is considerably more expensive, from a capital and operating cost perspective, than the discharge overboard option and is not considered economically feasible for the Deep Panuke Project. There is also considerable technical uncertainty with regard to suitability of injection reservoirs, which would not be resolved until the injection well was drilled and tested.

Simultaneous injection of produced water into the condensate/acid gas well is not practiced due to risks associated with phase separation (acid gas cap forms in the well reducing (or possibly prohibiting) the ability to inject), hydrate formation and corrosion. Simultaneous injection can be accomplished successfully, as proven by EnCana on the Thompson Lake facility in Alberta. However, the success of this process depends on the acid gas being completely dissolved in the water to prevent separation of the two phases. For the Deep Panuke development, the produced water production rate is not of a sufficient volume for dissolving the acid gas stream. The volume of water required to prevent phase separation would not be technically feasible to inject.

Injection into the annular space of an existing well is also not widely practiced due to the potential for considerable corrosion of the annular space casing strings. EnCana was successful in introducing cuttings injection technology to the East Coast in 1998/99, however, this technology is not immediately transferable to the injection of a produced water stream, as the injection volume is limited to a finite quantity before injection becomes inoperable. Furthermore, the potential exists for corrosion to shutdown either a production well or the condensate/acid gas injection well if problems occur in the annular space of these wells. Corrosion resistant material is available for this type of application, however, the costs associated with this material is similar to the high capital costs seen for a dedicated injection well. Due to this consequence, this option is not feasible.

2.10.2.8 Condensate Handling

Three options for condensate handling were evaluated for this Project, including the use of a dedicated pipeline to shore, use of condensate as a fuel, and storage and shipment by tanker. Two of the three alternatives were identified as technically and economically feasible with different types and levels of risk (refer to Table 2.17). The third option (subsea storage) was deemed not economically feasible. After reviewing the alternatives, it was determined that use of condensate as the primary fuel is the preferred option for the Project.

The potential volume of condensate that will be produced with Deep Panuke gas at peak production is less than 400 m^3/day. This is a very small volume of condensate compared to the SOEP, which produces approximately 3,000 m^3/day.

Table 2.17 Condensate Handling Alternatives

Alternative	Technical Suitability	Cost	Commercial Risk	Technically and Economically Feasible	Concept Deliverability	Safety	Environmental Impact
Dedicated pipeline to shore	• proven technology	• higher capital costs than use of condensate as a fuel	• no significant concerns	• yes	• no significant concerns	• pipeline must be buried to protect it from damage from fishing gear.	• environmental concern associated with rupture of the condensate pipeline although that possibility is very unlikely
Use of condensate as a fuel	• tri-fuel usage (gas/condensate/ diesel) not widely used in offshore production, but feasible	• least expensive	• no significant concerns	• yes	• specialized equipment which is not available in Canada has long lead delivery	• no significant concerns	• reduced transfers of diesel (required as a backup fuel) since a tri-fuel system will be in use
Storage and shipment by tanker	• proven technology	• substantial higher capital costs than use of condensate as a fuel	• no significant concerns	• no			

Use of a dedicated condensate pipeline would necessitate the construction of condensate handling facilities, such as storage tanks, onshore. The dedicated pipeline and associated handling facilities would have substantial capital costs associated with this option. The pipeline would have to be buried over the complete length to protect it from damage from conventional fishing gear. The environmental concern associated with rupture of the condensate pipeline is also a concern.

The use of condensate as the primary fuel on the production platform was also considered. Using condensate as fuel eliminates the substantial capital and operating costs associated with a condensate pipeline to shore and necessary onshore condensate handling facilities. The use of condensate as fuel provides a resource conservation measure by exploiting the uneconomic component of the Deep Panuke resource while making available more natural gas for sale.

A subsea storage tank for handling the total condensate volume offshore was also considered. A tank was investigated with an optimum off-loading frequency of approximately six months to accommodate the relatively small quantity of condensate to be produced. Although subsea storage tanks are used in other facilities, the relatively shallow water at the Deep Panuke site presented a risk for potential seafloor scour, necessitating large quantities of rock protection. The prohibitive installation costs resulted in this option not being economically feasible.

SBM/EMOBM Drill Cuttings Disposal

There are various alternatives for disposing of the drill cuttings; however, the options fall into three main categories: disposal overboard, injection, or “skip and ship”. All three alternatives were identified as technically and economically feasible with different types and levels of risk (refer to Table 2.18). After a review of the alternatives, it was determined that SBM and EMOBM cuttings will not be discharged overboard; they will be injected or skipped and shipped to shore. Water-based mud (WBM) cuttings will be discharged overboard.

There are three hole sections for each well, each of which has different mud-type requirements: surface hole section (from seabed to the Wyandot formation), intermediate hole section (from the Wyandot formation to the top of Abenaki formation), and the main hole section (from the top of the Abenaki formation to the production zone).

Table 2.18 SBM/EMOBM Cuttings Disposal Alternatives

Alternative	Technical Suitability	Cost	Commercial Risk	Technically and Economically Feasible	Concept Deliverability	Safety	Environmental Impact
Overboard (skip the centrifuge underflow)	• proven technology • meets guidelines with skip of centrifuge underflow	• base Case	• centrifuge underflow and slops need to be skipped and shipped to shore • unlikely to have a shutdown because skip and ship volumes are lower (smaller volumes for disposal at approved facility)	• yes	• no significant concerns	• some crane lifts and trucking required • HSE issues associated with handling SBM/EMOBM	• some cuttings brought to shore for disposal • current technology is achieving COR at <6.9% • probable low environmental impact (rate of dispersion likely to be similar to WBM), but EEM program is required to verify
Injection	• successfully used this technology on the Cohasset Project	• approximately equal to base case if no dedicated injection well is required	• loss of deck space which may affect rig selection criteria • may have other costs depending on the equipping of disposal well • risk of cost overrun potential in initial setup cost	• yes	• only applicable to development drilling	• pressurized wellhead in operation during drilling • HSE issues associated with handling SBM/EMOBM	• minimal environmental impact
Skip and Ship	• proven technology • utilized by SOEI and many other East Coast Operators	• more expensive than base case (up to $4.0 MM)	• drilling may get shut down in fast hole or large diameter section if skip turnaround is too slow or due to bad weather • control drilling is very expensive, if needed	• yes	• no significant concerns	• significant crane lifts and trucking required. • HSE issues associated with handling SBM/EMOBM	• onshore disposal options at NSDEL-approved treatment facilities

WBM will be used to drill the surface hole for several reasons. The hole angles of the top sections will likely not be extremely high, so the inhibition provided by SBM/EMOBM is not required. The hole section drills very quickly, so again, the higher level of inhibition is not required. But most importantly, the potential for surface (seafloor) break-through of the drilling fluid while drilling this hole section is fairly high. From an environmental and economic perspective, this break-through would be unacceptable. For the intermediate section, WBM or SBM/EMOBM will be used. The selection of the drilling fluid type for the intermediate hole section will be based on similar reasons as mentioned above. The hole angle, the formation types drilled (*e.g.*, mudstone, sandstone, clays) and the time of exposure will be the key drivers to determine the preferred drilling fluid type. An ongoing borehole stability study will provide additional information on the critical parameters that outline the selection process. Finally, for the main hole section, WBM will most likely be used in the case of AVC drilling.

EnCana intends to use WBM where it is technically practical, and only use SBM/EMOBM where hole conditions (*e.g.*, higher hole angles for longer reach directionally drilled wells) otherwise warrant. However, it seems very unlikely that WBM can be used for all wells.

If SBM/EMOBM are used, the whole mud will be returned to the shore base for reconditioning or disposal while the cuttings would be disposed of with one of the following practices:

- injection into a disposal zone, through either annular injection or a dedicated well; or
- by skip-and-ship transport to shore for treatment and disposal at an approved facility (EnCana does not intend to overboard discharge SBM/EMOBM cuttings).

Cuttings that are sent to shore for disposal will follow strict manifesting and comply with all applicable *Transportation of Dangerous Goods (TDG)* Regulations. The cuttings will be loaded into containers and lifted to a supply vessel for transit to EnCana's Supply Base facilities. A waste contractor will then take the containers to an NSDEL-approved disposal facility for treatment using low temperature thermal desorption or bioremediation.

A study will be undertaken to determine the optimal mud-type to be used for the Project. Some wells can be drilled with WBM, while others may need to use SBM/EMOBM. All wells could be drilled with SBM/EMOBM but at a higher drilling cost than with WBM. WBM offers the least health and safety risks while SBM/EMOBM offers the lowest drilling risk.

3 MALFUNCTIONS AND ACCIDENTAL EVENTS

This section provides an overview of potential malfunctions and accidental events that may occur during the Project with an emphasis on events that will likely have environmental effects. Spill risk and behaviors have been modeled to determine the probability and extent of impacts. A detailed discussion of spill risk and probability is included in Section 3 and Appendix B of the EIS (DPA Volume 4). While the likelihood of a significant spill or release of gas is extremely unlikely, the potential consequences of such an event need to be understood so that safety, emergency response and contingency planning can be completed to ensure the risk is further minimized.

3.1 Potential Malfunctions and Accident Events

Malfunctions and upset conditions having potential environmental effects include: small spills; malfunction of the acid gas management system; blowouts and pipeline ruptures; and collisions. The most serious accidents are probably well blowouts, involving large scale releases of raw gas (including condensate) and/or injected acid gas. Such an event is predicted to be highly unlikely (refer to Section 3.5). EnCana has incorporated design features and procedures to minimize and virtually eliminate this possibility (refer to Section 2.9). Safety, emergency response and contingency plans will be in place to limit adverse effects, should such an event occur (refer to Section 4).

Routine operations can be conducted with sufficient mitigation to ensure that effects on air quality, and therefore, on human health and safety, are not significant. There is potential for significant adverse environmental effects to occur in the extremely unlikely event of a blowout of an injection or production well, or an acid gas pipe rupture. Design, inspection, maintenance and integrity assurance programs, as well as proven engineering techniques, will be in place to prevent such events from occurring. All safety procedures will be documented and in place prior to the commencement of routine operations.

All fuel, chemicals and wastes will be handled in a manner that minimizes or eliminates routine spillage and accidents. EnCana's Environmental Protection Plans (EPPs) will contain safe chemical handling and storage procedures (refer to Appendix D). EnCana's Spill Response Plan will contain detailed measures for preparing for and responding to spills, including the use of cleanup equipment, training of personnel and identification of personnel to direct cleanup efforts, lines of communications and organizations that could assist cleanup operations (refer to Appendix D).

3.1.1 Platform-based Spills

Small spills/leaks are most likely to occur under valves and at hose connections. Valves are numerous and widespread over the platforms. An open-drain system supplemented by spill trays ensures that small spills/leaks are contained. Bulk transfer and hose handling procedures will also be included in the EPP to minimize spills during transfers of materials between the supply vessels and the platform. Workers will be trained in other task-specific activities to further reduce the likelihood of spills. Spills which occur during routine maintenance activities will be cleaned up immediately.

Table 3.1 includes reported spill volumes from the oil and gas industry offshore Nova Scotia as reported to the CNSOPB.

The risk and probability of marine spills is presented in Section 3.2.

3.1.2 Collisions

The risk of collision between platforms and vessels is anticipated to be extremely low based on compliance with standard procedures. A safety zone will be established in accordance with CNSOPB regulations and will most likely be a 500 m zone around the perimeter of each of the three jackets and take into account a temporary 500 m overlap from the drilling rig when it is on location. For further detail, refer to Section 2.4.3. Surface facilities will contain navigational aids, and anti-collision radar will provide early warning of a potential collision hazard. In the unlikely event that a collision cannot be avoided, EnCana's AERCP would address response procedures.

Only five oil spills occurred between 1971 and 1990 as a result of a collision between a vessel and a platform. Based on U.S. Minerals Management Service (MMS) statistics, the estimated probability for such an accident associated with the Deep Panuke Project is 2.78×10^{-4} spills per year, or one such accident every 3,600 years. This is therefore considered to be a very low probability event.

3.1.3 Malfunction of Acid Gas Management System

Under normal operations, waste acid gas will be injected into a disposal (injection) well. Malfunctions of compressors or other equipment associated with acid gas management could lead to conditions that require flaring of the acid gas. Equipment downtime and flaring will also be required for routine maintenance and is expected to be a brief period (*e.g.*, a few days or a week). In the unlikely event of major equipment malfunctions, equipment downtime and associated flaring could last up to 5 months (in the event a new injection well needs to be drilled and subject to CNSOPB approval). Flaring of acid gas normally results in emissions of SO_2; however, flare malfunction resulting in failure to ignite, will result in emissions of H_2S. Air emissions during upset conditions are described in detail in Section 6.3.1.

Table 3.1 Reported Spill Volumes from Nova Scotia Offshore Oil and Gas Industry Offshore Nova Scotia (1994-2001)

Product Type	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**Totals**
Crude Oil	1 m^3- cb								1 m^3
Produced Oil	0.6 m^3 – ls	1.8 m^3– cb							2.4 m^3
Oil			0.0835 m^3 -r/p	0.1 m^3 – ls	0.001 m^3–r/p	0.832 m^3– ls 0.005 sv	0.0001 m^3–r/p		1.0216 m^3
Fuel Oil						1.7 m^3 – ls			1.7 m^3
Compensator Fluid						0.015 m^3– ls			0.015 m^3
Diesel						0.038 m^3 – ls 0.15 m^3 –r/p 0.003 m^3-sv	0.39 m^3 –r/p	0.0007 m^{3-} r/p	0.5817 m^3
Preserving Oil						0.00015 m^3 – ls			0.00015 m^3
Hydraulic Oil			0.03 m^3 – ls			0.005 m^3– ls 0.022 m^3–r/p	0.08 m^3–r/p		0.137 m^3
Condensate/Light Crude		0.02 m^3– r/p	0.08 m^3 – r/p			0.055 m^3 – r/p	0.128 m^3–r/p		0.283 m^3
Oil/Water			0.1057 – r/p		0.1077 m^3 – r/p				0.2127 m^3
Oil-based mud		35 m^3 – r/p	3.4 m^3 –r/p	0.49 m^3 – r/p	0.881 m^3 – r/p 6- sv	0.154 m^3 – r/p 0.025 –sv	0.027 m^3 –r/p		45.977 m^3
Synthetic-based mud					0.001 m^3–r/p	0.717 m^3 –r/p	0.45 m^3–r/p	0.04 m^{3-} r/p	1.208 m^3
Light Oil					0.001 m^3-sv				0.001 m^3
Synthetic Oil						0.02 m^3–sv			0.02 m^3
Cable Oil							0.008 m^3 –sv		0.008 m^3
Annual Totals	**1.6 m^3**	**36.82 m^3**	**4.6505 m^3**	**0.59 m^3**	**6.9917 m^3**	**3.74115 m^3**	**1.083 m^3**	**0.0407 m^3**	**55.51705 m^3**

Key: cb = calm buoy; ls = large ship; r/p = rig/platform; sv = seismic vessel

Source: E. Theriault, pers. comm. 2001

The acid gas injection well will be drilled in a permeable geological formation. The intended well reservoir for disposal of the acid gas does not contain sulfur, therefore it is anticipated that a blowout during drilling of the injection well would not contain significant amounts of H_2S. The two levels of protection against blowouts during production are control valves at the wellhead and subsurface. The subsea valve is installed in the well approximately 200 to 300 m below the sea floor. This is a failsafe valve that must be maintained open by hydraulic pressure on a line from the surface. Interruption of pressure on this valve, either through control action on the platform, or by accidental event, results in rapid closure of the valve. This would limit the potential discharge to the volume of gas within the pipe. Figure 2.9 of the EIS shows a typical acid gas injection well schematic. Section 3.5.2.1 describes the fate and behavior of a blowout of the acid gas injection well.

3.1.4 Blowout Releases

The most serious, although extremely unlikely, spill scenarios for the Project are associated with well blowouts. There are two basic kinds of offshore oil/gas well blowouts. The first is a subsea blowout in which the discharging oil and gas emanates from a point on the sea bed and rises through the water column to the water surface. The other possibility is an above-surface blowout in which oil and gas discharges into the atmosphere from some point on the platform above the water surface, and subsequently falls on the water surface some distance downwind.

Probability of spills including blowouts is discussed in Section 3.2. Spill behaviour is discussed in Section 3.5. Atmospheric emissions related to well blowout is discussed in detail in Section 6.3.1. Design features to be used by EnCana to prevent or greatly minimize the chances of a serious spill are described in Section 2.9.

3.1.5 Pipeline Releases

The subsea pipeline to shore will transport market-ready gas; gas liquids (condensate) and H_2S will be removed during processing on the production platform. The pipeline will be designed to withstand impacts from conventional mobile fishing gear in accordance with the DNV Guideline No. 13, Interference between Trawl Gear and Pipelines, September 1997.

Leak detection for the pipeline will be carried out by the use of mass balancing which will be done on a periodic basis. This method is considered an accepted industry practice for a single pipeline. There will also be separate monitoring of the pipeline pressure for control purposes such that the maximum allowable operating pressure is not exceeded. Significant leaks that would have an impact on the environment will be detected immediately by process instrumentation. The control room will be staffed 24 hours a day, 7 days a week, monitoring the facilities.

In the unlikely event of a pipeline rupture, natural gas will rise to the surface at speeds between 5 to 10 m/s (rise time will depend on water depth at the location of the release) and dissipate into the atmosphere. This gas phase is composed largely of methane, but also contains, in lesser amounts, hydrocarbons (ethane, propane and butanes), plus inorganic contaminants (carbon dioxide, nitrogen, and hydrogen sulphide) in varying quantities.

The pipeline has a shutdown valve and check valves onshore to prevent gas from backing up. The pipeline is also designed with a SSIV assembly about 500 m from the platform. The check valves and SSIV are expected to close within 30 seconds of a pipeline rupture, limiting the amount of gas to be released.

Risks of onshore pipeline and subsea pipeline releases are described in Sections 3.3 and 3.4, respectively.

3.1.6 Effects of the Environment on the Project

Effects of the environment on the Project (*e.g.*, extreme waves, sea ice) which may cause upset conditions are discussed in Section 8.

3.2 Marine Spill Risk and Probability

A detailed discussion of spill risk and probability associated with the Project is presented in Appendix B of the EIS (DPA Volume 4). The calculated spill frequencies for the Project are summarized in Table 3.2.

3.2.1 Platform-based Spills

Small and medium platform-based spills could contain diesel oil, hydraulic fluid, lubricants, other refined oils, mineral oil, or non-aqueous drilling mud. The highest frequencies for all spills are for the smaller, platform-based spills. One spill in the 1 to 49.9 barrels (bbl) range might occur over the course of the Project, although its average size can be expected to be less than 10 barrels. There is about a 4 or 5% chance that a platform-based spill larger than 50 barrels might occur over the course of the entire Project.

The annual probability of having a large (>1000 bbl) or very large (>10,000 bbl) spill as a result of an accident on a platform is one in 8,300 and one in 23,000 respectively. This is calculated on the basis of United States. Outer Continental Shelf (US OCS) experience. This means that if the Project were to continue forever, one platform-based spill larger than 1,000 barrels might occur every 8,300 years. Similarly, very large platform spills (>10,000 bbl) might occur once every 23,000 years.

Table 3.2 Predicted Number of Blowouts and Spills for the Deep Panuke Project

Event	Historical Frequency	Deep Panuke Exposure	No. of Events	Annual Probability
BLOWOUTS				
1. Deep gas blowout during development drilling	2.4×10^{-4}/wells drilled	8 wells drilled over 15 months[2]	1.92×10^{-3}	one in 650
2. Gas blowout during production	1.17×10^{-4}/well-years	92 well-years	1.08×10^{-2}	one in 1,100
3. Blowout during production involving some oil discharge >1 bbl	1.04×10^{-5}/well-years	92 well-years	9.57×10^{-4}	one in 12,000
4. Development drilling blowout with oil spill > 10,000 bbl	5.3×10^{-5}/wells drilled	8 wells drilled over 15 months	4.24×10^{-4}	one in 2,400
5. Development drilling blowout with oil spill > 150,000 bbl	2.7×10^{-5}/wells drilled	8 wells drilled over 15 months	2.16×10^{-4}	one in 5,800
6. Production/workover blowout with oil spill > 10,000 bbl	2.0×10^{-5}/well-year	92 well-years	1.84×10^{-3}	one in 6,300
7. Production/workover blowout with oil spill > 150,000 bbl	8.0×10^{-6}/well-year	92 well-years	7.36×10^{-4}	one in 16,000
PLATFORM SPILLS (incl. blowouts)				
8. Oil spill > 10,000 bbl	5.5×10^{-6}/well-year	92 well-years	5.06×10^{-4}	one in 23,000
9. Oil spill > 1000 bbl	1.5×10^{-5}/well-year	92 well-years	1.38×10^{-3}	one in 8,300
10. Oil spill 50-999 bbl	4.8×10^{-4}/well-year	92 well-years	4.4×10^{-2}	one in 260
11. Oil spill 1-49 bbl	1.0×10^{-2}/well-year	92 well-years	0.92	one in 13

Notes:

1. Platform spill frequencies are derived from US OCS experience and gas blowout frequencies are based on both US OCS and North Sea records. Blowout spill data for spills larger than 10,000 bbl are derived from worldwide data. The relatively better record in the US is one reason that the frequency for platform spills >10,000 bbl is smaller than the frequency for the blowout spills >10,000 bbl. As well, the blowout frequencies for major spills is derived on the basis of worldwide data do not take into account falling trends, which are difficult to calculate because of lack of data. It is likely that the frequencies of blowout-based major spills predicted for Deep Panuke (items 4 through 7) should be significantly lower than noted in the table, based on trends in the US OCS and North Sea. Further information on data sources is presented in Appendix B of the EIS (DPA Volume 4).

2. A total of eight development wells was used to be conservative.

3.2.2 Blowouts

During the 15 months needed to drill 8 wells, the chances of an extremely large (>150,000 bbl) and very large (>10,000 bbl) oil well blowout from development drilling are extremely small. If this drilling rate were to continue forever, one could conservatively expect one extremely large spill every 5,800 years; a very large spill might occur every 2,400 years. For similar sized blowouts from production activities and workovers that might occur over the 11.5-year production period, one might expect one extremely large oil well blowout every 16,000 years, and one very large oil well blowout every 6,300 years of production. These predictions are based on worldwide blowout data and are strongly influenced by blowouts that have occurred in Mexico, Africa and the Middle East, where drilling and production regulations may be less rigorous.

Considering experience in the North Sea and the US Gulf of Mexico and taking into account the trend toward fewer and fewer blowouts, the prediction for Deep Panuke is that, during the initial 15 months when eight wells will be drilled, the probability is 0.19% chance per year (one-in-650) of having a deep blowout (one that could involve sour gas). Similarly, during production at Deep Panuke, gas blowouts might be expected to occur every 1,100 years, and blowouts involving small amounts of discharged oil (>1 bbl) might be expected to occur once every 12,000 years.

3.3 Onshore Pipeline Risk

A detailed risk assessment of the onshore portion of the pipeline has been conducted by EnCana: "PanCanadian Deep Panuke Onshore Pipeline Quantitative Risk Analysis" (Bercha Engineering Limited 2002). The following information summarizes some of the key findings of this assessment.

3.3.1 Accident Scenarios

The only accident scenarios associated with the onshore pipeline posing any threat to safety or environmental quality are accidental losses of containment. Although accidental losses of containment are extremely unlikely, it is important that the potential consequences of such an event is understood so that safety, emergency response and contingency planning can be completed to ensure the risk is further minimized.

An accidental release of natural gas would result in either dispersion or delayed ignition of the flammable gas. Losses of containment have been characterized as leaks (very small hole), holes, or ruptures. The likelihood of each of these is as follows:

- Leaks – 1 in 500 year
- Holes – 1 in 3,000 years
- Ruptures – 1 in 10,000 years

3.3.2 Hazards

The released gas only becomes hazardous in the instance that it is ignited. Due to the very low population density and level of industrial activity in the direct vicinity of the pipeline, leaks are virtually certain to remain unignited and, therefore, disperse harmlessly, while holes or ruptures are associated with a probability of ignition of approximately 20%. A large proportion of this probability of ignition would be auto-ignition, from the energy and possible sparks generated in the occurrence of the hole or rupture.

In the case of immediate ignition, a jet fire would result, involving the generation of a flame up to several hundred metres in length. In the case that ignition is delayed, under the most unfavourable atmospheric and release conditions, a natural gas cloud could extend several hundred meters, until it ignites from an accidental ignition source. The gas cloud would then ignite, flashing back to the origin, and resulting in a jet fire, lasting until the gas in the segment has been depleted.

The likelihoods of ignited leaks are negligible, while the possible occurrence of the above mentioned jet fires or flash fires from holes or ruptures are significantly less likely than the occurrence of the actual initiating loss of containment, giving likelihoods of potentially harmful scenarios (*i.e.*, associated with fires) as follows:

- Holes – 1 in 20,000 years
- Ruptures – 1 in 30,000 years

3.3.3 Risks

In the unlikely event of loss of pipeline containment, it is even more unlikely that any people would be hurt, as they are unlikely to be in the vicinity of the pipeline when such an event occurs. Environmental damage, however, in the instance of either a jet fire or a flash fire would likely result in the form of ignition of vegetation. Such damage, however, would only result over the footprint of the jet or flash fire, unless humidity and wind conditions were conducive to secondary fire escalation. Because the pipeline contains only market-ready gas, there can be no pipeline releases involving gas liquids that could pool and affect ecosystem components such as streams and wetlands.

In regards to public safety, the combination of the likelihood of the occurrence of an initiating accident, ignition probability, and likelihood of people being exposed results in risks in the order of 1 in 5 million years for individuals, and much less for (1 in 100 million years) for groups of people.

In summary, it can be stated, that risks from the proposed onshore pipeline segment, which are a combination of the probability and likelihood of adverse effect, are very low both in terms of public safety and any potential environmental damage.

3.4 Subsea Pipeline Risk

Internationally, the focus of offshore subsea pipeline accidents is on pipelines carrying oil because of the potential for oil spills. Consequently, there are comprehensive databases (in the US and North Sea) on pipeline spills involving oil, but less data on gas pipeline accidents and discharges. A detailed analysis of the offshore pipeline risk was presented in Addendum 1 (Appendix D). The following is a summary of that analysis.

3.4.1 Deep Panuke Risk Exposure

Market-ready gas, which is free of sour gas and condensate, will be transported via a 610 mm (24-inch) nominal diameter sub-sea pipeline to shore. The offshore portion of the Deep Panuke pipeline is approximately 175 km in length. The water depth along the offshore route varies, but is always greater than 25 m except close to at landfall.

3.4.2 General Comparison of Gas and Oil Pipeline Accident Frequencies

It is difficult to compare offshore gas pipeline spills to oil pipeline spills because data is lacking for gas lines; however, there is good data on onshore pipeline spills.

The overall average frequency of pipeline leakage frequencies for onshore pipelines in Western Europe is in the range of 0.4 to 0.6 discharges per 10^4 km-yrs (E&P Forum 1996). The leakage frequency due to corrosion is two to three times higher for oil lines compared to gas lines. The other failure modes have similar frequencies for both kinds of lines; this is because all failure modes other than corrosion are mechanical in nature and are as likely to affect the integrity of gas lines, as much as oil lines.

A review of subsea pipeline spills in the North Sea from 1970 to 1991, reveals that leaks due to corrosion are much less frequent for gas lines than for oil lines, as is the case for on-land pipelines. Only one leak from a gas line occurred in approximately 81,000 km-yrs of gas line experience (0.125 leaks/10^4 km-yrs). The overall average for all pipeline loss-of-containment accidents is 0.80 leaks/10^4 km-yrs (E&P Forum 1996).

Bercha (2001 in draft) uses MMS records of spills from subsea pipeline accidents and pipeline exposure in the US OCS derive spill frequencies as a function of a number of variables. Applying these derived frequencies to the Deep Panuke Project (pipe diameter = 610 mm, depth >10 m and segment length > 5km), then the frequency of spills (or loss of containment) would be in the range of 0.74 to 1.35 spills/10^4 km-yrs.

3.4.3 Prediction for Deep Panuke

Considering both gas and oil lines, and comparing the Gulf of Mexico-OCS recent experience to the North Sea experience, it is seen that a frequency of loss of containment of approximately 0.8 leaks/10^4 km-yrs is appropriate. This is the frequency that will be assumed for the Deep Panuke situation. This is a conservative estimate because it overestimates the effect of corrosion (Deep Panuke being a gas line) and assumes that accidents due to anchor dragging, trawling and other fishing-related effects will be as prevalent as those experienced in the Gulf of Mexico and North Sea, even though special precautions are planned in the Deep Panuke Project to minimize such effects.

The production life of the Deep Panuke Project is assumed to be 11.5 years; therefore, the frequency of gas leaks due to accidents over the 11.5-yr period is estimated to be

$$0.8 \text{ leaks}/10^4 \text{ km-yrs} \times 175 \text{ km} \times 11.5 \text{ yrs} = 0.16 \text{ gas leaks}$$

This is equivalent to 0.014 leaks per year (0.16/11.5). In other words, if the Project were endless, one might expect a gas leak from the subsea pipeline once every 71 years (1/0.014).

3.5 Marine Spill Release Behaviour

The following is a summary of the spill release modeling results presented in Section 3.3 of the EIS (DPA Volume 4). Refer to the EIS for a detailed description of the environmental data and modeling approach used.

3.5.1 Platform-based Spills

Small batch spills of diesel fuel or condensates from hose ruptures during transfer operations from a supply vessel or from platform storage facilities are a possibility. These spills are considered instantaneous events and are modeled by considering the surface spreading, evaporation, dispersion, emulsification and drift of a single patch or slick of oil.

Batch spill fate modeling was conducted for diesel fuel spill and condensate (10 and 100 barrels spill scenarios for both). There was found to be very little difference in the behavior of the winter and summer oil spill scenarios. The small differences that do exist are due to the warmer summer temperatures and slightly higher evaporation amounts prior to the full dispersion of the slicks. The following summaries provide descriptions of the fate of the various spill scenarios that apply to both seasons.

Diesel

The 10-barrel batch spill of diesel will lose about 30% through evaporation, persist as a slick for about 13 hours and travel about 18 km prior to the complete loss of the surface oil. The maximum dispersed oil concentration for this spill will be about 2 ppm and this will drop to 0.1 ppm within about 16 hours. The concentration of 0.1 ppm of total petroleum hydrocarbon is the exposure concentration below which no significant biological effects are expected, based on historical laboratory research. The dispersed oil cloud will travel about 20 km and have a maximum width of about 1,200 m.

The 100-barrel batch spill of diesel will also lose about 30% through evaporation, persist as a slick for about 19 hours and travel about 27 km prior to the complete loss of the surface oil. The maximum dispersed oil concentration for this spill will be about 4 ppm and this will drop to 0.1 ppm within about 42 hours. The dispersed oil cloud will travel about 35 km and have a maximum width of about 3,800 m.

These model results assumed a wind speed of 20 knots (37 km/h). By increasing the wind speed to 40 knots (74 km/h) and assuming a 3 % wind drift, model results indicate a 100-barrel spill would disperse in 6.5 hours and travel 14.4 km.

Condensate

Both the 10- and 100-barrel batch spills of condensate will evaporate and disperse very quickly. These batch spills are likely to persist on the surface for less than half an hour and travel only 400 to 700 m from the release point prior to dissipation under average wind conditions. The maximum condensate concentrations from these spills are estimated to be between 30 to 45 ppm. The dispersed oil concentration for the 10-barrel spill will drop to 0.1 ppm within about 15 hours. The dispersed condensate cloud will travel about 5 km and reach a maximum width of about 1,200 m. The dispersed oil concentration for the 100-barrel spill will drop to 0.1 ppm within about 42 hours. The condensate cloud for the larger release will travel about 15 km and reach a maximum width of 3,700 m.

3.5.2 Blowouts

Preliminary modeling of the behaviour and fate of condensate from subsea and surface blowouts has been completed for the Project. For both scenarios, there is little difference in winter and summer spill behaviors. The small differences that do exist are due to warmer summer temperatures and the consequent slightly higher evaporation rates of the condensate slicks during this period. Similarly, no condensate is predicted to reach the shores of Sable Island or mainland Nova Scotia.

3.5.2.1 Subsea Blowout Fate and Behavior

The results of the production well subsea blowout modeling from the Deep Panuke formation indicate that thin condensate slicks or sheen will form initially over a width of about 2 km. The slicks will be about 6 Fm thick and will disperse within minutes under average winds. The initial in-water condensate concentrations from these releases will be less than 0.5 ppm. Condensate concentrations will drop to 0.1 ppm within 22 hours if the modeled evaporation estimates (17 to 24%) are used. If 50% of the condensate is assumed to evaporate (a more likely estimate) then the in-water condensate concentrations will drop to 0.1 ppm within about 13 hours. The width of the condensate cloud will be 3 to 4 km when it reaches 0.1 ppm.

In the unlikely event of a subsea acid gas injection well blowout, H_2S gas could escape from the reservoir. This gas is estimated to flow at a rate of 1,616 g/s (50 Moles/s) at an estimated temperature of 85 ^{o}C. A fully developed bubble plume with water entrainment will force gas to the surface at an estimated speed of approximately 1 m/s. The rise time to the surface will be a function of the water depth and the subsea location of release.

Given the relatively shallow depths of the waters at the Deep Panuke site (approximately 40 m) and the estimated velocity of bubbles to the surface (1 m/s), it is highly likely that a significant gas flow will result in a rising plume of water made buoyant by its contents of gas bubbles which will speed the transport of H_2S to the surface (approximately 40 seconds to reach the surface).

A subsurface blowout resulting in the release of a large quantities of acid gas from the injection well would result in significant adverse effects to air quality for several criteria and could result in important consequences affecting the health and safety of workers on platforms and vessels within 4 km. It is estimated, however, that such an event would be extremely unlikely and of short duration, with the probability of occurrence further reduced through good design practices (refer to Section 2.9) and maintenance. Subsurface blowouts could last several months with the failure of all safety equipment, which is considered extremely unlikely.

3.5.2.2 Surface Blowout Fate and Behavior

Surface blowouts associated with a production well will generate relatively narrow (about 200 m wide) and relatively thin (<15 Fm) slicks. About 70 to 75% of the condensate will evaporate in the air prior to reaching the water surface and the remaining condensate will disperse into the water within minutes, under average wind conditions. The resulting dispersed condensate clouds will diffuse to 0.1 ppm condensate concentration in 6 to 7 hours and have a width of about 600 to 700 m at this point. The surface slicks will persist for only several minutes prior to dispersing.

The acid gas injection well surface blowouts will be narrower and thicker than production well blowouts due to the higher condensate and lower gas flows. The initial slicks will be about 100 m wide and 260 to 390 Fm thick. About 60 to 72% of the condensate will evaporate in the air prior to reaching the water surface, and the remaining condensate will disperse into the water within about half an hour. The resulting dispersed condensate clouds will diffuse to 0.1 ppm condensate concentration in 21 to 25 hours and have a width of between 1,760 and 2,100 m at this point.

No condensate is predicted to reach the shores of Sable Island (approximately 50 km away) or mainland Nova Scotia. The distance the surface condensate slick will travel is a function of the evaporation and dispersion rate, and the surface drift speed of the slick. The condensate release from the Uniacke G-72 incident is an example of an accidental event where there was no detectable condensate (surface slicks, aerosols or in-water condensate) at distances greater than 10 km from the source (Martec Limited 1984).

The Uniacke blowout occurred February 22, 1984 and continued for 10 days. The gas and condensate aerosol plume was estimated to rise approximately 10 m above its point of exit at the rotary table on the drilling floor. The slick that formed from the condensate fallout was approximately 300 m wide near the source and spread to a width of approximately 500 m. It was estimated that between 50 to 70% of the condensate volume evaporated in the air prior to reaching the water. Seventy-five percent of the slick area was estimated to be 1.8 µm thick. Condensate was detected in the upper 20 m of the water column, up to 10 km from the well, in concentrations generally below 100 ppb. The maximum in-water condensate concentration measured was 1.5 ppm. The slick was observed to physically dissipate once the well was capped and there were no visual observations of a residual slick on over-flights the day after capping (day 11 after the blowout) (Martec Limited 1984).

4 HEALTH, SAFETY AND ENVIRONMENTAL MANAGEMENT

Environmental protection is fundamental to EnCana's operations and forms an integral part of the Company's Environment, Health and Safety (EHS) Management System. EnCana's East Coast Region (ECR) is committed to the implementation of the requirements of ISO 14001, the International Standard for Environmental Management Systems.

The following is an outline of EnCana's corporate commitment to health, safety and environmental management, with an emphasis on environmental management for Deep Panuke. EnCana's environmental management framework, displayed in Figure 4.1, places Project specific plans in the context of EnCana's corporate framework.

These plans will be developed and continually revised as the Project moves through the phases of design, construction, installation, production, and decommissioning. Inherent in this management system is the provision for continual environmental improvement, ongoing consideration of stakeholders, and adaptability of these documents to respond to environmental concerns. EnCana's EHS Management System is designed to be able to adapt and respond to evolving circumstances so that predicted and actual effects are managed effectively.

A detailed outline of the following Plans, including purpose, scope, objectives, requirements and responsibilities, is provided in Appendix D:

- Environmental Management Plan (EMP);
- Environmental Protection Plan (EPP);
- Offshore Construction EPP;
- Onshore Construction EPP;
- Environmental Effects Monitoring Plan (EEMP);
- Physical Environmental Monitoring Plan (PEMP);
- Waste Management Plan (WMP);
- Chemical Management Plan (CMP);
- Spill Response Plan;
- Alert/Emergency Response Contingency Plan (AERCP);
- Fisheries Compensation Plan; and
- Decommissioning Plan.

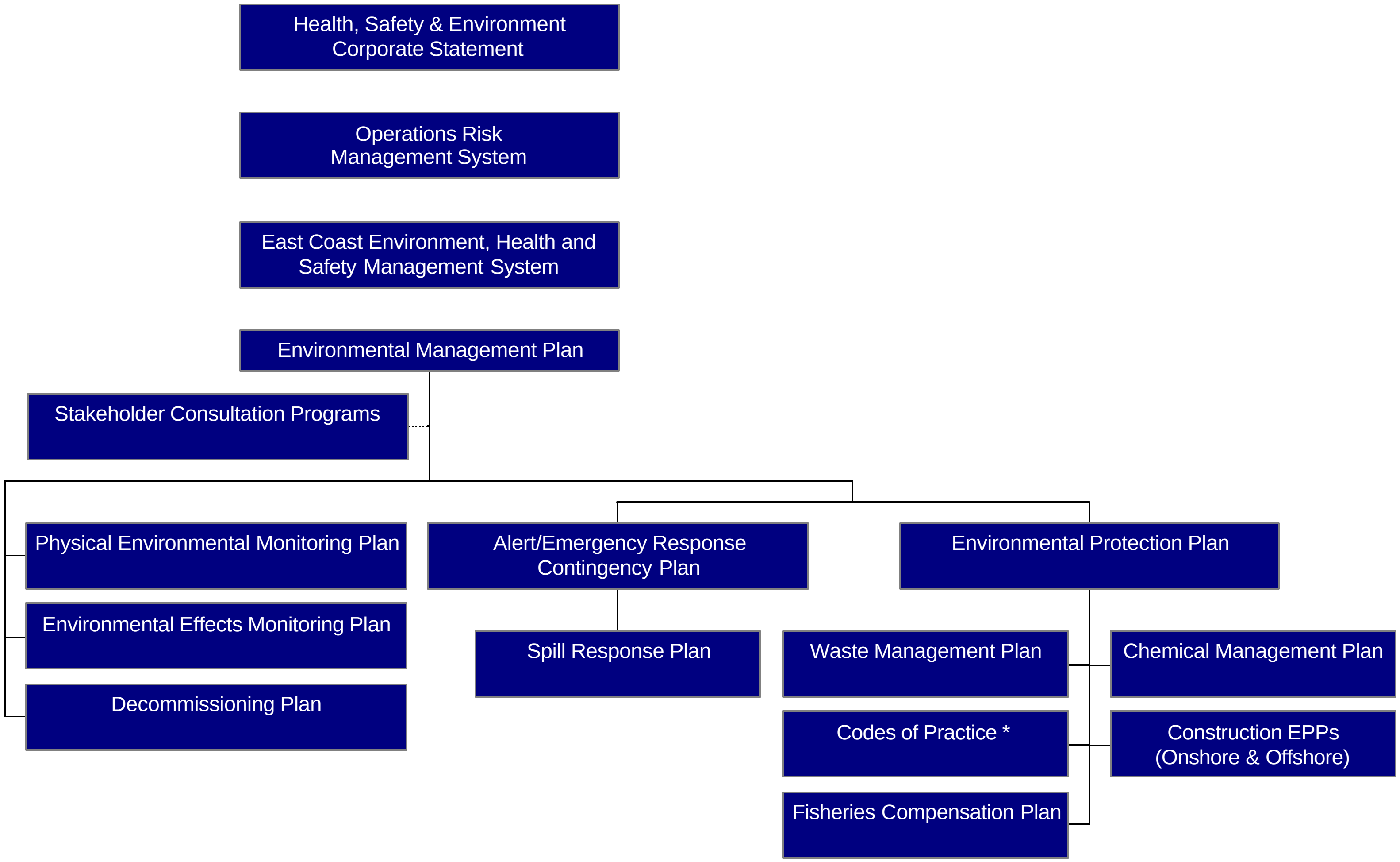


Figure 4.1 Deep Panuke Environmental Management Framework

* Codes of Practice have been adopted for Sable Island, Country Island and the Gully (refer to Appendix E).

Details of these plans can only be finalized once the Project design is finalized. These plans will be developed in consultation with various regulators to ensure their concerns are addressed in the planning process. Full versions of these plans will be provided to appropriate regulators for review prior to Project start-up.

As part of its commitment to adaptive management, EnCana will develop a follow-up program to be carried out over the life of the Project that takes into account impact predictions in the CSR, ongoing findings of the EEM program, mitigation measures adopted, and emerging issues that may arise. Specific issues for follow-up and monitoring have been identified by regulators during the course of their review of the draft CSR, DPA documents and Addendum 1. These issues to be addressed by EnCana include, but are not limited to:

- development of follow-up program principles;
- refining the EEMP with updated information on marine birds;
- management of spills and impacts on marine birds;
- influence of lighting and flaring on birds;
- the development of a program to monitor Project impacts on the Roseate Terns;
- development of a program to discourage all-terrain vehicle traffic on the pipeline RoW;
- verification of the absence of species of special concern;
- verification of the impacts of drilling muds and cuttings;
- applicability of the National Pollutant Release Inventory;
- verification of the impacts of produced water discharges; and
- consideration of resident organisms in the vicinity of the Project and contaminant transport.

Specific programs to address these issues will be developed in consultation with the relevant regulatory authorities. It is anticipated that this planning process will be managed by the CNSOPB.

4.1 Health, Safety and Environment Corporate Statement

EnCana Offshore & International Operations, and EnCana Offshore & New Ventures Exploration are committed to safeguarding the environment and minimizing health and safety risks to our employees, contractors and the communities in which we do business. EnCana pursues a policy of continual improvement in the measures taken to protect the environment and the health and safety of those who may be affected by our activities. Strong EHS performance is key to the success of EnCana, and EHS strategies are integrated into business decisions.

EnCana will achieve sound environmental, health and safety management by:

- integrating an environment, health and safety management system through all parts of our business operation. This system is aligned with Corporate policies and procedures, reflects industry best practices, and is designed to meet or exceed all relevant regulations and legislation where we operate;
- assuring that each employee, contractor and third party service provider understands their EHS responsibilities and is trained to meet them;
- identifying, assessing and effectively managing risks, and implementing processes to re-evaluate risks following changes to requirements, operations, facilities and personnel;
- consulting in EHS matters with all stakeholders in our areas of operation, and assessing all EHS matters before entering into new activities;
- actively protecting the environment in all our operating areas and seeking continual improvement in the efficient use of energy and natural resources;
- establishing EHS performance goals and objectives and regularly measuring our progress; and
- establishing an EHS program review process that assures our goal of continual EHS performance improvement.

Commitment to EHS is part of the EnCana culture and all employees are accountable in meeting EHS responsibilities. We will maintain EnCana as an environmentally responsible entity and assure the health and safety of our employees, contractors and the communities in which we operate. Our EHS policy is an integral part of our business and is publicly available.

4.2 Operations Risk Management System

EnCana's Operations Risk Management System (ORMS) was formally launched in 2000. It supports EnCana's commitment to the health and safety of individuals and the environment by providing a structured approach to ensuring safe and reliable operations. The ORMS serves as a framework or "umbrella" for the health, safety and environment policies, practices and guidelines implemented by EnCana. Specifically, the ORMS provides a structured approach to ensuring safe and reliable operations as a means to preventing incidents that could harm people and the environment. The ORMS focuses on 11 key elements required for successful management of the potential risk associated with EnCana's activities and outlines the expectation of each level in the organization for meeting the principles and objectives of each element. The 11 ORMS elements are as follows:

1. leadership, commitment and accountability;
2. risk management;
3. facilities design, construction and start-up;

4. operations and maintenance;
5. competency and training of employees;
6. third-party business relationships;
7. change management;
8. reporting and resolving incidents;
9. documentation;
10. emergency preparedness; and
11. evaluation and continuous improvement.

The ORMS also outlines the expectation of each level within the organization for meeting the principles and objectives of each element, namely Senior Management, Middle Management, and Front-line Personnel.

4.3 Environment, Health and Safety (EHS) Management System

EnCana has prepared an East Coast EHS Management System to provide guidance to EnCana East Coast employees and third parties acting on behalf of the company to ensure safe and environmentally responsible operations. The EHS Management System has been prepared in alignment with EnCana's Operations Risk Management System (ORMS) (refer to Section 4.2), CNSOPB regulations and Canadian Association of Petroleum Producers (CAPP) health, safety and environmental guidelines.

The primary components of the EHS Management System are:

- an organizational structure and defined EHS responsibilities and accountabilities for personnel;
- a safety performance objective system that provides a mechanism to measure and improve safety and recognize achievements in safety performance;
- a management plan to ensure compliance with regulations, goals and objectives;
- requirements for contractors to establish the minimum standards for a contractor safety and environmental program, and the interaction between EnCana and the contractor's safety and environmental programs;
- safe work practices and procedures documentation that establish basic precautions for preventing accidents, injuries or illnesses in the performance of work;
- environmental practices and procedures that establish minimum standards for all operations that have a potential to cause environmental problems;
- minimum safety training standards established to ensure that all personnel are aware of potential hazards and know safe work practices/emergency procedures;
- a medical and occupational health management program that will foster the maintenance and preservation of employees' good health and welfare;

- a safety meeting and Joint Health, Safety and Environment Committee structure that provides a forum for both management and non-management personnel to work together to identify and solve potential health, safety and environment problems at the worksite;
- an accident/incident reporting system that standardizes prompt reporting of all injuries, property damage, environmental incidents and near misses;
- an accident/incident investigation system that establishes investigation procedures for various categories of accidents/incidents;
- an Operations HS&E Review Committee that ensures EnCana and contractor management are aware of actual and potential hazards and therefore, can endorse or amend corrective action;
- a safety impact assessment intended to ensure installations not only provide an acceptable level of protection for personnel and property, but also meet all regulatory requirements;
- procedures for conducting major hazard reviews that will ensure the impacts of the full range of major accident scenarios that could affect the installations are within acceptable limits;
- procedures for conducting hazard and operability (HAZOP) studies, a systematic engineering technique for analyzing those routes whereby the operation or maintenance of an installation can lead to material damage, environmental damage, injury or death;
- a procedure to carry out formal safety and environmental audits for operations controlled by both EnCana personnel and contractors to verify compliance with approved plans, procedures, system specifications and/or other applicable contract requirements;
- a procedure for periodic operational safety and environmental inspections conducted to verify all activities conform to EnCana and regulatory agency requirements and are being conducted in a safe, efficient, and environmentally responsible manner;
- identification of potentially hazardous materials and exposures, controlled by WHMIS (Workplace Hazardous Materials Information System);
- procedures and an organization to initiate an organized response to an emergency or potential emergency situations, including periodic exercises; and
- a safety information management system that provides the ability to record safety information, analyze data and produce timely and relevant reports.

The environmental component of the East Coast EHS Management System will provide an umbrella for environmental protection planning, environmental monitoring, and stakeholder consultations. The environmental component will provide a framework, within the EHS Management System, to document, evaluate and communicate EnCana’s environmental performance. The system will be used by EnCana’s managers as a means of documenting the company’s overall strategic approach to environmental performance. The environmental component is also a means by which EnCana can demonstrate compliance with all required mitigation measures and regulatory requirements.

The EHS Management System is supported by various planning documents as shown in Figure 4.1. Additional documentation that supports the EHS Management System include, but are not limited to:

- EnCana Training and Qualifications Manual;
- EnCana Safe Work Practices and Procedures Manual;
- EnCana Offshore Seismic Safety Manual;
- EnCana Well Control Procedures Manual;
- EnCana Risk Control Matrix;
- American Petroleum Institute, "Model Environmental, Health & Safety (EHS) Management System and Guidance Document", API 9100 A & B; and
- Petroleum Safety Council Basic Safety Program Audit Protocol.

4.4 Stakeholder Consultation Programs

Inherent in the EnCana EHS Management System is the provision for stakeholder consultation, especially in relation to environmental issues. Stakeholders for the Deep Panuke Project include regulatory agencies, the fishing industry, non-government organizations and the general public. With respect to environmental management, effective consultation is crucial for issues such as environmental assessment, environmental effects monitoring (EEM), environmental protection, emergency response and compensation.

The objectives of the consultation program for the Deep Panuke Project are to:

- provide information to the public and interested stakeholders about the proposed Project in a timely fashion;
- provide opportunities for the public to have input into the Project to identify issues and concerns;
- provide early and adequate notice of these opportunities for involvement and input;
- seek advice from the scientific community to enhance environmental management; and
- develop relationships with the First Nations and Aboriginals and with stakeholders that can lead, where appropriate, to mutually beneficial relationships throughout the life of the Project, and also contribute to communications around other EnCana activities.

EnCana's Public Consultation Report (DPA Volume 6) describes the Project's public consultation program during various stages of development and the Project application process (refer also to Section 5 of this CSR).

5 PUBLIC CONSULTATION PROGRAM

5.1 Consultation Program Objectives

The consultation program for the Deep Panuke Project was developed following two preliminary rounds of consultation with various stakeholders, and was based in part on their stated input and preferences. The public consultation program has been focused on key stakeholder groups as follows:

- regulatory agencies;
- local municipalities and regional development authorities;
- nearshore fishing interests;
- offshore fishing interests;
- residents and businesses in the Guysborough County area;
- scientists;
- environmental non-governmental organizations (ENGOs); and
- the general public.

Discussions have also been held with First Nations and Aboriginal groups as outlined in Section 5.3.

The objectives of the consultation program are to:

- provide information to the public and interested stakeholders about the proposed Project in a timely fashion;
- provide opportunities for the public to have input into the Project to identify issues and concerns;
- provide early and adequate notice of these opportunities for involvement and input;
- seek advice from the scientific community to enhance environmental management;
- develop relationships with Aboriginal organizations and stakeholders that can lead, where appropriate, to mutually beneficial relationships throughout the life of the Project; and
- contribute to communications around EnCana activities.

5.2 Consultation Activities

5.2.1 Public Consultation Phases

Consultations for the Project began in July 2000 and have continued to October 2002. The consultation program has been undertaken in four phases:

Phase I	Preliminary Stakeholder Communications (July 2000–June 2001);
Phase II	Consultation on the Project Description and Issues Scoping (July 2001–November 2001);
Phase III	Consultation on Project Revisions and Environmental Assessment (December 2001-October 2002); and
Phase IV	Ongoing Communication (October 2002).

5.2.2 Phase I - Preliminary Stakeholder Communications

Approach

Preliminary stakeholder input laid the foundation for the consultation program. EnCana's preliminary consultation program (July 2000–June 2001) was with key regulators and a cross-section of stakeholders early in the planning process and prior to formal initiation of the environmental assessment. This consultation involved:

- establishing initial stakeholder contact;
- seeking input from potentially affected stakeholders regarding preferred methods and timing of consultation;
- sharing information about the Project, such as the nature and preliminary scope of the proposed Project;
- providing early notice of upcoming opportunities for consultation on the Project, including its scope, siting, facilities and assessment; and
- considering the input and interests of stakeholders in the early planning phase of the Project.

Activities

The primary objective of this stage was to get advice on appropriate formats and timing of subsequent consultations. Telephone interviews with stakeholders were undertaken in June-July 2000. A briefing meeting was also held between EnCana and fisheries stakeholder representatives on November 28, 2000. A second series of telephone conversations was undertaken by EnCana in March-April 2001 to provide an update, and to verify and enhance information gathering prior to further consultation.

Table 5.1 lists stakeholders who were contacted during Phase I.

Table 5.1 Stakeholders Contacted During Phase I	
Aquaculture Association of Nova Scotia	Municipality of the District of Guysborough
Area 19 Crab Fisherman's Association	Municipality of the District of St. Mary's
Atlantic Herring Co-operative	National Sea Products
Clean Nova Scotia Foundation	Nova Scotia Environmental Network
Clearwater Fine Foods Inc.	Nova Scotia Fishpacker's Association
Coastal Communities Network	Nova Scotia Women's Fish Net
Country Harbour Sea Farms	Oceans Act Implementation Office
Deep Sea Trawlers Ltd.	Program for Energy Research and Development (PERD)
Eastern Nova Scotia Mobile Gear Association	Regional Oceans Industry Liaison Officer
Eastern Shore Fishermens Protective Association	Richmond County Economic Development
Ecology Action Centre	Sable Island Preservation Trust
Enviro-Clare	Save Our Seas
Federation of Gulf Nova Scotia Groundfishermen	Scotia-Fundy Mobile Gear Fishers's Association
Fixed Gear Association	Seafood Producers Association of Nova Scotia (SPANS)
Groundfish Enterprise Allocations Council	Sable Environmental Effects Monitoring Advisory Group
Gulf of Nova Scotia Herring Foundation	Shelburne County Fixed Gear Association
Guysborough County Inshore Fisherman's Association (GCIFA)	Snow Crab Association (Canso area)
Guysborough County Regional Development Authority (GCRDA)	Strait-Highlands Regional Development Authority
High Liner Fine Foods Inc. – National Sea Products	South West Nova Fixed Gear Association
Inverness South Fishermen's Association	South West Nova Scotia Tuna Association
Isaacs Harbour-Goldboro Wharf Committee	Swordfishers Association
Marine Invertebrate Diversity Initiative	World Wildlife Fund
Maritime Fisherman's Union Local 6	

Information ascertained from telephone interviews and letters was considered by EnCana in developing further public consultation activities.

5.2.3 Phase II – Consultation on the Project Description and Issues Scoping

Approach

The primary objective of this phase of public consultation (July 2001–November 2001) was to discuss the Project Description and obtain stakeholder input on both the Project Description and the scope of the environmental and socio-economic assessments. This aspect of the public consultation program provided the First Nations and stakeholder groups, including the local potentially affected community, fishers groups, key government agencies, and the public with the opportunity to review the Project and to express their interests and concerns sufficiently early in the process to have them considered in the

Project plans including the design and siting of facilities and pipeline route selection, and to provide input into the scope of the environmental and socio-economic assessments.

The Project Description and issues scoping consultation involved various activities including: distribution of the Project Description, follow-up telephone conversations and meetings, distribution of a newsletter, community Open Houses, meetings with nearshore and offshore fishers, and meetings with the municipal government and regional development authority. There were also communications and a meeting to discuss seawater scrubbing with regulatory agencies.

Activities

A summary of the consultation activities is provided below. A detailed description of the activities is contained in the PCR (DPA Volume 6).

- Consultation on the draft Project Description was conducted with regulators, stakeholders, and First Nations organizations through letters, phone calls and meetings.
- EnCana considered comments received through this consultation and incorporated this input in revising and completing the Project Description.
- Open Houses were advertised and held in Goldboro, Guysborough and Port Bickerton in September 2001. 300 participants attended and were provided information on the Project and given the opportunity to provide comment and feedback.
- A meeting was held with nearshore fishers in the Guysborough County area (September 26, 2001) to provide information about the Project and obtain feedback from the fishers.
- Two meetings (one in Halifax and one in Yarmouth) were held with offshore fisheries representatives during this phase to present an initial description of the Project and to identify concerns.
- Meetings were held with the Municipality and the GCRDA (July 4, August 22, November 7, 2001) to discuss Project plans, particularly the evaluation of processing options, potential local access to gas for further industrial development, onshore pipeline routing and potential formation of a new Energy Industry Liaison Committee (EILC).
- Presentations to regulators and scientists were made on October 25, 2001 by EnCana and environmental assessment Study Team members, regarding the proposed use of a seawater scrubber for acid gas management.
- On October 29, 2001 the CNSOPB released the MOU (CNSOPB *et al.* 2001a) and Draft Scope of Environmental Assessment (CNSOPB *et al.* 2001b) for the environmental and socio-economic assessment of the Project. This was publicly advertised and distributed in a variety of locations to solicit public input and comment.

- During September and October 2001, EnCana prepared an information sheet summarizing the planned activities and requirements for an offshore pipeline survey and encouraging public questions/comments.

5.2.4 Phase III – Consultation on Project Revisions and Environmental Assessment

Approach

The primary objective of this phase of public consultation (December 2001 – October 2002) was to present revisions and updates to the Project, plans, schedules and environmental assessment. Since the presentation of the original Project Description, the Project evolved as a result of the FEED Study, scientific study, public and stakeholder inputs, financial analysis and feasibility evaluations. Most significantly, EnCana revisited the seawater scrubber technology for acid gas disposal in light of further analysis and concerns raised during the consultation process. EnCana instead opted for injection of acid gas to an offshore disposal well as the preferred acid gas disposal option (refer to Section 2.10).

Activities

A summary of the consultation activities is provided in this section with additional detail provided for activities that took place following the submission of the PCR in March 2002. More detailed information about activities prior to March 2002 is provided in the PCR (DPA Volume 6).

- On January 11, 2002, EnCana met with the CNSOPB to discuss design changes that had resulted from an internal review conducted during November and December 2001.
- In January, 2002 EnCana undertook a second round of Open Houses in Goldboro, Guysborough and Port Bickerton in order to present the updated Project Description and receive further comments on the revised Project and its assessment. A total of 281 participants attended.
- A second meeting in Goldboro with nearshore fishers was held on February 7, 2002. Changes to the Project Description were discussed, as well as compensation issues.
- EnCana will compensate to mitigate demonstrable economic losses resulting from spills, gear and vessel damage and lost opportunity for fishing.
- A meeting was held in Halifax with representatives from the offshore fishing organizations on February 12, 2002, to present changes to the Project Description and obtain feedback. Discussion focused on the need for an agreement between EnCana and offshore fishing interests similar to that negotiated for SOEP, and a fisheries observer program.
- Subsequent to discussions with the offshore fisheries, EnCana contracted the Oil and Gas Observers Program (OGOP) to conduct the Fisheries Observer Program for EnCana's offshore activities.

- Additional meetings (June 11 and September 11, 2002) were held to discuss the draft MOU between fishing interests and EnCana, specifically to address compensation issues related to gear and vessel damage.
- On February 8 and 14, 2002, EnCana hosted briefings and discussions for representatives from the Sable Island Preservation Trust, the Marine Invertebrate Diversity Initiative, Ecology Action Centre, Clean Nova Scotia and the World Wildlife Fund on a variety of technical and environmental aspects of the Project.
- EnCana met with the Municipality of the District of Guysborough, the GCRDA and representatives of M&NP on December 6, 2001 to discuss expansion of M&NP's pipeline. EnCana also presented a Project update to the first meeting of the EILC on April 10, 2002.
- A follow-up meeting was held with GCRDA and the Municipality on September 11, 2002 to discuss the Project update, status of pipeline routing, access to industrial park lands and issues in the landfall area.
- The draft CSR was submitted to regulatory authorities on March 1, 2002, and along with supporting documents, were advertised and available for public review for a six-week period from early March to mid-April 2002. The CNSOPB received approximately 1,300 comments and questions from seventeen organizations including regulatory agencies, Aboriginal groups and stakeholders. Responses to the comments and questions are presented in Addendum 1 submitted to the RAs in September 2002 and incorporated into the CSR, where applicable.
- As a result of requests for more information about training for employment in the oil and gas industry, EnCana undertook a series of presentations during May 2002 to three high schools in the Guysborough County and one in Antigonish County. Personal computers were also donated to the schools on behalf of EnCana.
- In response to issues regarding employment and training, EnCana developed a diversity database initiative to establish better links between offshore supply and service companies and groups that are traditionally under-represented in the energy industry. Traditionally under-represented groups include Aboriginal people, visible minorities, persons with disabilities and women in non-traditional roles.
- A presentation was made to the Fisheries Environment Advisory Committee on October 3, 2002, to provide an update on the Project and to provide information on the pipeline route and pipelay methods.
- A meeting was held with nearshore fishers on October 10, 2002 to discuss pipeline routing, pipelay options and nearshore construction.
- A meeting was held with the Municipality on October 11, 2002, to discuss details of pipeline routing, offshore pipelay methods and nearshore construction methods.

5.2.5 Phase IV - Ongoing Communication

Approach

EnCana is now moving into Phase IV, Ongoing Communication. Part of this process is the CNSOPB's and NEB's regulatory review. EnCana will continue to consult about the Project with interested stakeholders throughout this process. EnCana's goal is to address issues through ongoing consultation and update the CNSOPB and NEB, as necessary.

Activities

Ongoing activities will include the following components:

- ongoing liaison with nearshore fishers through open forum meetings, coordinated through local fishers and the GCIFA;
- creation of a locally-based nearshore fisheries liaison committee at a time closer to construction;
- meetings with offshore fisheries representatives as needed;
- continued liaison with ENGOs as appropriate;
- continued meetings with Aboriginal groups;
- ongoing discussions with local municipalities and regional development authorities;
- continued participation at the EILC, as requested by the Municipality of the District of Guysborough;
- distribution of newsletters updating the status of the Project to Guysborough County residents, stakeholders and other interested members of the public (Note: four newsletters have been prepared and distributed throughout the consultation process);
- provision of information provided through the website;
- provision of background information sheets on specific aspects of the Project;
- maintenance of a toll-free number where people can register concerns or ask for information;
- discussions with stakeholders affected by blasting;
- continued opportunities for further comment during the CSR review process; and
- continued participation on NS Petroleum Fisheries Liaison Group (NSPFLG).

5.3 Aboriginal Communications

The overall goal of communication with Aboriginal groups is to establish relationships, provide information on the Project and respond to issues that may be of concern to the Aboriginal community. Recognizing the need for assistance, EnCana has hired five Aboriginal consulting firms (four contracts –

one with both an Aboriginal lead consultant and an Aboriginal subconsultant) throughout the first three phases of the Aboriginal communications program.

5.3.1 Phase I – Preliminary Communications

The first phase of EnCana's Aboriginal communications program involved identification of Aboriginal groups who may have an interest in the Project and establishing initial contact with key representatives of these groups. To assist with this phase of the Project, EnCana contracted with an Aboriginal firm, ARC Group (Aboriginal Resource Consultants). Eskasoni Fish and Wildlife Services provided the original list of contacts in the Aboriginal community. Introductory letters were sent to the following organizations in September 2000:

- Confederacy of Mainland Mi'kmaq (CMM);
- Union of Nova Scotia Indians (UNSI); and
- Grand Council Chief.

EnCana did not receive any response to the letters and did not follow up as a result of Project refinement.

5.3.2 Phase II – Communication on the Project Description and Issues Scoping

In July 2001 a second effort commenced which included sending letters to the Executive Chair of UNSI and Executive Director of the CMM and enclosing the draft Project Description. These letters requested that the draft be shared with others and indicated that comments would be appreciated. An invitation to meet was also extended. The objective of this phase of consultation was to provide Project information and to obtain feedback. In addition to the Project Description, EnCana provided general information about the Project and a copy of the corporate Aboriginal policy.

In September 2001, EnCana contracted Membertou Corporate Division to assist with Aboriginal discussions. The following information sessions were organized by Membertou Corporate Division on behalf of EnCana in the Fall of 2001:

- Tripartite Committee on Economic Development, September 5, 2001;
- Native Employment Officers, October 1, 2001;
- Aboriginal Alliance of Companies, October 5, 2001; and
- Assembly of Mi'kmaq Chiefs Technical Committee (Tech Team), November 2, 2001.

Many of the questions raised during these sessions were answered at the sessions. Aboriginal treaty and rights issues were raised throughout discussions with the Aboriginal community. EnCana provided a consistent response that Aboriginal title and rights issues are not issues for resolution between EnCana and the Aboriginal community, but an issue between government (federal, provincial and Mi'kmaq). However, a new forum exists for discussion of these issues. On June 7, 2002, Nova Scotia, the federal government and the Mi'kmaq of Nova Scotia signed an Umbrella Agreement which commits the parties to work together in good faith to resolve issues of mutual concern. A major component of the Umbrella Agreement is the start of a broad negotiation process to consider constitutionally protected rights of the Mi'kmaq with respect to treaty rights, aboriginal rights and Mi'kmaq assertions of Aboriginal title.

Membertou Corporate Division also provided information on the Aboriginal fishery and socio-economic information. This information was incorporated into the Social-Economic Impact Statement (Volume 5 of the DPA) and the CSR. A copy of the report prepared by Membertou Corporate including a summary of the meetings is provided in Appendix B of the SEIS (DPA Volume 5).

5.3.3 Phase III – Project Revisions and Environmental Assessment

Copies of the Draft Scope of the Environmental Assessment and the MOU were sent by the CNSOPB to the following organizations:

- Native Council of Nova Scotia (Native Council);
- CMM;
- UNSI; and
- Eskasoni Fish and Wildlife Commission.

The CMM and the Native Council submitted comments on the draft documents. The CNSOPB met with the Native Council on December 14, 2001 to discuss the Project following the release of the Draft Scope in November 2001. Final copies of the Scope document were sent to the same organizations on December 18, 2002.

EnCana held a preliminary meeting with the Native Council in February 2002 to share information about the Project and to better understand the issues raised by the Native Council. Four subsequent meetings were held in May, July and August, 2002. The Native Council and EnCana are in the process of developing a Memorandum of Cooperation and Understanding to guide the relationship.

Copies of the draft CSR were sent by the CNSOPB to the Native Council, CMM, UNSI and the Eskasoni Fish and Wildlife Commission on March 1, 2002. Responses were received from the CMM and the Native Council. In addition, EnCana funded a review of the draft CSR by the Unama'ki

Institute of Natural Resources. The report detailing this review by Trevor Kenchington was endorsed by the five Cape Breton Chiefs and submitted to the CNSOPB on April 24, 2002. Responses to the questions and issues raised by the three organizations are provided in Addendum 1 and incorporated into the CSR.

Meetings were held with the CMM on July 19, 2002 and September 12, 2002 to discuss onshore and offshore traditional ecological knowledge issues. EnCana will continue discussions with the CMM to ensure additional survey work is completed prior to construction.

Subsequent to the filing of the draft CSR, EnCana sent several letters to the CMM and the UNSI asking to meet to discuss the Project and address any questions or concerns they may have regarding the Project. In September 2002, the Technical Committee of the Assembly of Nova Scotia Mi'kmaq Chiefs held their regular meeting and addressed the issue of how to respond to requests from the oil and gas industry. In the Fall of 2002, EnCana will meet with representatives of the UNSI and the CMM to discuss the Project. Subsequent to that meeting, presentations will be made to the Technical Team and to the Assembly of Nova Scotia Mi'kmaq Chiefs.

In June 2002, EnCana initiated a diversity project to address concerns raised during the Project about the need for employment and contracting opportunities. EnCana hired a lead Aboriginal firm, Diversity Management Group, and their subcontractor, Lafford Business Services, to develop a database of companies owned by members of the traditionally under-represented groups (Aboriginal, visible minorities, persons with disabilities and women in non-traditional roles) to facilitate contract and procurement opportunities.

5.3.4 Phase IV – Ongoing Communications

Ongoing activities with the Aboriginal community include the following components:

- meeting with representatives of the UNSI and the CMM;
- presentation to the Technical Team;
- presentation to the Assembly of Nova Scotia Mi'kmaq Chiefs;
- ongoing discussions with the CMM to discuss the use of lands and water for traditional purposes in the vicinity of landfall;
- ongoing meetings with the Native Council to develop the Memorandum of Cooperation and Understanding, share information and work towards establishing a mutually beneficial relationship;
- ongoing discussions with the Aboriginal community regarding training, employment and contracting opportunities;
- distribution of newsletters updating the Aboriginal community on the status of the project;

- maintenance of a toll-free number where people can register concerns or ask for information;
- provision of information provided through the website;
- continued opportunities for comment during the final CSR review period; and
- ongoing discussions about the Project as requested by the Aboriginal community.

5.4 Integration of Issues and Concerns into Project Planning

Through the preliminary communications, stakeholder meetings, two rounds of Open Houses, fisheries meetings and ENGO sessions, EnCana gathered a wide range of questions, issues and concerns. By considering the concerns and the broader issues they pointed to, EnCana was able to identify the key issues requiring evaluation and attention. The key issues raised were:

- seawater scrubber technology;
- acid gas injection technology;
- offshore versus onshore processing;
- sour gas;
- offshore pipeline routing;
- onshore pipeline routing and facilities siting;
- effects on fishery;
- cumulative effects;
- employment and training;
- aboriginal issues; and
- general issues.

Issues and concerns identified through the consultation process were tracked and forwarded to the appropriate EnCana departments and consultants for consideration in Project planning, design and the environmental and socio-economic assessment. EnCana responded to questions, issues and concerns in a variety of ways including immediate response at Open Houses and meetings, follow-up communications, and within the environmental and socio-economic assessment. For example, acid gas injection became the preferred option to seawater scrubbing even though it is more costly, and an engineering solution to using condensate for fuel eliminated the condensate pipeline reducing the number of pipelines and minimize construction impacts.

5.5 Integration into Project Planning

The public consultation and communication process undertaken and ongoing for the Deep Panuke Project identified a variety of questions, issues and concerns associated with the Project. These inputs have been utilized by Project planners and the environmental and socio-economic assessment teams to:

- identify the environmental and socio-economic issues of concern and to incorporate these issues into the assessment;
- highlight these issues and bring them to the attention of Project team so that they are considered in Project planning in order to improve Project design; and
- supplement information and knowledge of the environment and VECs to assist in routing, siting and design to minimize adverse environmental effects.

EnCana has responded to issues and concerns brought forward by stakeholders during the public consultation process in a variety of ways. Responses to issues and specific questions raised during the review of the draft CSR are provided in Addendum 1. Table 5.2 outlines the means by which issues and concerns have been addressed. As detailed planning proceeds, EnCana is committed to continuing discussions with the Aboriginal community and consultation with stakeholders and the public.

Table 5.2 Integration of Key Issues Overview

Issue and Primary Concerns	*Response*
Seawater Scrubber Technology	
• Discharge of deleterious substances • Impact on fish and other aquatic organisms • Demonstrated prior examples	• The engineering and scientific experts closely studied effects predictions and refinements to the technology. Alternative technologies and means of processing sour gas were also evaluated. Following these evaluations, the seawater scrubbing technology was replaced by acid gas injection.
Acid Gas Injection Technology	
• Short and long term safety and reliability of technology • Possibility of acid gas seepage or accidental release	• Acid gas injection is a well-known and well-proven technology. Proper engineering will ensure safety and reliability through the full life cycle of acid gas injection and storage. The injection formation will be selected so that accidental seepage will not occur. Information on these details will be available to the public and regulators as completed.
Offshore versus Onshore Processing	
• Reasons for decision to process offshore, transparency of EnCana decision making process • Relative environmental, health and safety concerns • Fewer benefits in terms of local onshore jobs and facilities	• Extensive discussion with stakeholders at Open Houses and meetings. EnCana has identified offshore processing as the preferred option. Refer to Section 2.10.2.5 of the CSR for additional details. • Alternative scenarios and their relative impacts, risks and benefits have been evaluated. Information is available in Section 2.10 of the CSR. • Employment opportunities will be available on the platform offshore, and in the service industry.

Table 5.2 Integration of Key Issues Overview

Issue and Primary Concerns	*Response*
Sour Gas	
• Safety, reliability and environmental impacts associated with treatment and disposal • Specific sour gas concerns regarding Sable Island	• Provided information through Open Houses, Seawater Scrubber Information Sessions, ENGO and fisheries sessions, and the EILC • Additional information made available through website, newsletters, information sheets and newspaper articles. • Health and safety and emergency response planning will also detail EnCana practices, training and response measures. • Continue to meet with Sable Island Preservation Trust to discuss emergency planning.
Offshore Pipeline Routing	
• Loss of fisheries access and opportunity • Location of pipeline • Pipeline construction methods • Impact on sensitive ecological and/or commercial habitat • Effects of pipeline construction and operation	• Meetings with nearshore and offshore fishers to understand and discuss concerns. • Will continue to meet with stakeholders to discuss pipeline routing and construction methods as information becomes available. • EnCana also discussed with stakeholders the need to minimize impacts through "corridorization" of pipeline and consideration of ecological constraints. • EnCana will negotiate compensation agreements with individual fishers to mitigate demonstrable economic losses resulting from spills, gear and vessel damage and lost opportunity for fishing. • Work with NSPFLG to develop an industry standard compensation plan.
Onshore Pipeline Routing and Facilities Siting	
• Integration with Municipal plans for Industrial Park • Impacts to local residents • Mineral rights along pipeline route	• Ongoing consultation with Municipality regarding preferred routing requirements in the Industrial Park. • An Onshore Construction EPP will be developed (see Appendix D of the CSR). • Siting process will consider engineering, environmental and socio-economic constraints. • Mineral rights issues referred to legal counsel.
Effects on Fishery	
• Loss of opportunity for fishing • Gear loss, vessel damage and compensation • Impacts to species and habitat • Effects of pipelaying on nearshore fishing and aquaculture • Schedule of construction • OGOP • Support for effective nearshore monitoring • Opportunities for local fishers to provide services to the Project • Concentrating effects in one area could be seen as penalizing the same group of fishers over again. • Noise from pipeline, effects on tuna and crab • Consultation should be organized efficiently, "get to the point" and should not take too much time	• EnCana will compensate individual fishers affected. • Ongoing meetings with local fisherman, organised through GCIFA to discuss pipeline route and construction techniques. • Establish and work with local fisheries liaison committee prior to start of construction. • Construction will not take place during lobster season • OGOP initiated in January 2002. • EnCana has committed to making all EEM data available to the public. See Appendix D of the CSR for more info on EEMP. • EnCana will use local vessels when possible. • Provincial Energy Strategy identifies the need to establish utility corridors to concentrate pipeline and other underwater utilities to minimize the amount of land used for these activities. • Continue to seek advice from stakeholders regarding most effective and efficient methods of ongoing consultation and communication. • Support ESRF study of monitoring of noise/pipeline interaction. • Information regarding contribution of fishing industry to Guysborough County's economy was incorporated in SEIS. • Strive to develop an agreement on principles of co-operation with offshore fishing representatives.

Table 5.2 Integration of Key Issues Overview

Issue and Primary Concerns	*Response*
Cumulative Effects	
• On valued ecological and commercial components of offshore environment. • Of oil and gas development on social and economic factors onshore and offshore. • Need for integrated offshore regional planning prior to further development offshore • ENGOs unable to spend time in project-by-project consultation; they would prefer to focus efforts on cumulative effects and onshore regional integrated use planning • Increase in vessel traffic and seismic activity	• Carry out cumulative effects assessment as required under *CEAA*. Cumulative effects info is provided in Section 6.3.9 and 7.4 of the CSR. • Collaborate with other operators through CAPP on future cumulative effects initiatives. • Participate with DFO through CAPP in an integrated ocean management and planning program.
Employment and Training	
• Maximising local and provincial benefits • Preparing workforce for Project opportunities	• $2M funding for offshore training initiative through Nova Scotia Community College (NSCC) • Ongoing support for training initiatives that build capacity • Make information available on labour requirements and training needs, as it becomes available. • Presentations made to high schools in Guysborough and Antigonish Counties on career opportunities in the oil and gas industry. • Undertook traditionally under-represented groups initiative. • Participation with the EILC, as requested by the Municipality.
Aboriginal Issues	
• Consultation • History of EnCana's involvement with Aboriginal groups • Aboriginal title and rights • Traditional ecological knowledge study (TEK) • Offshore Aboriginal marine archaeology survey	• EnCana is committed to working with Aboriginal groups to determine the best means of achieving mutually beneficial relationships • Both PanCanadian Energy and Alberta Energy Company who merged in April 2002 to form EnCana, have long histories of working with Aboriginal communities • Aboriginal title and rights issues are not issues for resolution between EnCana and the Aboriginal community, but an issue between governments (federal, provincial and Mi'kmaq). On June 7, 2002, Nova Scotia, the federal government and the Mi'kmaq of Nova Scotia signed an Umbrella Agreement which commits the parties to work together in good faith to resolve issues of mutual concern. A major component of the Umbrella Agreement is the start of a broad negotiation process to consider constitutionally protected rights of the Mi'kmaq with respect to treaty rights, aboriginal rights and Mi'kmaq assertions of aboriginal title. • A TEK study was done in the same area for SOEP. An Aboriginal review of the report was conducted and it was determined that a small area would need to be surveyed. EnCana will be conducting this survey.

Table 5.2 Integration of Key Issues Overview	
Issue and Primary Concerns	***Response***
General Issues	
• Business development activities • Effect on local infrastructure • Unmarked military disposal sites	• EnCana provides means through toll-free line, website and future announcements to access information on Project requirements. • Impacts on infrastructure are addressed in Section 7.3.4 of the CSR. • DND, CFB Halifax, confirmed that Project facilities are not located in proximity to any known sites with Unexploded Ordnance (UXO). Shallow geophysical surveys undertaken at the Deep Panuke site and along the pipeline route confirmed this.

6 BIOPHYSICAL ASSESSMENT

6.1 Ecological Setting

The following sections provide an overview of the Deep Panuke Project's ecological setting, including the marine physical environment, marine biological environment, and onshore environment. Information in this section has been provided through a variety of sources, including field studies, existing literature, experience from the Cohasset Project, and SOEP EEM data publicly available through the proceedings of the Sable Offshore Energy Inc. Environmental Effects Monitoring Advisory Group (SEEMAG).

A more detailed description of the region's existing biophysical environment is provided in the Deep Panuke Offshore Gas Development EIS (Section 5), with supplemental information provided in the Response Document (Addendum 1).

6.1.1 Marine Physical Environment

6.1.1.1 Climatology

A Meteorological Service of Canada (MSC) weather station located on Sable Island has a sufficiently long period of record to derive climate normals. The climate at Sable Island is likely to be typical of the offshore areas of Nova Scotia, including the Project area, although it has been noted that windspeeds are slightly lower than those observed by ships at sea (Walker and Wilson 1984).

The daily mean temperature at Sable Island is 7.5 °C, ranging from –1.3 °C in February to 17.6 °C in August. Daily maximum temperatures range from 1.4 °C (February) to 20.3 °C (August), with daily minimum temperatures ranging from –4.2 °C (February) to 14.8 °C (August). Extreme temperatures at Sable Island have reached nearly +30 °C in the summer and can fall below -20 °C in the winter (MSC 2001). This temperature cycle is about 10 °C smaller than coastal stations because of the moderating influence of the ocean. During the winter, freeze/thaw cycles are common and can be a hindrance to construction activities.

Annual precipitation at Sable Island averages approximately 1,411 mm, and ranges from an average of 99.6 mm in May to 148.4 mm in January. Total annual rainfall in the area is approximately 1,281 mm, ranging from 81.7 mm in February to 141.5 mm in November. Rain is common during the winter, and a typical cyclonic passage might include snow ahead of the warm front, freezing rain during the frontal passage, and rain in the warm sector of the system. Annual snowfall is approximately 122.4 cm, with snow typically occurring from November to May. The number of days per year with measurable precipitation at Sable Island is typically 183, ranging from 12 in August – September to 20 in December – January. The number of days per year with freezing precipitation is typically five, (usually from December to June), with 130 days of fog annually, ranging from four in December, to 22 in July (MSC 2001).

Winds in the area most frequently have a westerly component, with winds in the area originating primarily from the west or southwest. Average wind speeds ranged from 18 km/hr from the southwest in July/August to 32 km/hr from the west in January. Extreme hourly speeds ranged from 74 km/hr from the east in July to 130 km/hr from the west in November, with extreme gusts ranging from 100 km/hr from the east in July to 174 km/hr from the west in November (MSC 2001).

6.1.1.2 Air Quality

In general, the offshore areas of Nova Scotia have excellent air quality. Except for isolated sources, such as engine emissions from vessels transiting the area and a few exploration rigs and production platforms, there are no local sources of air pollution. The low-level air pollutants observed in the study area can be attributed to long-distance transport from cities along the Atlantic coast and in the northeast United States.

It is likely that air quality in the study area falls within the desirable objectives of the federal classification and well within provincial limits, as evidenced by the results of the SOEI Onshore EEM air monitoring program at the gas plant in Goldboro (SOEI 2001a). These results show some detectable, and some non-detectable NO_x concentrations when the wind direction was from the gas plant toward the monitoring station. The magnitude of these concentrations was generally similar to the magnitude of NO_x from other wind directions; that is, very low, and likely due to vehicular traffic on the local road. There have been occasional concerns from local residents about the visible plume from the flare at the gas plant; however, air quality monitoring has not detected any significant effects (SOEI 2001a).

6.1.1.3 Physical Oceanography

The most recent and comprehensive sources of wave data at Panuke were analyzed in detail by EnCana (2001b). Wave data from the Cohasset field collected during its operation from 1993 to 2000 provide information on monthly mean and maximum significant wave heights (Hsig). These data indicate that the monthly mean Hsig ranges from 1.3 m in June - July to 3.4 m in January. Maximum Hsig ranges from 4.0 m in June to 11.8 m in January. In terms of annual extreme waves, maximum Hsig for the 1, 10, and 100-year return periods are 16.3 m, 20.0 m and 23.7 m, respectively.

The Canadian Hydrographic Service tidal constituents for Sable Island give a maximum tide of 1.6 m above chart datum. In terms of storm surges above mean sea level, the maximum annual water levels in

Halifax suggest a 100-year surge on the order of 0.7 m, with a 100-year return wave crest height of 16.3 m.

Tsunamis, or long period waves created by large-scale movement of the seafloor from submarine earthquake, landslide, or volcanic eruption, can be damaging in shallow coastal areas. The probability of such an event is estimated to be extremely low (around 1 in 10,000 years).

The dominant current is a seasonally varying southwesterly flow along the Shelf edge, whose origins can be traced to events in the Labrador and Greenland Seas. This Shelf edge current is predominant in all seasons, with a peak near-surface flow of 30 cm/s in the winter season, and lower rates during summer. The flow is strongest at around 200 m depth and decreases shoreward. Further inshore, the southwesterly directed Nova Scotian current is predominant in all seasons, with peak near-surface speeds of around 30 cm/s. A persistent feature of the seasonal circulation is the partial clockwise gyre around Sable Island and Western Bank. This flow has a strong seasonal component, but numerical modeling indicates that the overall gyre is weakest and least closed in spring, with its western limb and central core extending farthest west in winter. Typical speeds are in the range of 5 to 15 cm/s. Currents associated with the semi-diurnal and diurnal tides are of moderate strength, being primarily clockwise, rotating at rates averaging 25 cm/s or less.

Icebergs originate from glaciers in Greenland where they drift with the Labrador Current, typically decaying on the Grand Banks of Newfoundland. Iceberg sightings data based on the reports of the International Ice Patrol for the period 1960 to 2000 indicate the occurrence of one iceberg in the medium size class (16-45 m height above water; 61-120 m width or length) just off Cape Canso and one of a small iceberg (5-15 m height above water; 15-60 m width or length) on the western end of Sable Bank.

At the Deep Panuke site, the frequency of occurrence of ice is less than 1%. In the coastal area around Country Harbour, the frequency of occurrence of ice could be up to 33% during the first week of March and between 1% and 15% in February and the rest of March. The 30-year median of the predominant ice type is new or grey-white ice (less than 30 cm thick) in February, grey ice (less than 15 cm thick) during the 1st week of March, and first year ice (up to 70 cm thick) for the rest of March (Environment Canada 2000).

6.1.1.4 Water Quality

Marine water quality refers to the condition of the physical and chemical environment that constitutes the aquatic medium that supports all marine life. Available water quality data for the Deep Panuke region are provided in Appendix F.

The chemical composition of seawater is complex, nevertheless the relative concentrations of the major ions are generally constant throughout the oceans (Culkin 1965). Approximately 86% of the total salt content of seawater is due to sodium and chloride ions, with magnesium and sulfate ions contributing an additional 11%. Other ions are present in much lower concentrations.

The pH of seawater is relatively constant throughout the oceans with values ranging from 7.5 to 8.4 (mean = 7.8) (Wilson 1975). Measured values for pH in surface waters in the region of the Project range from 8.05 to 8.11, with intermediate waters (ca. 30 m depth) from 8.03 to 7.96, and bottom waters (>60 m depth) from 8.02 to 7.89 (BIO BioChem Database 2001).

Dissolved oxygen is essential for the respiration of aquatic life. The solubility of oxygen in seawater is a function of salinity, temperature and pressure. The major sources of dissolved oxygen in seawater are attributed to exchange with the atmosphere and production by marine plants. Although the waters in the Project area are thermally stratified from May to October, the depths are shallow (Petrie *et al.* 1996). Consequently dissolved oxygen concentrations are likely to be at or near saturation with values in the order of 8 to 10 mg/l. There is no indication that the oxygen demand in any area of the Scotia Shelf is high enough to deplete dissolved oxygen to such an extent that marine life would be affected (Fornier *et al.* 1977).

There are limited published suspended particulate matter (SPM) values for the Deep Panuke area. Data collected from Emerald Bank in 1970 indicated a variation of 5.5 mg/l at the surface, increasing to 10.1 mg/l at 20 m and then decreasing to 4.0 mg/l below this depth. The data reflect the strong influence of biological activity during and after spring bloom. However, observations suggest that concentrations of suspended particulate matter on Sable Bank are much lower than those measured on Emerald Bank (SOEP 1996a).

Data are available for nutrient concentration in the Deep Panuke area and adjacent areas as a result of the Scotian Shelf Icthyloplankton Project (SSIP) and other programs (O'Boyle *et al.* 1982; Petrie *et al.* 1996). Concentrations of nitrite (as NO_2-N/L) in the euphoric zone have been observed to range from 5.0 to 10.0 µg in the early spring, dropping and remaining low at 0.5 to 1.5 µg during the summer, before rising slowly through the autumn from 0.5 to 10.0 µg. Phosphate concentrations (as PO_4-P/L) ranged from 0.6 to 0.9 µg in the early spring, dropping through the summer to 0.1 to 0.2 µg range and remaining at or about this level through the fall (Appendix F).

Trace metal inputs to the Deep Panuke area are a function of the natural and human inputs from Nova Scotia, the Gulf of Saint Lawrence, and, to a limited extent, from atmospheric transport from central and eastern North America. Predicted trace metal concentrations from the SOEP area range from 0.002 Fg/L (mercury) to 25 Fg/L (barium) (Appendix F).

Like temperature, salinity is an important parameter of marine water quality. Data provided in Petrie *et al.* (1996) shows that the average surface salinity ranges from a low of 31.30 in December to a high of 32.34 in April. At 10 m depth average salinity is lowest in November (30.96) and peaks in April at (32.30). In deeper waters of about 50 m the average salinity is least in February (31.69) and greatest again in April at (32.65) (Petrie *et al.* 1996).

Hydrocarbons arising from both recent biogenic processes and petrogenic sources are ever present in the marine environment. It is reasonable to assume that concentrations in the water column will be at the threshold of detection because of the large distance from any highly populated and heavily industrialized centers. However, infrequent detectable amounts may be found due to illegal discharge of bilge water by vessels within the region.

Temperature affects almost every property of seawater, as well as many chemical and biological processes. The annual sea temperature in the vicinity of the Project ranges from a low of 1.55^{o} C in February to a high of 16.36^{o} C in September at a depth of 10 m (Petrie *et al.* 1996).

Although the presence of polychlorinated biphenyls (PCBs) and various organohalogen pesticides (particularly DDT) has been widely studied, there are no data on these compounds available for the waters of the Panuke area. Nevertheless, there is no reason to expect significant concentrations of these or related compounds in the region.

6.1.1.5 Sediment Quality

A number of sediment quality investigations have been previously undertaken in the general region. Sediment quality in the Cohasset field, approximately 1,400 m SSE of the existing Panuke platform, was characterized in 1993 (John Parsons & Associates 1994) and 2000 (JWEL 2000b).

Sediment quality at the Deep Panuke well site area was characterized in December 2001 (JWEL 2002). Table 6.1 provides the range and mean concentrations of sediment quality parameters. Sand is the predominant sediment at the well site. Carbon and trace metal concentrations in the sandy sediment at the well site are within levels characteristic of the Sable Island Bank substrate. Barium concentration at the well site ranged from 150 to 230 mg/kg which is within background levels on Sable Island Bank. Sixteen of the twenty sampling stations at the Deep Panuke well site had TPH concentrations under the detection limit of the laboratory analytical method. Four stations had detectable petroleum hydrocarbons within background levels for the Scotian Shelf (JWEL 2002).

Table 6.1 Sediment Chemistry at the Deep Panuke Well Site						
Parameter	**EQL**	**Unit**	**Min**	**Max**	**Mean**	**St. Dev.**
Total Carbon	0.1	g/kg	0.2	0.7	0.24	0.11
Total Organic Carbon	0.1	g/kg	0.1	0.2	0.19	0.03
Total Inorganic Carbon	0.1	g/kg	<0.1	0.5	0.18	0.16
Benzene	0.025	mg/kg	< 0.025	< 0.025	0.00	0.00
Toluene	0.025	mg/kg	< 0.025	< 0.025	0.00	0.00
Ethylbenzene	0.025	mg/kg	< 0.025	< 0.025	0.00	0.00
Xylenes	0.05	mg/kg	< 0.05	< 0.05	0.00	0.00
>C10-C21 (Fuel Range)	0.25	mg/kg	<0.25	0.533	0.16	0.10
>C21-C32 (Lube Range)	0.25	mg/kg	<0.25	0.642	0.08	0.14
Aluminum	10	mg/kg	10000	15000	12318.18	1170.53
Antimony	2	mg/kg	<2	<2	0.00	0.00
Arsenic	2	mg/kg	2	2	2.00	0.00
Barium	5	mg/kg	150	230	196.82	19.12
Beryllium	5	mg/kg	<5	<5	0.00	0.00
Cadmium	0.3	mg/kg	<0.03	<0.03	0.00	0.00
Chromium	2	mg/kg	2	6	3.73	1.03
Cobalt	1	mg/kg	1	1	1.00	0.00
Copper	2	mg/kg	<2	2	1.05	0.22
Iron	20	mg/kg	2100	3700	2704.55	504.72
Lead	0.5	mg/kg	3.6	5.1	4.35	0.42
Lithium	2	mg/kg	2	3	2.64	0.49
Manganese	2	mg/kg	24	84	44.50	16.94
Molybdenum	2	mg/kg	<2	<2	0.00	0.00
Nickel	2	mg/kg	<2	2	1.45	0.51
Selenium	2	mg/kg	<2	<2	0.00	0.00
Strontium	5	mg/kg	41	58	49.36	4.77
Thallium	0.1	mg/kg	0.1	0.2	0.12	0.04
Tin	2	mg/kg	<2	<2	0.00	0.00
Uranium	0.1	mg/kg	0.2	0.4	0.21	0.05
Vanadium	2	mg/kg	5	9	6.45	1.14
Zinc	2	mg/kg	5	9	6.05	0.90
PAHs	0.05	mg/kg	< 0.05	< 0.05	0.00	0.00
EQL – estimated quantification limit (laboratory detection limit)						
Source: JWEL (2002)						

The majority of the pipeline corridor is located on a predominantly fine to coarse sand and gravel bottom type with trace amounts silt and clay. The sandy sediments of the Sable Island Bank are relatively low in organic content. Therefore, the concentrations of organohalogens and other lipophilic contaminants in surface sediments are low. Along the pipeline corridor, the trace metals with the highest concentrations were aluminum, barium, iron, manganese and strontium. There is a correlation between metal concentration and silt content. Total petroleum hydrocarbon concentrations ranging from <0.25 mg/kg to 5.3 mg/kg along the pipeline corridor are typical of background petroleum concentrations in offshore sediment on the Scotian Shelf (JWEL 2002).

The bottom substrate of the nearshore region is composed mostly of rocks ranging from gravel to boulders interspersed with bands of sandy substrate. Carbon concentrations are consistent throughout the area. The trace metals in the nearshore area with the highest concentrations are aluminum, barium, chromium, strontium, vanadium, zinc and manganese. Biogenic and petrogenic sources contribute to hydrocarbons in marine sediments. With the exception of one sample, the petroleum hydrocarbon concentrations in the nearshore area are under the laboratory detection limit (JWEL 2002).

6.1.1.6 Marine Geology and Geomorphology

The bedrock geology of the Scotian Shelf consists of two main components: Cambro-Ordovician (600 to 440 million years ago (Ma)), meta-sediments (acoustic basement), and the accretionary wedge of Mesozoic (225 to 65 Ma) and Cenozoic (< 65 Ma) sediments which form the Scotian Basin. The acoustic basement crust underwent extension and thinning during the Mesozoic breakup of Pangaea prior to the initiation of seafloor spreading in the North Atlantic Ocean. Resulting subsidence and erosion of continental crust onshore created the thick accumulation of Mesozoic and Cenozoic sediments, making up the Scotian Basin.

The five main Quaternary formations within the study area overlay the acoustic basement and consist of Scotian Shelf Drift, Emerald Silt, Sambro Sand, Lahave Clay, and Sable Island Sand and Gravel. The Sable Island Sand and Gravel Formation is a fine to coarse-grained, well-sorted sand, grading laterally to very coarse, rounded gravel with rounded boulders. The lithology of the clasts of the gravel and boulders is similar to the Scotian Shelf Drift. The unit varies in thickness up to 40 m on Sable Island Bank (Amos and Nadeau 1988).

The Deep Panuke site is located on Sable Island Sand and Gravel. Most of the 175 km of the pipeline route is also located on Sable Island Sand and Gravel, with some short stretches traversing an exposure of Emerald Silt, Sambro Sand, and Lahave Clay. A sand-rich, inshore equivalent of Lahave Clay occurs within Country Harbour. Where the route crosses the inner shelf, it is likely that the Sable Island Sand and Gravel is dominated by gravel to boulder-sized material, with frequent bedrock outcrops.

The Scotian Shelf seabed is strongly influenced by storm waves and currents, which is extremely important to surficial geological assessment, benthic stock management, and offshore development (Amos and Judge 1991).

6.1.2 Marine Biological Environment

6.1.2.1 Marine Benthos

The following section describes the marine benthic environment. This information has been derived from existing information presented in the SOEP EIS (SOEP 1996a, 1996b), data collected for the Cohasset Project (John Parsons & Associates 1994) and surveys conducted for EnCana (JWEL 2000a, 2000b; JWEL 2002).

Benthic organisms are the main food source for commercial fish species and are extremely diverse. The settlement and survival of marine benthic community assemblages in the Deep Panuke Project area are largely dictated by the nature of the substrate types that occur within the Project area. The occurrence of a particular benthic species also depends on currents, sediment type, temperature, salinity, and quality and quantity of the food supply. The success of settlement is dependent upon physical factors, such as temperature, level of biological productivity in overlying waters, bottom current, wave energy and seabed stability. In the nearshore subtidal environments, diverse marine algae and associate fauna can occur, for example, sea urchins (*Stronglyocentrotus droebachiensis*), mussels, gastropods, starfish (*Asterias* sp.), and barnacles (*Balanus* sp.).

The following describes the benthic habitat and communities at the Project well site, along the pipeline route and at landfall.

Benthic Habitat and Communities in the Offshore Environment

Three benthic surveys have been conducted in the EnCana oil and gas fields west of Sable Island (John Parsons & Associates 1994; JWEL 2000a and 2000b; JWEL 2002).

Benthic fauna on Sable Island Bank is characterized, on a broad scale, by a seabed assemblage of sand dollar (*Echinarachnius parma*), ocean quahog (*Arctica islandica)*, surf clam (*Spisula solidissima)*, and northern propellor clam (*Solemya velum*) (Mobil Oil Canada 1983).

Table 6.2 lists the benthic organisms found in the vicinity of the Cohasset, Panuke, and Deep Panuke fields. The substrate at these fields is primarily fine to medium well-sorted sand. Underwater videos from the three surveys show that the epifaunal community at these fields is sparse, and the habitat is best described as barren; the infaunal community is more diverse. Similar species assemblages are found at these three sites. Based on surveys conducted by EnCana in 2001, the majority of the organisms on or in the substrate are polychaetes (representing 59.3–71.5% of the taxa) followed by nematoda (21.1–36.7%), crustacea (1.5–4.8%), echinoidea (0.9–3%), bivalvia (0.5–2.4%), and gastropoda (0.5–1.9%). The infaunal benthic species (*i.e.*, those that live in or burrow through the sediment) that comprise the community are relatively consistent within 1000 m of the proposed Deep Panuke production platform (JWEL 2000b) Mega-epifauna (*i.e.*, species that live on the surface of the sediment) observed at the Cohasset well site included sculpin, moon snail (*Lunatia triseriata)*, hermit crab (*Pagurus* sp.), Jonah crab (*Cancer borealis*) and sea anemone (JWEL 2000a). Of the stations surveyed, the predominant infaunal organism within 500 m of the Cohasset platform was ocean quahog. Other bivalves and gastropods were present and mixed with shell debris. At the existing Panuke jacket (within 50 and 100 m) dense clusters of blue mussels (*Mytilus edulis)* have fallen off providing a food source for sea stars, sea cucumbers (*Cumcumaria frondosa*) and flounders, which were observed congregating in these areas (JWEL 2000a). Other megafauna observed included hermit crabs, and Jonah crabs. The common infaunal organisms within 500 m of the Panuke structure are ocean quahog, surf clam and polychaetes. Mega-epifauna within 500 m of Well H-08 observed included flatfish and hermit crab, but they were not common (JWEL 2000b).

Table 6.2 Benthic Macroinvertebrates Observed Within the Cohasset Project Fields and at the Deep Panuke Well Site

Taxa	Species
Nematoda	No species observed
Gastropoda	*Cylichana alba* (Bubble Shell) *Diaphana minuta* *Lunatia heros* (Northern Moon Shell) *Lunatia triseriata* *Nassarius trivittatus* (New England Dog Whelk) *Oenopota reticulata* (Whelk)
Bivalvia	*Astarte borealis* *Astarte montagui* (Astarte Clam) *Cyrtodaria siliqua* (Northern Propeller Clam) *Ensis directus* (Common Razor Clam) *Mytilus edulis* (Blue Mussel) *Serripes groenlandicus* *Spisula solidissima* (Surf Clam) *Modiolus modiolus* (Horse Mussel) *Mactra* (Giant Clam) *Pandora gouldiana* *Yoldia myalis* (Yoldias) *Hiatella arctica* (Arctic Rock Borer) *Arctica islandica* (Black Clam/Ocean Quahaug) *Lunatia triseriata* (Spotted Moon Snail) *Mactromeris polynyma* (Arctic (Stimpson's) Surf Clam)
Polychaeta	*Ammotrypane cylindricaudatus* (Opheliid Worms) *Anobothrus gracilis* *Aricidae wassi* *Asebellides siberica*

Table 6.2 Benthic Macroinvertebrates Observed Within the Cohasset Project Fields and at the Deep Panuke Well Site

Taxa	Species
	Capitella capitata (Capitellid Thread Worms) *Cheatozone setosa* *Clymenella torquata* (Bamboo Worms) *Eteone* (Paddle Worms) *Euchone elegans* *Eunicidae* (Red-Gilled Marphysa) *Exogone hebes* *Exogone sp. A* *Glycera* (Blood Worms) *Glycera dibranchiata* (Blood Worms) *Goniada maculata* (Chevron Worms) *Lumbrineris acuta* (Lumbrinerid Thread Worms) *Lumbrineris fragilis* (Lumbrinerid Thread Worms) *Lumbrineris* (Lumbrinerid Thread Worms) *Maldanidae* (Bamboo Worms) *Nephyts buccera* (Red-Lined Worms) *Nephtys discors* *Nephtys neotenus* *Nephtys sp.* *Nereis* (Clam Worms) *Nereis zonata* *Ophelina* (Opheliid Worms) *Orbibia swani* *Orbinia ornata* (Orbiniid Worms) *Parougia caeca* *Pectinaria granulata* *Pholoe minuta* *Phyllodoce groenlandica* *Polyhysia crassa* (T-Headed Worms) *Polynoidae* (Scale Worms) *Scolelepis squamata* *Scoloplos armiger* (Orbiniid Worm) *Scoloplos sp.* *Sigalionidae* (Burrowing Scale Worms) *Spio filicornis* *Spionidae* (Mud Worms) *Spiophanes bombyx* (Mud Worms) *Syllis sp.* *Sylliade* (Syllid Worms)
Crustacea	*Acanthohaustotius millsi* *Edotea triloba* *Erichthonius difformis* (Tubicolous Amphipods)

Table 6.2 Benthic Macroinvertebrates Observed Within the Cohasset Project Fields and at the Deep Panuke Well Site	
Taxa	**Species**
	Haustorius arenarius (Digger Amphipods) *Hippomedon serratus* *Photis macrocoxa* *Podoceropsis nitida* (Amphipod) *Psammonyx nobilis* *Psammonyx sp.* *Pseudoleptocuma minor* *Tmetonyx quadratus* (Amphipod) *Unciola irroratus* (Amphipod) *Chirodotea tuftsi* (Idotea) *Cirolana polita* (Greedy Isopod) *Diastylis quadrispinosa* (Cumaceans) *Eudorellopsis deformis* (Cumaceans) *Leptocuma minor* (Cumaceans) *Pagurus* (Hermit Crab) *Pagurus acadianus* (Acadian Hermit Crab) *Photis reinhardii* (Amphipod) *Cirolana polita* (Slender Isopod) *Aeginella longicornis* (Long-Horn Skeleton Shrimp) *Caligus curtus* (Booted Sea Lice) *Crangon septemspinosa* (Sand Shrimp) *Lamprops quadriplicata* (Cumaceans) *Cancer borealis* (Jonah Crab)
Echinoidea	*Echinarachnius parma* (Sand Dollar) *Strongylocentrotus droebachiensis* (Green Sea Urchin) *Asterias vulgaris* (Asteriid Sea Stars) *Cumcumaria frondosa* (Large Northern Sea-cucumber)
Source: John Parsons & Associates 1994; JWEL 2000a, 2000b, 2002	

Benthic Habitat and Communities along the Offshore Pipeline Route

An offshore benthic habitat and community survey was undertaken by EnCana along the entire Deep Panuke offshore and nearshore pipeline route. Habitat mapping also exists for the SOEP pipeline corridor (SOEP 1996a; Mobil Oil Canada 1983).

The proposed route of the Deep Panuke offshore pipeline is 175 km in length and is expected to parallel the existing SOEP pipeline corridor for approximately 70-75% of the pipeline route. The SOEP EIS (SOEP 1996a) identifies benthic communities, based on dominant species, through which the EnCana pipeline will cross. The major part of the offshore portion of the Project pipeline on Sable Island Bank will pass through a shallow water community comprised of sand dollars (*Echinarachinus parma*), ocean quahog, and surf clam. Closer to the coast, is a community dominated by horse mussels (*Modiolus modiolus*) and brittlestars, which coincides with the gravelly sand of the Sambro Sand formation. Nearest to the coast, the benthic community is dominated by horse mussels and red algae (SOEP 1996b).

Along the Deep Panuke pipeline route, the distribution of organisms depends on substrate type. A total of 155 species in 13 taxonomic classes were identified from the 33 collected samples along the route. The average density per sampling station is low and ranged from 1.2 to 7.7 organisms/0.1 m^2; however the diversity (Shannon Index) is high and ranged from 1.2 – 0.4 with a mean of 0.90 (±0.2).

Benthic Habitat and Communities in the Nearshore Environment

Off the Nova Scotia coast, the rocky subtidal zone typically extends to about 15 m below the mean low water mark and grades into sand/gravel sedimentary bottom. The intertidal and subtidal region within 1 km of pipeline landfall is comprised of rocky substrate of cobble and boulders with interstitial sand and gravel.

Rocky substrate in the nearshore is important for seaweed habitat, which is dominated by barnacles, periwinkles (*Littorina littoria*), whelks, hermit crabs, sea urchins, lobsters (*Homus americanus*), rock crabs (*Cancer irroratus*), blue and horse mussels, small crustaceans, polychaetes, bryozoans, sponges, tunicates and other invertebrates. Marine algae are limited to relatively shallow depths by light availability. The Deep Panuke pipeline route survey revealed a benthic substrate dominated by kelp beds, red filamentous algae and coralline algae in the nearshore. Marine flowering plants (sea grasses and saltmarsh grasses) are found primarily in shallow, protected coastal areas. The rocky subtidal community (within approximately 100 m from shore) includes rock crabs, lobsters, sea stars, demersal fish (*i.e.*, sculpins, flounder, cunner (*Tautogolabrus* sp.)) and mussels. A site-specific survey along the nearshore section of the pipeline corridor determined that the most common animals were sea stars and bivalves.

The Country Harbour substrate (approximately 1 km from landfall) is primarily rocks ranging from gravel to boulders interspersed with sandy areas. The epibenthic community is patchy in distribution with high biodiversity in some locations, and barren in others; it is generally described as a typical rocky shore environment of the Atlantic Coast.

Table 6.3 lists the species observed along the pipeline route in the nearshore region during a survey of the proposed pipeline corridor.

Table 6.3 Species Observed Along the Nearshore Pipeline Corridor	
Taxa	**Species**
Algae	*Laminaria longicruris* (kelp)
	Laminaria saccharina (kelp)
	Laminaria digitata (tangle)
	Alaria esculaenta (winged kelp)
	Agarum cribrosum (sea colander)
	Corallina officinalis (coral weed)
	Lithothamnium sp.
	Phymatolithon sp.
	Clathromorphum sp.
	Ascophyllum nodosum (knotted wrack)
	Fucus spp. (wrack)
Echinoidea	*Stronglyocentrotus droebachiensis* (green sea urchin)
	Asterias spp. (sea stars)
Crustacea	*Polyplacophora* sp. (chitons)
	Cancer irroratus (rock crab)
	Homarus americanus (lobster)
	Balanus sp. (barnacles)
	Hyas spp. (toad crab)
Bivalvia	*Mytilus edulis* (blue mussel)
	Placopecten magellanicus (sea scallop)
Gastropod	*Littorina littoria* (periwinkle)
	Patella uulgata (limpet)
Source: JWEL 2002	

6.1.2.2 Marine Fish

Fish are the most abundant and diverse group of vertebrates in the ocean, with 538 species recorded in the Canadian Atlantic Region alone. Three main groups of fishes are represented in Nova Scotia waters: jawless; cartilaginous; and bony fishes (NSM 1997). The familiar commercial species of marine fish in Nova Scotia make up only a small proportion of the total number of species. Numerous lesser-known, but in some cases abundant, species inhabit the different marine and estuarine habitats.

Changes in the species assemblages have resulted in the following trends over the last two decades:

- groundfish resources have declined precipitously;
- invertebrate stocks have increased; and
- there has been an overall shift to harvesting the lower trophic levels (*i.e.*, invertebrates).

Habitat and Occurrence

The marine fish likely to be found in the waters off Nova Scotia may be divided into five groups: fishes of estuaries and coastal inlets; groundfish; pelagic species; mesopelagic (intermediate depth) species; and exotic warm-water and eastern-arctic species. Shallow-water environments offer more opportunities for specialization and therefore have high species diversity. Further offshore, species diversity is lower but the biomass is high (NSM 1997).

Coastal and Estuarine Species

Up to twenty fish species are commonly found in estuaries around the coast of Nova Scotia. They include species that remain in estuaries for their entire life cycle or migrate into fresh water for short periods to spawn. Anadromous fishes that pass through estuaries on their way to spawning grounds in freshwater include gaspereau *(Alosa pseudoharengus)*, Atlantic salmon (*Salmo salar*), Atlantic smelt (*Osmerus mordax*), and American shad *(Alosa sapidissima)*. Species, such as brown trout *(Salmo trutta)*, brook trout *(Salvelinus fontinalis)*, and four species of stickleback *(Gasterosteus* sp.*)*, which typically live in fresh water, often feed in coastal estuaries during parts of the year because of the abundance of food and favourable temperatures. The juveniles of many demersal (bottom) and pelagic fishes (open ocean), such as cod (*Gadus morhua*), pollock (*Pollachius virens*), and herring (*Clupea harengus harengus*), also feed in coastal environments (NSM 1997).

Groundfish (Demersal) Species

Groundfish occur both offshore and in coastal inlets and estuaries. They live close to the bottom for much of their adult life. The shallow waters close to Sable Island are an important nursery area for many juvenile fish. Sand lance and juvenile groundfish also provide food for seals and seabirds.

Studies on the Scotian Slope have placed fish within various assemblages. In the shallow slope waters (>200 m), redfish (*Sebastes* sp.) predominate. White (*Urophycis tenuis*), red (*Urophycis chuss*), and silver hake (*Merluccius bilinearis*), American plaice (*Hippoglossoides platessoides*), witch flounder *(Glyptocephalus cynoglossus)*, and Atlantic argentine *(Argentina silus)* also occur in these waters. Fish, more characteristic of slope waters, occur deeper than 800 m (Markle *et al*. 1988).

Pelagic Species

Pelagic fish travel mostly in large schools, feeding primarily in surface waters or middle depths. Most species prey on other pelagic fish and are seasonal visitors in the study area. Key commercial species on the Scotian Shelf include Atlantic herring, Atlantic mackerel (*Scomber scombrus*), tuna, swordfish *(Xiphias gladius)*, and porbeagle shark *(Lamna nasus)*. Other pelagic species include capelin (*Mallotus villosos*), which appear to have increased in abundance during the recent period of declining water temperature, as have many coastal and estuarine species.

Mesopelagic Species

Mesopelagic species, including lanternfish (myctophids), live on the Continental Slope and are unlikely to be seen in inshore waters. Many of these deepwater species migrate vertically towards the surface at night and toward the bottom by day.

Data on mesopelagic species in the study area were compiled from surveys along the Scotian Slope from 1984 to 1989 by Halliday *et al.* (1995). More than 200 species of mesopelagic fish were found. Many have a predominately southern distribution, with a large number of expatriates from tropical waters. Lanternfish dominated; other predominant species included lightfish (Gonostomatidae), viperfish (Chauliodontidae), silver hatchetfish (Sternoptychidae), scaled dragonfish (Stomiidae), sawpalate (Serrivomeridae), snipe eel (Nemichthyidae), dogfish shark (Squalidae), longneck eel (Derichthyidae), and gulper (Eurypharyngidae).

Exotic and Transient Species

The diversity of the coastal fish fauna off Nova Scotia is increased by a number of exotic visitors brought in by warm water currents from the continental slope. Studies in St. Margarets Bay and Prospect Bay yielded 31 species from warmer waters, including flying fish, seahorses *(Hyppocampus* sp.*)*, Priacanthids, and mullet *(Mugilidae* sp.*)*. Several species of shark are also found in the warm waters of the Gulf Stream. In addition, several species of eastern origin, such as Greenland cod *(Gadus ogac)*, mailed sculpin *(Triglops murrayii)*, and Arctic eelpout (*Lycodes reticulatus*), have been recorded from cold-water areas on the banks and eastern shore. Transient species with a typically southern distribution that migrate seasonally to or through the study area include species such as bluefin tuna (*Thunnus thynnus*), swordfish, sunfish (*Mola mola*), and basking sharks (*Cetorhinus maximus*). There are occasional inshore species, such as salmon, sturgeon (*Acipenser* sp.), and species from deep water such as grenadiers (Macrouridae). These occasional visitors are not of local commercial importance.

Species at Risk

Only two fish species found in the general area of the Scotian Shelf are currently listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). These are Atlantic cod, categorized as a species of special concern, and Atlantic whitefish (*Coregonus huntsmani*), listed as endangered (COSEWIC 2002). Atlantic whitefish is an anadromous fish occupying estuarine and freshwater areas of the Tusket River drainage in southwestern Nova Scotia. There is no evidence that this species migrates to, or through, the study area.

Reproduction and Early Life History

The Sable Island/Western Bank complex is particularly important for juvenile Atlantic cod and haddock (Frank *et al.* 1997). The banks and their edges are also spawning areas for Atlantic cod, mackerel, silver hake, white hake, haddock, winter flounder, yellowtail flounder, and deep sea scallop (*Placopecten magellanicus*) (Davis *et al.* 1998). Herring are reported to spawn on middle Sable bank in the fall (Harris and Stephenson 1999).

Sable Island, Western and Middle Banks are spawning and nursery areas for many fish species. A relatively persistent gyre allows for retention of eggs and larvae over the banks where conditions are favourable for their development. Some species spawn more or less year-round on Sable Island Bank and over most of the Scotian Slope.

The spawning times and habitat locations of major species are summarized in Table 6.4.

Table 6.4 Life Stages of Fish Species Occurring in the Study Area

Species	Spawning Areas	Areas of Concentration of Adults
Atlantic Cod	Sable Island Bank from Sept. to May, peak in Nov. and through winter; another peak in May/June	Sable Island Bank (summer); upper part of the continental slope (winter) at depths of 65-135 m and temperatures of 2-10°C
Atlantic Halibut	February to May at depths of 183 m or greater. Spawning location is uncertain but likely occurs in slope area	Edge of the continental shelf; some found northeastern Sable Island Bank in the summer. Adults in depths of 200-500 m; juveniles on shoals. Temperatures near 5°C.
Haddock	Sable Island Bank in April and May	Sable Island Bank and shelf edge at depths of 50-350 m and hard sand or gravel bottom.
Pollock	Some spawning on Sable Island Bank during late summer and fall	Sable Island Bank; shelf break, especially areas near Laurentian Channel in depths to approx. 185 m.
Redfishes	Shelf edge from April to July. Release live young.	Scotian Slope, found from depths of 100-700 m and temperatures of 3-8°C
Yellowtail Flounder	Shoals of Sable Island Bank from April to early Oct with a peak in May/June.	Sable Island Bank, generally from 37-91 m (deeper in winter) and temperatures of 2-6°C
Witch Flounder	Scotian Shelf and slope from May to Oct. with a peak in July/Aug.	Common on continental shelf slope at depths of 50-300 m (though found much deeper) and temperatures

Table 6.4 Life Stages of Fish Species Occurring in the Study Area		
Species	**Spawning Areas**	**Areas of Concentration of Adults**
		of –1 to 11°C
Winter Flounder	Sable Island Bank from March to July	Sable Island Bank
American Plaice	Sable Island Bank and some slope areas from March to June generally at depths of less than 183 m.	Throughout study area at depths of 73-274 m, found at more than 700 m and temperatures of 0-1.5°C
Silver Hake	Shoals of Sable Island Bank from June to Sept	Sable Island Bank (summer) and edge (winter and spring). Temperatures of 7-10°C
White Hake	Spawning likely occurs on slope area during Spring/early summer and late summer/early autumn.	Slope of continental shelf; including slope area by Laurentian Channel. Depths of 50-200 m and temperatures of 3-10°C
Sand lance	Sable Island and Middle Banks during late November and December	Distributed across Scotian Shelf in association with most of the offshore banks at depths of less than 50 m and temperatures of 1-5°C.
Atlantic Herring	Sable Island Bank from Aug. to Oct.	Northern portions of Sable Island Bank
Atlantic Mackerel	Some spawning on shoals of Sable Island Bank from June to Aug.	Migrate through Sable Island Bank. Some in slope area in winter.
Adapted from CNSOPB 2000b.		

Seasonal Distributions

The following discussion on movements of major fish species within the study area has been largely adapted from SOEP (1996a). Major seasonal movements of fish include the shift of many groundfish species, including cod and haddock, from deeper warmer waters around the edges of the banks in winter, to the surface of the banks in the summer. Herring and mackerel also show major spring and fall movements, with major concentrations of herring overwintering in Chedabucto Bay. Shark also move onto the Scotian Shelf as waters warm in the spring, returning south in the fall. Large pelagics, tuna, and swordfish, show migration patterns also related to water temperature, with fish following the Gulf Stream in spring and then moving towards the Shelf Slope in summer. The distribution of the fisheries, can provide a good indication of areas where fish may be found at different times of the year.

Winter

During winter, most groundfish species move off the tops of the banks to deeper, warmer waters along the bank edges and in the adjoining basins (Scott and Scott 1988). These include cod (off Emerald, Sable, Banquereau Banks), haddock, silver hake, and mackerel (off Western and Emerald Banks), American plaice (off Banquereau Bank), redfish, wolffish (*Anarhichas lupus*), and argentine (off Sable and Banquereau Banks). Other species more tolerant of colder temperatures, including yellowtail (Western, Sable, and Middle Banks) and most skate species (Banquereau and Sable Banks), remain on the banks during the winter. Of particular note is the presence of winter flounder on Sable Island Bank. Witch flounder, wolffish, and monkfish (*Lophius americanus*) appear to remain in the same general location throughout the year (Kulka and Stobo 1981). Reports from the winter herring fishery indicate that fish have shifted from the traditional wintering grounds in Chedabucto Bay to an area off Halifax

(Stephenson *et al*. 1995). The winter months are peak spawning periods for several species including American sand lance (Sable Island and Middle Banks and Banquereau Bank) and pollock (Emerald-Western Banks). Migratory species such as tuna and swordfish are not found in the study area in winter.

Spring

As surface waters warm in the spring, groundfish such as Atlantic cod, haddock, silver hake, and American plaice move into shallower water on the banks. Deeper water species, such as Atlantic argentine, white hake, and redfish, remain in the deeper areas along the Shelf edge. In the spring, many species migrate over the Scotian Shelf on the way to summer feeding or spawning grounds. Spring is a peak spawning period for species such as herring (Chedabucto Bay, Eastern Shore), haddock (Emerald-Western Banks), American plaice (Emerald Bank, north Banquereau Bank), argentine, and redfish (Emerald Bank, Shelf edge). In recent years, the traditionally significant spring spawning of Atlantic cod (including the Sable-Banquereau and Emerald-Western Bank areas) has all but disappeared.

Summer

In summer, most groundfish species are dispersed over the tops of the banks. Species found on the banks include: Atlantic cod (western region of Sable Island Bank, Banquereau Bank), haddock (Sable Island Bank), silver hake, winter flounder (Western and Sable Banks), American plaice, thorny skate, and wolffish (Middle Bank), yellowtail (Sable and Middle Banks), halibut (northeastern Sable Island Bank), winter skate (western and northeastern regions of Sable Island Bank), barndoor skate (*Dipturus laevis*) (isolated east of Sable Island Bank), sand lance (north Sable Island and Middle Bank), mackerel, and squid (Western and Middle Banks).

Fall

In early fall, migratory species present on the Scotian Shelf move offshore, to the south. Atlantic mackerel migrate south through the area to wintering areas along the Shelf off Sable Island Bank, beginning in October. Tuna, swordfish, and shark leave the Shelf by November. Squid move offshore toward the Gulf Stream in October and November. In late fall, as the surface temperature drops, adults of most groundfish species move into deeper waters along the bank edges and the basins. Atlantic cod move to the Sable Island/Western Bank area for spawning. Haddock range over the Middle, Western and Sable Island Banks. Redfish move to the southern edges of Sable Island Bank. Juvenile fish (*e.g.,* silver hake, haddock) move to deeper waters. Winter flounder remain in the shallow areas of Sable Island and Western Banks.

6.1.2.3 Sea Turtles

Three species of sea turtle are known to occur off the Atlantic Canadian coast, including the leatherback (*Dermochelys coriacea*), Atlantic loggerhead (*Caretta caretta*), and Kemp’s ridley (*Lepidochelys kempii*). A fourth species, the green turtle (*Chelonia mydas*) is a wide-ranging species and may be an occasional visitor to the area, but has yet to be positively identified. The leatherback turtle is listed as endangered by COSEWIC (2002). The United States National Marine Fisheries Service (NMFS) and Fish and Wildlife Service (USFWS) list the leatherback and Kemp’s ridley turtles as endangered and the loggerhead turtle as threatened (NMFS and USFWS 1991; USFWS and NMFS 1992).

The Kemp’s ridley turtle, and, to a lesser extent, the loggerhead turtle, are generally confined to more southern waters and are not found on the Scotian Shelf as frequently as the leatherback turtle, due to the fact that Kemp’s ridley and loggerhead turtles largely lack the counter-current biophysical flow mechanism that allows active leatherback turtles to keep warm in very cold water. The average northern occurrence of loggerheads was thought to be much further south (38E 20’N), than for leatherbacks (40E 05’N) (Shoop and Kenney 1992). However, recent accidental catch rates by pelagic longline operations in Atlantic Canadian waters indicate that loggerheads are, at least in some years, more common than previously thought (Smith 2001, cited in Breeze *et al.* 2002). The American longline fleet reported catching 3,000 loggerheads off of Newfoundland from 1992 to 1995 (McAlpine 2001, cited in Breeze *et al.* 2002).

Leatherback turtles, in their search for jellyfish prey (generally *Cyanea* or *Rhizostoma* sp. in temperate latitudes, and perhaps amphipods living on these jellyfish), travel into waters off the Scotian Shelf in late spring and early summer, then north to Cape Breton and Newfoundland. Although cold-blooded like all other reptiles, leatherbacks have the capability of living in cold waters due to their thick layer of fat, their large volume to surface ratio, and their aforementioned counter-current biophysical flow mechanism (Davenport *et al*. 1990, cited in Breeze *et al.* 2002). These physiological adaptations allow large leatherbacks to maintain their body temperature 18^{o}C higher than the surrounding water (CWS 2001, cited in Breeze *et al.* 2002). From late summer to mid or late fall, they move south, either in coastal or far offshore waters (M. James, Leatherback Working Group, pers. comm. 2001; C. Clark, Sea Turtle Expert, pers. comm. 2001).

Being land-nesters, sea turtles are particularly vulnerable to disturbance by human activities. Along with natural predation, the nesting success of sea turtles has been diminished by various anthropogenic factors, including egg collection, loss of nesting beaches to commercial development, illumination of nesting beaches, shoreline pollution, ingestion of plastic and other debris, illegal hunting, and entanglement in fishing gear. Turtles, particularly sea turtles, mature slowly and exhibit moderate reproductive effort. Considerable natural mortality occurs on eggs and small juveniles. Any loss of breeding adults, above that caused through natural predation and disease, can lead to profound declines in population sizes, and possibly extirpation and/or extinction.

In Nova Scotian waters, adult and larger juvenile turtles feeding in the area may be affected by entanglement in and ingestion of debris. Entanglements in fishing line, lobster pot lines, nets, and other fishing gear have been reported. Sea turtles are caught with some regularity on longlines targeting tuna, swordfish or other large pelagics. Often these turtles have mistakenly swallowed the bait, as opposed to being foul hooked, and although are cut loose while still alive (J. Brett, local nature cinematographer, pers. comm. 2002), the rate of survival after being caught and released is unknown (Breeze *et al.* 2002). Little is known about the direct effects of the offshore oil and gas industry on sea turtles. Sea turtles may be affected by the presence of structures, underwater noise and disturbance by vessels and drill rigs, bilge or sewage discharges, cooling water and other platform discharges, and accidental hydrocarbon spills (Thomson *et al.* 2000). Most of these potential interactions, however, are considered to have effects of only short duration.

According to Thomson *et al.* (2000) and Husky Oil (2001), effects of routine exploration and production activities are expected to be same for sea turtles as those predicted for marine mammals (*i.e.*, negligible).

The accidental release of hydrocarbons could have adverse effects if sea turtles are present in the area. Prolonged exposure to oil may disrupt sea turtle feeding behaviour, cause gross and histologic lesions in the skin, reduce lung diffusion capacity, decrease oxygen consumption, decrease ingestion efficiency, and damage nose and eyelid tissue (Thomson *et al.* 2000). However, any blowout from the Project would release condensate which would quickly dissipate (refer to Chapter 3). Other accidental releases from the platform or vessels would be very small and localized. The potential interaction of the Deep Panuke Project with sea turtles has been deemed to be negligible due to the very low likelihood of a significant spill event, the development of the AERCP and Spill Response Plan to deal with spills, and effective solid waste management. Therefore, sea turtles have not been carried forward for further analysis in this assessment.

6.1.2.4 Marine Mammals

Whales

Fourteen whale species are regular or occasional residents on the Scotian Shelf (Table 6.5) (Sutcliffe and Brodie 1977; Kenney 1994; Reeves and Brown 1994; Whitehead *et al.* 1998; Lucas and Hooker 2000; Palka 2001). The fourteen cetacean species have all been recorded within the study area, close to Sable Island.

Table 6.5 Cetaceans Observed on the Scotian Shelf (estimated mean numbers per 100 km^2)[1]			
		Eastern	**Western**
Baleen whales (filter feeders)			
Minke whale	*Balaenoptera acutorostrata*	0.23 (0.47)	0.26 (0.53)
Fin whale*	*Balaenoptera physalus*	0.71 (0.40)	1.42 (0.48)
Blue whale+	*Balaenoptera musculus*	0 -	0 -
Sei whale	*Balaenoptera borealis*	0 -	0 -
Humpback whale*	*Megaptera novaeangliae*	0.74 (0.74)	0.80 (0.56)
Northern right whale+	*Eubalaena glacialis*	0 -	0.62 (0.81)
Toothed whales: Medium to large body size			
Sperm whale	*Physeter macrocephalus*	0.06 (1.06)	0.37 (0.84)
Long-finned pilot whale	*Globicephala melas*	3.23 (0.57)	3.59 (0.73)
Northern bottlenose whale[2]*	*Hyperoodon ampullatus*	0 -	0 -
Toothed whales: Smaller body size			
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	25.88 (0.54)	8.56 (0.47)
Short-beaked common dolphin	*Delphinus delphis*	1.30 (0.98)	22.94 (0.71)
Bottlenose dolphin	*Tursiops truncatus*	1.56 (0.76)	0 -
Striped dolphin	*Stenella coeruleoalba*	0 -	0 -
Harbour porpoise**	*Phocoena phocoena*	0 -	0.17 (0.52)

Notes:
[1]Estimated mean densities per 100 km^2 (with CVs [SD/mean]) on the eastern and western Scotian Shelf are based on summer aerial surveys in 1995 and 1998 (Palka 2001).
[2]The Gully population of the Northern bottlenose whale is designated as a species of special concern.

Key: Species Designation by COSEWIC (2002)
* Species of special concern
+ Endangered
** Threatened

The general distribution of whales on the Scotian Shelf defines important areas of marine production, areas that are often associated with the edges of banks, the slope of the Shelf, and inlets or canyons (Sutcliffe and Brodie 1977). The ocean dynamics associated with these bottom features result in higher levels of biological production. Filter-feeding baleen whales are attracted to areas with high densities of large copepods and euphausiids that can be efficiently harvested (Brodie *et al.* 1978). The larger copepods (McLaren *et al.* 2001) and euphausiids (Herman *et al.* 1981) are known to become concentrated in deeper waters of the Scotian Shelf basins and off the Shelf break through advection and vertical (including seasonal) migration. The Scotian Shelf is also a region of high diversity of prey items, and baleen whales have adapted their seasonal feeding strategies, as well as fat storage, accordingly (Brodie 1975).

The larger toothed whales (sperm and northern bottlenose) are associated with deeper waters, inlets, and canyons, where they feed on deepwater squid and fish. The association of the bottlenose whale with the Gully is well known, although recent work (Gowans 1999) indicates that only about one-third of the population of 130 is present in the Gully at any given time; presumably others are dispersing north and south along the Shelf slope. Sperm whales are more likely to venture out of the deep water than bottlenose, sometimes moving onto the banks of the Scotian Shelf (Sutcliffe and Brodie 1977). The pilot whale, a medium-sized toothed whale, feeds over a wide range of the Scotian Shelf, as evidenced by their status as the most abundant whale in Sable Island strandings (Lucas and Hooker 2000). During spring and summer, they feed on squid and fish along the shelf break, but are often found over banks, and may move across the Shelf to the nearshore by late summer (Kenney 1994). They are observed in large numbers on both coasts of Cape Breton Island, following shoals of mackerel, and occasionally stranding in groups (P. Brodie, Marine Researcher, pers. comm. 2001).

Dolphins can range throughout the Scotian Shelf, over deep water on the Shelf break, and into coastal inlets and harbours. Groups of Atlantic white-sided dolphins occasionally enter Bedford Basin during the summer, feeding for several weeks (P. Brodie, Marine Researcher, pers. comm. 2001).

Seals

The grey seal (*Halichoerus grypus*) and harbour seal (*Phoca vitulina*) are routinely present in the study area. Both species haul out on Sable Island throughout the year, most abundantly during their respective breeding seasons (winter for the grey seal and spring for the harbour seal). The total population of grey seals in Atlantic Canada is about 174,000 individuals (Hammill and Stenson 2000). Approximately 25,000 pups were produced on Sable Island in 1997 (Bowen *et al.* 1999), and possibly 30,000-35,000 in 2000 (D. Bowen, DFO, pers. comm. 2001), compared with approximately 500 pups in the early 1960s. The size of the harbour seal population in Atlantic Canada is much less certain, but is estimated to have increased from about 13,000 individuals in the early 1970s to about 32,000 in 1996 (Hammill and Stenson 2000). The population breeding on Sable Island, however, has declined recently from a level of pup production of approximately 600 in 1989 to approximately 40 in 1997.

Occurrences of both hooded (*Cistophora cristata*) and harp seals (*Phoca groenlandica*) on the beaches of Sable Island, mostly in winter and spring, have increased dramatically since the mid-1990s (Lucas and Daoust submitted).

Species at Risk

The western North Atlantic population of the humpback whale, the Gully population of the northern bottlenose whale, and the Atlantic Ocean population of the fin whale are designated as species of special concern by COSEWIC (2002). The northern right whale and blue whale are classified as endangered (COSEWIC 2002). With the exception of the harbour porpoise, which is classified as threatened, toothed whales present in the study area are designated as species not at risk (COSEWIC 2002). There are no seal species of special status within the study area.

6.1.2.5 Marine Related Birds

The study area includes both offshore and coastal marine habitats inhabited by a wide range of migratory and resident bird species. The offshore study area is dominated in the summer by non-breeding seabirds from the northern and southern hemisphere, and in the winter by seabirds that breed in the eastern Canadian Arctic and West Greenland (Lock *et al.* 1994). Coastal habitats, including beaches and dunes, brackish ponds, and shallow inshore waters are important to birds that breed on or near the coast, winter in coastal waters, or migrate along the coast. Information on distributions, abundance, and seasonality of all species has been derived from Tufts (1986), McLaren (1981a and b), the regional journal *Nova Scotia Birds*, and Lock *et al.* (1994). Huettmann and Diamond (2000) summarize and map important information on moulting and movement patterns of immature seabird species.

Sea Ducks

The most common waterfowl resident year round in saltwater habitats in the study area are the American Black Duck (*Anas rubripes*), largely found in salt marshes and inner bays, and Common Eider (*Somateria mollissima*) and Red-breasted Merganser (*Mergus serrator*), found in bays, along the coast, and around islands. A number of diving ducks, including Greater Scaup (Aythya *marila*), Long-tailed Duck (*Clangula hyemalis*), scoters (*Mellanitta* spp.), Common Goldeneye (*Bucephala clangula*) and Bufflehead (*Bucephala albeola*), are also common in winter.

Shorebirds

Whereas most shorebirds in the study area are autumn transients, the Killdeer (*Charadrius vociferus*), Willet (*Catoptrophorus semipalmatus*), and Spotted Sandpiper (*Tringa erythropus*) breed along the mainland coast; Least (*Calidris minutilla*) and Spotted sandpipers breed on Sable Island. Transient shorebirds may migrate up to 12,000 km from breeding to wintering grounds, intensively foraging at traditional stopover sites to meet their high-energy requirements. Most migrant shorebirds in coastal Nova Scotia frequent salt marshes and mudflats. Sanderlings (*Calidris alba*) are more common on sandy beaches. Purple Sandpipers (*Calidris maritima*) commonly occur in winter along rocky, exposed shorelines, and massive flocks of Red Phalaropes (*Phalaropus fulicaria*) have been seen off Sable Island in spring (McLaren 1981a and b).

Seabirds

Over 25 species of seabirds have been observed on the Scotian Shelf, their distribution depending on availability and distribution of preferred prey and the breeding status of the species. Some, like cormorants and gulls, are largely found in inshore waters. Most species in offshore waters are truly pelagic, spending no time ashore in the study area; however, breeding gulls and terns from Sable Island are also present on the outer Shelf.

Records of marine birds from seismic exploration surveys were collected from May to September 1998 to 2000, in conjunction with OGOP. The majority of the birds were observed near Sable Island or south of the proposed Project area. The most commonly observed species in the offshore study area were: Northern Fulmar (*Fulmarus glacialis*), Greater (*Puffinus gravis*) and Sooty (*P. griseus*) Shearwaters, Wilson's (*Oceanites oceanicus*) and Leach's (*Oceanodroma leucorhoa*) Storm-petrels, Northern Gannet (*Morus bassanus*), Herring (*Larus argentatus*) and Great Black-backed (*L. marinus*) gulls, and Black-legged Kittiwake (*Rissa tridactyla*). Fewer alcids and terns were detected; the former are known to be scarce in summer, and the latter do not range far off Sable Island. These observations support the more extensive data in Lock *et al*. (1994) and summaries in Thomson *et al.* (2000).

The offshore seabird community of the Scotian Shelf consists primarily of shearwaters and storm-petrels during the summer months, and, in winter, kittiwakes, fulmars, and alcids such as: Dovekie (*Alle alle*), Common (*Uria aalge*) and Thick-billed (*Uria lomvia*) Murres, Razorbill (*Alca torda*), Atlantic Puffin (*Fratercula arctica*) and, least commonly far offshore, the Black Guillemot (*Cepphus grylle)* (Lock *et al.* 1994). From late fall to spring, dovekies and murres are the most abundant alcids found near Sable Island, after which they migrate to their more northern breeding colonies in Newfoundland and Labrador, the Canadian Arctic Archipelago, Greenland, and Iceland. Large numbers of Leach's Storm-Petrels arrive in Canadian waters in May, breeding on coastal islands and remaining abundant there until they migrate south in autumn. Large numbers of these birds nest on Country Island and other small islands in the vicinity, and a few have recently nested on Sable Island (Z. Lucas, Sable Island, pers. comm. 2001). The more abundant Wilson's Storm-Petrel breeds in the southern hemisphere on Antarctica and adjacent islands, spending the austral winter in the northern hemisphere.

In the vicinity of Sable Island, Northern Gannets are most abundant during March-May and September-November, although some immature Gannets remain through summer. Migrant shearwaters generally begin to appear in April and may be seen until late in the year. Greater Shearwaters are most common in July-August, and Sooty Shearwaters in May-June, and most begin to migrate south to breeding colonies in the South Atlantic in August (Thomson *et al.* 2000).

Northern Fulmars are present around Sable Island throughout the year, being most abundant between October and December, and least abundant between January and April (Thomson *et al.* 2000).

Greater Black-backed Gulls and Herring Gulls are the most abundant breeding seabirds in the Project area. They are present year-round, but are most abundant from April to September when they are present at breeding colonies on Sable Island. Black-legged Kittiwakes are common in the area from October through April, but are scarce from May to September when they move to breeding colonies north of the study area. Common (*Sterna hirundo*) and Arctic (*Sterna paradisaea*) terns breed widely along the coast of Nova Scotia, including Country Island and Sable Island. They are present in the study area during the breeding season from May through August, after which their young fledge and begin to migrate out of the study area.

Country Island is a nearshore island in the study area, approximately 5 km south of Goldboro. It is one of only a few nesting sites in Canada of the endangered Roseate Tern (*Sterna dougallii*). Roseate Terns nest among Arctic and Common terns on Country Island during the summer months. After a 1997 crash in numbers, the population of Roseate Terns at Country Island was restored by predator control, increasing to 3, 16 and 53 pairs respectively in 1998, 1999 and 2000. There was no measurable effect from pipe laying in Country Harbour associated with the SOEP during the 1999 breeding season (Smith *et al.* 2001). However, there was complete abandonment of the site for unknown reasons in spring 2001 (M. Leonard, Dalhousie University, pers. comm. 2001). Roseate Terns are extremely susceptible to disruption on their nesting grounds but, like all terns, also sometimes choose to abandon previously used sites and nest elsewhere. Such events may be related to changes in local hydrography and food availability. The closest nesting Roseate Terns to the Country Island colony have occurred no closer than St. Margarets Bay, since at least the mid-1990s (Leonard *et al.* in review).

Table 6.6 presents the temporal distribution of the most common seabird species expected to occur within the offshore study area.

Table 6.6 Temporal Distribution of Seabirds Likely to be Found Offshore within the Study Area

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Northern Fulmar	■	■	■	■	■	■	■	■	■	■	■	■
Northern Gannet			■	■	■				■	■	■	
Greater Shearwater						■	■	■	■			
Sooty Shearwater				■	■	■	■	■				
Wilson’s Storm-petrel						■	■	■				
Leach’s Storm-petrel						■	■	■	■			
Herring Gull	■	■	■	■	■	■	■	■	■	■	■	■
Great Black-backed Gull	■	■	■	■	■	■	■	■	■	■	■	■
Glaucous and Iceland Gull	■	■	■	■	■				■	■	■	■
Black-legged Kittiwake	■	■	■	■						■	■	■

Table 6.6	**Temporal Distribution of Seabirds Likely to be Found Offshore within the Study Area**											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Arctic Tern					■	■	■	■				
Common Tern					■	■	■	■				
Dovekie	■	■	■	■							■	■
Common Murre	■	■	■	■								■
Note: Smaller numbers of species noted may occur outside of the indicated periods. Source: Adapted from Thompson *et al*. 2000												

Species at Risk

Two endangered (COSEWIC 2002) bird species may occur in the study area at some point in their life cycles: Roseate Tern and Piping Plover (*Charadrius melodus melodus*). Roseate Terns breed on Country Island and Sable Island. Piping Plovers formerly nested on Sable Island (McLaren 1981); there are no published reports of transients in the mainland study area in the regional journal *Nova Scotia Birds*. The Ipswich Sparrow (*Passerculus sandwichensis princeps*), classified as a species of special concern (COSEWIC 2002), nests almost exclusively on Sable Island. Harlequin Ducks (*Histrionicus histrionicus*), which are designated as a species of special concern (COSEWIC 2002), were not detected near Country Harbour during a 1997 winter waterfowl survey conducted by NSDNR. However, Harlequin Ducks undoubtedly migrate through the area in small numbers, as there are wintering and staging areas on the outer coast.

Other bird species observed in the study area which have been designated by NSDNR as being sensitive to disturbance (yellow rating) include the Red Phalarope, Arctic Tern, Common Tern, Atlantic Puffin, Common Loon (*Gavia immer*) and Nelson's Sharp-tailed Sparrow (*Ammodramus nelsoni*). Fea's petrel (*Pterodroma feae*), a globally threatened species (no COSEWIC or provincial designation), may be present in the study area (one record for the Gully) (Hooker and Baird 1999).

Other coastal birds in the study area that are sensitive to human disturbance include Great Blue Heron (*Ardea herodias*), Osprey (*Pandion haliaetus*), and Belted Kingfisher (*Ceryle alcyon*). All of these species normally migrate south for the winter. Loons, grebes (*Podiceps* spp.), cormorants and Bald Eagles (*Haliaeetus leucocephalus*) are resident year round.

6.1.2.6 Special Places

Sable Island

Sable Island is a federally protected area on the Scotian Shelf and is designated as a Migratory Bird Sanctuary, administered by the Canadian Wildlife Service. Operations on the island are now largely administered by the Sable Island Preservation Trust, under the Conservation Strategy for Sable Island, and funded largely by the federal and provincial governments, and the offshore oil and gas industry. EnCana maintains an approved helicopter refueling facility on Sable Island for emergency purposes.

The geology of Sable Island is unique to Nova Scotia in that the complete sequence of surficial materials are sand-sized particles. There are no bedrock outcrops or clay deposits on the island and soil profiles (including paleosols) are thin (JWEL 2000c). Sable Island is the only exposed portion of the outer continental shelf in the Northwest Atlantic. The main body of the island is defined by two well-developed systems of sand dunes paralleling the north and south beaches (Hennigar 1976).

Approximately 35% of Sable Island is covered by vegetation (Stobo and McLaren 1975; Catling *et al.* 1984) whereas the remaining 65% is essentially unvegetated sand. The island's vegetation is subdivided into seven main plant communities which include Sandwort, Marram-Forb, Marram-Sparse Grassland, Marram-Fescue, Shrub Heath, Cranberry Heath, and Pond Edge Herbaceous plant communities (Catling *et al.* 1984). Six plant taxa that are considered rare in Nova Scotia (Pronych and Wilson 1993) have been recorded on Sable Island. These include *Centunculus minimus*, *Coeloglossum viride* var. *virescens*, *Epilobium nesophilum* var. *sabulonense*, *Juncus bulbosus*, *Juncus pelocarpus* var. *sabulonense*, *Potamogeton oblongus*, *Senecio pseudo-arnica*, and *Tillaea aquatica*.

Over 330 species of birds have been recorded on or near Sable Island, and 25 species have nested there (McLaren 1981a; *Nova Scotia Birds*). Of the breeding species, only the American Black Duck, Northern Pintail (*Anas acuta*), Red-breasted Merganser (*Mergus serrator*), Semipalmated Plover (*Charadrius semipalmatus*), Least Sandpiper, Herring and Great Black-backed gulls, Common and Arctic Terns, European Starling (*Sturnus vulgaris*), and Ipswich Sparrow nest regularly in some numbers. The endangered Piping Plover has not nested here since 1964. The endangered Roseate Tern has been found breeding on Sable Island (four pairs in 2000; one pair in 2001). The Ipswich Sparrow, classified as a species of special concern (COSEWIC 2002), nests almost exclusively on the island (a few have mated with Savannah Sparrows (*Passerculus sandwichensis*) on mainland beaches).

There are no native terrestrial mammals on Sable Island. Of a number of species introduced in the past, only the horses (*Equus caballus*) remain. The horse population fluctuates, with the population ranging from 200 to 220 in most years. The feral horses have been protected since 1961 through the *Sable Island Regulations* under Section 258 of the *Canada Shipping Act* (Wright 1989).

Grey and harbour seals breed on the island's beaches, and walrus (*Odobenus rosmarus*) once did so. Sable Island supports the largest grey seal breeding population in the world (Bowen *et al.* 1999).

The waters immediately adjacent to Sable Island are characteristic of the Sable Island Bank. The substrate consists mainly of the same well-sorted sands that form the island's substance. Currents and storms keep the water column at most weakly stratified. As the sands are constantly shifting, the benthos is relatively sparse and non-diverse. Fish diversity is also relatively low.

Sable Gully

The Sable Gully is located approximately 40 km east of Sable Island on the edge of the Scotian Shelf. The Gully is the largest submarine canyon on the east coast of North America, at 80 km long by 30 km wide (WWF 1986). A wide trough is located at the north of the feature and the more than 2,000 m deep canyon is located at the south. It is unique among canyons of the eastern Canadian margin because of its depth, steep slopes and extension back into the continental shelf (DFO 1998).

The Gully provides wide habitat diversity to a variety of marine mammals, groundfish, pelagic fish and invertebrate species, as well as benthic and planktonic populations. Deep-sea corals are a significant feature of the Gully's benthic fauna. The Gully is important as foraging habitat for squid-feeding cetaceans, supporting a resident population of approximately 280 northern bottlenose whales. It is also home to an additional 12 species of cetaceans (Faucher and Weilgart, 1992; Whitehead *et al*., 1992; 1997a; 1997b).

DFO designated the deep canyon area of the Gully as a whale conservation area (now a whale sanctuary) in 1994 in an effort to reduce ship collisions and noise disturbance to the whales, and in 1997 initiated the Sable Gully Conservation Strategy to address growing conservation interest (DFO 1998). It is currently an "Area of Interest" under DFO's Marine Protected Area (MPA) program and there are draft regulations to designate the Gully as an MPA.

Country Island

Country Island is a 19 ha island located approximately 8 km offshore from Drum Head, Nova Scotia. The Island hosts a sizeable breeding colony of Common and Arctic terns. In addition, it is one of the few remaining Canadian breeding sites for the Roseate Tern. The use of Country Island by this species is discussed in Section 6.1.2.5.

There are currently no formal restrictions on travel to Country Island. The Country Island complex has been designated internationally as an Important Bird Area and a proposal to designate Country Island as a Migratory Bird Sanctuary under the *Migratory Bird Convention Act* has been prepared.

6.1.3 Onshore Environment

6.1.3.1 Landform and Topography

The terrain of the Goldboro area is predominantly hummocky with gently rolling ridges and valleys interspersed with flat coastal lowland plains and extensive bogs, open lakes and associated intermittent streams and bogs. The landscape rises from sea level to 50 to 75 m within 1 km of the shoreline and has regional elevation rising to 120 m. The topography of the area appears to result from glacial erosion and the deposition of glacial landforms. The coastline is submerged and indented with headlands and long inlets with few islands.

6.1.3.2 Geology and Soils

The area around Goldboro consists mainly of the Goldenville Formation with bands of Halifax Formation. The Cambro-Ordovician aged Meguma Group (O'Reilly *et al.* 1992) consists of the older Goldenville Formation (greywacke, quartzite, siltstone and minor slates) and the younger Halifax Formation (slates, siltstone and minor schists). The structural geology of the area is relatively complex with highly to intensely fractured bedrock. The bedrock is also highly faulted. Although the Goldenville Formation is not susceptible to the formation of solution cavities or sinkholes, there exists potential however, for subsidence associated with former gold mine workings in the Goldboro area.

Most of the immediate area around Goldboro is underlain by stony, silty sand till of the Quartzite Till sheet. The thickness of this ground moraine lodgement till typically averages 3 m, but may reach over 20 m. The shoreline in the immediate vicinity of the proposed pipeline land fall is pebble-cobble beach from Webbs Cove to Drum Head with a short section (200 m) of boulder beach occurring just prior to Drum Head. Beyond Drum Head the shoreline consists mostly of bedrock and human made-structures (wood and stone). The lower intertidal zone in the area consists of mixed coarse (no sand) beach material and bedrock resistant platforms with a wharf and breakwater in Drum Head Harbour.

In terms of hydrogeology, based on 1:10 000 topographic mapping of the onshore study area, no wells appear to be within 1 km of the landfall. The closest industrial well (SOEP gas plant) is greater than 500 m from the closest point of the onshore pipeline corridor near its tie-in with the M&NP pipeline. The closest residential well is located approximately 900 m from any onshore pipeline activity. There is, therefore, not likely to be any interactions between the Project and well water supplies in the area.

Three major soil series occur within the study area, Halifax; Aspotogan; and Organic. Halifax soils are associated with the gently undulating to hilly topography of the study area. These soils are well drained and support fair to good stands of mixed forest (Hilchey *et al.* 1964). Aspotogan soils are shallow, poorly drained soils located in lower areas of the study area landscape. They are derived from a sandy to gravelly sand quartzite till, which is often exceedingly stony. Aspotogan soils are classified as Gleyed Ferro-Humic Podzols (SOEI 2000). Organic soils occur in very poorly drained areas of the study area either adjacent to water or in depressions in the landscape. Profiles consist of brown semi-decomposed fibrous material consisting mainly of sphagnum moss. Depth of the organic material may be as great as 2 m.

6.1.3.3 Vegetation

The vegetation in the onshore study corridor can be divided into four broad categories: forests; shrub thickets; wetlands; and disturbed areas (SOEI 2000). These in turn can be subdivided into a number of plant communities.

Forests in the study corridor are boreal in nature and are characterized by relatively low species richness. All of the forest plant communities present in the study corridor are dominated by various combinations of black spruce (*Picea mariana*), balsam fir (*Abies balsamea*), tamarack (*Larix laricina*), and mountain white birch (*Betula cordifolia*). Five distinct forest plant communities are present within the study corridor, including balsam fir/mountain white birch/black spruce forest, black spruce/balsam fir/tamarack forest, black spruce/tamarack/balsam fir forest, black spruce/tamarack forest, and tamarack/black spruce/balsam fir forest.

Shrub thickets are found in a variety of locations in the study corridor, ranging from well drained to imperfectly drained. This plant community consists of a dense tall shrub canopy underlain by a well developed, low shrub understory. The tree layer is very sparse consisting of scattered trees of a variety of species. The tall shrub overstory is typically composed of witherod (*Viburnum nudum*), false holly (*Nemopanthus mucronata*), downy alder (*Alnus viridis*), and pin cherry (*Prunus pensylvanica*). The low shrub understory generally consists of lambkill (*Kalmia angustifolia*), blackberry (*Rubus canadensis*), rhodora (*Rhododendron canadense*), and Labrador tea (*Ledum groenlandicum*). The ground vegetation layer is largely of bunchberry (*Cornus canadensis*), Schreber's moss, bracken fern (*Pteridium aquilinum*), evergreen wood fern (*Dryopteris intermedia*), and stair-step moss.

The study corridor contains both bogs and swamps. Eight bogs are present in the study corridor. Based on the Canadian Wetland Classification System (National Wetlands Working Group 1987), a large bog located on Betty's Cove Brook is classed as a shore bog. The remaining seven bogs are classed as basin bogs. Stream swamp is the only swamp type found in the study area. Stream swamp is found along the shores of Betty's Cove Brook in the southern portion of the study corridor.

Much of the study area has been subjected to forest harvesting activity in recent years and clear-cuts are present over most of the southern portion of the area. The most recent source of disturbance has been the construction of the SOEP gas plant and SOEP and M&NP pipelines.

A total of 155 vascular plant species were recorded in the study area during the field survey including nine tree species, 36 shrub species, and 110 ground vegetation species. One of these species, the northern commandra (*Geocaulon lividum*) is considered to be rare in Nova Scotia (Pronych and Wilson 1993) but is not considered to be nationally rare (COSEWIC 2002; Argus and Pryer 1990). Two other rare species, Newfoundland dwarf birch (*Betula michauxii*) and variegated horsetail (*Equisetum variegatum*), were recorded within approximately 1 km of the study area (SOEI 2000), but were not encountered within the study area during the field survey. Both of these species are considered to be rare in Nova Scotia, but not nationally.

6.1.3.4 Wildlife

Bird, mammal, and herpetofaunal surveys were conducted in the study area in September 2001 and June 2002 as part of the field surveys for the environmental assessment. Additional sources of information included data collected for other environmental assessments conducted in the area for the SOEP gas plant and pipelines (SOEP 1996b; SOEP 1996c). These surveys have concluded that there are no bird, mammal, reptile, or amphibian species at risk breeding in the proposed pipeline corridor. None of the plant or animal species listed under the *Endangered Species Act* in Nova Scotia have been detected in the corridor. Further detail is provided below.

Birds

The environmental assessments for the gas plant and pipeline (SOEP 1996b; SOEP 1996c) did not record the presence of any rare or sensitive bird species in the area adjacent to the SOEP gas plant. Very little breeding bird atlas data is available for the study corridor (Erskine 1992). Only three species of bird, Common Loon, American Black Duck, and Dark-eyed Junco, were recorded in the 10 km x 10 km breeding bird atlas square within which the study corridor is located.

Avifaunal observations made during the field survey in early September 2001 indicated the presence of 32 bird species. None of these species is considered to be rare in Nova Scotia (Scott 1994; Erskine 1992) or in Canada (COSEWIC 2002). The most abundant species, in descending order of abundance, were Cedar Waxwing (*Bombycilla cedrorum*), American Crow (*Corvus brachyrhynchos*), Common Yellowthroat (*Geothlypis trichas*), White-throated Sparrow (*Zonotrichia albicollis*), Boreal Chickadee (*Parus hudsonicus*), Palm Warbler (*Dendroica palmarum*), Blue Jay (*Cyanocitta cristata*), Northern Junco (*Junco hyemalis*), and Swamp Sparrow (*Melospiza georgiana*).

In June 2002, a breeding bird survey was conducted within the pipeline corridor. This survey indicated that the most abundant bird species in forested habitats are Magnolia Warbler (*D. magnolia*), Nashville Warbler (*Vermivora ruficapilla*), Yellow-rumped Warbler (*D. coronata*), Ruby-crowned Kinglet (*Regulus calendula*), Swainson's Thrush (*Catharus ustultus*), and Yellow-bellied Flycatcher

(*Empidonax flaviventris*). This survey indicated that there are no bird species at risk breeding in the corridor.

Mammals and Critical Habitat

No rare or particularly sensitive mammals have been recorded in the general vicinity of the study corridor (Fuller 1998). Eight mammal species were detected during field surveys, including American red squirrel (*Tamiasciurus hudsonicus*), meadow vole (*Microtus pensylvanicus*), American porcupine (*Erethizon dorsatum*), snowshoe hare (*Lepus americanus*), red fox (*Vulpes vulpes*), coyote (*Canis latrans*), American black bear (*Ursus americanus*), and white-tailed deer (*Odocoileus virginianus*). None of these species is considered to be at risk in Nova Scotia (Scott 1994) or in Canada (COSEWIC 2002).

Other mammal species expected to be found in the general area include raccoon (*Procyon lotor*), ermine (*Mustella erminea*), bobcat (*Lynx rufus*), little brown bat (*Myotis lucifugus*), northern flying squirrel (*Glaucomys sabrinus*), red-backed vole (*Clethrionomys gapperi*), deer mouse (*Peromyscus maniculatus*), common shrew (*Sorex cinereus*), short-tailed shrew (*Blarina brevicauda*), and smoky shrew (*Sorex fumeus*).

Little brown bats are considered to be vulnerable to disturbance during winter, when they gather in large numbers at their hibernacula. Abandoned mine shafts are frequently used as winter hibernacula. An inspection of mine shafts in the area conducted in early June 2002 revealed unlikely hibernacula for little brown bats. Although the distribution of tree bats (red bat, hoary bat and silver-haired bat) in Nova Scotia is poorly understood, there have been no known recorded observations of these species in the vicinity of the onshore pipeline corridor.

Herpetofauna (Amphibians and Reptiles)

A review of Fuller (1998) did not reveal any records of rare amphibian or reptile species in the vicinity of the study corridor. However, the environmental assessment for the SOEP gas plant (SOEP 1996b) identified six herpetile species at risk possibly present in the vicinity of the gas plant: blue-spotted salamander (*Ambystoma laterale*), erythristic phase eastern redback salamander (*Plethodon cinereus*), four-toed salamander (*Hemidactylium scutatum*), mink frog (*Rana sepentrionalis*), wood turtle (*Clemmys insculpta*), and northern ringneck snake (*Diadophis punctatus edwardsi*). Of these six species, COSEWIC (2002) designates only the wood turtle as a species of concern.

A herpetile survey was conducted as part of the field investigation for the Deep Panuke onshore terrestrial habitat assessment. This survey indicates the presence of four amphibian and two reptile species: redback phase eastern redback salamander, wood frog (*Rana sylvatica*), green frog (*Rana* *clamitans melanota*), northern spring peeper (*Pseudacris crucifer crucifer*), maritime garter snake (*Thamnophis sirtalis pallidula*) and northern redbelly snake (*Storeria occipitomaculata occipitomaculata*). None of the species of concern were found during the field survey. The study area does not provide suitable habitat for four of the species of concern, (*i.e.*, erythristic phase eastern redback salamander, blue-spotted salamander, mink frog, and wood turtle), while the available habitat is marginal for northern ringneck snakes.

The study area contains suitable breeding habitat for four-toed salamander. The four-toed salamander is currently listed as being sensitive (status = yellow) to anthropogenic activities, (NSDNR 2001a), although the Nova Scotia Museum and NSDNR have indicated that the four-toed salamander is more abundant and widespread than previously thought and status re-assessment will likely result in it being assigned a status of "green" (not believed to be sensitive or at risk). COSEWIC (2002) has designated the four-toed salamander as "not at risk" in Nova Scotia. Areas identified as having high potential to support four-toed salamanders during the September 2001 survey were searched intensively by a highly experienced herpetologist in June 2002 to determine if four-toed salamanders were present. This species has very specific breeding habitat requirements (loose sphagnum moss hummocks at the edges of pools or sluggish streams), so it was possible to determine if there was a high potential for four-toed salamanders to breed in the wetlands. No four-toed salamanders were found, indicating that this species is not present within the corridor.

6.1.3.5 Wetlands

Information regarding wetlands in the study corridor were derived from several sources including Wetland Atlas-Wetland Protection mapping (Canadian Wildlife Service 1984), 1:10,000 scale topographic mapping, air photo interpretation, and field surveys. Wetland atlas data consist of a wetland identification number, wetland size and types, and the Golet score for the wetland (which helps to provide an indication of its value as wildlife habitat). Wetlands with Golet scores greater than 65 are considered to be important wildlife habitat. Only three of the eight wetlands present in the study corridor appear on the wetland atlas mapping. On the wetland atlas mapping, two wetlands have a Golet score of 60, indicating that they likely have limited value as wildlife habitat. The third wetland has no Golet score associated with it, indicating that it has a Golet score of less than 60. Therefore, none of the wetlands in the study area have high value or potential high value according to their Golet scores. However, three of the wetlands support or have high potential to support rare species which must be considered.

None of the wetlands provides important hydrological functions and only one appears to have any socio-economic value. Betty's Cove Brook, which passes through this wetland, may provide angling opportunities for recreational fishers.

6.1.3.6 Freshwater Fish Habitat

There are three small streams in the study corridor and several intermittent or subsurface streams. Betty's Cove Brook is the only major watercourse within the study corridor (Figure 2.6). Betty's Cove Brook is a first order stream, draining to Betty's Cove and then to Country Harbour.

The most valued fish species in the region are Atlantic salmon, brook trout and brown trout. DFO considers Betty's Cove Brook important for brook trout but not for Atlantic salmon. Habitat limitations in Betty's Cove Brook include a limited drainage basin, low water velocity, and fine particulate substrate, although the deep water is appropriate refuge for large fish in summer, and the water quality conditions appear acceptable for salmonids (SOEP 1996b). Elevated levels of arsenic have been found in fish tissue analysis from Gold Brook and Seal Harbour Lake, where mine tailings having degraded the water quality (SOEP 1996b).

6.1.4 Summary of Special Status Species

A number of species that are considered to have special status by either the provincial and/or federal governments have been discussed in the preceding sections. Table 6.7 provides a summary of these species.

Table 6.7 Species of Special Status that May Occur in the Study Area

SPECIES	STATUS
Marine Fish	
Atlantic Cod (*Gadus morhua*)	Species of Special Concern (COSEWIC 2002)
Atlantic Whitefish (*Coregonus huntsmani)*	Endangered (COSEWIC 2002)
Striped Bass (*Morone saxatilis)*	Extremely rare throughout its range in NS (ACCDC 2000)
Marine Reptiles	
Leatherback Sea Turtle (*Dermochelys coriacea)*	Endangered (COSEWIC 2002; NMFS)
Kemp's Ridley Sea Turtle (*Lepidochelys kempii)*	Endangered (USFWS and NMFS 1992)
Loggerhead Sea Turtle (*Caretta caretta)*	Threatened (NMFS and USFWS 1991)
Marine Mammals	
Fin Whale (*Balaenoptera physalus)*	Species of Special Concern (COSEWIC 2002)
Blue Whale (*Balaenoptera musculus)*	Endangered (COSEWIC 2002)
Humpback Whale (*Megaptera novaeangliae)*	Species of Special Concern (COSEWIC 2002)
Northern Right Whale (*Eubalaena glacialis)*	Endangered (COSEWIC 2002)
Harbour Porpoise (*Phocoena phoconea)*	Threatened (COSEWIC 2002)
Northern Bottlenose Whale (*Hyperoodon ampullatus*)	Species of Special Concern (COSEWIC 2002)
Marine Related Birds	
Roseate Tern (*Sterna dougallii)*	Red listed (NSDNR 2001a); Endangered (COSEWIC 2002)
Piping Plover (*Charadrius melodus)*	Red listed (NSDNR 2001a); Endangered (COSEWIC 2002)
Harlequin Duck (*Histrionicus histrionicus)*	Red listed (NSDNR 2001a); Species of Special Concern (COSEWIC 2002)
Red Phalarope (*Phalaropus fulicaria)*	Yellow listed (NSDNR 2001a)

Table 6.7 Species of Special Status that May Occur in the Study Area	
SPECIES	**STATUS**
Arctic Tern (*Sterna paradisaea*)	Yellow listed (NSDNR 2001a)
Common Tern (*Sterna hirundo*)	Yellow listed (NSDNR 2001a)
Atlantic Puffin (*Fratercula arctica)*	Yellow listed (NSDNR 2001a)
Common Loon (*Gavia immer*)	Yellow listed (NSDNR 2001a)
Nelson's Sharp-tailed Sparrow (*Ammodramus nelsoni)*	Yellow listed (NSDNR 2001a)
Fea's Petrel (*Pterodroma feae*)	Globally Threatened (No formal designation)
Great Blue Heron (*Ardea herodias)*	Sensitive to human disturbance
Osprey (*Pandion haliaetus)*	Sensitive to human disturbance
Belted Kingfisher (*Ceryle alcyon)*	Sensitive to human disturbance
Grebes (*Podiceps* spp.)	Sensitive to human disturbance
Cormorants (*Phalacrocorax* spp.)	Sensitive to human disturbance
Bald Eagles (*Haliaeetus leucocephalus)*	Sensitive to human disturbance
Ipswich Sparow (*Passerculus sandwichensis princeps*)	Yellow listed (NSDNR 2001a); Species of Special Concern (COSEWIC 2002)
Onshore Flora	
Northern Commandra (*Geocaulon lividum)*	Rare in Nova Scotia
Bulbous Rush (*Juncus bulbosus*)	Rare in Nova Scotia
Cinnamon-spot pondweed (*Potamogeton oblongus)*	Rare in Nova Scotia
Newfoundland dwarf birch (*Betula michauxii)*	Rare in Nova Scotia
Pygmyweed *(Crassula aquatica)*	Rare in Nova Scotia
American frog orchid (*Coeloglossum viride*)	Rare in Nova Scotia
Chaffweed (*Centunculus minimus*)	Rare in Nova Scotia
Variegated horsetail (*Equisetum variegatum)*	Uncommon in Nova Scotia
Onshore Fauna	
Little Brown Bat (*Myotis lucifugus)*[1]	Vulnerable to Disturbance; Yellow listed NSDNR (2001a)
Blue Spotted Salamander (*Ambystoma laterale)*[2]	Uncommon in Nova Scotia
Erythristic Phase Eastern Redback Salamander *(Plethodon cinereus)*[2]	Rare color phase in Nova Scotia
Four-toed Salamander (*Hemidactylium scutatum)*[1]	Yellow listed NSDNR (2001a)
Wood Turtle (*Clemmys insculpta)*[2]	Yellow listed NSDNR (2001a); Species of Special Concern (COSEWIC 2002)
Freshwater Fish	
Atlantic Salmon (*Salmo salar)*	Red listed (NSDNR 2001a); Inner Bay of Fundy Populations Endangered (COSEWIC 2002)
Brook Trout (*Salvelinus fontinalis)*	Yellow listed NSDNR (2001a)
Brown Trout (*Salmo trutta)*	Sensitive to Habitat Disturbance
[1] Field survey indicated species presence is unlikely in the study area. [2] Study area does not provide suitable habitat for these species.	

A number of these species are discussed further as part of the VECs considered in this environmental assessment.

6.2 Impact Assessment Methodology

This environmental assessment has been prepared to meet the regulatory requirements of the *CEAA*, as well as the Scope of Environmental Assessment (CNSOPB *et al.* 2001b). In particular, the assessment addresses the specific requirements for a comprehensive study pursuant to the *CEAA*.

6.2.1 Issues Scoping and Selection of Valued Environmental Components

An important part of the assessment process is the early identification of the Valued Environmental Components (VECs) upon which the assessment will focus (Beanlands and Duinker 1983). VECs may represent "key" or "indicator" species, communities, species groups, or ecosystems, as well as "pathways" (*e.g.,* air, water) that act as media for the transfer of environmental effects. VECs may also reflect issues of social, cultural or economic value. This section outlines the steps taken to identify the VECs considered in this assessment.

6.2.1.1 Issues Scoping

Issues scoping is an important part of the VEC identification process. The issues scoping exercise for this environmental assessment included: stakeholder consultation; regulatory agency consultation (including review of the draft CSR); preliminary research, including review of similar environmental assessments; and the Study Team's professional judgement.

Chapter 5 of this CSR provides an overview of the public consultation program undertaken by EnCana in relation to this environmental assessment, and the results of this process. Information from this process assisted the identification and scoping of VECs for the environmental assessment. The final phase of EnCana's public consultation program involves ongoing communication and regulatory review consultation during the application review and post application follow-up process. More detailed information on the Deep Panuke consultation program can be found in EnCana's PCR (DPA Volume 6) and the Response Document (Addendum 1).

Regulatory issues and guidelines, as well as consultations with regulators and other government officials, also formed an integral part of the issues scoping process. As discussed in Section 1.3, an MOU has been negotiated between the various RAs under *CEAA*, the CEA Agency, and the Province of Nova Scotia (as represented by NSDEL) to ensure the interests of federal and provincial government departments and agencies are included in the environmental assessment, and to coordinate their respective environmental assessment processes and responsibilities. These signatory parties prepared a scoping document (December 18, 2001, revised February 15, 2002) (CNSOPB *et al.* 2001b) outlining issues to be addressed in the environmental assessment. This CSR has been prepared in accordance with the scoping document.

In addition to the requirements presented in the scoping documents, the scoping exercise considered relevant federal, provincial and municipal regulations and guidelines. Issues considered in this assessment, as well as the methodological approaches used, were derived from the *CEAA*, having regard to the various CEA Agency guidance documents. Regulatory issues and concerns have also been identified through various communications and meetings held by EnCana and the Study Team with representatives of relevant regulatory authorities.

Preliminary research included a review of relevant scientific research publications and regulatory documents. These included environmental assessments of other oil and gas development projects such as the Cohasset-Panuke Initial Environmental Evaluation (LASMO 1990a); the Sable Offshore Energy Project EIS (SOEP 1996a); the White Rose Oilfield Development Comprehensive Study (Husky Oil 2000); and various LASMO (the previous operator of the Cohasset Project) and EnCana studies (JWEL 2002; 2000a, 2000b; John Parsons & Associates 1999). The informed professional judgement of the environmental assessment Study Team and EnCana staff was also an important component of the issues scoping exercise.

6.2.1.2 Selection of Valued Environmental Components

Section 6.2.1.1 describes the issues and factors that determined the scope of the environmental assessment. The environmental issues to be addressed, as listed in the scoping document, are shown in Table 6.8, along with the rationale for inclusion/exclusion as a VEC, based on professional judgement.

Table 6.8 Selection of Valued Environmental Components

Environmental Component[1]	Considerations in Subsequent Scoping	Selected VEC
Air Quality	Focus on offshore air emissions from a potentially major source (*i.e.*, gas processing), although onshore emissions associated with construction are also considered.	• Air Quality
Water Quality	Due to specific comments and requests of the RAs, marine water quality is considered a VEC in the CSR. Water quality is a pathway for potential ecosystem effects, inherent to several VECs, such as Marine Fish, Marine Benthos, Marine Mammals and Marine Related Birds.	• Marine Water Quality
Sediment Quality	Marine sediment is a pathway for potential ecosystem effects on benthic communities.	• Marine Benthos
Soil Capability and Quality	Soil conditions are described in CSR Section 6.1. Due to the limited capability of these soils for agriculture and forestry, and lack of interaction with the Project during operations, this component has not been selected as a VEC.	N/A
Fish and Fish Habitat	Focus on marine commercial species offshore and nearshore, and focus on potential interaction with Betty's Cove Brook onshore.	• Marine Fish • Onshore Environment (in discussion of freshwater habitat)

Table 6.8 Selection of Valued Environmental Components

Environmental Component[1]	Considerations in Subsequent Scoping	Selected VEC
Mammals	Focus on potential Project disturbance offshore and onshore. Offshore, the focus is on whales, particularly toothed whales because of noise effects. Onshore, the focus is on Deer Wintering Areas (DWAs) and rare and sensitive species (*e.g.*, little brown bats).	• Marine Mammals • Onshore Environment (in discussion of terrestrial mammals and habitat)
Archaeological and Heritage Resources	Addressed as a Socio-Economic Component and included in Section 7 and DPA Volume 5.	See Section 7 and DPA Volume 5
Benthos	Focus on construction (*e.g.*, trenching, drilling) effects on marine benthos. Included in this VEC is a consideration of marine algae.	• Marine Benthos
Vegetation (plants, trees, forests)	Focus on potential interaction with onshore facilities. Marine algae is addressed under the Marine Benthos VEC.	• Onshore Environment
Plankton	Zooplankton and phytoplankton are important to the marine ecosystem, however, due to their abundance and ubiquitous distribution and lack of oceanographic concentrating mechanisms for plankton in the Project area (Hannah *et al*. 2001), these ecosystem components will not be adversely affected on a population basis by this Project and are not considered VECs. Monitoring of hydrocarbon spills from a blowout showed no detrimental effect to plankton communities (Riley 1984). Ichthyoplankton are included in the Marine Fish VEC. The focus here is on potential interactions associated with accidental events.	• Marine Fish (in discussion of ichthyoplankton)
Amphibians and Reptiles	Focus on rare terrestrial species. Leatherback and Loggerhead turtles may be present in the study area during summer. Threats to adults in Canadian waters (non-breeding) are from entanglement in fishing gear and debris, and ingestion of plastic bags. No solid debris will be discharged from the offshore facilities. No previous indication of significant effects on sea turtles from petroleum exploration on the Scotian Shelf or Slope (Thomson *et al*. 2000), therefore excluded as a VEC. Further discussion of endangered sea turtles is included in Section 6.1. Terrestrial amphibians and reptiles are addressed in the Onshore Environment VEC in Section 6.3.8 of the CSR.	• Onshore Environment (in discussion of rare and sensitive herpetiles)
Birds and Bird Habitat	Focus on shorebirds and seabirds, as well as migratory species. Specific focus on pelagic birds and seasonality of activities; small spills and chronic discharges may affect marine birds, therefore, they have been included as a VEC.	• Marine Related Birds • Onshore Environment
Special Places (Sable Island, the Gully and environmentally sensitive areas)	Sable Island is included as a VEC due to stakeholder concern and status as a conservation area for migratory birds. The Gully was considered during issues scoping, however, available information indicates that the potential for interaction between the Gully and Project activities is practically nil. The basis for this statement is the information available from monitoring at the Venture platform. Changes in sediment chemistry did not appear to be major outside of 1,000 m from the Venture jacket. Petroleum hydrocarbons were not detected at levels higher than 10,000 ppm or even 1,000 ppm at 250 m from the Venture jacket in the fall of 1998 or the spring of 1999. The	• Sable Island • Marine Related Birds

Table 6.8 Selection of Valued Environmental Components

Environmental Component[1]	Considerations in Subsequent Scoping	Selected VEC
	figures did not exceed 75.2 ppm. (SEEMAG 1999a) The Venture platform is located 45 km from the Gully. Considering comparable sediment chemistry effects, it is extremely unlikely any sediment contamination would migrate to the Gully from the Deep Panuke Project due to the physical distance between the Project and the Gully (*i.e.*, 140 km) and oceanographic processes. Project related noise and vessels or helicopter traffic would likewise not interact with the Gully. Spills from the Project (large or small) are not predicted to reach Sable Island (CSR Section 6.3.7); likewise, the Gully, at a greater distance from the Project would not be affected. Country Island is considered a "special place" as it hosts a sizable breeding colony of Common and Arctic terns and is one of the few remaining Canadian breeding sites for the Roseate Tern. There is no direct Project interactions with Country Island beyond potential interactions with the birds breeding on the island. EnCana has also adopted Codes of Practice for Sable Island, the Gully and Country Island, which will govern Project activities and minimize Project interactions with these special places.	
Species at Risk	Species at risk are discussed within their relevant environmental component. Table 6.7 provides a listing of all the species at risk considered in the CSR and their current status. The decision to consider species at risk within their relevant VEC, as opposed to a single discussion, was based on the judgement of the Study Team. The Project interactions potentially affecting a rare terrestrial plant species are very different from those affecting rare bird species on Sable Island or a rare fish species. Looking at all species at risk would have created a very large and disjointed discussion, whereas the Study Team is confident that discussion of the species within their respective VEC has resulted in a thorough and comprehensive assessment with a more logical format.	• Marine Benthos • Marine Fish • Marine Mammals • Marine Related Birds • Onshore Environment
Groundwater Resources	Groundwater resources are discussed in Section 6.1 of the CSR. No groundwater resource users (municipal, industrial, or domestic), other than a few domestic wells for the adjacent SOEP Gas Plant site, are identified in the immediate area of the landfall, pipeline and onshore facilities. The closest residential well appears to be approximately 900 m from the landfall site. This information will be confirmed through a pre-construction survey. Should any wells be identified within 500 m, EnCana will have standard mitigation procedures outlined in their Onshore Construction EPP. This would consist of interviewing the well owner prior to construction, and collecting and archiving water samples for comparison of water chemistry in the event that effects on the well supply are suspected as a result of Project activities.	N/A

Table 6.8 Selection of Valued Environmental Components		
Environmental Component[1]	**Considerations in Subsequent Scoping**	**Selected VEC**
	With respect to any future groundwater resource users in the area, there are several factors that will limit any future Project-environment interactions: • The pipeline will be installed in a manner that prevents the trench from becoming a lateral drain for groundwater for practical purposes of erosion control and corrosion prevention; • The pipeline trench is relatively shallow (approximately 2 m) in comparison to groundwater wells in the area at a depth of 30 to 60 m; and • No person will be allowed to construct a dugwell within 100 m of the pipeline for safety reasons. Due to the likely lack of any Project-environment interactions with groundwater users (onshore facilities will avoid interaction with residential well water supply) and the standard mitigation in place to address this issue, groundwater resources has been excluded as a VEC.	
Surface Water Resources	No surfacewater resource users (municipal, industrial, or domestic) are identified in the immediate area of the landfall, pipeline and onland facilities. Seasonal dwellings (such as hunting camps) using surface water have not been individually assessed. However, there are no seasonal dwellings within the proposed pipeline corridor. If any dwellings are identified in the pre-construction survey, a practical means of mitigation during the construction stage will be to advise owners immediately down-stream of crossings to limit water use during the few days of site activity. This can be accomplished through provision of bottled water to affected individuals. Once pipeline construction is complete, the only potential interaction with surface waters would be in the unlikely event of an accident or malfunction. Thus, any future surface water users would also be protected. Freshwater resources are discussed in CSR Section 6.1. Although not selected as a VEC, they were considered as part of the broader onshore environment, particularly as they provide aquatic habitat for freshwater fish. With the exception of Betty's Cove Brook, which is a small watercourse located outside of the proposed onshore pipeline corridor, there are no significant watercourses in the area. Furthermore, with modern pipeline construction practice, the preparation and application of a site-specific EPP and EEM program for this portion of the Project will ensure that surface water resources will be avoided and/or protected from negative effects during construction and operation of the onshore portion of the EnCana pipeline.	• Onshore Environment (in discussion of freshwater fish habitat)
Wetlands and Wetland Functions	Included as a VEC due to regulatory considerations and ecological sensitivity. Onshore pipeline routing will avoid wetlands.	• Onshore Environment
[1]Environmental Component (candidate VEC to be considered) as listed in the Scope of Environmental Assessment (CNSOPB *et al.* 2001b)		

Table 6.9 lists the VECs selected for this assessment, as well as providing the definition and scope of these VECs.

The decision to separate or group individual components as VECs is based on professional judgement and the extent and uniqueness of Project-environment interactions associated with various ecosystem components. To assess all species and ecosystem components separately is not practical or most effective. It leads to large, unwieldy reports, considerable repetition and diminishes the importance of an ecosystem approach. With respect to the onshore environment, all components were subject to similar project activities associated with the construction and operation of the pipeline. Assessing these components as a single VEC ensured that effects on specific aspects of the onshore environment, as well as the onshore environment as a whole, were thoroughly addressed.

Table 6.9 Definition and Scope of the VECs

Valued Environmental Component	Definition for EA Purposes
Air Quality	Air quality is a general term that provides a measure of the presence of air contaminants, including greenhouse gases, in the environment.
Marine Water Quality	Marine water quality includes offshore and nearshore marine waters in the study area and provides a measure of chemical parameters in the marine environment.
Marine Benthos	Marine Benthos refers to the benthic habitat and associated benthic communities, with a focus on benthic macroinvertebrates.
Marine Fish	Marine Fish includes all life stages of finfish species found within the study area (including the eggs and larvae stages), invertebrate species Northern shrimp and squid, and their planktonic food organisms (*e.g.*, krill).
Marine Mammals (Seals and Whales)	Marine Mammals includes cetaceans and pinnipeds in the study area.
Marine Related Birds	Marine Related Birds include seabirds, shorebirds, and other birds that use inshore or offshore habitats in the vicinity of the Project, at some point in the life cycle.
Sable Island	Sable Island focuses on the value of the habitats on the Island rather than resident and transient species.
Onshore Environment	Onshore Environment includes the potential habitat and wildlife resources occurring in the vicinity of the onshore study area, including rare and sensitive species, a habitat and special areas for these species.

6.2.1.3 Scoping of Other Projects for Potential Cumulative Interactions

An environmental assessment pursuant to the *CEAA* must include consideration of the "cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out." A critical step in the environmental assessment, therefore, is determining what other projects or activities have reached a level of certainty (*e.g.*, "will be carried out") such that they are required to be considered by the *CEAA*.

It is helpful to consider the clarification provided by the Joint Review Panel for the Express Pipeline Project in Alberta. Following an analysis of subsection 16(1)(a) of *CEAA*, the Joint Review Panel determined that certain requirements must be met for the Panel to consider cumulative environmental effects:

- there must be a measurable environmental effect of the project being proposed;
- that environmental effect must be demonstrated to operate cumulatively with the environmental effects from other projects or activities; and
- it must be known that the other projects or activities have been, or will be, carried out and are not hypothetical (NEB and CEA Agency 1996).

Furthermore, the Joint Review Panel indicated that it is an additional requirement that the cumulative environmental effect is *likely* to occur, that is, there must be some *probability*, rather than a mere possibility, that the cumulative environmental effect will occur. These criteria were used to guide the assessment of cumulative environmental effects of the Deep Panuke Project.

In the early stages of the assessment, a scoping exercise was conducted to identify other past, present, and future projects and activities, the effects of which may interact cumulatively with those of the Project. These are listed below and included in Table 6.10.

Other Projects

- Cohasset Project– Offshore oil development project located approximately 10–12 km from the Deep Panuke site in Phase I of decommissioning, currently with no plans for Phase II (removal of jackets).

- SOEP – Natural gas development project located approximately 45 km from the Deep Panuke site with offshore and onshore facilities (Goldboro and Point Tupper), including subsea and onshore pipelines. Tier I (included construction and development of Thebaud, North Triumph and Venture fields, onshore processing and fractionation facilities, and pipelines) was completed in December 1999 with Tier II (development of Alma, South Venture and Glenelg fields) scheduled for first gas at Alma in 2003 (others to follow) (refer to Figure 6.1).

- Maritimes and Northeast Pipeline (M&NP) Gas Transmission – Onshore natural gas transmission system currently transporting Sable gas from the SOEP, with planned expansion that will accommodate gas volumes produced by the Deep Panuke Project; custody transfer facility will be constructed and operated at the tie-in point to accept Deep Panuke gas (refer to Figure 6.1).

- Blue Atlantic Transmission System – Proposed future gas transmission system involving offshore and onshore infrastructure to transport natural gas from Scotian Shelf to the New York/New Jersey area; there have been no official regulatory filings to date (refer to Figure 6.1 for preliminary project corridor).

- Neptune Subsea Electrical Transmission Cable – Subsea high voltage direct current (HVDC) cable to connect Atlantic Canada and Maine to energy markets in the Northeastern United States; in process of obtaining additional regulatory approvals.

- Hudson Energy Company Project – Proposed natural gas-fired power generation facility in Goldboro (proposed site 600 m southwest of SOEP gas plant) with offshore subsea HVDC cable to transport power to New York City; project description filed in 2001, as of May 2002, project is on hold (refer to Figure 6.1 for proposed location).

- Sable Island Wind Turbine Project – Proposed wind energy system scheduled to be constructed on Sable Island in 2002.

- EnCana Exploration Drilling Program – Proposed exploration drilling to occur consecutively on Margaree (EL2387), Grand Pre (EL2357) and Lower Musquodoboit (EL2360) in late 2002 to early 2003. Margaree and Lower Musquodoboit are adjacent licences to Deep Panuke. EnCana's deepwater drilling program will involve six licences, with one well to be drilled on Torbrook (approximately 100 km west of Deep Panuke) in late 2002. Drilling is expected to be conducted consecutively on the remaining licences between 2002 and 2005.

Other activities

- Offshore petroleum exploration drilling (past, present and future activity)
- Seismic exploration (past, present and future activity)
- Shipping (domestic and international) (past, present and future activity)
- Commercial fishery (past, present and future activity)
- Commercial whaling (past activity)
- Tourism (past, present and future activity)
- Military exercises (past, present and future activity)
- Use and occupation of Sable Island (past, present and future activity)
- Long range transport of air pollutants (past, present and future activity)

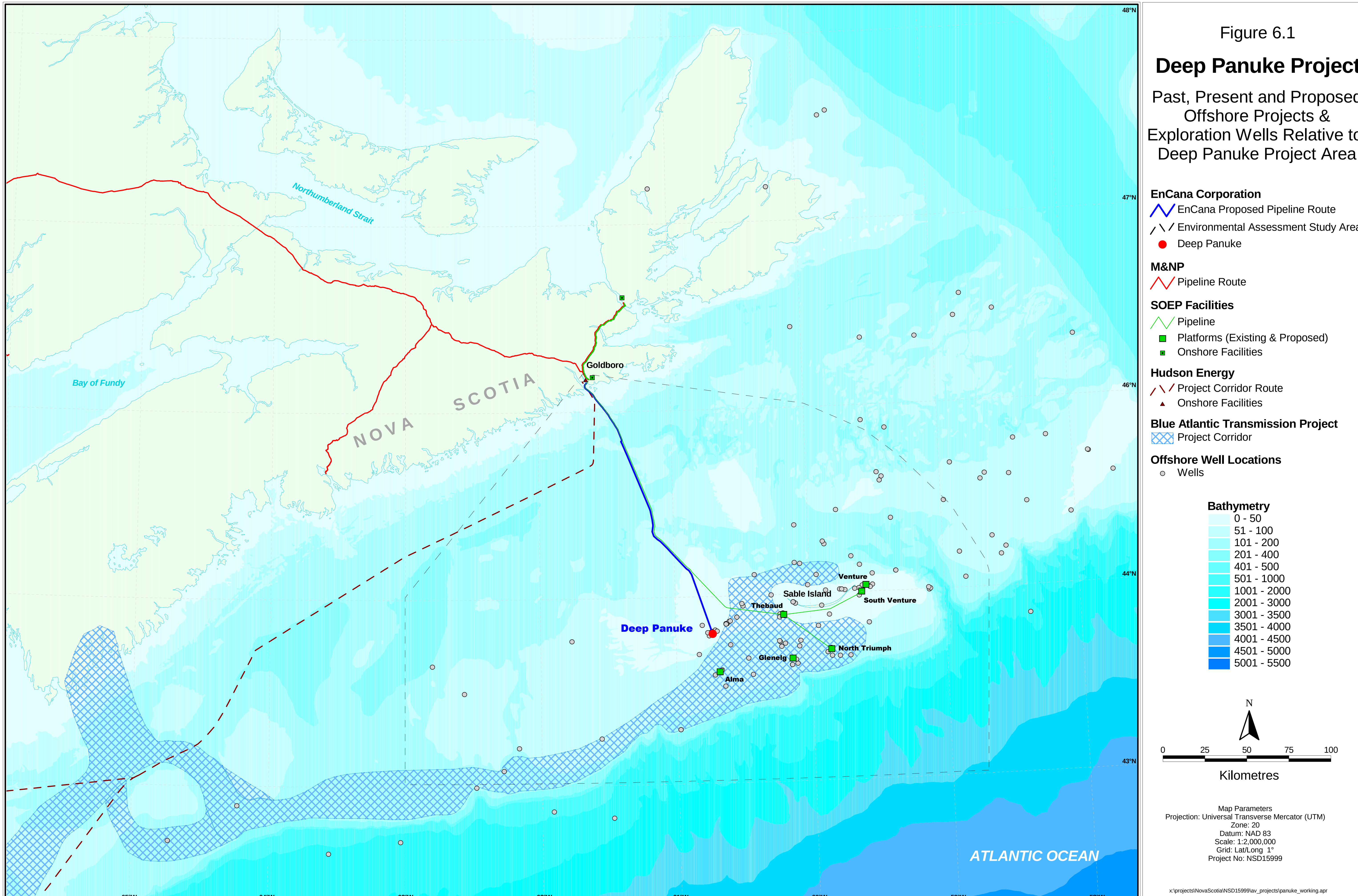


Figure 6.1

Deep Panuke Project

Past, Present and Proposed Offshore Projects & Exploration Wells Relative to Deep Panuke Project Area

The VECs selected for effects assessment through the scoping process described in Section 6.2.1.2 are also considered appropriate and inclusive for the consideration of potential cumulative effects.

6.2.2 Potential Interactions Between Project Activities and Valued Environmental Components

Table 6.10 summarizes the potential interactions between Project activities and the selected VECs. A potential interaction does not necessary indicate a predicted impact, but warrants further analysis in the environmental assessment. The specific nature and extent of these interactions with each VEC are discussed and evaluated in the environmental effects assessment (Section 6.3).

6.2.3 Environmental Effects Assessment Framework

This section provides an overview of the steps involved in the assessment of potential Project effects. The analysis presented in Section 6.3 follows these steps for each VEC. The analysis methodology employed for the assessment represents accepted practice as defined in the CEA Agency's *Practictioner's Guide to the Canadian Environmental Assessment Act* (CEA Agency 1994) and has been successfully used in assessing the effects of other oil and gas projects in Atlantic Canada.

6.2.3.1 VEC Identification and Description of Context

To ensure that the assessment is holistic, the CEA Agency guidance documents (1994) require a description of the ecological and socio-cultural context for each VEC. The consideration of the current state of a VEC, and any Project-related effects, requires an evaluation of the relationship of each VEC with other components of the ecosystem or human systems (*e.g.,* trophic relationships).

6.2.3.2 Boundaries

An important step in the environmental assessment process is the determination of the boundaries of the assessment. Temporal and spatial boundaries encompass those periods during which, and the areas within which, the VECs are likely to interact with, or be influenced by the Project. The temporal and spatial boundaries for each VEC are described in Section 6.3.

Table 6.10 Summary of Potential Interactions Between Project Activities and VECs

Project Activities		Valued Environmental Components								Potential Interactions
		Air Quality	Marine Water Quality	Marine Benthos	Marine Fish	Marine Mammals	Marine Related Birds	Sable Island	Onshore Environment	
Construction										
Offshore Platform Installation	• Pile driving • Vessel/helicopter traffic • Installation of platform jackets	✓	✓	✓	✓	✓	✓			Equipment exhaust; disturbance to benthic environment; noise (surface and underwater); vessel presence/maneuvering
Development Drilling	• Temporary mobilization/ presence of jack-up rig	✓	✓	✓	✓	✓	✓			Minor liquid and air emissions (exhaust) from rig movement and operation; elevated SPM; attraction of birds to lights and flares; disturbance to benthic environment; disturbance/attraction of mammals; attraction of fish (reef effect);
	• Drilling of development wells	✓	✓	✓	✓	✓	✓			Air emissions; discharge of WBM and associated cuttings; elevated SPM; localized smothering of benthos; ingestion of contaminants; underwater noise; disturbance to marine fish, birds, mammals, and benthos
Onshore Fabrication/ Storage	• Laydown areas for onshore fabrication/pipe coating/stockpile	✓							✓	Air emissions (exhaust) from equipment/vehicle operations and site preparation; disturbance of terrestrial habitat; noise
Subsea Pipeline	• Pipe laying/trenching	✓	✓	✓	✓	✓	✓			Air emissions (exhaust); resuspension of sediments; disturbance to benthic environment; underwater noise; vessel presence/maneuvering
	• Hydrostatic testing		✓		✓	✓	✓		✓	Seawater discharges containing corrosion inhibitors, biocides and marker dyes to ocean

Table 6.10 Summary of Potential Interactions Between Project Activities and VECs

Project Activities		Valued Environmental Components								Potential Interactions
		Air Quality	Marine Water Quality	Marine Benthos	Marine Fish	Marine Mammals	Marine Related Birds	Sable Island	Onshore Environment	
Onshore Facilities	• Clearing of RoW • Trenching/blasting • Installation of pipeline • Installation of transfer facility • Access road construction	✓	✓						✓	Dust and air emissions (exhaust); disturbance of terrestrial habitat; noise; erosion and sedimentation of marine and freshwater; hydrological effects on wetlands; sensory disturbance to terrestrial wildlife
					Operation					
Offshore Production	• Acid gas disposal (injection) • Routine flaring • Gas processing/sweetening	✓	✓	✓	✓	✓	✓			Air emissions from processing operations; noise associated with compressor operation; marine discharges of produced water and effluent from processing; attraction of birds to flaring
	• Other platform operations	✓	✓		✓		✓			Air emissions from power generation; discharges of sewage, deck drainage, etc.
	• Presence of platforms			✓	✓	✓	✓			Attraction of birds to lights; increases in marine habitat diversity (reef effect); exclusion of fishing activity (refuge effect); attraction of mammals
Offshore Support Operations	• Vessel traffic	✓	✓			✓	✓			Air emissions (exhaust); liquid discharges (*e.g.*, bilge/ballast) to marine environment; collisions with marine mammals; underwater noise; light emissions; disturbance to birds
	• Helicopter traffic	✓				✓	✓	✓		Air emissions (exhaust); noise; sensory disturbance to wildlife
Subsea Pipeline	• Presence of pipeline			✓	✓					Attraction of fish and benthic organisms (reef and refuge effects); obstacle for benthic invertebrate migration

Table 6.10 Summary of Potential Interactions Between Project Activities and VECs

Project Activities		Valued Environmental Components								Potential Interactions
		Air Quality	Marine Water Quality	Marine Benthos	Marine Fish	Marine Mammals	Marine Related Birds	Sable Island	Onshore Environment	
Onshore Facilities	• Maintenance of pipeline and RoW								✓	Noise and other disturbance of terrestrial habitat and wildlife
	• Maintenance of transfer facility	✓							✓	Noise and other disturbance of terrestrial habitat and wildlife
Decommissioning										
Project Facilities Decommissioning	• Offshore facilities • Onshore facilities	✓	✓	✓	✓	✓	✓		✓	Air emissions (exhaust); minor liquid emissions from vessels; noise; disturbance to birds and mammals; attraction of fish (reef effect); terrestrial habitat disturbance
Malfunctions and Accidents										
Well Blowout	• Subsea • Surface	✓	✓	✓	✓	✓	✓	✓		Contamination of waters; oiling of species; sediment contamination; uptake of contaminants by benthos and fish; air emissions; effects on Sable Island habitat
Pipeline Rupture	• Offshore Pipeline	✓	✓	✓	✓	✓	✓			Contamination of waters; air emissions
	• Onshore Pipeline	✓							✓	Air emissions; fire/explosion; soil contamination; damage to terrestrial habitat ecosystem
Spills	• Spills from platform • Fuel/hazardous material spills onshore	✓	✓	✓	✓	✓	✓	✓	✓	Contamination of waters and sediments; oiling of species; tainting; air emissions; effects on Sable Island habitat
Flaring/Venting for Upset Conditions	• Flaring of acid gas	✓					✓	✓		Air emissions; attraction of birds to flare; potential effects on Sable Island air quality and habitat

Table 6.10 Summary of Potential Interactions Between Project Activities and VECs

Project Activities		Air Quality	Marine Water Quality	Marine Benthos	Marine Fish	Marine Mammals	Marine Related Birds	Sable Island	Onshore Environment	Potential Interactions
Other Projects and Activities (Past, Present, Future) with Potential for Cumulative Interactions										
Cohasset Project (Past and Present)	• Drilling • Production • Presence of Infrastructure • Decommissioning		✓	✓	✓			✓		Sediment contamination; effects on benthic communities; presence of jackets and interfield flow lines; reef and refuge effects on fish and benthic organisms
Sable Offshore Energy Project (Past, Present)	• Offshore platforms and pipeline operation	✓	✓	✓	✓	✓	✓	✓		Air emissions; routine discharges; noise; vessel and helicopter traffic; flaring; effects on sediment and benthic communities; reef and refuge effects on fish
	• Nearshore pipeline operation		✓	✓	✓		✓			Effects on benthic communities; reef and refuge effects on fish; past pipeline construction effects on bird colonies
	• Onshore plants and pipelines operations	✓							✓	Air emissions; loss of terrestrial habitat; erosion and sedimentation
Sable Offshore Energy Project Tier II Development (Future)	• Development drilling • Offshore platforms and subsea flowline installation and operations	✓	✓	✓	✓	✓	✓	✓		Air emissions; routine discharges; noise, particularly from pile driving; vessel and helicopter traffic; flaring; localized sediment contamination and smothering of benthos; reef and refuge effects on fish; effects on Sable Island
M&NP Gas Transmission (Past, Present Future)	• Onshore pipeline • Compression facilities • Custody transfer facility to accept Deep Panuke gas at tie-in		✓						✓	Loss of terrestrial habitat; erosion and sedimentation; traffic, sensory disturbance to wildlife

Table 6.10 Summary of Potential Interactions Between Project Activities and VECs

Project Activities		Valued Environmental Components								Potential Interactions
		Air Quality	Marine Water Quality	Marine Benthos	Marine Fish	Marine Mammals	Marine Related Birds	Sable Island	Onshore Environment	
Blue Atlantic Transmission System (Future)	• Subsea pipeline construction • Vessel/helicopter traffic • Onshore facilities • Potential offshore facilities	✓	✓	✓		✓	✓	✓	✓	Air emissions; minor liquid discharges to marine environment; disturbance to benthic habitat; underwater noise associated with construction vessels; marine vessel traffic; elevated SPM
Neptune Subsea Electrical Transmission Cable (Future)	• Laying of subsea electrical transmission cable • Vessel traffic • Onshore power generation	✓	✓	✓		✓			✓	Air emissions; minor liquid discharges to marine environment; disturbance to benthic habitat; underwater noise associated with construction vessels; marine vessel traffic; elevated SPM
Hudson Energy Company Power Project (proposed, on hold)	• Construction and operation of natural gas fired power generation facility in Goldboro area • Installation and operation of offshore subsea high voltage direct current (HVDC) cable from Nova Scotia to New York/New Jersey	✓	✓	✓		✓	✓		✓	Air emissions; minor liquid discharges to marine environment (associated with construction vessels); disturbance to benthic habitat; underwater noise; elevated SPM
Sable Island Wind Turbine (future)	• Delivery, installation and operation of wind energy system (including five 7.5 kW wind turbines	✓					✓	✓		Reduced greenhouse gas and noxious air emissions; mortality of birds; vessel traffic during construction

Table 6.10 Summary of Potential Interactions Between Project Activities and VECs

Project Activities		Valued Environmental Components: Air Quality	Marine Water Quality	Marine Benthos	Marine Fish	Marine Mammals	Marine Related Birds	Sable Island	Onshore Environment	Potential Interactions
Offshore Petroleum Exploration Drilling (Past, Present, Future)	• Recent and planned future exploration drilling on the Sable Bank includes, but is not limited to: - EL 2389 (Huckleberry) - EL 2376 (Southampton) - EL 2360 (Lower Musquodoboit) - EL 2387 (Margaree) - EL 2357 (Grand Pre) - EL 2401 (Marquis) - EL 2377 (Annapolis) - EL 2359 (Mahone) - SDL 2121 (Onondaga) • Various deepwater drilling programs	✓	✓	✓	✓	✓	✓	✓		Minor liquid discharges to marine environment; noise; release of drill mud and cuttings (localized smothering of benthos); air emissions; attraction/disturbance to mammals; attraction of birds to lights and flares; vessel and helicopter traffic
Seismic Exploration	• Future seismic exploration: no programs currently approved, but reasonably foreseeable activity		✓		✓	✓	✓			Noise; vessel traffic; air emissions (exhaust); minor liquid discharges to marine environment; sensory disturbance to marine mammals and fish
Shipping (Past, Present, Future)	• Domestic • International		✓			✓	✓	✓		Air emissions (exhaust); liquid discharges to marine environment (*e.g.*, bilge/ballast); noise; collisions with marine mammals
Commercial Fishery (Past, Present, Future)	• Fixed gear • Mobile gear		✓	✓	✓	✓	✓			Air emissions (exhausts); liquid discharges to marine environment; disturbance to benthic habitat from draggers/trawlers; entanglements with marine mammals; overfishing

Table 6.10 Summary of Potential Interactions Between Project Activities and VECs

Project Activities		Valued Environmental Components: Air Quality	Marine Water Quality	Marine Benthos	Marine Fish	Marine Mammals	Marine Related Birds	Sable Island	Onshore Environment	Potential Interactions
Commercial Whaling (Past)	• Vessel traffic • Harvesting of whales					✓		✓		Whale mortality; population effects
Tourism (Past, Present, Future)	• Vessel traffic		✓			✓		✓		Noise; minor liquid discharges to marine environment; harassment of wildlife
Military Exercises	• Vessel traffic • Hydroacoustics		✓		✓	✓				Noise; liquid discharges to marine environment; collision with marine mammals
Use and Occupation of Sable Island (Past, Present, Future)	• Cultivation • Hydrocarbon exploration • Habitation • Helicopter traffic						✓	✓		Introduction of non-indigenous species; destabilization of terrain; habitat alteration; disturbance due to noise, human presence
Long Range Transport of Air Pollutants (Past, Present, Future)	• Transport of products of combustion of fossil fuels downwind to Nova Scotia	✓						✓	✓	Additional loading of air pollutants

6.2.3.3 Establishment of Residual Environmental Effects Evaluation Criteria

Section 16(1)(b) of the *CEAA* requires that the significance of environmental effects be determined. Accepted practice in meeting this requirement involves establishing and applying evaluation criteria for the determination of significance. Residual environmental effects rating criteria have been established based on information obtained in issues scoping, available information on the status and characteristics of the VEC, and often involves the application of environmental standards, guidelines or objectives, where these are available (*e.g.*, applicable ambient air quality guidelines). The CEA Agency suggests that relevant environmental standards, guidelines, and objectives should also be helpful in determining significance of cumulative environmental effects. As well, the CEA Agency notes that consideration of the carrying capacity, tolerance level, or assimilative capacity of the area may be helpful, even though it may not be possible to quantify these characteristics.

Guidance documents prepared by the CEA Agency (1994) list a number of criteria that should be taken into account in deciding whether adverse environmental effects are significant, including: magnitude; geographic extent; duration; frequency; reversibility; and ecological and/or socio-cultural context. These criteria have been considered in this assessment with regard to determining the significance for each VEC. Additionally, it is necessary to articulate clearly what makes an effect significant. For each VEC, in Section 6.3, a definition is provided for "significant adverse effect" and "positive effect".

6.2.3.4 Potential Interactions, Issues, and Concerns

The potential interactions between Project activities and the selected VECs are summarized in Table 6.10. The specific nature and extent of these interactions with each VEC are discussed and evaluated. Potential interactions with VECs (*i.e.*, a description of the degree to which VECs are exposed to each Project activity) are described in the assessment. Where appropriate, the assessment includes a summary of major concerns or hypotheses of relevance regarding the effect of each Project activity on the VECs being considered. Where existing knowledge indicates that an interaction is not likely to result in an effect, certain issues may not warrant further analysis.

6.2.3.5 Analysis, Mitigation, and Residual Environmental Effects Prediction

The assessment focuses on the evaluation of potential interactions between the VECs and the various Project activities outlined in the Project description. A standard evaluation system has been developed to ensure that potential effects are clearly and completely evaluated. Residual environmental effects are those that remain after mitigation and control measures are applied. The prediction of residual environmental effects follows three general steps, as suggested by the CEA Agency (1994).

Determining Whether Environmental Effects are Adverse

The effects evaluation for each VEC is conducted by Project phase (construction, operation, decommissioning) and for malfunctions and accidents. For each phase, the Study Team selects those Project activities that may result in a positive or adverse effect. To determine if there are adverse effects, the Study Team considers a number of factors, including those recommended in the CEA Agency guidance documents (1994).

Determining Whether the Adverse Environmental Effects are Significant

The analysis evaluates the interactions between Project activities and the VEC and determines the significance of any residual adverse environmental effects (*i.e.*, effects that may persist after all mitigation strategies have been implemented), according to the evaluation criteria established for the VEC. These effects are assigned a rating of significant adverse, non-significant adverse, or positive. The evaluation includes consideration of specific mitigation strategies and the residual environmental effects evaluation criteria mentioned above.

Determining Whether the Significant Residual Adverse Environmental Effects are Likely to Occur

For significant adverse environmental effects, the assessment also considers their probability of occurrence, and scientific uncertainty.

The effects assessment analysis conducted for each VEC is summarised in two template matrices. The Residual Environmental Effects Assessment Matrix summarises the effects by Project activity for each Project phase and describes the mitigation and analysis for each activity. The modifiers used to characterise the various criteria considered in the determination of effect significance may vary for different VECs. The Residual Effects Summary Matrix provides the overall residual environmental effects rating, including cumulative effects, by Project phase.

6.2.4 Cumulative Effects Assessment

Subsection 16(1)(a) of the *CEAA* requires that every comprehensive study of a project include an assessment of the "cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out." Other past, present, and reasonably certain future projects and activities that may interact cumulatively with the effects of the Project are listed in Table 6.10.

For the purposes of this assessment, it is assumed that the existing status or conditions of each VEC reflects the influence of other past and current projects and activities occurring within or outside of the Project area. It also is assumed (unless there is evidence to the contrary, such as a predictable down- or upward trend in a population) that these existing activities will continue to be carried out in the future and to have similar effects as observed now. Therefore, the future status or conditions of each VEC in the absence of the Project would be similar to today. The predicted effects of the Project described in Section 6 therefore integrate the cumulative effects of these other ongoing projects and activities. It also is recognized that there are other future projects and activities in addition to the Deep Panuke Project that may result in additional effects on VECs in the study area. The effects of these other projects and activities are considered and assessed for each VEC.

The residual environmental effects prediction made for each VEC integrates the potential cumulative effects of these other past, present, and future projects and activities. The cumulative effects for each VEC are summarized in Section 6.3.9. The methodology used in assessing cumulative effects for this Project follows current practice and is consistent with the *CEAA* and informed by the assessment framework presented in the *Cumulative Effects Assessment Practitioners Guide* (CEA Agency 1999).

6.2.5 Follow-Up and Monitoring

Section 16(2)(c) of the *CEAA* requires consideration of the need for, and requirements of, any follow-up studies. Monitoring and follow-up requirements are evaluated for each VEC and are linked to the sensitivity of a VEC to both Project related and cumulative environmental effects. The likelihood and importance of such effects, as well as the level of confidence associated with the adverse residual effects rating, are also taken into consideration.

6.2.6 Sustainable Use of Renewable Resources

Section 16(2)(d) of the *CEAA* requires consideration of the capacity of renewable resources that are likely to be significantly affected by the Project to meet both present and future needs. This discussion is restricted to any significant adverse environmental effects on renewable resources.

6.2.7 Summary of Residual Environmental Effects Assessment

Finally, the adverse environmental effects on each VEC by Project phase, as well as adverse environmental effects that might result from malfunctions or accidents are summarized.

6.3 Biophysical Impact Assessment

6.3.1 Air Quality

Air quality is considered a VEC because of its intrinsic value to human and ecosystem health. Air quality is a general term that provides a measure of the presence of air contaminants, including greenhouse gas (GHG), in the environment. Potential air contaminants from the Project include: sulphur dioxide (SO_2), hydrogen sulphide (H_2S), nitrogen oxides (NO_x), carbon monoxide (CO), carbon dioxide (CO_2), methane (CH_4), some trace products of incomplete combustion and total suspended particulate matter (TSP) (refer to Section 2.7.1).

6.3.1.1 Boundaries

The interaction of the Project with the atmospheric environment is independent of time or season. Air quality effects may extend for days (*e.g.*, during construction) or continuously during operation for the life of the Project.

The assessment of air quality has been conducted on a spatial domain encompassing mainland Nova Scotia nearest to the Project area, Sable Island, and the atmospheric environment over the waters in the study area (refer to Figure 1.1). Due to the nature of the Project (*i.e.*, offshore processing), the assessment of air quality will focus primarily on the offshore environment. Assessment of onshore effects are confined to routine construction emissions (*e.g.*, grading, vehicle emissions, dust); the onshore portion of the pipeline (Figure 2.6) connects into an existing sales gas pipeline (M&NP).

The potential effects of routine air emissions from the Project are evaluated to such a distance that the concentration falls to near background level. For malfunctions or accidents, the spatial extent of air quality effects are evaluated beyond distances corresponding to regulatory or other criteria. The assessment domain includes the areas of ocean where occupants of fishing, recreational, or transient vessels may be exposed, and specific receptors such as Sable Island, SOEP's offshore platforms at Alma (future), and Thebaud, and the coast of the Nova Scotia mainland.

6.3.1.2 Residual Environmental Effects Evaluation Criteria

The definitions for the evaluation of significance of effects on air quality have been developed from various provincial, federal health, safety and environment (HSE) criterion and standards. For the purposes of this assessment, the standard used for routine emissions is the Nova Scotia Maximum Permissible Ground Level Concentration as specified under the Nova Scotia *Air Quality Regulations* under the Nova Scotia *Environment Act* (Table 6.11). The air quality guidelines for tolerable, acceptable, and desirable, as defined under the *Canadian Environmental Protection Act* (*CEPA*), have also been provided in Table 6.11 for comparison purposes. The maximum tolerable level denotes a concentration beyond which appropriate action is required to protect the health of the general population. The maximum acceptable level (equivalent in almost all aspects to the Nova Scotia criterion) is intended to provide protection against effects on soil, water, vegetation, visibility, and human well-being. The maximum desirable level is the long-term goal for air quality.

Table 6.11 Nova Scotia Air Quality Regulations (Environment Act) and Canadian Environmental Protection Act Ambient Air Quality Objectives

Pollutant and units (alternative units in brackets)	Averaging Time Period	Nova Scotia	Canada			
		Maximum Permissible Ground Level Concentration	Canada Wide Standards (pending)	Ambient Air Quality Objectives		
				Maximum Desirable	Maximum Acceptable	Maximum Tolerable
Nitrogen dioxide µg/m³ (ppb)	1 hour	400 (213)	-	-	400 (213)	1000 (532)
	24 hour	-	-	-	200 (106)	300 (160)
	Annual	100 (53)	-	60 (32)	100 (53)	-
Sulphur dioxide µg/m³ (ppb)	1 hour	900 (344)	-	450 (172)	900 (344)	-
	24 hour	300 (115)	-	150 (57)	300 (115)	800 (306)
	Annual	60 (23)	-	30 (11)	60 (23)	-
Total Suspended Particulate Matter (TSP) µg/m³	24 hour	120	-	-	120	400
	Annual	70	-	60	70	-
PM2.5 µg/m³	24 hour, 98th percentile over 3 consecutive years	-	30 (by 2010)	-	-	-
PM10-2.5 µg/m³		-	(to be recommended in 2003)	-	-	-
Carbon Monoxide mg/m³ (ppm)	1 hour	35 (31)	-	15 (13)	35 (31)	-
	8 hour	15 (13)	-	6 (5)	15 (13)	20 (17)
Oxidants – ozone µg/m³ (ppb)	1	160 (82)	-	100 (51)	160 (82)	300 (153)
	8 hour, based on 4th highest annual value, averaged over 3 consecutive years	-	128 {by 2010} (65)	-	-	-
	24 hour	-	-	30 (15)	50 (25)	-
	Annual	-	-	-	30 (15)	-
Hydrogen sulphide µg/m³ (ppb)	1 hour	42 (30)	-	-	-	-
	24 hour	8 (6)	-	-	-	-

For the purposes of assessing malfunctions, process upsets and accidental events a number of applicable HSE standards have been considered in the determination of significance of adverse effects. The critical criteria selected for this analysis include:

Lower Explosive Limit (LEL) – the lowest concentration at which the gas can ignite.

Immediate Danger to Life and Health (IDLH) – the Occupational Safety and Health Administration (OSHA) defines an immediately dangerous to life or health concentration in their hazardous waste operations and emergency response regulation as an atmospheric concentration of any toxic, corrosive or asphyxiant substance that poses an immediate threat to life or would cause irreversible or delayed adverse health effects or would interfere with an individual's ability to escape from a dangerous atmosphere. The escape period is considered to be 30 minutes.

Threshold Limit Value – Short-Term Exposure Limit (TLV-STEL) – the time-weighted average concentration for a conventional 8-hour workday and a 40-hour workweek to which it is believed that nearly all workers may be repeatedly exposed, day after day, without adverse effect (ACGIH 2002).

Threshold Limit Value- Short-Term Exposure Limit (TLV-STEL) – a 15-minute time weighted average (TWA) exposure which should not be exceeded at any time during a workday even if the 8-hour TWA is within the TLV-TWA (ACGIH 2001).

Air Quality Criterion – the relevant criterion from the provincial or federal air quality standards and objectives (refer to Table 6.13).

The above criteria are listed in order of decreasing concentration. The final criterion is for protection of the environment and the general public. The other criteria are applied for consideration of safety and health.

A **significant** adverse environmental effect on air quality is one that involves a sustained exceedance of any applicable regulatory or HSE criterion or standard as described above.

A **positive** effect is an effect that measurably reduces the atmospheric contaminant loading as a result of Project actions.

6.3.1.3 Potential Interactions, Issues, and Concerns

The most important interaction to consider is the possible degradation of air quality to levels that can lead to a deterioration in human and/or ecosystems health.

Project construction and operations activities will generate air emissions from:

- vessel and aircraft engines (CO, NO_x, CO_2, TSP);
- generators and compressors on drill rigs and platforms (NO_x, SO_2, H_2S);
- flaring (H_2S, SO_2, NO_x, CO_2, TSP); and
- other fugitive emissions (CH_4, lubricant spills).

Common air pollutants that may be emitted from the Project are described in Section 2.7.1.

Flaring is an essential component of the safety system for all phases of the Project, necessary to ensure safe working conditions on the platform. During construction and drilling, there will be occasions requiring flaring of excess gases, test flaring of the wells, and possible emergency flaring. During Project operation, continuous flaring will take place for TEG off gas; this flare will be stabilized by fuel gas as necessary. Acid gas will also be flared during routine maintenance of the acid gas management system. Prior to the removal of H_2S from the gas, there is the potential for occasional, localized fugitive releases of odours. Conditions leading to these emissions will be regulated by operating procedures and worker health and safety procedures which will be developed for the Project (refer to Section 4).

Air quality concerns during decommissioning would be limited to emissions from vessels and aircraft engines and other fugitive emissions.

Project malfunctions or accidents can lead to relatively minor and temporary discharges of SO_2, H_2S, and CO_2, and to additional flaring associated with an upset in the acid gas management system. While extremely unlikely, the potential consequences of large scale releases of CH_4 and H_2S associated with blowouts are of major concern as they could have health and safety consequences for platform workers and passengers of vessels within several kilometres downwind. A blowout of the acid gas injection well or piping break could potentially result in the release of high concentrations of H_2S.

H_2S has a strong characteristic odour of "rotten eggs". The odour threshold for H_2S ranges from 10 to 200 ppb (Petroleum Communication Foundation 2000). At concentrations of 1 to 10 ppm, there is a strong odour, and exposed persons may experience nausea, tearing of the eyes and headaches. Severe health effects are experienced in the range of 150 to 750 ppm, and higher concentrations may be fatal in minutes or less. The units of micrograms per cubic meter ($\mu g/m^3$) are used in ambient air quality practice and regulations, and the units of parts per billion (ppb) are more common in occupational health and safety applications. Both units are used in this section for the convenience of the reader.

In the Deep Panuke flare, there is likely no significant source of chlorine compounds in the flare stream. Produced water is not directed to the flare; the flare will consume only vapour phase water and light end petroleum hydrocarbons which are highly flammable; longer chain hydrocarbons and liquids are retained in the flare knockout drum. Compounds necessary for the creation of dioxins and furans are not present in measureable quantities.

A rupture of the onshore or offshore pipeline containing pressurized market-ready gas will have localized, temporary air quality effects (methane release), but will not contain H_2S.

6.3.1.4 Analysis, Mitigation, and Residual Environmental Effects Prediction

The assessment of the effects of the Project on air quality has been conducted using a modeling approach, whereby the dispersion of air contaminants from the Project sources to the environment has been simulated using a mathematical computer model of atmospheric transport. Appendix C contains additional information on the dispersion modeling methodology. The US EPA Industrial Source Complex, (ISC-PRIME) model was used to model routine emissions. ISC-PRIME allows the evaluation of building downwash, and was used to establish the Good Engineering Practice (GEP) stack height for the sources. The model was executed using a meteorological dataset from Environment Canada based on observations at Sable Island.

For the worst-case analysis of upset conditions, the approach is based on worst-case meteorology, whether or not that condition appears in the Sable Island record. For this purpose, the US EPA SCREEN3 model was used as it contains the same dispersion model algorithms as ISC3, but automatically determines the worst-case meteorology.

The models make 1-hour predictions, and were set up to compute highest 1-hour, highest 24-hour, and annual averages. For comparison with the occupational health and safety levels, shorter averaging periods were computed using the methods of Turner (1970).

Typically, about 90% of the total nitrogen oxides (NOx) are emitted as NO, and the remainder as the regulated form, nitrogen dioxide (NO_2). The Ozone Limiting Method (OLM) was used to estimate the conversion of NO to NO_2 in the atmosphere.

Construction

During the construction phase of the Project, wells will be drilled and equipment moved and commissioned at the site. Construction activities, are described in Section 2.3. There will be a wide range of emission sources and types from these activities. Engines and generators result in emissions of CO, NO_x, CO_2 and some TSP. Typical air emission rates for construction and operation equipment are presented in Table 6.12. The effects of these activities are temporary, localized, and not significant with regard to potential air quality effects, particularly given the physical isolation of the Project offshore. Onshore construction activities will also generate equipment emissions and some dust. Dust will be suppressed if necessary, using measures specified in the Onshore EPP (*e.g.,* water application). Onshore air emissions will be temporary, localized and not significant.

Table 6.12 Typical Air Emissions for Construction and Operation Equipment

	Power [HP]	**Power [kW]**	**PM (TSP) [g/s]**	**SO_2 [g/s]**	**NOx [g/s]**	**CO [g/s]**	**CO_2 [g/s]**
Supply/Tug boat	10000	7457	0.54	31.26	22.79	3.11	1657.11
Supply/Tug boat	16000	11931	0.86	50.01	36.46	4.97	2651.38
Truck Type Tractors	300	224	0.03	0.02	0.42	16.59	40.80
Motor Grader	180	134	0.02	0.01	0.25	9.95	24.48
Skid Steer Loaders	60	45	0.01	0.00	0.08	3.32	8.16
Excavators	320	239	0.03	0.02	0.44	17.69	43.53
Backhoe Loaders	90	67	0.01	0.01	0.12	4.98	12.24
Pipelayers	230	172	0.02	0.02	0.32	12.72	31.28
Wheel Tractor-Scrapers	265	198	0.02	0.02	0.37	14.65	36.04
Construction Trucks	1450	1081	0.13	0.11	2.01	80.17	197.22
Articulated Trucks	365	272	0.03	0.03	0.51	20.18	49.65
Wheel Tractor-Soil Compactors	480	358	0.04	0.04	0.66	26.54	65.29
Wheel Loaders - Integrated Toolcarriers	235	175	0.02	0.02	0.33	12.99	31.96
Track Loaders	120	89	0.01	0.01	0.17	6.63	16.32
Telescopic Handlers	105	78	0.01	0.01	0.15	5.81	14.28
Paving Products	500	373	0.05	0.04	0.69	27.64	68.01
Power generator	5	4	0.00	0.00	0.01	0.28	0.68
Helicopter	2740	2043	0.25	0.20	3.80	151.49	372.68

Source: Adapted from US EPA 2000.

In addition to engine and generator emissions, flaring will be used during well testing to safely handle the disposal of gas and produced organic liquids. Types of emissions to be expected from well test flaring will depend on the specific composition of gasses and liquids encountered during testing. In general, high combustion efficiency will be used in the flaring (target 98%). Typical emissions will include CO_2 (present in the reservoir gas), plus additional CO_2 formed by the oxidation of the hydrocarbons (mostly methane). H_2S will be oxidized in the flare to SO_2. There will also be some minor amounts of products of incomplete combustion such as: carbonyl sulfide; carbon disulphide and mercaptans (from the sulphur); PAH and VOC (from the hydrocarbons). The duration of the testing period for each well will be relatively short (*i.e.*, approximately 12 hours).

EnCana will develop flaring mitigation procedures in the Offshore EPP to reduce, where practical, the temporary and localized emissions and potential effects associated with flaring events. These procedures will specify:

- procedures during perforating/well testing to minimize smoky plumes;
- safe zones for vessels to occupy during the test flares;
- go/no go zones for vessels;
- safety gear and procedures on board platforms and vessels;
- wind direction forecast requirements such as the need to be sure of sustained wind directions during the test;
- visibility and other weather requirements to permit flaring to proceed;
- real-time requirements to monitor the efficiency of the flare and downwind effects;
- reporting requirements to document the safe conduct of the work and potential improvements; and
- notification procedures for shipping, staff and environmental staff.

With the implementation of these procedures, and considering the short duration of the test period, no long or short term significant adverse effects from this procedure is expected.

The flare system is designed to enhance buoyancy of the flared gases, which will promote dispersion in the atmosphere. Although adverse weather conditions can intermittently reduce the efficiency of the flare, an efficiency of 98% is achievable (CAPP 2000). Flaring has been studied extensively in Alberta (Strosher 1996). Improperly operated, or inefficient flares, can result in products of incomplete combustion, which may be of concern if present in high enough concentrations. Low combustion efficiency also results in a visible plume that is aesthetically objectionable. EnCana's flaring procedures will ensure that such potential effects will be reduced. For example, if the flare begins to produce a sooty emission, the gas composition/rate can be modified to enable clean burning. This can be done by source adjustments or by adding additional purge gas to the flare.

Assuming implementation of recommended mitigative measures, no significant adverse effects on air quality during Project construction are anticipated.

Operation

There are a number of sources for the routine emission of air contaminants during the normal operations of the Project, including:

- acid gas management system;
- flare systems;
- turbines for power generators and compressors; and
- glycol dehydrator (to flare).

Table 6.13 shows the air emission modes, probabilities, sources and rates for Project operations. The prediction of effects for these emissions are discussed below.

Acid Gas Management

Acid gases will be managed in this Project by injection into a contained reservoir. The acid gas stream, comprising about 18% H_2S, and the remainder CO_2, is taken directly from the acid gas removal system and compressed for injection through a dedicated piping system. The injection system is expected to operate normally 95% of the time; the acid gas will be sent to flare approximately 5% of the time as required by routine maintenance and occasional malfunctions. Table 6.13 indicates emission rates during routine operation of the injection system.

Flare Systems

Two flare systems will operate on a routine basis (high-pressure and low-pressure). The low pressure flare will handle small volumes of routine emissions (TEG offgas and pilot and purge gas) stabilized with fuel gas as necessary. The purpose of the high pressure flare is to handle flare gas during process upset conditions. These intermittent upsets are a part of normal operations. The flares are also designed to cope with higher gas discharges during certain emergency situations. Table 6.13 indicates estimated emission rates and probabilities associated with routine continuous flaring, and flaring during maintenance and for upset conditions. Intermittent testing, emergency procedures, and process excursions will result in occasional instances of visible emissions. EnCana will continually strive to reduce flaring to optimize process efficiency and to improve environmental performance. Occasional, temporary flare events are not anticipated to cause significant adverse effects on air quality.

Table 6.13 Summary of Air Emissions During Project Operation (Normal and Upset Conditions)

Operating Mode	Plant Status	Emission Mode	Frequency	Approx. Duration	Source	Key Emissions Rates [g/s] H_2S	SO_2	NO_X	GHG [$ktCO_2E$]
Normal	Production (Normal)	Injection of acid gas; TEG waste gas purge and pilot gas to flare; compression and power generation.	95%	347 days/year	Power Generator 1	N/A	0.75	3.4	304 (347 days)
					Power Generator 2	N/A	0.75	3.4	
					Power Generator (spare)	N/A	0	0	
					Main Feed Compressor	N/A	1.5	10.7	
					Export Compressor 1	N/A	2.25	15.8	
					Export Compressor 2	N/A	2.25	15.8	
					Flare	6E-5	0.003	0.3	14 (347 days)
	Equipment Maintenance	Flaring of acid gas; produced water stripper gas, TEG waste gas, purge and pilot gas to flare; power generation.	5%	18 days/year	Power Generator 1	N/A	0.75	3.4	304 (18 days)
					Power Generator 2	N/A	0.75	3.4	
					Power Generator (spare)	N/A	0	0	
					Main Feed Compressor	N/A	1.5	10.7	
					Export Compressor 1	N/A	2.25	15.8	
					Export Compressor 2	N/A	2.25	15.8	
					Flare	12.4	1054	2.5	7 (18 days)

Table 6.13 Summary of Air Emissions During Project Operation (Normal and Upset Conditions)

Operating Mode	Plant Status	Emission Mode	Frequency	Approx. Duration	Source	Key Emissions Rates [g/s]			GHG [$ktCO_2E$]
						H_2S	SO_2	NO_X	
Upset	Emergency Shut down	Inlet separator to flare; power generation.	Twice per year	15 min	Flare	14.8	1272	182	0.3 (15 min)
	Upset requiring flaring	Major injection well/equipment problem requiring repairs or redrilling; production continues.	Extremely unlikely	Momentary up to 5 months (extremely unlikely) for well replacement	As in normal mode, equipment maintenance	12.4	1062	51.6	525 (1 month)
	Upset requiring venting	Flare ignition malfunction during acid gas flaring resulting in venting.	Occasional	Likely to be momentary	Flare vent	436	N/A	N/A	0.003 (30 sec)
	Upset leading to shutdown	Injection well blowout (return of injected acid gas)	Extremely unlikely	Minutes to months (months extremely unlikely)	Subsea or surface release	1614	N/A	N/A	1.0 (1 day)
		Surface blowout of raw gas	Extremely unlikely	Minutes to months (months extremely unlikely)	Broken piping above surface	210	N/A	N/A	73 (1 day)
		Subsea blowout of raw gas	Extremely unlikely	Minutes to months (months extremely unlikely)	Subsea release	210	N/A	N/A	73 (1 day)

N/A = Not applicable or insignificant emissions

Electrical Power Generation System

The electrical load on the platform will vary between 18 and 35 MW over the life of the Project. The capacity will be provided by multiple turbines that will use condensate as the primary fuel source. The turbines will also be designed to burn market-ready gas and diesel fuel as condensate volume fluctuates over the life of the Project, or due to other operational considerations. SO_2 and NO_x emissions from the turbines are estimated based on the 35 MW capacity, which is the most conservative assumption (*i.e.*, worst case) for modeling air emissions. Any surplus will be returned to the condensate injection well. The use of condensate for fuel results in significant Project efficiencies. It results in emissions that are higher than those that would result from the use of sales gas, but similar to a distillate oil such as diesel fuel. One reciprocating diesel engine generator will serve as back-up.

Stack height is currently under design review. Modeling to date for the Project has determined that a minimum stack height of 11 m meets the ambient air quality criteria at sea level and on the accommodations platform. The final determination of the stack height will likely be above 11 m to ensure safe working conditions on the production platform.

Glycol Dehydrator System

Moisture is removed from the gas stream by a circulating system containing TEG which absorbs water. This water is later released when the TEG is recharged. In addition to water, the gas contains an array of other hydrocarbons in small, variable amounts. These compounds, including benzene, may also be absorbed by the TEG and released during the recharge of the TEG. A Canada-wide working group has promulgated criteria for the discharge of contaminants to the atmosphere from these dehydrator units. In this Project, the TEG offgases will be routed to the low-pressure flare system which will ensure thorough destruction of trace hydrocarbons.

Dispersion Modeling Results During Normal Operating Mode

Air dispersion modeling for the normal operating mode takes into account normal production (95%) and routine maintenance (5%). Air emissions (Table 6.13) during the production include:

- low pressure flare loading comprising TEG dehydrator offgases, pilot and purge gas to ensure flare stabilization and complete combustion;
- power turbine emissions; and
- compressors (export and main)

Air emissions (Table 6.13) during maintenance of the acid gas management system include:

- acid gas directed to flare along with routine low pressure gases;
- power turbine emissions; and
- compressors (export and main).

Table 6.14 and 6.15 present the modeling results from the injection mode and flaring mode emissions as maximum ground level concentrations (GLC) compared with Nova Scotia Standards. The results of the air dispersion modeling are shown graphically in Figures 1 to 6 in Appendix C.

Table 6.14 Atmospheric Effects from Normal Production (Acid Gas Injection)

Nova Scotia Criterion	Criterion Concentration [μg/m^3]	Predicted Maximum [μg/m^3]	Distance to Maximum GLC [m]	Percent of Criterion [%]
1 hour SO_2	900	381	187	42.4
24 hour SO_2	300	300	187	100
Annual SO_2	60	18	100	29.4
1 hour H_2S	42	0.00008	2,500	<0.01
24 hour H_2S	8	0.00001	1,000	<0.01
Annual H_2S	N/A	<0.00001	2,500	N/A
1 hour NO_2	400	395	187	98.6
24 hour NO_2	N/A	319	187	N/A
Annual NO_2	100	100	100	100

Note 98% flare efficiency assumed in conversion of H_2S to SO_2
OLM Method used in estimation of NO conversion.

Table 6.15 Atmospheric Effects from Equipment Maintenance and Upset of Acid Gas System (Acid Gas Flaring)

Nova Scotia Criterion	Criterion Concentration [μg/m^3]	Predicted Maximum [μg/m^3]	Distance to Maximum GLC [m]	Percent of Criterion [%]
1 hour SO_2	900	900 (1,427)*	2,500	100 (158.5)*
24 hour SO_2	300	10	187	100
Annual SO_2	60	18	100	29.5
1 hour H_2S	42	15	2,500	36.4
24 hour H_2S	8	3	5,000	34.0
Annual H_2S	N/A	0.12	5,000	N/A
1 hour NO_2	400	395	187	98.6
24 hour NO_2	N/A	319	187	N/A
Annual NO_2	100	100	100	100

Note 98% flare efficiency assumed in conversion of H_2S to SO_2
OLM Method used in estimation of NO conversion
* Mitigation applied for the estimated worst case 1.4 hours/year exceedance of 1 hour SO_2 criterion; unmitigated potential maximum is shown in brackets.

The routine operation of the facility (*i.e.*, injection mode) will meet all air quality standards for the parameters modeled. Flaring of the acid gas stream is predicted to occur approximately 5% of total operating time during periods of planned maintenance or shutdown of the acid gas management system. The model predictions of atmospheric discharges during flaring of the acid gas stream show a potential exceedance of SO_2 with respect to the one-hour ground-level criterion of 900 µg/m^3 for an average of 1.4 hours per year, as a worst case. The only meteorological condition under which this might occur is during a period of thermal inversion which would act to confine the plume below the thermal layer. The maximum hourly exceedance would be about 50% over the standard, occurring at sea level about 2.5 km from the platform where it would not constitute a perceptible impact or a threat to human health or the environment. The actual probability of this exceedance will be reduced by one or more mitigation measures such as: scheduling maintenance activities to avoid adverse weather conditions; reducing the sulphur levels; employing process controls to reduce the flow to the flare; or temporarily adding additional fuel gas to increase the buoyancy of the plume. Using these measures during acid gas flaring under unfavourable meteorological conditions will effectively reduce the ground level concentrations to within criterion levels. In summary, worst-case predicted ground level concentrations of SO_2 during temporary flaring of acid gas has the potential for extremely infrequent, minor exceedances of very short duration of the ground level standard for SO_2. These exceedances, were they to occur, would have no appreciable adverse effect on human or environmental health in the Project area. These concentrations will be reduced through the flaring mitigation procedures noted above, and incorporated in the Offshore EPP.

Greenhouse Gas Emissions

Normal Operation

The Project incorporates significant design elements to reduce GHG emissions, specifically the reinjection of the CO_2 associated with the acid gas stream. Table 6.16 compares Deep Panuke GHG emissions with estimated Nova Scotia GHG emissions.

Table 6.16 Nova Scotia GHG Emissions (1997) by Sector

Greenhouse Gas Source Category	**Total CO_2 Equivalent (kilotonnes/yr)**	**Percent of Total (%)**
ENERGY:		
Fossil Fuel Industries	649	3.2
Electricity and Stream generation	7,720	38.6
Mining	41	0.2
Manufacturing	701	3.5

Table 6.16 Nova Scotia GHG Emissions (1997) by Sector

Greenhouse Gas Source Category	Total CO_2 Equivalent (kilotonnes/yr)	Percent of Total (%)
Construction	30	0.2
Transportation: Land Vehicle	4,252	21.3
Transpiration: Air/Marine/ Rail	1,090	5.5
Residential	2,100	10.5
Commercial and Industrial	942	4.7
Other Combustion	250	1.3
Fugitive Gases	690	3.5
Energy Total	**18,400**	**92.0**
Industrial Process	270	1.4
Solvent & Other Product Use	14	0.1
Agriculture	580	2.9
Land use Change in Forestry	15	0.1
Waste Total	660	3.3
TOTAL	**20,000**	**100**
Notes: Totals may not always reflect sums of numbers in the table, due to rounding. In order to avoid double-counting, residential energy use excludes residential transportation use (counted under "transportation") as well as the emissions resulting from electricity generation. Source: Neitzert *et al*., 1999 in GPI Atlantic, 2001.		
Deep Panuke Project	**Total CO_2 Equivalent (kilotonnes/yr)**	**Deep Panuke as a percentage of 1997 NS total GHG (20,000 kilotonnes) (%)**
Normal Production Flaring (347 days)	14	0.07
Maintenance Flaring (18 days)	7	0.04
Power Generation and Compression	304	1.52
Support Vessels and Vehicles	10	0.05
Total GHG of Deep Panuke Project	**335**	**1.68**

The Project will emit GHG (including CH_4 and CO_2,) from power generation and other mobile and stationary sources. The GHG emissions from the Project are anticipated to be similar to those generated by other industrial processing facilities of comparable size and scope. The sulphur management option selected for this Project, injection of the acid gas stream, will also inject the CO_2 stripped from the raw gas. The injected CO_2 will amount to approximately 83,400 tonnes/year.

GHG emissions are a global issue; therefore, EnCana manages its GHG emissions at the corporate level. EnCana is a leader in the area of GHG management and is a gold level Voluntary Challenge Registry

(VCR) reporter and a member of the VCR Champions in Action council. A corporate approach to GHG reductions allows EnCana to target the largest and most cost effective reduction opportunities across the organization. Nevertheless, EnCana will consider all reasonable opportunities to reduce GHG emissions from the Deep Panuke Project in the engineering design process within the constraints of the location (*i.e.*, offshore) and facility safety.

The Project has also been analysed against the CAPP "Global Climate Change Voluntary Challenge Guide" (CAPP 2000) for determining the ratio of energy production to greenhouse gas emissions. The Project is predicted to perform significantly better than the industry norm for similar facilities during production.

Abnormal Operation

The extremely unlikely occurrence of a surface or subsurface blowout of a production well represents the greatest potential emission of GHG. The quantity of CH_4 that could be emitted is estimated to be ~4000 tonnes/day (refer to Table 6.13). The immediate repair of blowouts is of the highest priority because of the associated safety and environmental risk. Design measures to minimize the risk of blowouts and GHG releases are presented in Section 2.9. EnCana will develop an AERCP to rapidly respond to and minimize the duration of such a release.

Sound engineering practice will be used to design valves to minimize fugitive emissions. Awareness training will be conducted for employees to supplement the safety program (with respect to CH_4 releases) with knowledge about the cumulative impact of the Project on climate change. EnCana acknowledges the Government of Canada position that reduction of natural gas leaks be a part of the national strategy for greenhouse gas emission reduction.

Decommissioning

The Project activities associated with decommissioning would be similar to those of construction. Specifically, emissions may result from vessel and equipment engines and fugitive leaks and spills. Assuming the same mitigative measures are implemented during decommissioning as are used during construction, no significant adverse environmental effects on air quality are expected.

Malfunctions and Accidents

Upset Condition Resulting in Acid Gas Flaring

As noted for routine operations, acid gases are diverted to the flare during either routine maintenance of the injection system or during certain upset conditions (5% of the time in total).

In the event of a malfunction that takes the acid gas injection compressor out of service, the acid gas will be rerouted directly to the flare. The H_2S will be oxidized to SO_2 in the flare, a conversion estimated to be 98% efficient. Flaring of the bypass gas will provide significant thermal buoyancy to compensate for the increased SO_2 loading. Increased SO_2 emissions would continue until the injection system was returned to service.

The injection compressor is a robust component of production equipment, and a major equipment failure requiring sustained redirection of the acid gas to the flare is thus considered unlikely. The repair time on an outage would likely be three to seven days. Longer repair times are possible if weather conditions delay deliveries of replacement parts to the site. The spare parts inventory will be designed to prevent protracted delays that might otherwise result from adverse weather. Up to five months of flaring could be required in the extremely unlikely event that a new injection well was required and the necessary drilling equipment or vessels were not readily available. EnCana is committed to an immediate response to an unplanned change to flaring mode due to injection well problems. It is proposed that within seven days of the mode shift, a written response would be submitted to the CNSOPB outlining the options, actions, and schedule for resumption of normal operating mode. These procedures will be outlined in the flaring procedures to be included in the Offshore EPP.

Emissions from full acid gas flaring during upset conditions are summarized in Table 6.13. The maximum distance of predicted concentrations exceeding criteria levels for H_2S and SO_2 emissions from the flare are presented in Table 6.17 and 6.18.

Table 6.17 Upset Conditions – Acid Gas Flaring – H_2S

Criterion	Criterion Concentration	Criterion Exceeded
Lower Explosive Limit	4% (40,000 ppm, 56 g/m^3)	not exceeded
Immediate Danger to Life and Health	87 ppm (121 mg/m^3)	not exceeded
Threshold Limit Value – STEL	11 ppm (16 mg/m^3)	not exceeded
Threshold Limit Value - Time Weighted Average	10 ppm (14 mg/m^3)	not exceeded
Air Quality Criterion (1-hour)	30 ppb (42 μg/m^3)	not exceeded
Air Quality Criterion (24-hour)	6 ppb (8 μg/m^3)	not exceeded

Table 6.18 Upset Conditions – Acid Gas Flaring – SO_2		
Criterion	**Criterion Concentration**	**Criterion Exceeded**
Lower Explosive Limit	n/a	n/a
Immediate Danger to Life and Health	87 ppm (228 mg/m^3)	not exceeded
Threshold Limit Value - STEL	3.8 ppm (9.9 mg/m^3)	not exceeded
Threshold Limit Value - Time Weighted Average	2 ppm (5.2 mg/m^3)	not exceeded
Air Quality Criterion (1-hour)	0.346 ppm (900 µg/m^3)	not exceeded
Air Quality Criterion (24-hour)	0.115 ppm (300 µg/m^3)	not exceeded*
n/a = not applicable * with mitigation		

The flare stack is designed to enhance plume dispersion.

Upset Condition – Acid Gas Venting

It is possible, but unlikely, that the flare could be extinguished while acid gas is being redirected to the flare during maintenance or equipment malfunction. A flare failure occurs when the flare does not ignite. A camera system provides continuous visual monitoring of the flare. Although there is a high level of reliability in this design, there are known cases in the industry where the flare pilot flame has extinguished for some reason. If the flare is out, the gas stream will be emitted without combustion, and CH_4 and H_2S levels would be high for a short period of time (Table 6.13). Such an outage would likely last only a matter of seconds due to the redundancy in the system including the continuous ignitors and a pilot. In the event of a failure of these systems, the process safety system would alert operators, and the appropriate action would be taken. The likelihood of a sustained flare failure combined with an acid gas management system bypass is considered extremely remote. The results of modeling of CH_4 and H_2S from acid gas venting are presented in Tables 6.19 and 6.20 respectively.

The modeling results indicate that the Lower Explosive Limit for CH_4 (the only critical level that has been established for this parameter) would not be exceeded in this scenario. The maximum ground-level concentrations for CH_4 and H_2S (10.5 mg/m^3 and 10.1 mg/m^3, respectively) would occur about 1,000 m from the source. The TLV for H_2S would not be exceeded. This scenario would result in an exceedance of the 1-hour criterion for H_2S (odour detection by humans) within a distance of >100 km from the source. This scenario is extremely unlikely and uncombusted emissions would only occur for a very brief period before the flare is re-ignited. This occurrence would likely result in short duration episodes of perceptible to strong odour. The tabulated values correspond to the worst-case meteorological conditions.

Table 6.19 Upset Condition – Acid Gas Venting – CH_4		
Criterion	**Criterion Concentration**	**Criterion Exceeded**
Lower Explosive Limit	5% (50,000 ppm, 35.6 g/m^3)	not exceeded
Immediate Danger to Life and Health	n/a	n/a
Threshold Limit Value - STEL	n/a	n/a
Threshold Limit Value - Time Weighted Average	n/a	n/a
Air Quality Criterion (1-hour)	n/a	n/a
Air Quality Criterion (24 hr)	n/a	n/a
n/a = not applicable; levels not defined for methane.		

Table 6.20 Upset Condition – Acid Gas Venting – H_2S		
Criterion	**Criterion Concentration**	**Criterion Exceeded**
Lower Explosive Limit	4% (40,000 ppm, 56 g/m^3)	not exceeded
Immediate Danger to Life and Health	87 ppm (121 mg/m^3)	not exceeded
Threshold Limit Value – STEL	11 ppm (16 mg/m^3)	not exceeded
Threshold Limit Value - Time Weighted Average	10 ppm (14 mg/m^3)	not exceeded
Air Quality Criterion (1-hour)	30 ppb (42 μg/m^3)	exceeded 100 km
Air Quality Criterion (24-hour)	6 ppb (8 μg/m^3)	not exceeded

System Depressurizing Event

During a one-time testing event, and possibly in response to an emergency, it will be necessary to depressurize all systems to the flare. This blowdown event will result in the supply of 200 MMscfd of gas to the flare for approximately 15 minutes, followed by a flow decreasing to a base level within one hour. This situation does not increase sulphur emissions, but does increase the fuel gas supply to the flare. This results in a further increase in plume buoyancy and reduction of potential impacts during this transient event.

Acid Gas Injection Well Blowout – Subsea Blowout

The acid gas management system involves the construction of an injection well system. During drilling for this well, there is an extremely low probability of pressures in the injection reservoir causing a blowout of the well, accompanied by the release of gas and fluids from the reservoir (refer to Section 3.2). The intended reservoir for disposal of the acid gases does not contain sulphur, therefore it is anticipated that blowout during drilling would not contain significant amounts of H_2S, although the potential concerns with respect to water quality and safety are recognized. A blowout prevention device would limit the potential of a blowout during injection well drilling.

For production, the injection well will have two levels of fail safe valves that will operate in the event of an emergency to avoid release of acid gases from the well back to the surface. In an emergency situation, gas flow would be shut off at the surface on the injection tree, and simultaneously at the subsurface safety valve located 200 to 300 m beneath the sea floor. In the extremely unlikely case of failure of these systems, a release rate based on flow limited by the size of the pipe has been assumed (Table 6.13). The gas would bubble to the surface and be released to the atmosphere. The predicted downwind concentrations are shown in Table 6.21.

Table 6.21 Acid Gas Injection Well Blowout (Production Phase) – H_2S

Critical Level	Criterion Concentration	Criterion Exceeded
Lower Explosive Limit	4% (40,000 ppm, 56 g/m^3)	not exceeded
Immediate Danger to Life and Health	87 ppm (121 mg/m^3)	exceeded within 4,350 m
Threshold Limit Value - STEL	11 ppm (16 mg/m^3)	exceeded within 21,000 m
Threshold Limit Value - Time Weighted Average	10 ppm (14 mg/m^3)	exceeded within 23,500 m
Air Quality Criterion (1-hour)	30 ppb (42 μg/m^3)	exceeded > 100 km
Air Quality Criterion (24-hour)	6 ppb (8 μg/m^3)	exceeded > 100 km

Production Well - Subsea Blowout

A subsea blowout would result in the discharge of compressed gas into the sea. The estimated volume and discharge rate for a maximum credible event is approximately 200 MMscfd, or about 65.5 m^3/s. The atmospheric emissions of a subsea blowout are summarized in Table 6.13 and modeled using SCREEN3. The modeling assumed the maximum credible blowout, and that the gas reached the surface in an area of about 100 m diameter.

The critical conditions and the radius of the zone of influence for CH_4 and H_2S under this scenario are shown in Tables 6.22 and 6.23 respectively. These distances are computed on the basis of 1-hour and 24-hour concentrations. The actual potential consequences may extend to a greater distance because of higher fluctuating concentrations; for example, peak fluctuations may result in instantaneous concentrations ten times higher than the 1-hour average.

Table 6.22 Production Well - Subsea Blowouts – Raw Gas – CH_4		
Criterion	**Criterion Concentration**	**Criterion Exceeded**
Lower Explosive Limit	5% (50,000 ppm, 35.6 g/m^3)	exceeded within 630 m
Immediate Danger to Life and Health	n/a	n/a
Threshold Limit Value – STEL	n/a	n/a
Threshold Limit Value - Time Weighted Average	n/a	n/a
Air Quality Criterion (1-hour)	n/a	n/a
Air Quality Criterion (24-hour)	n/a	n/a
n/a = not applicable; levels not defined for methane.		

Table 6.23 Production Well - Subsea Blowout – Raw Gas – H_2S		
Criterion	**Criterion Concentration**	**Criterion Exceeded**
Lower Explosive Limit	4% (40,000 ppm, 56 g/m^3)	not exceeded
Immediate Danger to Life and Health	87 ppm (121 mg/m^3)	exceeded within 950 m
Threshold Limit Value – STEL	11 ppm (16 mg/m^3)	exceeded within 4,250 m
Threshold Limit Value - Time Weighted Average	10 ppm (14 mg/m^3)	exceeded within 4,800 m
Air Quality Criterion (1-hour)	30 ppb (42 μg/m^3)	exceeded >100 km
Air Quality Criterion (24-hour)	6 ppb (8 μg/m^3)	exceeded >100 km

The modeling results indicate that the Lower Explosive Limit for CH_4 would be exceeded up to a distance of 630 m downwind from the source. For H_2S, the modeling results indicate the Immediate Danger to Life and Health criterion is exceeded within 950 m from the source. Threshold Limit Values, STEL and TWA, would be exceeded within 4,250 m and 4,800 m respectively. One-hour and 24-hour criteria (based in the upper range of odour detection by humans) may be exceeded within a zone extending up to 100 km or greater, from the source.

The nearest permanent installation with workers aboard beyond Deep Panuke is the SOEP platform at Thebaud, approximately 45 km away and slightly closer than staffed locations on Sable Island. The future SOEP platform Alma is closer than Thebaud (23 km); however, workers will only be aboard for temporary work assignments which will not include overnight accommodation. In the extremely unlikely event of a subsea blowout from a production well, and depending on wind direction, an H_2S gas odour might be perceptible at Alma, Thebaud and Sable Island, but it would not pose a risk to safety. The greatest danger would be to persons aboard the platform at Deep Panuke, or aboard vessels within approximately 4 km. In addition to the danger to human health, the plume would represent a risk to seabirds, marine mammals, and other exposed creatures.

In Alberta, typically, emergency response planning zones (EPZ) are based on the 100 ppm isopleth for concentrations of H_2S which would require an emergency response plan for that zone. In this situation, the EPZ would be approximately 4 km, on a worst case basis. Section 2.9.3 describes blowout prevention devices to be incorporated into the Project design. Section 3.2 provides additional information on the low probability of system failures.

The maximum atmospheric emissions from blowouts are predicted to result from low wind speeds (about 1 m/s) that are sometimes observed on the Scotian Shelf. In the event of a blowout, the time of travel of the plume to a potential ignition source or persons on vessels is an important factor in the potential consequences of the event. For example, every kilometer downwind represents a travel time of over 16 minutes at a wind speed of 1 m/s. This time delay affords the opportunity to mitigate the effect through warning and alarm systems. Increased windspeed will reduce the travel time but will also provide additional dilution to the gas. For the annual average windspeed of 25 km/hr, a gas release would travel 1 km in about 2.4 minutes and be diluted to one seventh of the concentration at 1 m/s (3.6 km/hr). Activation of shut off valves would limit the duration of downwind exposure to a period from several seconds to a few minutes.

A detailed Safety Case analysis will be undertaken by EnCana to ensure that appropriate engineering design and materials procurement procedures are incorporated to ensure a safe facility. A comprehensive training program, combined with state-of-the-art detection systems will alert the facility to the occurrence of an accidental release of sour gas and minimize the exposure should a blowout occur. EnCana will develop an AERCP (refer to Section 4); this Plan will include detailed procedures and training to be incorporated during Project operations. The training will cover both the operational staff on the facility and the Emergency Response Team. All safety procedures will be documented and in place prior to the commencement of operations.

Production Well - Surface Blowout

A rupture of piping above the surface is estimated to yield the same raw gas emission rate as that which would result from a subsea event. The atmospheric emissions of a surface blowout are summarized in Table 6.13. A surface blowout would emit a plume from the ruptured pipe somewhere on the structure. The environmental effects beyond a few hundred metres of the platform, would be very similar to a subsea blowout, and the critical distances would be essentially the same, except for small differences due to wind speed and the height of release. A sustained release of more than a few minutes during production is considered extremely unlikely because of the failsafe valve beneath the sea floor and at the production tree; an extended release on the platform is not considered possible. The release would last for a period from several seconds to a few minutes, with the rate of release decreasing rapidly as the gas volume within the piping was exhausted. The critical conditions and downwind distance for CH_4 and

H_2S are shown in Tables 6.24 and 6.25 respectively. It is important to note that instantaneous fluctuations could be a factor of 10 higher than 1-hour averages.

Table 6.24 Production Well - Surface Blowout – Raw Gas - CH_4

Criterion	Criterion Concentration	Criterion Exceeded
Lower Explosive Limit	5% (50,000 ppm, 35.6 g/m^3)	exceeded within 490 m
Immediate Danger to Life and Health	n/a	n/a
Threshold Limit Value – STEL	n/a	n/a
Threshold Limit Value - Time Weighted Average	n/a	n/a
Air Quality Criterion (1-hour)	n/a	n/a
Air Quality Criterion (24-hour)	n/a	n/a
n/a = not applicable; levels not defined for methane.		

Table 6.25 Production Well - Surface Blowout – Raw Gas - H_2S

Criterion	Criterion Concentration	Criterion Exceeded
Lower Explosive Limit	4% (40,000 ppm, 56 g/m^3)	exceeded within <100 m
Immediate Danger to Life and Health	87 ppm (121 mg/m^3)	exceeded within 770 m
Threshold Limit Value - STEL	11 ppm (16 mg/m^3)	exceeded within 4,100 m
Threshold Limit Value - Time Weighted Average	10 ppm (14 mg/m^3)	exceeded within 4,600 m
Air Quality Criterion (1-hour)	30 ppb (42 μg/m^3)	exceeded within >100 km
Air Quality Criterion (24-hour)	6 ppb (8 μg/m^3)	exceeded within >100 km

The modeling results indicate that the Lower Explosive Limit for CH_4 would be exceeded up to a distance of 490 m from the source. The modeling results also indicate that the Immediate Danger to Life and Health criterion for H_2S is exceeded within 770 m from the source. One-hour and 24-hour criteria may be exceeded within a zone greater than 100 km, although the limited duration of the release would prevent the 24-hour average from reaching the criterion.

Because of the significant hazard that these concentrations would pose to the immediate environment and worker health, the engineering design is focused on the reduction of the probability of occurrence. Surface and subsea blowouts would produce similar maximum concentrations downwind; however, a blowout aboard the platform could have more serious consequences to workers aboard compared with a subsea blowout. The multiple levels of blowout prevention controls are designed to minimize the risk; however, emergency operating procedures will also be developed to ensure the protection of platform workers. As discussed above, the time delay associated with the worst-case meteorology (*i.e.*, low wind speed resulting in long travel times) provides an opportunity to warn and thereby protect vessels downwind. EnCana's AERCP is discussed in Section 4.

Acid Gas Piping Rupture

The rupture of acid gas piping on the platform is considered to be an extreme event, resulting in hazards to personnel aboard. Systems to protect worker safety (*e.g.*, emergency shut down devices and H_2S monitors) ensure that any adverse occurrence is of extremely short duration and the release is of low volume. The adequate protection of workers aboard the platform ensures the protection of the environment beyond. The volume of gas that may be released will be limited to the volume and pressure of the segment of piping between the two nearest shutoff valves. The gas volume and pressure that could be released in this emergency scenario are not yet known; therefore, the critical distances cannot be modeled. It is standard practice during detailed engineering design to determine specific risks, and to optimize the design and responses. Because the design will limit the risk to all workers on the platform, the effect on the environment beyond will not be significant.

Pipeline Release

The low probability of an offshore or onshore leak or rupture of the market-ready gas pipeline is discussed in Section 3.3 and 3.4. A pipeline release would consist of methane which would cause a temporary, localized degredation of air quality near (at the surface) of the release. Additional air quality effects could occur in the unlikely event of a rupture of the onshore pipeline with ignition and secondary fire (*i.e.*, vegetation). Large releases of gas from the pipeline would be rapidly detected through process monitoring equipment with shutoff valves triggered. Pipeline integrity measures are described in Section 2.9.

Summary

In summary, routine operations can be conducted with sufficient mitigation to ensure that effects on air quality are not significant. There is potential for significant adverse environmental effects to occur in the extremely unlikely event of blowouts of injection or production wells, or acid gas pipe ruptures; therefore design, inspection, maintenance, and integrity assurance programs will be in place to minimize this risk. Proven engineering techniques are available to prevent these events, and will be employed for the Project. All safety procedures will be documented and in place prior to the commencement of routine operations.

6.3.1.5 Cumulative Effects Assessment

The ambient air quality in the study area, described in Section 6.1.1.2 reflects the influence of emissions from other past and current projects and activities occurring within or outside of the Project area. Other past and current sources of emissions within the study area include emissions from hydrocarbon exploration and production platforms, and engine emissions from vessels engaged in fishing, tourism, hydrocarbon exploration (including seismic and drilling activities), supply of hydrocarbon production facilities (*e.g.*, SOEP), military activities, and domestic and international shipping. It has been estimated that about 80% of Nova Scotia's air pollution originates outside the provincial borders, primarily in the industrial centre of North America (Province of Nova Scotia 2001). Pollutants transported from these industrial areas typically include sulphates, nitrates and ozone precursors. All quantities are significantly lower than the Nova Scotia air quality criteria. It is assumed, for the purposes of this assessment that these existing activities will continue to be carried out and to produce emissions at current levels.

It is anticipated that incremental emissions will result from future seismic and exploration activities that will be carried out in the study area and from the construction of the recently announced Blue Atlantic, Neptune, and Hudson Energy (currently on hold) projects that will traverse the study area. No cumulative interactions with the Sable Island Windpower project affecting air quality are anticipated.

Construction of onshore components of the Project and construction of onshore components of Neptune and Hudson Energy Projects may overlap temporally and spatially. However, the effects of emissions from construction of the Project (*e.g.*, dust, construction vehicle emissions) are small in geographic extent, short in duration, and reversible and will not cause significant cumulative effects with these other proposed projects. The cumulative effect of emissions from Project construction in combination with all existing (and ongoing) emission sources affecting the study area is not expected to be significant. There may be some temporal and/or spatial overlap of the Project construction emissions with emissions from other future exploration drilling activities outside of the Panuke lease but within the study area, and seismic exploration both on and outside the Panuke lease. These other future emissions, however, would be similar in scale to those of the Project construction, and are not expected to result in a significant cumulative adverse effect on air quality. No temporal overlap with construction of the SOEP platform at Alma is expected; therefore, no cumulative effects are anticipated as a result of construction phase activities.

The cumulative effect of operational emissions in combination with all existing (and ongoing) emission sources affecting the study area is not expected to be significant. Emissions from vessel traffic and flaring during Project operation are expected to be similar in extent, duration, and reversibility to those during construction. There may be spatial and temporal overlap between Project operations and construction activities for the Blue Atlantic Transmission System or the Neptune and Hudson Energy subsea cables in the future; however, any cumulative interaction is not expected to result in a significant adverse effect on air quality due to the low scale of the Project emissions. Routine Project air emissions, including those from flaring and power generation on the platform, will be within regulatory limits and generally outside of the zone of influence of air emissions generated by future projects such as hydrocarbon exploration on other leases, and the Blue Atlantic, Neptune and Hudson Energy Projects. In the areas where the Hudson and Neptune projects are expected to generate significant air emissions from operation of gas fired power generation facilities, along with the current operation of the SOEP gas plant (*i.e.*, Goldboro), Deep Panuke Project air emissions will be limited mainly to dust and construction vehicle emissions generated during installation of the onshore portion of the pipeline. The onshore portion of the Blue Atlantic project (*i.e.*, gas processing) is expected to be located at a significant distance from the Deep Panuke Project (*i.e.*, in southwest Nova Scotia). The Neptune and Hudson Energy projects are expected to use gas fired turbines which will minimize the generation of the long range transport of air pollutants (*e.g.*, SO_2) which could interact cumulatively with Deep Panuke Project air emissions. It is expected that Blue Atlantic gas processing operations will be required to meet all current and future emissions requirements (*e.g.*, SO_2 limits) which, in combination with its distance from the Project, will minimize the potential for significant cumulative effects with the Deep Panuke Project.

A visible flare plume from Thebaud has been reported. While quantitative determinations have not been made of the air quality impacts at Thebaud, the "sweet" SOEP gas is not expected to contain large volumes of pollutants (*e.g.*, SO_2) which could interact significantly with Deep Panuke offshore emissions. SOEP Tier II development may result in additional air emissions at Thebaud, however these emissions are not anticipated to overlap spatially with Deep Panuke emissions.

The Project will emit GHG (including CH_4 and CO_2) from power generation and other mobile and stationary sources. The issue of global warming and the role of GHG is an international issue. Canada has been actively involved in developing strategies to limit GHG emissions through mechanisms such as the VCR program. The estimated contribution of the Deep Panuke Project to total estimated GHG by all Canadian human-made sources is extremely small (0.03% of 1995 Canadian totals) (Environment Canada 1997). Since 1994, EnCana has achieved a cumulative reduction in GHG emissions of 2.5 million tonnes of CO_2 equivalent (to the end of 2000). This cumulative reduction amounts to approximately 14% of the total reductions reported by the oil and gas industry to CAPP through the VCR program. EnCana is committed, in the VCR program, to continuous improvement and has implemented a program to reduce GHG emissions throughout its operations through process optimization and technological improvements. The choice of acid gas injection incorporates permanent disposal of a significant quantity of CO_2 that would otherwise be emitted to the atmosphere. EnCana is committed to investigating other GHG reduction opportunities that arise during this Project.

The governments of Canada and Nova Scotia have agreed to an SO_2 emissions cap of 189,000 tonnes annually in Nova Scotia (Canada/Nova Scotia Agreement Respecting Acid Rain Reduction Program). This program is designed to limit sulphur emissions to prevent acid rain damage. A limit of 145,000 tonnes of this cap has been allocated to Nova Scotia Power Inc. in the provincial *Air Quality Regulations* under the *Environment Act*. The SO_2 emissions from the Deep Panuke Project are about 1,596 tonnes per year, or 1% of the cap.

The Government of Nova Scotia has issued an energy strategy for the province, Seizing the Opportunity: Nova Scotia's Energy Strategy (2001), that includes, among other initiatives, the further reduction of SO_2 emissions in the province. The strategy requires a 25% reduction in SO_2 emissions by 2005, and a further 25% reduction by 2010. The EnCana sulphur management strategy results in permanent disposal of sulphur by-products to an underground reservoir, minimizing the release to the atmosphere; this is assumed to be fully compatible with this part of the provincial energy strategy.

The potential environmental effects, including cumulative effects, of decommissioning would be similar to those of construction; no significant adverse effects are anticipated.

The potential future cumulative effects resulting from a malfunction or accident would be the same as those described previously in this section. Other than the extremely unlikely possibility of a significant adverse effect due to a surface or subsurface blowout, or pipe rupture at the platform, no significant adverse cumulative effects on air quality are predicted.

6.3.1.6 Follow-up and Monitoring

Routine atmospheric discharges will be tested on a regular basis to verify the efficiency of the systems. Continuous monitoring systems will be put in place to ensure that fugitive or emergency releases of gas are detected immediately and responded to appropriately. During construction, the process will include test procedures to ensure that the specified equipment is installed and correct tolerances achieved.

In operation, the Project will adhere to proactive maintenance procedures. The effects of corrosion, vibration, mechanical wear and fatigue will be estimated and repair and replacement performed with an adequate margin of safety. During the operation of the facility, environmental monitoring programs are in place to document compliance with environmental standards and reports are submitted to the CNSOPB on a regular basis.

Significant adverse effects on air quality could occur due to emissions of H_2S and CH_4 in the extremely unlikely event of an accidental release of large amounts of raw gas from a production well or acid gas from the injection well. It is therefore critical to the success of the Project that the safety measures, contingency planning, and equipment condition be tested and monitored as a highest priority. In particular, emergency shutdown systems will be tested at routine intervals to ensure that they are functioning properly, and that releases, should they occur, are safely managed to the shortest possible duration.

The EPP will contain procedures for reporting emissions in accordance with regulatory requirements. The EPP will also outline procedures for monitoring of emissions and identification of opportunities for continual environmental improvement. EnCana supports the establishment of a regional EEM framework and has contributed to the establishment of the new Sable Island Air Quality Monitoring Station, which will monitor a wide variety of emission types from regional sources.

EnCana will adhere to provisions of the National Pollution Release Inventory (NPRI) with respect to reporting emissions to the atmosphere. NPRI reporting requirements with respect to East Coast offshore oil and gas industry are currently being addressed in Environmental Studies Research Fund (ESRF) studies on air emissions and pollution prevention opportunities. In conjunction with the Offshore Chemical Selection Guidelines (NEB *et al.* 1999) and the WMP and CMP, EnCana will strive to reduce or eliminate wastes and transfers of NPRI substances throughout the life of the Project.

EnCana submits annual VCR reports, which include detailed descriptions of annual performance, descriptions of GHG reduction projects, projections of future GHG levels, Product Energy Intensity (PEI) and Product Carbon Intensity (PCI) targets, and plans to achieve these targets.

6.3.1.7 Sustainable Use of Renewable Resources

No significant effects on air quality are predicted that would affect the sustainable use of renewable resources. Emissions from a blowout event will dissipate in a short time.

6.3.1.8 Summary of Residual Environmental Effects Assessment

Flaring is necessary for safe operation and testing during Project construction and commissioning; however, to the extent possible, these events will be scheduled to ensure that flaring is carried out safely and in accordance with flaring procedures specified in EnCana's Offshore EPP (refer to Section 4). Other emissions from construction, such as the exhausts of equipment and supply vessels, and dust will be temporary, localized, and not significant. Routine operations will result in the emissions of NO_X and SO_2 from power generation and from normal continuous flaring; these will be within the applicable air quality criteria levels. Some GHG emissions will be produced though injection of acid gas will significantly reduce these emissions. EnCana is committed to continuous improvement in GHG management in its operations.

Acid gas flaring resulting from maintenance or malfunctions of the acid gas management system will result in additional air contaminants. Flaring of acid gas, incorporating mitigative measures when necessary, will cause temporary, but acceptable, increases in emissions. No significant adverse effects from these upset conditions are likely.

A surface or subsurface blowout resulting in the release of large quantities of raw gas from a production well or acid gas from the injection well, would result in significant adverse effects to air quality for several criteria and could result in important consequences affecting the health and safety of workers on the platforms and vessels within 4 km. It is estimated, however, that such an event would be both extremely unlikely (refer to Section 3.2) and of short duration with the probability of occurrence further reduced through good design practices (refer to Section 2.9) and maintenance. Subsea or surface blowouts could last up to several months with the failure of all safety equipment, though a total failure of all safety equipment is considered extremely unlikely. EnCana will develop and implement the AERCP (outlined in Section 4) for all potential malfunctions and accidents to minimize the potential adverse effect on air quality and human health and safety.

Potential adverse residual environmental effects on air quality are predicted to be not significant for construction and operation phases. Significant adverse effects on air quality could occur as a result of an accidental release of large amounts of raw gas or acid gas through a blowout or pipe break; however, such an event would be temporary and is considered extremely unlikely. Cumulative effects with other current or reasonably foreseeable future projects are considered not significant. Tables 6.26 to 6.27 summarize the residual environmental effects on air quality.

Table 6.26 Residual Environmental Effects Assessment Matrix: Air Quality

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effect	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/ Social-cultural and Economic Context		
CONSTRUCTION									
Flaring	• Localized reduction in air quality; visible plume (A)	• Flaring procedures specified in Offshore EPP (*e.g.*, scheduling to avoid adverse weather conditions and presence of vessels)	2	3	3/2	R	2	N	2
Miscellaneous emissions from vessels, power generation, and construction equipment	• Localized reduction in air quality (A)	• Use of energy efficient and low emission technology where appropriate • Dust suppression techniques if required	1	3	2/6	R	2	N	3
OPERATION									
Power generation	• Localized reduction in air quality (A)	• Use of energy efficient and low emission technology where appropriate • Sufficient stack height to minimize platform and ground level concentrations	1	3	5/6	R	2	N	3
Flaring	• Localized reduction in air quality; visible plume (A)	• Manage operations to minimize flaring • Flaring procedures included in Offshore EPP (*e.g.*, adjust operations for adverse weather conditions)	2	3	5/6	R	2	N	3

Table 6.26 Residual Environmental Effects Assessment Matrix: Air Quality

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects: Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/ Social-cultural and Economic Context	Residual Environmental Effect	Level of Confidence
Miscellaneous emissions from vessels	• Localized reduction in air quality (A)	• Use of energy efficient and low emission technology where appropriate	1	3	5/6	R	2	N	3
MALFUNCTIONS AND ACCIDENTS									
Blowout of wells (surface and subsurface) Piping rupture	• Severe reduction in air quality (A)	• Blowout prevention design and equipment • Alert/Emergency Response Contingency Plan • Notification to Mariners	3	6	1/0	R	2	S	2
Acid gas system malfunction	• Increased flaring or venting of H_2S or SO_2 and reduction of air quality (A)	• Spare part inventory • Equipment maintenance program • Asset integrity management	2	4	1/1	R	2	N	2
Pipeline break	• Release of market-ready gas (methane) with reduction of air quality	• Pipeline design to maintain integrity • Leak detection and shutoff valves	2	3	1/0	R	2	N	3

Table 6.26 Residual Environmental Effects Assessment Matrix: Air Quality

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effect	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/ Social-cultural and Economic Context		

KEY

Magnitude: 1 = Low (*e.g.*, within the normal variability of baseline conditions); 2 = Medium (*e.g.*, increase/decrease with regard to baseline but within standards and objectives); 3 = High (*e.g.*, singly or as a significant contribution in combination with other sources causing exceedances or impingement upon standards and objectives)
Geographic Extent: 1=<500 m^2; 2=500 m^2 – 1 km^2; 3=1-10 km^2; 4=11-100 km^2; 5=101-1000 km^2; 6=>1000km^2
Duration: 1=<1month; 2=1-12 months; 3=13-36 months; 4=37-72 months; 5=>72 months
Frequency: 0= unlikely to occur; 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: R=Reversible; I=Irreversible
Ecological/Socio-cultural and Economic Context: 1=Pristine area; 2= Area affected by human activity; 3=Evidence of adverse effects
Residual Environmental Effect Rating: S=Significant Adverse Environmental Effect; N=Nonsignificant Adverse Environmental Effect; P=Positive Environmental Effect
Confidence: 1=Low level of confidence; 2=Medium level of confidence; 3=High level of confidence

Table 6.27 Residual Environmental Effects Summary: Air Quality (All phases)			
Phase	**Residual Environmental Effect Rating**	**Likelihood of Significant Adverse Effects**	
		Probability of Occurrence	**Scientific Uncertainty**
Construction	N	N/A	N/A
Operations	N	N/A	N/A
Decommissioning	N	N/A	N/A
Malfunctions and Accidents	S	1	3

KEY

Residual Effects Rating: S=Significant Adverse Environmental Effect; N=Non-significant Adverse Environmental Effect; P=Positive Environmental Effect
Probability of Occurrence: Based on professional judgement; 1 = Low; 2 = Medium; 3 = High; N/A = Not applicable (effect is not predicted to be significant)
Scientific Uncertainty: Based on scientific information and statistical analysis or professional judgement; 1 = Low level of confidence; 2 = Medium level of confidence; 3 = High level of confidence; N/A = Not applicable (effect is not predicted to be significant)

6.3.2 Marine Water Quality

Marine water quality refers to the physical and chemical condition of the medium that supports all marine life. Marine organisms depend on water for all aspects of their life cycle. Consequently there is an intrinsic link between marine water quality and marine organisms resident in, or transient to, the Project area. Legislation and guidelines regulate industrial discharges to the marine environment in order to protect water quality. Project related discharges to marine waters are discussed elsewhere in this document with respect to potential effects on: marine benthos (Section 6.3.3); marine fish (Section 6.3.4); marine mammals (Section 6.3.5); and marine related birds (Section 6.3.6). Marine water quality in this assessment is therefore addressed primarily in relation to potential effects on key marine biological receptors. Marine water quality is addressed as a separate VEC at the request of regulatory authorities.

6.3.2.1 Boundaries

Temporal boundaries for marine water quality encompass the construction, operation and decommissioning phases of the Project. Malfunctions and accidental events (*e.g.*, well blowout, pipeline rupture, platform spills) may also affect water quality. Temporal boundaries for such events would be dependent upon the nature, duration and magnitude of the accident and its effects.

The spatial boundary for marine water quality includes the entire water column, and encompasses the potential zone of influence of Project related discharges and potential spills.

6.3.2.2 Residual Environmental Effects Evaluation Criteria

A **significant** adverse effect is one that results in the degradation of marine water quality by causing one or more parameters to exceed maximum allowable limits as stipulated in applicable guidelines (*e.g.*, OWTG), such that there is a sustained or repeated exceedance of parameters affecting water quality causing significant adverse effects on other valued environmental components depending on water quality (*i.e.*, benthos, marine fish, marine mammals, marine related birds) as assessed elsewhere in this document.

A **positive** effect is one that measurably improves marine water quality over existing conditions.

6.3.2.3 Potential Interactions, Issues and Concerns

Potential interactions with marine water quality may occur during the Project's construction, operation and decommissioning phases, as well as due to malfunctions and accidental events.

Potential issues and concerns related to marine water quality include:

- temporary and localized increase in suspended particulate matter (SPM) as a result of pipeline and jacket installation;
- discharge associated with hydrostatic testing;
- overboard disposal of WBM and associated cuttings;
- discharge of routine operational discharges (*e.g.*, produced water, cooling water, sewage, *etc.*); and
- accidental release of hydrocarbons following a blowout, pipeline rupture, or platform spill.

The most relevant activity during routine Project operations is the discharge of produced water, which has the potential to affect a number of water quality parameters, including temperature, dissolved oxygen, trace metals, and pH. Marine water quality may also be affected during operations as a result of deck drainage, cooling water discharge, and other Project-related discharges.

6.3.2.4 Analysis, Mitigation and Residual Environmental Effects Prediction

Construction

Pipeline and Platform Installation

Pipeline trenching will result in localized increases in SPM in waters immediately surrounding the trench. The nature and duration of elevated levels of SPM are primarily a function of the physical characteristics of the sediment (*i.e.*, coarse material will settle quickly, and fine grain material over a longer period). SPM concentrations of the fine material may reflect that which naturally occurs during storm conditions and/or levels associated with periods of high primary biological productivity. It is unlikely that the short periods of elevated SPM would affect water quality significantly.

Blasting may be required within 300-500 m of the shoreline. Toxic gas by-products of explosives are primarily carbon monoxide and nitrous/nitric oxides of the detonation reaction. The type of charge used will therefore be an important consideration, as certain compounds produce insignificant toxic gas production, and consequently, little, if any, detrimental effect to the localized water quality (Keevin and Hempton 1997). Both trenching and blasting are short-term, localized events that are unlikely to evoke a prolonged effect on marine water quality conditions. All marine blasting activities will be conducted in accord with the Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters (Wright and Hopky 1998); this will further reduce impacts to marine habitat.

Onshore-related construction activities will be conducted according to DFO and NSDEL guidelines for erosion and sediment control. These control measures, also specified in the Onshore Construction EPP, will minimize or prevent silt-laden surface run-off from entering the marine environment. Land-based construction activities are therefore not anticipated to affect marine water quality.

Mobilization and installation of the platforms may result in an increase in the local concentration of SPM above ambient levels. This activity and any resulting increase in SPM will, however, be short-term, and occur within a small zone of influence. It is unlikely that any resulting increase in concentrations of SPM would exceed natural elevated levels caused by storms or internal waves.

Hydrostatic Testing

Hydrostatic testing of the pipeline may involve discharge of seawater treated with corrosion inhibitors, biocides, and oxygen scavengers (refer to Section 2.3.2). A study, consisting of a toxicity biossay program and plume dispersion modeling, will be undertaken to optimize the method of discharge of hydrostatic water from the pipeline and to identify the chemicals best suited for application and discharge into the environment. The proposed method of discharging the one-time use of hydrostatic water from the pipeline will be to direct the water to the production platform, and mix it with cooling water, prior to discharge through the caisson. It is estimated that the pipeline will contain approximately 47,000 m^3 of hydrostatic test water and that the pipeline will be emptied over an estimated period of 4 to 5 days. The discharge rate will be approximately 470 m^3 per hour. The cooling water discharge at the platform is estimated to be approximately 3,050 m^3 per hour. Therefore, there will be a 7:1 dilution of the hydrostatic test water at the cooling water caisson discharge. The chemicals used in hydrostatic testing will be selected from a list of approved chemicals for use in Canada and subject to the Offshore Chemical Selection Guidelines (NEB *et al.* 1999) and EnCana's CMP (refer to Appendix D).

Development Drilling

Only WBMs and associated cuttings will be discharged into the marine environment. Section 6.3.3 contains drill waste dispersion modeling results and describes predicted effects on marine benthos. The basis of WBM modeling is that WBM can remain in the benthic boundary layer, the thickness of which can range from metres to tens of metres depending on ambient currents (Hannah *et al.* 1995). Modeling results presented in Thomson *et al.* (2000) of WBM on the Sable Bank showed that peak mud concentrations of 10 mg/L could persist in the boundary layer for several days and peak levels of 1 mg/L could persist for a 10-day period (refer to Section 6.3.3 for additional detail).

SBM and EMOBM will either be injected or shipped to shore for treatment and/or disposal. EnCana will also screen all component chemicals of drilling muds to be used, as per the Offshore Chemical Selection Guidelines (NEB *et al.* 1999). EnCana and its Contractors will also comply with all other regulations of the OWTG (NEB *et al.* 1996, and updates) and any other regulatory conditions regarding discharges and waste management (*e.g.*, deck drainage, hazardous and non-hazardous wastes) during the construction phase to minimize potential water quality impacts. EnCana's WMP will be developed and implemented to address these issues for both staff and contractors.

Vessel Discharges

All Project vessels will adhere to applicable regulations (*e.g.*, MARPOL) with respect to discharge of substances affecting marine water quality (*e.g.*, bilge, lubricants, solid waste, fuels, etc.). The WMP will also apply to construction vessels. Project related vessel traffic will therefore not have a significant effect on marine water quality.

In summary, through the use of standard and accepted industry procedures and mitigation measures, adherence to applicable regulations and guidelines, and waste management planning, the construction phase of the Deep Panuke Project will not result in a significant adverse effect on marine water quality.

Operation

Produced Water Discharge

The OWTG (NEB *et al.* 1996, and updates) specify a hydrocarbon limit of 30 mg/L (30-day weighted average) in produced water. EnCana is striving to exceed this guideline, with a dispersed target level of 25 mg/L (30-day weighted average). Treated produced water will be introduced into the cooling water line and discharged from a pipe at a depth of 10 m below the water surface. Discharge at depth will increase effluent dispersion characteristics and reduce interaction with the zone of relatively higher primary productivity nearer to the surface. The total maximum discharge rate will be 3,095 m^3/hr, of which 3,050 m^3/hr will be cooling water (recirculated seawater) and 45 m^3/hr will be produced water. Therefore, an initial dilution of produced water of 68:1 will occur prior to discharge into the marine environment.

Results from produced water dispersion modeling is found in Appendix C. The conclusions of the dispersion modeling are considered conservative as the model assumed a produced water discharge rate of 65 m^3/hr with a dilution rate of 48:1. As the design of the Project has advanced, the produced water maximum discharge rate has been reduced to 45 m^3/hr, with a higher dilution rate of 68:1.

The temperature of the discharge will be about 20^o C, and will provide some buoyancy to the discharge plume. The discharge temperature will however, rapidly decline to within 1^o C of background levels within the immediate vicinity of the platform. Low dissolved oxygen in the produced water will not be a concern since the produced water is mixed with natural seawater (cooling water) from an intake approximately 10 m deep, with dissolved oxygen concentrations near saturation at this depth.

The pH of produced water may be influenced by the H_2S content. However, the design specifications are to treat the produced water to a range of 1 to 2 ppm H_2S prior to mixing with cooling water. Dispersion of low levels of H_2S discharged with produced water has been assessed by modeling of the combined produced water and cooling water discharge. Combination of the produced water stream with cooling water achieves an initial dilution of 68:1 (48:1 dilution was modeled). Modeling shows that after discharge, the total effluent undergoes further dilution of at least 10 to 20 fold within 30 to 100 m of the discharge pipe based on one hour averages within the 20 m x 20 m model grid cells. This results in an overall dilution of produced water H_2S levels by factors of greater than 500:1 to 1,000:1. Based on discharge levels of 1 to 2 ppm, maximum average H_2S levels in the marine environment of less than 0.004 ppm (0.004 mg/L) are predicted at the point of discharge from the Deep Panuke production platform. In addition to rapid dilution, residual H_2S will be rapidly oxidized to sulphate (a common ion in seawater). Significantly higher natural levels have been recorded in waters overlying sediments (20.4 ppm) (Fenchel 1969). Bagarino and Vetter (1989), and Glickman *et al.* (1999), examined H_2S

concentrations at "end of pipe" (95 to 160 mg/L) and at the edge of mixing zone (50 to 96 Fg/L) at three California offshore sites and predicted no hazard to marine aquatic life. The H_2S levels in routine Project discharges are expected to be significantly lower than those that have been shown to cause harmful effects in marine fish (refer to Section 6.3.4). Consequently no significant H_2S effects are likely from the discharge of produced water.

Although formation waters were not available for testing when the Deep Panuke discovery was made, information on produced water chemistry was adopted from the Musquodoboit Wildcat drill stem tests. It is anticipated that this chemistry is representative of Deep Panuke. Analysis of trace as well as major element concentrations within this produced water indicates that the initial mixing of the produced water with cooling water (dilution of 68:1) and subsequent discharge will not result in a significant impact on water quality with regard to trace metals.

There are no specific data for nutrient concentrations in produced water (NO_2-N, PO_3-P, SiO_2), however, modeling of effluent plume dynamics indicates that the average total dilution of the produced water component in the near-field is from 500:1 to 1,000:1. Any nutrients in the produced water stream would not result in a significant effect on the near-field water quality.

Online oil monitors, backed up with platform based laboratory facilities, are currently proposed for produced water sampling. If online monitoring cannot be provided reliably and economically, a sample laboratory facility approach will be employed. By meeting or improving upon the OWTG (NEB *et al.* 1996, and updates) criteria, it is unlikely that water quality will be significantly affected by hydrocarbons from produced water during Project operation.

Other Operational Discharges

Sanitary and food waste will be macerated to a particle size of 6 mm or less prior to ocean discharge, in accordance with the OWTG. Deck drainage water could contain traces of petroleum hydrocarbons such as lube oils, helicopter fuel, and diesel fuel. Deck drainage will be treated using cartridge-style water polishers and tested prior to discharge. Deck drainage will comply with OWTG (NEB *et al.* 1996, and updates) of 15 mg/L or less of hydrocarbon prior to ocean discharge. Every effort will be made to prevent chemical contamination on decks which could be entrained in deck drainage. Storage areas for totes containing chemicals and petroleum products will have secondary containment to prevent discharge onto deck surfaces. With these procedures in place, under normal operating conditions, marine water quality will not be significantly affected by these operational discharges.

Vessel Discharges

As with construction, all Project vessels will adhere to applicable regulations (*e.g.*, MARPOL) with respect to the use and release of fuel and lubricants and other waste materials (*e.g.*, solid waste, bilge) at sea. EnCana will require all contract vessel operators to adhere to the WMP. Project related vessel traffic during Project operations will therefore not have a significant effect on marine water quality.

In summary, by adhering to applicable regulations and guidelines, implementing mitigation measures, applying standard industry procedures, the operational phase of the Deep Panuke Project will not result in a significant adverse effect on marine water quality. This conclusion is further demonstrated in Sections 6.3.3 to 6.3.6 with regard to potential water quality effects on other VECs during Project operation.

Decommissioning

Decommissioning and abandonment will be performed in accordance with the regulatory requirements applicable at the time of such activities. Requirements for eventual removal of facilities will be taken into account during the detailed design phase. The abandonment/recovery of offshore facilities may result in some minor effects to water quality (*e.g.*, increased SPM due to seafloor disturbance), although any such increase will be localized and of a short-term duration. The potential presence of contaminants that could be encountered during recovery and transportation of the facilities will be taken into account. A Decommissioning Plan will be developed for the Project, which will provide detailed procedures for decommissioning onshore and offshore facilities (refer to Appendix D).

Decommissioning is not predicted to have a significant adverse effect on water quality.

Malfunctions and Accidents

Malfunctions and accidental events which could have implications for marine water quality include platform spills, blowouts, and pipeline ruptures.

Platform Spills

Storage areas for totes containing chemicals and petroleum products will have secondary containment to prevent discharges onto deck surfaces. Drainage from equipment areas on platforms will be directed through a header system to a collection tank to an oil/water separator treatment unit on the production platform. All offshore platforms and drilling rigs will have spill mitigation and clean-up equipment on board to respond to any deck spills. Absorbent pads and dry chemicals will be used immediately in the event of a spill to reduce the potential of spilled material entering the water. Any spills from the platform to the marine environment will likely be small in quantity and frequency and will disperse rapidly (refer to Chapter 3). These small platform spills will be mitigated through development and application of EnCana's Spill Response Plan (refer to Section 4 and Appendix D). The Spill Response Plan will become an integral training component for all offshore EnCana and contractor staff, as applicable.

It is the responsibility of all EnCana employees and contractors to report any accidents, incidents or spills to the Offshore Installation Manager for immediate action. EnCana will report all spills to the CNSOPB. The standby vessel in the field will also be tasked, as part of its regular duties, to observe and report any spills from the facilities. In summary, it is unlikely that platform spills will significantly affect marine water quality.

Well Blowouts

Accidental events which could have the most widespread implications for marine water quality are well blowouts. A production well blowout would release raw gas into the marine environment, and a subsea blowout of the injection well could release liquid hydrocarbon (condensate) as well as H_2S gas into the marine environment. An analysis of the probability of these spills, and fate and behavior modeling, is presented in Section 3. A number of safeguards (*e.g.*, blowout preventors and SC-SSSV) to prevent such accidental events have been incorporated into the Project design (refer to Section 2.9.3). The probability of a blowout is extremely low, with the significance of potential effects dependant upon the nature and magnitude of the event. In addition to design measures to minimize the probability and potential duration of such major releases, EnCana will implement an AERCP and a Spill Response Plan to further reduce the severity of potential environmental effects in the unlikely event a major spill were to occur (refer to Appendix D). These Plans will comply with all applicable regulatory requirements and become an integral part of EnCana's overall environmental management planning structure (refer to Section 4). Potential effects from blowouts on marine environmental receptors are considered in Section 6.3.3 to 6.3.6.

Pipeline Rupture

The release of natural gas (primarily methane) from a subsea pipeline rupture will cause localized, non-significant effects on water quality and associated VECs. In the unlikely event of a pipeline rupture, natural gas (composed largely of methane) will rise to the surface at speeds between 5 to 10 m/s and dissipate into the atmosphere. The toxic potential of natural gas to water column species is expected to be low because worst case concentrations of natural gas constituents (*e.g.*, methane, carbon dioxide, nitrogen and hydrogen sulphide) are below effect concentrations (Howard and Meylan 1997). The probability of a pipeline break is considered very low (refer to Section 3.4).

Summary

Releases containing condensate (*i.e.*, blowouts) or H_2S (injection well blowout) can have relatively widespread adverse effects on VECs potentially affected by reduced water quality (*i.e.*, fish, birds, marine mammals, benthos). However, given the widely distributed nature of VECs in the platform area, the ability of many species to detect and avoid areas of lowered water quality, and likely limited probability and duration of a major release, it is unlikely that VECs will be significantly affected at a population level. Significant adverse effects on VECs that rely on water quality due to malfunctions or accidental events are not considered likely; significant adverse residual effects on water quality are thus also not predicted.

6.3.2.5 Cumulative Effects Assessment

Past and existing projects and activities have, to varying degrees, affected marine water quality on the Scotian Shelf. These include domestic and international vessel traffic, oil and gas exploration and production, and fishing activity. The effects of these other past and present activities are reflected in the description of the existing (baseline) water quality conditions (described in Section 6.1). The existing data for the Project area do not indicate any particular water quality concerns, though occasional events, such as illegal discharges from passing vessels have been reported offshore Nova Scotia.

On-going and future projects and activities in the region which may affect marine water quality include: vessel traffic; the SOEP (existing and future development); offshore petroleum exploration drilling activity and seismic exploration; commercial fishing; and potentially, the future Blue Atlantic, Neptune and Hudson Energy projects. A number of these project activities have or would have similar discharges to the marine environment as the proposed Project, and thus, similar effects on marine water quality. Like the Deep Panuke Project, these other projects and activities will, however, also be subject to specific guidelines and regulations to prevent and minimize their environmental effects. These guidelines and regulations are regularly reviewed and refined to provide ever-increasing protection to the marine environment. In addition, developers are applying new methods and technology to reduce the potential for potential effects on the environment. The potential effects of the Deep Panuke Project on marine water quality are likely to be minor, localized and of relatively short-term duration. Given the widespread spatial and temporal distribution of these future projects and activities, there is limited potential for the effects of these actions to interact with those of the proposed Project. It is therefore not likely that the Deep Panuke Project will result in significant cumulative environmental effects in combination with other projects and activities.

6.3.2.6 Follow-up and Monitoring

Environmental compliance monitoring (ECM) for marine discharges, including toxicity testing of species deemed appropriate by Environment Canada, will be conducted to verify adherence to applicable regulatory requirements and conditions of approval. ECM will primarily involve monitoring for conformance with the discharge limits specified in the OWTG (NEB *et al.* 1996, and updates). The ECM program will be specified in the EPP to be developed by EnCana. EEM for water quality will be undertaken as required and in consultation with regulators. Implementation of ECM will provide early identification of regulatory exceedences to EnCana and regulators (through required reporting), and allow for prompt remedial action. At a minimum, this will include monitoring of water quality after a significant spill, in conjunction with monitoring of various biological components (*e.g.*, birds, fish). The EEM program will be specified in an EEM Plan to be developed by EnCana. EEM will help detect any adverse effects on environmental receptors due to reduced water quality. This may include the monitoring of environmental receptors (*e.g.*, marine biota) which may be affected by Project related changes in marine water quality. These plans will become part of EnCana's overall environmental management planning structure (refer to Section 4).

6.3.2.7 Sustainable Use of Renewable Resources

No significant adverse residual environmental effects on marine water quality are predicted; therefore, further assessment regarding sustainable use of renewable resources is not required.

6.3.2.8 Summary of Residual Environmental Effects Assessment

Project construction, operation, and decommissioning activities are not predicted to have a significant residual effect on marine water quality. Malfunctions/accidents, specifically those related to well blowouts and pipeline ruptures would have an effect on marine water quality, but the effects on VECs dependant on water quality are not likely to be significant. EnCana's design prevention measures and AERCP and Spill Response Plan will reduce the probability of accidental releases and minimize environmental effects. The proposed Project is therefore not likely to result in a significant adverse effect on marine water quality. Tables 6.28 and 6.29 summarize the residual environmental effects on marine water quality.

Table 6.28 Residual Environmental Effects Assessment Matrix: Marine Water Quality

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effect	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/ Social-cultural and Economic Context		
CONSTRUCTION									
Infrastructure installation (pipelines, platforms)	• Sedimentation (A)	• Efficient installation with minimal seabed disturbance (including prefabrication onshore) • Use of silt curtains during nearshore dredging (if required)	1	2	3/3	R	2	N	3
Hydrostatic Testing	• Discharge may contain biocides, oxygen scavengers, and corrosion inhibitors (A)	• Bioassay and plume dispersion modeling • Controlled discharge at platform diluted with cooling water	2	2	1/1	R	2	N	3
Development Drilling	• Increased SPM (A)	• Management of drill waste to minimize discharges • No ocean discharge of SBM/EMOBM • Reduced disposal of bulk WBM through batch drilling • Compliance with CNSOPB disposal requirements • Adherence to Offshore Chemical Selection Guidelines and CMP	2	2	3/6	R	2	N	3

Table 6.28 Residual Environmental Effects Assessment Matrix: Marine Water Quality

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effect	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/ Social-cultural and Economic Context		
Vessel Traffic	• Water quality degradation associated with bilge and ballast discharges (A)	• Compliance with applicable legislation and regulations • Adherence to WMP	1	5	5/6	R	2	N	3
Onshore Construction	• Sedimentation of nearshore waters (A)	• Adherence to the Onshore Construction EPP • Compliance with DFO and NSDEL guidelines	1	2	2/1	R	2	N	3
OPERATION									
Produced Water	• Water quality degradation (A)	• Treatment / testing to meet or exceed OWTG • Dilution of treated produced water with cooling water	2	2	5/6	R	2	N	3
Other Project-related discharges (*e.g.*, deck drainage, sewage, cooling water, etc.).	• Discharge to marine environment (A)	• Treatment in accordance with OWTG • Adherence to WMP	1	2	2/6	R	2	N	3
Vessel Traffic	• Water quality degradation associated with bilge and ballast discharges (A)	• Compliance with applicable regulatory requirements • Adherence to WMP	1	5	5/6	R	2	N	3

Table 6.28 Residual Environmental Effects Assessment Matrix: Marine Water Quality

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effect	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/ Social-cultural and Economic Context		
MALFUNCTIONS AND ACCIDENTS									
Well Blowout	• Release of hydrocarbons from development well and injection well (A) • Release of H_2S from injection well (A)	• Design measures (*e.g.*, BOP and SC-SSSV) • Implement AERCP and Spill Response Plan	3	2	2/0	R	2	N	3
Pipeline Rupture	• Release of methane (A)	• Pipeline design to codes/standards • Design and installation to maintain pipeline integrity (*e.g.*, scour protection, "trawler-proof", burial in depth less than 85 m) • Leak detection and shut off valves • Implement AERCP	2	2	1/0	R	2	N	3
Platform Spills	• Release of hydrocarbons (A)	• Design prevention (*e.g.*, secondary containment, oil/water separation) • Spill prevention procedures/training • Spill monitoring and reporting • Implement AERCP and Spill Response Plan	1	2	1/1	R	2	N	3

Table 6.28 Residual Environmental Effects Assessment Matrix: Marine Water Quality

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effect	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/ Social-cultural and Economic Context		

KEY

Magnitude: 1 = Low (*e.g.*, undetectable or negligible change to existing conditions) ; 2 = Medium (*e.g.*, increase but within standards and objectives; 3 = High (*e.g.*, causing exceedances or impingement upon standards and objectives).
Geographic Extent: 1=<500 m^2; 2=500 m^2 – 1 km^2; 3=1-10 km^2; 4=11-100 km^2; 5=101-1000 km^2; 6=>1000km^2
Duration: 0 = highly unlikely; 1=<1month; 2=1-12 months; 3=13-36 months; 4=37-72 months; 5=>72 months
Frequency: 0= unlikely to occur; 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: R = Reversible; I = Irreversible
Ecological/Socio-cultural and Economic Context: 1=Pristine area; 2 = Area affected by human activity; 3 = Evidence of adverse effects
Residual Environmental Effect Rating: S=Significant Adverse Environmental Effect; N=Nonsignificant Adverse Environmental Effect; P=Positive Environmental Effect
Confidence: 1=Low level of confidence; 2=Medium level of confidence; 3=High level of confidence

Table 6.29 Residual Environmental Effects Summary: Marine Water Quality (All phases)			
Phase	**Residual Environmental Effect Rating**	**Likelihood of Significant Adverse Effects**	
		Probability of Occurrence	**Scientific Uncertainty**
Construction	N	N/A	N/A
Operation	N	N/A	N/A
Decommissioning	N	N/A	N/A
Malfunctions and Accidents	N	N/A	N/A

KEY

Residual Effects Rating: S=Significant Adverse Environmental Effect; N=Non-significant Adverse Environmental Effect; P=Positive Environmental Effect
Probability of Occurrence: Based on professional judgement; 1 = Low; 2 = Medium; 3 = High; N/A = Not applicable (effect is not predicted to be significant)
Scientific Uncertainty: Based on scientific information and statistical analysis or professional judgement; 1 = Low level of confidence; 2 = Medium level of confidence; 3 = High level of confidence; N/A = Not applicable (effect is not predicted to be significant)

6.3.3 Marine Benthos

The marine benthic community is important as a component of the marine ecosystem and also in its connection to commercial fisheries. Environmental effects on benthic fauna may affect the success of finfish and/or shellfish populations in the area. Project discharges may affect benthic habitat and communities on the seabed through deposition of drill cuttings and muds, disturbance of sediments from pipeline installation, and discharge of produced water or hydrocarbons during an accidental event. Resulting changes in sediment quality may affect the quality of habitat for demersal fish species, benthic communities, and commercial species that feed on them. Organic and inorganic contaminants, if present in sediments, may be ingested by benthic organisms or become biologically available if re-suspended into the water column. Presence of pipeline infrastructure on the seabed, as well as the platforms, may also have implications on benthic habitat. Discussions of potential impacts on marine fish are found in Section 6.3.4. Discussions of potential effects on fisheries are found in Section 7.3 and the SEIS (DPA Volume 5). Marine benthos was identified as a VEC based on regulatory and public concern, and professional experience with other petroleum industry projects.

6.3.3.1 Boundaries

The spatial boundaries for the assessment of marine benthos are based on: experience in similar project environments; sediment sampling; sediment dispersion modeling; and, video observations. These boundaries contain a near-field component (*i.e.*, 500 m from platforms) to accommodate potential acute effects such as smothering of benthic organisms, and a far-field component (*i.e.*, 10 km) to accommodate transport of lower concentrations of SPM in the benthic boundary layer. A spatial boundary of 2 km wide has been assigned to the pipeline corridor (zone of influence for anchor locations and cables, if applicable). The temporal boundaries of the assessment are continuous until cessation of the discharges from well development, completion of pipeline installation, and recovery to background conditions. For the case of infrastructure presence in the marine environment, the temporal boundary includes the operational period of the Project and thereafter until the structures are removed.

6.3.3.2 Residual Environmental Effects Evaluation Criteria

A **significant** adverse environmental effect is one that alters valued benthic habitat either physically, chemically, or biologically, in quality or extent, to such a degree that there is a decline in abundance and/or change in composition and distribution of the benthic community beyond which natural recruitment (reproduction and immigration from unaffected areas) would not return that community to its former level of diversity within five years following cessation of Project activities that could interact with the benthos (*i.e.*, pipeline installation, discharge of WBM drill waste).

A **positive** effect may enhance habitat quality or quantity or increase species diversity.

6.3.3.3 Potential Interactions, Issues, and Concerns

Benthic macroinvertebrate organisms live and feed on the seafloor. Because most of these organisms are sedentary or sessile and feed upon particulates raining down through the water column (suspension feeders) or directly upon the sediments (deposit feeders), they can be vulnerable to contaminant accumulation and high suspended particulate loads.

Potential issues and concerns related to marine benthos include:

- displacement and smothering of benthic organisms directly within the footprint area and adjacent areas of sediment deposition during pipeline installation;
- disturbance to the benthos and benthic communities during nearshore blasting, if applicable;
- disturbance to the benthos from pipeline anchors and cables, if applicable;
- smothering of benthic communities from deposition of drill cuttings/drilling muds during well development;
- change in biodiversity from organic enrichment or toxicity from drilling muds;
- change in sediment particle size distribution or physical nature of the sediments due to deposition of drill cuttings/drilling muds during well development;

- contaminant uptake by benthic organisms as a result of drill mud/cuttings and produced water disposal;
- the presence of structures and unburied or settled pipelines may affect movement of benthic invertebrates and increase hard substrate habitat (colonized by local flora and fauna) in otherwise barren sandy or soft bottom areas;
- platforms may attract fish which in turn may increase predation pressure on the benthic community; and
- in the unlikely event of an accidental blowout or pipeline rupture, contamination of the benthos at the point of the breach through adherence of hydrocarbons to particulate matter.

6.3.3.4 Analysis, Mitigation and Residual Environmental Effects

Construction

Installation of Structures

Project interactions with nearshore and offshore benthic habitat and communities will occur during the construction phase. Physical disruption and alteration, of the seabed will occur as a result of placement of the structures on the substrate (*i.e.*, platform legs and pipeline footprints). These activities will displace a limited number of benthic organisms. Settling of suspended sediments may alter habitat adjacent to seabed disturbances. These effects are considered reversible, as disturbed areas will soon recolonize. The species expected to be affected in the intertidal and shallow subtidal zone by landfall trenching include: *Fucus vesiculosis*, *Laminaria* spp., blue mussels, *Corallina officinalis*, barnacles, amphipods, isopods, periwinkles, and sea stars. These are all species ubiquitous to the coastal rocky intertidal zone.

The installation of platforms and pipelines is not anticipated to change sediment chemistry. Trenching the subsea pipeline in shallow water may temporarily alter sediment grain size; however, conditions should revert back to those naturally occurring within months through sediment transport processes. It is predicted that the zone of influence on marine benthos due to trenching activities will be approximately 20 m wide (10 m on either side of the pipeline).

If an anchored pipelay vessel is used, there will be additional disturbance to the marine benthos associated with anchor placement and cable movement. The zone of influence for these effects are limited to 1 km on either side of the pipelay vessel. A maximum of 5 % of the total area within the 2 km wide corridor may be disturbed by anchor handling activities. This disturbance will be reduced through application of an anchor handling plan. Elements of this plan could include: anchor placement to avoid sensitive areas where practical (*e.g.*, inshore lobster and scallop habitat); use of midline cable buoys to reduce the length of cable on the seafloor in sensitive areas where complete avoidance is not practical; and reduction of number of anchors deployed where operating conditions allow. Effects from anchor handling activities will be localized and temporary. Recovery of disturbed benthic communities is predicted to take less than five years and will be assessed as part of an EEM program. No significant effects are predicted from subsea pipeline installation.

Permanent benchmark sites established for the nearshore SOEP EEM demonstrated no change in bottom conditions throughout Stormont Bay from trenching-related activities and that seafloor material typically did not move outside the immediate area of the pipeline route (SEEMAG 2001a). Detailed EEM surveys conducted in the nearshore from shoreline to 1000 m seaward showed kelp and other seaweeds reestablishing shortly after pipeline installation (SEEMAG 2001b). Marine plant life and bottom dwellers recolonized and moved back into disturbed areas. Full recovery of habitat over the pipeline took up to three years. A widespread die-off of sea urchin along the eastern shore over the post construction period was attributable to factors other than construction of the pipeline (Li and Cormick 1982; Scheibling and Hennigar 1997; SEEMAG 2001b).

Blasting, if required, will be conducted within 300 to 500 m of the shoreline and in accordance with the Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters (Wright and Hopky 1998). Keevin and Hempton (1997) have reviewed the environmental effects of underwater blasting. The results of all studies reviewed indicated that invertebrates are insensitive to pressure related damage from underwater explosions (apart from direct exposure to pressure wave). This may be attributed to the fact that invertebrates lack a gas containing organ(s). Toxic gaseous by-products of explosions are chiefly carbon monoxide and nitrous/nitric oxides of the detonation reaction. The selection of blasting compound is important since certain compounds produce insignificant toxic gas production and, consequently, little, if any detrimental effect to the environment. No interaction with the nearshore marine benthos is predicted if directional drilling is used to install the pipeline in the nearshore.

No significant adverse effects on the marine benthos are likely to result from pipeline or platform installation, as habitat disturbances will be localized and temporary during construction, and it is anticipated that benthic communities will colonize exposed structures over one to several seasons. Physical effects on the marine benthos will be minimized during construction through the prefabrication of the majority of structures onshore, and topside on the barge. A seabed debris survey will be conducted prior to pipeline and platform installation to provide further data to mitigate effects on marine communities near Project facilities. EnCana will consult with DFO and Environment Canada on HADD and Disposal at Sea permits once engineering design and installation methods have been finalized.

Development Drilling

No SBM or EMOBM and associated cuttings will be discharged to the marine environment during development drilling for the Project. WBM and associated cuttings will be discharged overboard as is permitted by the OWTG (NEB *et al.* 1996, and updates). Bulk releases of WBM will be minimized by batch drilling to the extent possible. Drill waste dispersion modeling presented in the EIS (DPA Volume 4) has been updated below, to reflect the latest worst case drilling scenario, drilling eight wells and using WBM for all hole sections.

WBM cuttings will be released, more or less continuously, from the surface after processing during the drilling phase. Water based cuttings are expected to be in the coarse to fine sand size range with settling rates in the range of 0.3 m/s to 0.03 m/s. Because the discharge rate is low on average, only the dynamic settling of individual particles need be considered.

It is estimated that 412 m^3 of cuttings particles will be generated from each of the six production wells and the additional "contingency" well, plus 270 m^3 from the injection well, for a total volume of 3,154 m^3. The distribution of this material on the bottom will be determined primarily by the advection caused by currents during decent of the particles. Based on the settling rates given above, and a site depth of 40 m, the settling time of particles in the water column will be from 130 to 1300 seconds. The current regime is dominated by tides, which constitute about 90% of the total energy. Tidal currents rotate clockwise and range in strength from about 10 cm/s to about 35 cm/s over the monthly spring/neap cycle. Average tidal current speed is about 25 cm/s. Based on the average tidal current and range of particle settling times, the deposition area will extend to a distance of about 32 m for the fastest settling particles and to about 320 m for the slowest settling particles. On occasion, wind generated currents will oppose the tide with the result that the current will diminish to zero so that material will also be deposited directly below the discharge pipe.

Given the variables involved, it is reasonable for assessment purposes to assume that the material forms a cone with a base radius determined by the range of particle settling rates and average tidal current. This results in a range in base radius of 32 m to 320 m. Smothering of benthic organisms can result if the thickness of the cuttings layer exceeds 1 cm (Bakke *et al.* 1989). If the radius is 32 m, the cuttings mound could attain a maximum height of 2 m under the discharge pipe. The area affected by deposition in excess of 1 cm would extend nearly to the edge of the cone (32 m) (0.32 ha). In the latter case, the maximum height of the mound would be 2 cm and the area of deposition in excess of 1 cm would extend to 160 m, covering an area of approximately 8.04 ha.

Cuttings piles associated with SOEP are lasting longer than predicted as the NovaPlus SBM cuttings are cohesive (SEEMAG 2001b). WBM cuttings do not have that characteristic. Generally, deposits from SOEP have been much smaller and thinner than predicted (500 m), observable within 70-100 m of the platforms (SEEMAG 2001b; 2000a). The cuttings pile at Venture is no longer present following two years cessation of drilling discharges of SBM cuttings. The Thebaud SBM cuttings pile reduces in size annually. Site surveys of drill waste related to the Cohasset Project have indicated that cuttings piles were not evident more than 50 m from the Cohasset and Panuke platforms, or Well H-08 several months following drilling.

In the dynamic and energetic environment of the Sable Bank, WBM cuttings piles from the Project are not expected to persist for more than a year. Experience at other sites in eastern Canada (Hurley 2000; Taylor 2000) shows that WBM discharged cuttings and muds were dispersed by wave action and currents. Following dissipation of the cuttings pile, the benthic community is expected to recover within a further 2 to 3 years through reproduction and migration from other areas.

No permanent change in grain size has been observed at any of the Atlantic Canadian offshore petroleum projects outside of the nearfield (100 m) area. The post drilling monitoring program conducted in 1993 for the Cohasset Project did not show evidence of an adverse effect on benthos biomass or diversity, nor was there an apparent change in sediment grain size in the vicinity of, or directly adjacent, to the rig (John Parsons & Associates 1994).

WBM will be released typically in a bulk discharge when mud types are changed. For the six production wells and the additional "contingency" well, there should be a one-time release of WBM of 1075 m^3 per well. The discharge for the injection well will be 685 m^3. The total volume of WBM released over the well development phase is estimated at 8,210 m^3.

The generic assessment for exploration drilling (Thomson *et al.* 2000) showed that a bulk release of WBM creates a turbulent plume which will sink to a level of neutral density in sufficiently deep water. Model results by Andrade and Loder (1997) for the Cohasset Project indicated that the plume reaches the seafloor when the currents are low (<0.085 m/s) for all mud densities and conditions of stratification except when mud densities are low and stratification is strong. In all cases with typical mud densities, the plume will reach the lower third of the water column, thus interacting with the seafloor.

The basis of WBM modeling is that WBM can remain in a dynamic benthic boundary layer, the thickness of which can range from metres to tens of metres, depending on ambient currents (Hannah *et* *al.* 1995). The boundary layer model is complex; the modeling is further complicated by the fact that, while most of the particles in WBM are small (< 50 µm), they tend to flocculate when discharged in seawater, potentially increasing the settling velocity of the particles by 1-2 orders of magnitude (Gordon *et al*. 2000).

A recent comprehensive treatment of boundary layer dynamics (Thomson *et al.* 2000) focused on WBM releases at several Scotian Shelf sites including Sable Bank. Modeling results for the Sable Bank site showed that peak mud concentrations of 10 mg/L could persist in the boundary layer for several days and peak levels of 1 mg/L could persist for a 10-day period. The area of the bottom affected was shown to have a typical radius of up to approximately 10 km. The location of the center of this area will be advected by tidal and mean currents and can vary with season, spring/neap cycle, etc.

Laboratory research subjecting scallops to chronic exposure (24-72 days) of WBM indicated the following effects.

- A WBM can cause low mortality at concentrations between 0.5 and 10 mg/L (Cranford *et al.* 1999).
- Exposure of scallops to barite in suspended particulate matter (SPM) at low concentrations of 0.5 mg/L caused sublethal effects (cessation of gonad growth) (Cranford and Grant 1990).
- Bentonite concentrations of 1 mg/L were shown to cause sublethal effects on scallops (Cranford and Grant 1990).
- Scallop growth was enhanced by a mixture of WBM and fine cuttings particles at concentrations <10 mg/L due to increased food availability from adsorbed organic matter onto the particles (Cranford *et al.* 1999).

As reported by Gordon *et al.* (2000), no effects on Atlantic sea scallops growth were observed at mud concentrations (bentonite) of 2 mg/L or less, however the "no effects" concentration for barite was estimated to be 0.1 mg/L. These effects were noted based on laboratory trials of 24 to 72 days exposure to WBM. DFO catch and effort data (1996-2000) show some records of scallop catch within 12.5 km from the Deep Panuke site, however large concentrations of scallop beds are located approximately 35 km from the site. No interaction between WBM and commercial concentrations of scallops is anticipated. Lobster and snow crab, which are not filter-feeders, are not common in the shallow sandy sediment of the Deep Panuke area of the Sable Island Bank and are therefore not likely to be affected by discharges of WBM and associated cuttings. No significant adverse effects on the benthic habitat is likely to result from the short duration (worst case of 10 days) of exposure to a bulk release of WBM. This is consistent with EEM observations for the SOEP and Cohasset Project. No effects were noted from WBM discharges related to the SOEP over a three year period (Hurley 2000). On only one occasion was a drill mud plume detected with elevated SPM at 10 m depth, 500 m from the platform

(SEEMAG 1999a). It was therefore concluded that the effects of the WBM discharges did not extend beyond 500 m of the platforms.

At the end of the drilling program, 300 m^3 of completion fluid (for each well) will be pumped to the surface and discharged as a bulk release. This fluid is composed of filtered seawater or freshwater, which may have some added biocide, oxygen scavenger and corrosion inhibitors. Given its near neutral density, it will remain on, or near, the sea surface and is not predicted to impact the benthic community.

No significant adverse environmental effects are therefore predicted on the marine benthos due to Project construction and drilling activities. Further detail on drill waste discharges is found in Section 2.5.4

Operation

Presence of Structures

While the physical presence of Project infrastructure (platforms, protective mattresses, and pipelines) will create a long-term alteration of benthic habitat, the areas will recolonize with local species within one to three years (Scarratt 1968). Concrete mattresses and rocks used to stabilize the pipeline will provide a hard stable substrate that creates benthic habitat in what is otherwise a predominantly sandy mobile environment. These hard surfaces will be colonized by a variety of local marine flora and fauna (creating a "reef" effect). Such an effect was noted on the existing Panuke and SOEP platforms. In particular, EEM surveys of the protective mattresses at Thebaud, Venture and North Triumph show mattresses have been colonized by seaweed, sea cucumbers, snow crabs, Jonah crabs, mussels and fish (SEEMAG 2001a; 2001b). Underwater video surveys around SOEP platforms showed juvenile gadoids, blue mussels and crabs (SEEMAG 2001b). Flounders, sculpins, hermit crabs and Jonah crab were observed on the seafloor in association with mussels which sloughed off the Panuke platform. Species observed to colonize the SOEP pipeline one year after installation included starfish, sea urchins and sea anemones (SEEMAG 2001b). Project structures also create niches on the seafloor and water column in which juvenile demersal and pelagic species can find refuge. This reef effect is anticipated to have a minor positive effect on the benthic community in the Project area. The positive reef and refuge effect associated with the platform structures may be temporarily offset by a localized reduction in sediment quality from WBM discharges.

With regard to concerns of interference of crustacean migration due to the presence of the subsea pipeline, it is anticipated that lobsters and other crustacea will be able to navigate unburied portions of the subsea pipeline. American lobsters have well developed walking legs that also afford great agility in climbing, especially over relatively smooth surfaces such as rock faces in canyon environments. In addition, American lobsters exhibit abdominal flexing which raises the individual off the bottom and propels it through the water column. This flexing may extend for several seconds and propel the lobster in excess of three metres (Scrivener 1971). Concrete coating on the subsea pipeline provides a rough surface which would aid movement of lobster on the pipe. The colonization of the pipeline by other benthic organisms will also increase the roughness of the pipe surface, thereby further facilitating the capability of crustaceans to climb over the pipe. Crab species (including snow crabs) were observed on and along sides of the SOEP pipeline (SEEMAG 2001b) and lobsters have been observed in underwater video negotiating a large diameter subsea discharge pipe for another industrial project (Abitibi-Price 1990). Considering these factors, it is highly unlikely that the proposed subsea pipeline, where unburied, would constitute a significant concern as a physical barrier to migration of crustaceans on the Scotian Shelf.

Concerns have also been identified that noise produced by the subsea pipeline could result in avoidance by crustaceans. Background noise on the Scotian Shelf is strongest at low frequencies, between 50 and 100 Hz (refer to Table 2.7 for typical underwater noise levels for ambient and human generated noise). Detection of such low frequency sound levels by crustacea, such as lobsters and crabs, is not well defined. American lobster, for example, have no specific hearing organs and hearing has not been demonstrated (Cohen and Dijkgraaf 1961); yet this species can detect pressure waves (Offutt 1970). In addition, there is no documented evidence to indicate that chronic low frequency sound induces attraction or avoidance behavior in crustacea, such as crabs or lobsters. Low frequency sound produced within a subsea pipeline is caused by turbulent flow within the pipe. The degree to which this sound would be transferred to the surrounding water and propagate through the water would, in part, be a function of the pressure within the pipe, and pipe diameter, wall thickness and coating. Any external coating or covering of the pipe would further reduce the propagation of low frequency sound. In addition, low frequency sound attenuates rapidly in shallow water (< 50 m) where water depth is shallow relative to wavelength. Considering all of the above factors, the low frequency sound that reaches the surrounding water as a result of turbulent flow within a subsea pipeline, would likely be less than that of background noise levels; it is therefore unlikely to be noticed by crustaceans.

Routine Operational Discharges

Operational discharges generated at the offshore platforms, including produced water, will not significantly affect benthic communities, as they will be treated to comply with the OWTG (NEB *et al.* 1996, and updates), and quantities reaching the seafloor will be negligible, if any (refer to Appendix C for discharge modeling results). Effects of produced water on pelagic eggs and larvae are discussed further in Section 6.3.4.4. While there have been studies on the effects of produced water on pelagic larvae of benthic species (*e.g.*, Raimondi and Schmitt 1992; Krause *et al.* 1992), it is anticipated that these effects would be similar to those predicted for early life stages of pelagic species (*i.e.*, not significant at a population level). It is possible that particles (*e.g.*, trace metals) may separate from the discharge and sink to the benthic boundary layer (Lee 2000), however, this complex pathway is a subject of scientific debate and has not been modeled for this assessment. Modeling shows that produced water discharges will be diluted 500 to 1000 times within the first 20 m from the effluent pipe. This is consistent with monitoring results from SOEP. Produced water was not detected within the immediate vicinity of the discharge caisson (SEEMAG 2001b). Contaminant uptake is therefore not considered to be an issue for marine benthos.

Research is being conducted through the Program of Energy Research and Development (PERD) to investigate the impacts of produced water discharges in the Atlantic Region. EnCana will review results of produced water studies and adapt their EEM program as appropriate.

Based on the above discussion, there are not likely to be any significant adverse environmental effects on the marine benthos from the presence and operation of the Project.

Decommissioning

Decommissioning activities are not expected to interact with the benthic environment, except where structures above the seafloor are removed. In this case, there may be some temporary disruption of sediments and disturbance to organisms. These effects would be similar to the effects of construction. Any reef or refuge effects would be reversed once facilities are removed. No significant adverse environmental effects from decommissioning are predicted.

Malfunctions and Accidents

Any effects on the benthos in the unlikely event of a spill or blowout from a platform would be localized near the area of release, as the raw gas (including condensate) is buoyant and would rise in the water column (refer to Section 3.5.2). Market-ready gas in the pipeline to shore would also rise to the surface in the event of a pipeline break. Any localized effect on the benthos would recover through recolonization by local species. Potential adverse effects of malfunctions and accidents on the marine benthos are not considered to be significant.

6.3.3.5 Cumulative Effects Assessment

Projects and activities in the study area that may interact cumulatively with marine benthos include past and present offshore platforms (Cohasset Project and SOEP), the SOEP pipeline, exploration drilling associated with offshore petroleum exploration and commercial fishing. While it is anticipated that marine benthos may be subject to incremental effects from future exploration activities in the study area, it is not anticipated that ongoing or future projects along the Scotian Shelf edge (including the proposed Blue Atlantic, and Hudson Energy projects) will contribute to cumulative effects.

Land-based sources of pollution were considered as a potential contribution to cumulative effects on benthos, particularly in the nearshore. Results of a survey completed for EnCana in 2001, however, found that in the nearshore Goldboro area, with the exception of one sample, the petroleum hydrocarbon concentrations were under the laboratory detection limit. This survey also found no evidence of contaminated sediments from old mine tailings, reported to possibly occur in the area.

Based on ongoing monitoring programs at SOEP, it is unlikely that any adverse effects due to construction or operation of the SOEP could interact cumulatively with Deep Panuke. The distance between the SOEP and Deep Panuke platforms (45 km to Thebaud and 23 km to the future platform at Alma) will further reduce the likelihood of cumulative effects on marine benthos. Similarly, no significant adverse effects on the benthos have been observed from the installation and presence of the SOEP pipeline, and none are anticipated with the Deep Panuke pipeline; therefore, no significant cumulative effects on benthos from the presence of the two pipelines are predicted.

Exploration drilling activities are generally short term (60 to 90 days) in any one area, are localized and not likely to result in significant effects on marine benthos. In addition to the temporary, localized nature of exploration drilling, the potential for cumulative effects with Deep Panuke are further limited by the widely dispersed nature of these activities and lack of spatial and temporal overlap. Previous development and exploration drilling for the Cohasset Project and Deep Panuke are concentrated closely within the immediate Project area and monitoring has indicated that benthic communities have for the most part returned to their pre-drilling state. Since localized disturbances of the benthos from the current Project are expected to be temporary (one to three years), there is no significant cumulative effect anticipated with regard to past drill waste discharges. Future exploration drilling conducted by EnCana within the Panuke licence will have similar effects as those of the proposed development drilling program and no significant cumulative effects are anticipated.

In conclusion, there is currently no evidence of incremental degradation of benthic communities from oil and gas activities on the Scotian Shelf. Effects from discharges, as evidenced from EEM results, have been relatively localized, temporary and unlikely to overlap spatially or temporally with other projects. EEM conducted for the Deep Panuke Project (including baseline monitoring) has, and will continue, to provide information that will (in conjunction with monitoring data from other projects), begin to detect any widespread, incremental environmental changes. The EEM will detect and assess Project-induced changes in the environment, providing essential feedback to operational managers who can effect any necessary modifications to operational activities or emissions.

Messieh *et al.* (1991) reported that fishing boats have trawled or dredged 4.3 million square km of seabed on the eastern Canadian seaboard from 1985 to 1991. In this context, effects on benthos from drilling operations would result in negligible increases to the perturbation that already exists.

6.3.3.6 Follow-up and Monitoring

EnCana will include benthic habitat/community and sediment quality monitoring in the EEM program to be designed in consultation with stakeholders and the relevant regulatory authorities for both the nearshore and offshore regions. This program, which will be developed based on experience from the Cohasset Project and SOEP EEM programs will include potential toxicity, fate, and environmental effects of WBM and associated cuttings. EnCana will continue to support research initiatives related to the ecological risk of discharges of WBM and associated cuttings and will review the results of the research as they become available. Follow-up programs and mitigation will be adapted as necessary to reflect results of this research. A seabed debris survey will be conducted prior to pipeline and platform installation to provide further data to mitigate effects on marine communities near Project facilities. During ROV inspection of the BOP and riser installation, a survey of the seafloor around the well site for a cuttings mound will verify the prediction of likely effects. Mud logs will be reviewed to verify the volume of mud and cuttings discharged. Colonization of the exposed pipeline will be assessed during a pipeline monitoring survey.

6.3.3.7 Sustainable Use of Renewable Resources

No significant adverse residual environmental effects on benthic habitat are predicted, therefore, further assessment regarding sustainable use of renewable resources is not required.

6.3.3.8 Summary of Residual Environmental Effects

Due to the reversibility and limited duration, magnitude, and geographic extent of the potential adverse environmental effects, including cumulative effects, associated with the Project, no significant adverse residual environmental effects for marine benthos are predicted. A minor positive effect is predicted with regard to the addition of hard substrate associated with the platform structure and unburied portion of the pipeline creating a reef effect. The positive reef and refuge effect associated with the platform structures may be temporarily offset by a localized reduction in sediment quality from WBM discharges. Tables 6.30 and 6.31 summarize the residual environmental effects on marine benthos.

Table 6.30 Residual Environmental Effects Assessment Matrix: Marine Benthos

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects: Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/ Social-cultural and Economic Context	Residual Environmental Effect	Level of Confidence
CONSTRUCTION									
Offshore platforms installation	• Benthic disturbance and sedimentation (A) • Habitat alteration (A)	• Prefabricate onshore and topside • Efficient installation with minimal seabed disturbance (including seabed debris survey)	1	2	2/6	R	2	N	3
Subsea pipeline installation	• Benthic disturbance and sedimentation (A) • Habitat alteration (A)	• Efficient installation with minimal seabed disturbance (including seabed debris survey) • Adherence to Guidelines for Use of Explosives in or Near Canadian Fisheries Waters and General Blasting Regulations • Implementation of anchor handling plan • Use of silt curtains during nearshore dredging (if required)	1	3	2/6	R	2	N	3
Development drilling	• Discharge of drill waste to displace benthic communities (A)	• No ocean discharge of SBM/EMOBM • Reduce disposal of bulk WBM through batch drilling • Compliance with CNSOPB disposal requirements	2	2	3/6	R	2	N	3

Table 6.30 Residual Environmental Effects Assessment Matrix: Marine Benthos

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effect	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/ Social-cultural and Economic Context		
OPERATION									
Presence of structures	• Habitat loss / alteration (A)	• Minimize footprints of infrastructure	2	4	5/6	R	2	N	3
	• Artificial reef effect and substrate (P)	• No mitigation necessary	2	4	5/6	R	2	P	3
MALFUNCTIONS AND ACCIDENTS									
Well blowout or pipeline rupture	• Disturb benthic habitat in immediate area of subsea blowout or pipeline rupture (A)	• Prevention • Implement AERCP and Spill Response Plan	2	1	1/0	R	2	N	3

KEY

Magnitude: 1= Low: *e.g.*, specific group or habitat, localized, one generation or less, within natural variation; 2 = Medium: *e.g.*, portion of a population or habitat, 1 or 2 generations, rapid and unpredictable change, temporarily outside range of natural variability; 3 = High: *e.g.*, affecting a whole stock, population or habitat outside the range of natural variation.
Geographic Extent: 1=<500 m^2; 2=500 m^2 – 1 km^2; 3=1-10 km^2; 4=11-100 km^2; 5=101-1000 km^2; 6=>1000km^2
Duration: 1=<1month; 2=1-12 months; 3=13-36 months; 4=37-72 months; 5=>72 months
Frequency: 0= unlikely to occur; 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: R=Reversible; I=Irreversible
Ecological/Socio-cultural and Economic Context: 1=Pristine area; 2= Area affected by human activity; 3=Evidence of adverse effects
Residual Environmental Effect Rating: S=Significant Adverse Environmental Effect; N=Nonsignificant Adverse Environmental Effect; P=Positive Environmental Effect
Confidence: 1=Low level of confidence; 2=Medium level of confidence; 3=High level of confidence

Table 6.31 Residual Environmental Effects Summary: Marine Benthos (All phases)			
Phase	Residual Environmental Effect Rating	Likelihood of Significant Adverse Effects	
		Probability of Occurrence	Scientific Uncertainty
Construction	N	N/A	N/A
Operation	N/P	N/A	N/A
Decommissioning	N	N/A	N/A
Malfunctions and Accidents	N	N/A	N/A

KEY

Residual Effects Rating: S=Significant Adverse Environmental Effect; N=Non-significant Adverse Environmental Effect; P=Positive Environmental Effect
Probability of Occurrence: Based on professional judgement; 1 = Low; 2 = Medium; 3 = High; N/A = Not applicable (effect is not predicted to be significant)
Scientific Uncertainty: Based on scientific information and statistical analysis or professional judgement; 1 = Low level of confidence; 2 = Medium level of confidence; 3 = High level of confidence; N/A = Not applicable (effect is not predicted to be significant)

6.3.4 Marine Fish

6.3.4.1 Boundaries

Interactions between marine fish and Project activities may occur at any time of the year, though different species and life cycle components vary seasonally. For example, eggs and larvae are most abundant during the summer and fall, but juveniles and adults of those same species are present year-round. The temporal boundaries for this assessment include the construction, operation and decommissioning phases of the Project.

Spatial boundaries for the assessment of marine fish are generally determined by the stock boundaries, representing the area within which a population is self-sustaining. The stock boundaries of many species considered in this assessment fall roughly within NAFO Division 4W, but may extend to the broader North Atlantic for migratory species such as tunas. Fish, including eggs and larvae, are also distributed spatially within different levels of the water column, ranging from the thin surface layer (neuston) to the ocean bottom (epibenthos). The spatial boundaries were set to the limits of NAFO division 4W to ensure that any effects that might be detectable at the "stock" level would be included.

6.3.4.2 Residual Environmental Effects Evaluation Criteria

A **significant** adverse environmental effect is one in which the abundance of one or more species is reduced to a level from which recovery of the population is uncertain, or more than one season would be required for a locally depleted population or altered community to be restored to pre-event conditions. To be considered significant, Project related mortality would exceed the range of natural mortality experienced by a population as a whole.

A **positive** effect occurs when the abundance of fish within a population is increased, or natural mortality is reduced.

6.3.4.3 Potential Interactions, Issues and Concerns

Pile driving, well development and pipeline construction are Project activities that may interact with marine fish. Other potential issues and concerns related to the effects of the Project on marine fish include:

- contamination of marine fish through discharges of hydrostatic test fluids during pipeline construction, WBM drill cuttings and muds during well development and routine operational discharges (*e.g.*, produced water, cooling water, deck drainage, sewage);
- noise disturbance during construction and operations;
- creation of reef effects from presence of platforms and pipeline structure;
- creation of a refuge area for spawning due to 500 m "no-fishing" safety zone around the platforms;
- accidental release of gas condensate following a blowout, or platform spills, could effect fish eggs and larvae, particularly those in near-surface waters; and
- reduced survival of fish eggs, larvae and other planktonic organisms caused by routine and accidental discharges.

6.3.4.4 Analysis, Mitigation and Residual Environmental Effects

Construction

Subsea Pipeline Construction

Effects associated with pipeline construction are predicted to be localized and temporary and within a limited zone of influence. As discussed in Section 6.3.3, disturbed areas of the marine benthos are expected to be recolonized in less than five years. Excavation or jetting of soft bottom sediments will result in temporary sedimentation. Herring, whose sticky eggs adhere to the bottom and could be smothered by silt would most likely be affected. The subsea pipeline will be laid in the summer and the likelihood that this activity would coincide with herring spawning in time and space is unlikely. Even if it were to coincide, it would not cause significant effects on the herring population.

Blasting, if required, will be conducted in accordance with the "Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters" (Wright and Hopky 1998). Pipeline construction is not expected to have a significant adverse effect on marine fish.

Installation of Structures

Noise from pile driving is of concern because of the magnitude of the noise and vibrations. It is possible that such noise and vibration could interact with fish larvae and adults. Driving the jacket legs (estimated to last 4-7 days) will likely generate up to 135 dB re 1µPa at 1 km distance from the construction vessel (Richardson *et al.* 1995). At source, in 40 m depth, the maximum noise level is estimated to be approximately 180 dB re 1µPa based on standard cylindrical spreading. EnCana will gradually increase pile driving noise, by building up to necessary intensity over a period of time. The distance for this sound level to attenuate to an ambient level of 100 dB is approximately 10 km.

The noise from pile driving may cause fish to move out of the affected areas close to the source. There is considerable variation in the hearing ability of fish, therefore it is difficult to make general statements about behavior of many fish species relative to this activity.

Turnpenny and Nedwell (1994) summarized the following physical effects of noise on fish:

- transient stunning at 192 dB re 1 µPa;
- internal injuries at 200 dB re 1 µPa;
- egg/larval damage at 220 dB re 1 µPa; and
- fish mortality at 230 to 240 dB re 1 µPa.

In addition, Turnpenny (Fawley Aquatic Research Laboratories Ltd., pers. comm. 2002) and Pearson *et al.* (1992) both note that the lower noise threshold that can cause subtle changes in fish behavior is approximately 160 dB. Extrapolating from Richardson *et al.* (1995), as noted above, it was calculated that this lower noise threshold (*i.e.*, 160 dB) would occur out to a radius of approximately 255 m from the Deep Panuke construction site during pile driving.

Based on these anticipated noise levels, no adverse physical effects are expected on adult, juvenile or eggs and larvae of commercial or non-commercial species from pile driving. Regarding a potential behavioral response (*e.g.*, at noise levels above 160 dB) such as disturbance during spawning periods or shifts in migration routes, a 255 m radius from the Project area is considered as the zone of influence. Silver hake are the only commercial species shown to spawn within the Project footprint and this radius accounts for a very small percentage of their spawning area. If the 4 to 7 day pile driving activity occurs within the silver hake spawning period (June to September), the short duration of this activity relative to the extended period of hake spawning and the localized area of potential effect are not likely to result in any significant adverse effects on silver hake.

Hydrostatic Testing

The discharge of hydrostatic testing fluid from the pipeline during construction could have adverse effects on marine fish. Hydrostatic testing fluid may consist of seawater, dye, biocide, corrosion inhibitor and dissolved oxygen scavenger. The chemicals used in this application will be screened through the Offshore Chemical Selection Guidelines (NEB *et al.* 1999). A toxicity bioassay testing program and plume dispersion modeling will be applied to confirm there will be minimal impact to the marine environment from this one time discharge (refer to Section 2.3.2).

Development Drilling

Contamination from drilling discharges may effect bottom dwelling fish, particularly flatfish, however the effects will be highly localized in the vicinity of the discharge (refer to Section 6.3.3 for a discussion on drill waste dispersion and effects). Due to the high-energy environment at the Project site, WBM cuttings piles will likely be dispersed within one year. Therefore, no significant adverse effect on marine fish is predicted from discharges during construction.

Drilling is expected to continue for approximately 450 days. Underwater noise from drilling units (at 119 to 127 dB re 1µPa) is less than that produced by fishing trawlers and other surface vessels (170 to 191 dB re 1µPa) (Buerkle 1975a; 1975b). Received levels at 100 m distance will be approximately 114 dB re 1µPa. Transient stunning of marine fish occurs at noise levels above 192 dB re 1µPa; therefore, no significant effects of noise on marine fish are predicted.

Assuming implementation of the proposed mitigative measures, no significant adverse effect on marine fish is predicted during Project construction.

Operation

Routine Operational Discharges

Effects from produced water and other discharges will likely be undetectable beyond 500 m from the platform. Produced water dispersion modeling results for the Project are included in Appendix C.

A great deal of research has been performed to describe the potential consequences of discharging produced water in the marine ecosystem (*i.e.*, Brendehaug *et al.* 1992; Montgomerry *et al.* 1987; Schiff *et al.* 1992; Sauer *et al.* 1992; Johnsen *et al.* 1994; Querbach *et al.* 2000). These studies showed that there are field variations in the toxicity, but that the acute toxicity of produced water to marine organisms is relatively low. Querbach *et al.* (2000) studied potential effects of produced water exposure on haddock, lobster and sea scallop, and concluded that survival, growth and fertilization success was reduced for these species. The aromatic and phenol fractions appear to be the main contributor to the acute toxicity of produced water (Johnsen *et al.* 1994); this is supported by an experiment which showed that biodegradation of the aromatic and phenol fractions played a dominant role in the decrease of the acute toxicity. Because the toxicity of produced water is relatively low and the dilution high, no measurable effects in marine organisms (in situ) have been reported. Adult fish are not expected to be significantly affected by discharges as they will likely detect and avoid areas of lower water quality (*e.g.*, Zitko and Carson 1974, Wildish *et al.* 1977). The early life stages, or planktonic stages, are particularly sensitive to contaminants due to the inability of these larvae or eggs to actively move from areas of contamination. However, the predicted effect is not considered to be significant since the proportion of the total population that is exposed to these routine discharges at any time is small and any effect caused will be within natural variation for these populations. Sommerville *et al.* (1987) found that cod and herring larvae and phytoplankton appear to be unaffected by produced water.

Studies have been undertaken to investigate potential chronic and sublethal effects of produced water components (*e.g.*, alkyphenols, PAHs) on fish (Meier *et al.* 2002, OLF 1998, Aas *et al.* 2000). However, field studies to date to address these potential effects are too limited to be definitive at this time. This difficulty is compounded by the lack of published information on potential effects with regard to specific species that frequent or reside in the area (*i.e.*, Aas and Klungsryr 1998). More recently however, large research programs have been designed to develop monitoring tools with laboratory experiment (Aas *et al.* 2000, Camus *et al.* 1998, Beyer *et al.* 2001, Baussant *et al.* 2001a; 2001b). EnCana will continue to support similar research initiatives in Canada and will review results of ongoing research as they become available.

EnCana acknowledges the emerging concern with regard to produced water and deck drainage discharges and the difficulty in assessing potential effects in situ (particularly for benthic and pelagic species) given relatively low toxicity and high dilution.

Effects of routine discharge of hydrogen sulphide (H_2S) contained in produced water discharge are expected to be localized, minimal, and not significant. Maximum end of the pipe concentrations will be in the order of 0.004 ppm (0.004 mg/L), and will be both rapidly diluted and rapidly oxidized to sulphate (a common ion in sea water). H_2S toxicity data are lacking for oceanic species, which are generally believed to be intolerant of high concentrations of H_2S. The 2-hour LC50 for the open water flounder

(*Citharichthys stigmaeus*) is approximately 200 µM (6.8 mg/L). Bagarinao and Vetter (1989) and Glickman *et al.* (1999) examined H_2S concentrations at "end of pipe" (95 to 160 mg/L) and edge of mixing zone (50 to 96 µg/L) at three Californian offshore sites and predicted no hazard to marine aquatic life.

Small pelagic and planktonic organisms in the immediate vicinity of the production platform may become entrained in platform water intakes or the zone of discharges. Mortality of organisms will be reduced by intake of water at depth (*i.e.*, minimum 10 m depth) according to DFO guidelines on water intake (*e.g.*, Freshwater Intake End-of-Pipe Fish Screen Guideline (DFO 1995)). This loss of plankton is considered negligible particularly at depth, relative to the widespread distribution of plankton on the Scotian Shelf.

Presence of Structures

Noise from routine operations is not anticipated to have a measurable effect on local fish populations.

The presence of infrastructure (platforms, pipeline) and pipeline protective mattresses may have a minor positive effect in that fish will be attracted to the structure, due to the reef effect. Reef structures not only provide shelter from predation for many species of marine fish, but also contribute to provision of productive feeding grounds. The creation of a 500 m “no-fishing zone” associated with the safety zone around the platforms, can also have a minor positive effect on marine fish by providing further refuge areas for spawning fish. Myers and Barrowman (1996) demonstrated, through meta-analysis of 254 commercial fish stocks, that the highest measures of recruitment occur when the spawning stock biomass is high. Thus, any Project effect that increases the spawning stock biomass of a species can have a positive effect on recruitment into that population.

Various studies in the North Sea and Gulf of Mexico have reported evidence of fish aggregation near offshore platforms and pipelines (AUMS 1987a; 1987b; ICIT 1991; Bohnsack and Sutherland 1985; Picken *et al.* 2000; Soldal *et al.* 1999). Known offshore species attracted to northern reefs include pollock (*Pollachius virens*), cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), ling (*Molva molva*), and mackerel (*Scomber scombrus*) (Soldal *et al.* 1999).

Fish aggregating near platforms will be exposed to produced water and other effluents. Past studies on the health of fish caught near platforms in the North Sea did not demonstrate any major effects of substances discharged in produced water (AUMS 1989; Aas and Klungsryr 1998; Mathers *et al.* 1992a; 1992b). However, a need for insitu research has been identified (Meier *et al.* 2002; Cranford *et al.* 2001).

No significant adverse residual effects on marine fish from Project operations are predicted; a minor positive effect is predicted based on an anticipated reef and refuge effect associated with unburied portions of pipeline and fishing exclusion zone around the platforms.

Decommissioning

Project activities during decommissioning will likely include vessel traffic, equipment and structure removal, and routine discharges. The potential effects of these activities are expected to be similar (or less than) those of construction; therefore, no significant adverse environmental effects are predicted. The removal of structures, and fishing exclusion associated with the platform safety zone will remove the reef and refuge effect thereby returning the area to its pre-Project condition.

Malfunctions and Accidents

Malfunctions and accidents could result in a condensate plume from a well blowout or platform spills. Eggs and larvae would be more at risk than adult fish because they tend to be congregated in the upper water column where released condensate would travel. The risk of a major release of hydrocarbon from a blowout or large spill is considered extremely low (refer to Section 3.2).

Sable Island Bank is an important spawning and nursery area for many species of fish and commercially important invertebrates. Water circulation forms a gyre over the bank during many months of the year, retaining eggs and larvae over the Bank. This retention increases the potential risk of exposure in the event of an accidental release of condensate contained in a blowout of raw gas, or other oil. However, rapid evaporation and dispersion of natural gas and condensate reduces the magnitude of the risk, especially in comparison to heavy oil. During summer there may be localized mortality of fish eggs and larvae close to the blowout site, but evaporation of the condensate would be rapid. Overall concentrations of dissolved hydrocarbons would be well below the lethal level for blowouts and platform spills; mortality of fish eggs and larvae would be within the range of natural population variation for species present on the Scotian Shelf. The likelihood of tainting of fish is extremely remote.

In the extremely unlikely event of a subsea acid gas injection well blowout, H_2S gas could be released into the water column. The chemical reaction of H_2S with seawater will result in the production of H_2SO_4 (aq). In the receiving waters there will be a lowering of the pH, a potential increase in chemical oxygen demand (COD) and an associated increase in water temperature. Fish within the zone of influence will likely detect and avoid abnormal water quality such as low pH, low dissolved oxygen and elevated temperature. Furthermore, fish are known to show a strong avoidance reaction when they detect H_2S, but this information is lacking for indigenous fish species such as cod, haddock, pollock, yellowtail flounder, herring and mackerel. The primary concern of an H_2S subsea blowout is centered on the small pelagic eggs and planktonic organisms that cannot actively avoid being exposed to deteriorating water quality (*i.e.*, phytoplankton, zooplankton and fish eggs and larvae). Studies regarding the distribution of plankton and fish eggs and larvae on the Scotian Shelf (Shackell 2000) indicate that while there is seasonal variation, the Deep Panuke area supports relatively low concentrations of fish eggs and larvae relative to the Western and Sable Island Banks (Shackell and Frank 2000).

Market-ready gas from a rupture of the pipeline to shore is expected to quickly rise to the surface without significant interaction with fish. Adverse effects from a pipeline rupture would be largely limited to localized, short-term direct physical disturbance associated with the release of pressurized gas since gas liquids (condensate) are removed at the platform. These effects would not be widespread, and any losses would be quickly replenished through recruitment from neighboring fish resources.

In summary, there is not anticipated to be a significant adverse effect on marine fish populations as a result of malfunctions and accidental events.

6.3.4.5 Cumulative Effects Assessment

Projects and activities in the study area that may interact cumulatively with marine fish at the Deep Panuke site include oil and gas exploration and production, commercial fishing and domestic and international shipping. In addition to these human activities, marine fish populations in the study area may be affected by natural factors, such as changes in prey and predator populations in areas within their natural range that are outside of the study area. However, it is not anticipated that ongoing or future projects or activities along the Scotian Shelf including the Blue Atlantic, Neptune and Hudson Energy projects) will contribute to cumulative effects.

Based on ongoing monitoring programs at the SOEP, it is unlikely that any adverse effects due to construction or operation of the SOEP could interact cumulatively with Deep Panuke. The distance between the SOEP and Deep Panuke platforms (45 km to Thebaud and 23 km to the future platform at Alma) will further reduce the likelihood of cumulative effects on marine fish. Similarly, no significant adverse effects on fish have been observed from the installation and presence of the SOEP pipeline, and none are anticipated with the Deep Panuke pipeline, therefore no significant cumulative effects on marine fish from the presence of the two pipelines are predicted.

Exploration drilling activities are generally short term (60 to 90 days) in any one area, localized and not likely to result in significant effects on marine fish. In addition to the temporary, localized, nature of exploration drilling, the potential for cumulative effects with Deep Panuke are further limited by the widely dispersed nature of these activities and lack of spatial and temporal overlap. Future seismic exploration in the study area could adversely affect fish, eggs, and larvae (CNSOPB 1998); however, these effects (which include avoidance and minor egg/larval mortality) are not considered to be significant. These effects could interact cumulatively with the Project; however, the effects related to seismic exploration are expected to be temporary and are not expected to result in significant cumulative adverse effects.

The Cohasset Project, currently in Phase I of decommissioning, lies approximately 12 km to the northwest of the Project site. No significant effects on fish populations have been observed thus far from this decommissioning operation, and no cumulative interactions with the Deep Panuke Project are anticipated.

The Project will add to the existing safety and fishing exclusion zones already established around other offshore platforms in the region (*i.e.*, Cohasset Project, SOEP). Fishing activity within these zones is restricted, possibly resulting in a minor positive cumulative effect on recruitment into marine fish populations, by providing a larger refuge area for spawning individuals. This positive effect could be offset by a localized reduction in water quality associated with routine discharges from operational platforms. Unburied portions of the pipeline will provide an additional reef effect similar to that created by the SOEP pipeline, potentially providing a minor cumulative positive environmental effect on fish.

The effects resulting from a malfunction or accident are likely to be short-lived and limited in spatial extent and are therefore unlikely to interact with effects from other projects and activities to cause significant cumulative effects on marine fish populations. Any effect would likely approximate normal variability or rapidly return to pre-spill levels. These effects would overlap spatially and temporally with the normal effects of the Project and other projects or activities. However, it is not likely that such a low probability event, would overlap either temporally or spatially with a spill from any other project or activity.

6.3.4.6 Follow-up and Monitoring

Routine monitoring of Project related discharges will ensure compliance with regulatory standards. Appropriate remedial action during any upset conditions will ensure that potentially adverse environmental effects are minimized. EnCana will continue to support research initiatives related to the ecological risk of produced water discharges from East Coast oil and gas operations and will review the results of this research as they become available. Follow-up programs and mitigation will be adapted as necessary to reflect results of this research.

6.3.4.7 Sustainable Use of Renewable Resources

No significant adverse residual environmental effects on this VEC are predicted, therefore, further assessment regarding sustainable use of renewable resources is not required.

6.3.4.8 Summary of Residual Environmental Effects

Project construction, operation, and decommissioning activities, including malfunctions and accidents, are not predicted to have significant adverse residual effects on marine fish populations. A minor positive effect is predicted due to the reef effect associated with the platform structure and unburied portions of the pipeline; a refuge effect is also predicted associated with the no-fishing zone around the platforms. The positive reef and refuge effect associated with the platform structures may be offset by a localized reduction in water quality from routine discharges. Tables 6.32 and 6.33 summarize the residual environmental effects on marine fish.

Table 6.32 Residual Environmental Effects Assessment Matrix: Marine Fish

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effect	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/ Social-cultural and Economic Context		
CONSTRUCTION									
Offshore platforms installation	• Noise from pile driving (A)	• No mitigation recommended	1	3	1/1	R	2	N	3
Subsea pipeline installation	• Habitat alteration (A)	• Blasting will be conducted in accordance with Guidelines for Use of Explosives in or Near Canadian Fisheries Waters	1	5	2/1	R	2	N	3
	• Noise (A)	• No mitigation recommended	1	5	2/6	R	2	N	3
Development drilling	• Noise (A) • Water quality reduction (A)	• No ocean discharge of SBM/EMOBM • Reduce disposal of bulk WBM through batch drilling • Compliance with CNSOPB disposal requirements	1	2	3/6	R	2	N	3
Hydrostatic testing	• Water quality reduction (A)	• Conduct bioassay tests and conduct plume dispersion modeling to minimize potential environmental effects	1	2	1/1	R	2	N	3

Table 6.32 Residual Environmental Effects Assessment Matrix: Marine Fish

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects: Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/ Social-cultural and Economic Context	Residual Environmental Effect	Level of Confidence
OPERATION									
Offshore production	• Water quality reduction from effluents (A) • Entrainment of small pelagic organisms (A)	• Treatment of effluents to regulatory standards • Water intake at depth and in accordance with DFO guideline (DFO 1995)	1	2	5/6	R	2	N	3
Subsea pipeline presence	• Unburied pipeline sections provide fish refuge (P)	• No mitigation recommended	1	5	5/6	R	2	P	3
MALFUNCTIONS AND ACCIDENTS									
Well blowout	• Habitat alteration (A) • Fish mortality (A)	• Prevention through application of design standards and maintenance • Implement AERCP and Spill Response Plan	1	4	2/0	R	2	N	2
Platform spills	• Water quality reduction (A)	• Prevention through application of design standards and maintenance • Implement AERCP and Spill Response Plan	1	1-4	1/1	R	2	N	3

Table 6.32 Residual Environmental Effects Assessment Matrix: Marine Fish

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effect	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/ Social-cultural and Economic Context		

KEY

Magnitude: 1= Low: *e.g.*, specific group or habitat, localized, one generation or less, within natural variation; 2 = Medium: *e.g.*, portion of a population or habitat, 1 or 2 generations, rapid and unpredictable change, temporarily outside range of natural variability; 3 = High: *e.g.*, affecting a whole stock, population or habitat outside the range of natural variation.
Geographic Extent: 1=<500 m^2; 2=500 m^2 – 1 km^2; 3=1-10 km^2; 4=11-100 km^2; 5=101-1000 km^2; 6=>1000km^2
Duration: 1=<1month; 2=1-12 months; 3=13-36 months; 4=37-72 months; 5=>72 months
Frequency: 0= unlikely to occur; 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: R=Reversible; I=Irreversible
Ecological/Socio-cultural and Economic Context: 1=Pristine area; 2= Area affected by human activity; 3=Evidence of adverse effects
Residual Environmental Effect Rating: S=Significant Adverse Environmental Effect; N=Nonsignificant Adverse Environmental Effect; P=Positive Environmental Effect
Confidence: 1=Low level of confidence; 2=Medium level of confidence; 3=High level of confidence

Table 6.33 Residual Environmental Effects Summary: Marine Fish (All phases)			
Phase	**Residual Environmental Effect Rating**	**Likelihood of Significant Adverse Effects**	
		Probability of Occurrence	**Scientific Uncertainty**
Construction	N	N/A	N/A
Operation	N/P	N/A	N/A
Decommissioning	N	N/A	N/A
Malfunctions and Accidents	N	N/A	N/A

KEY

Residual Effects Rating: S=Significant Adverse Environmental Effect; N=Non-significant Adverse Environmental Effect; P=Positive Environmental Effect
Probability of Occurrence: Based on professional judgement; 1 = Low; 2 = Medium; 3 = High; N/A = Not applicable (effect is not predicted to be significant)
Scientific Uncertainty: Based on scientific information and statistical analysis or professional judgement; 1 = Low level of confidence; 2 = Medium level of confidence; 3 = High level of confidence; N/A = Not applicable (effect is not predicted to be significant)

6.3.5 Marine Mammals (Seals and Whales)

6.3.5.1 Boundaries

Marine mammals are present in the study area year-round with seals using Sable Island and surrounding waters at all times of year and whales, depending on the species, also using the area at all times of the year. With the exception of the northern bottlenose whale whose distribution is centered in the Gully, distribution patterns for other marine mammals are less well defined. However, representative numbers of several marine mammal species have been observed in the area of the SOEP platforms (SEEMAG 1999b) and are expected to be present in the vicinity of the Deep Panuke Project site as well.

6.3.5.2 Residual Environmental Effects Evaluation Criteria

A **significant** adverse environmental effect is one that affects a population of marine mammal species in such a way as to cause a decline or change in abundance or distribution of the population over one or more generations.

A **positive effect** may enhance a marine mammal population such that an increase is evident.

6.3.5.3 Potential Interactions, Issues and Concerns

The existing Panuke platform has been established as a local feature for years, both in terms of physical presence and a source of noise from onboard activity. Marine mammals continue to be present within the area of SOEP gas exploration and production (SEEMAG 1999b). Several cohorts of seals and whales have been born since the onset of offshore oil and gas production. Project elements that could potentially interact with marine mammals in the study area include:

- noise disturbance/blasting nearshore during construction;
- disturbance from presence of infrastructure;
- disturbance/collisions from vessel traffic;
- contamination from development and operational discharges (WBM drill cuttings, produced water, deck drainage); and
- adverse effects from accidental events such as blowouts and pipeline ruptures.

Routine operational discharges, including produced water discharged at a depth of 10 m, are not likely to adversely affect marine mammals, which exchange air above the sea surface. Detection of an adverse change in water quality will likely cause them to move away from the source of discharge (Richardson *et al.* 1989). Impact of treated oily waste on marine mammals is considered negligible (Neff 1990, cited in Thomson *et al.* 2000). There is no subsea infrastructure associated with the Project that could create risk of entanglement for wildlife.

6.3.5.4 Analysis, Mitigation and Residual Environmental Effects

Construction

Installation of Structures

Marine mammals have a hearing system that is necessarily robust and sensitive to the frequencies in which they communicate, navigate and locate their prey (Richardson *et al.* 1995; Ketten 2000). This system functions within a wide range of background noises and is conditioned to pressure changes in the ear passages that could range 2-fold to100-fold over seconds to minutes. While such adaptations may allow them to endure the impulsive noises from undersea industrial activity, marine mammals may have little protection against rapid shifts in pressure resulting from explosives. However, while there will be potential blasting nearshore (within 300-500 m of the shoreline), there will be no offshore blasting operations; therefore, interactions with marine mammals with regard to blasting noise will be minimal.

Pile driving would likely represent the most impulsive noise for the marine mammals present near this activity. Richardson *et al.* (1995) provides examples of pile driving sound intensities (25-35 dB) above ambient at 1 km from the source and of marine mammals both ignoring and moving away from sounds of such intensity. As reported in SEEMAG (1998), acoustic monitoring of pile driving activity during

SOEP installation revealed the area of influence (zone at which the noise could affect mammals) did not extend beyond 0.5 km of the pile driving source. The specific nature of the potential effects at this distance (*e.g.*, physiological, behavioral) were unclear from the SEEMAG reference, and the source report (Greene 1998) was not available to EnCana. Pile driving is expected to last approximately 4 to 7 days in total, though will likely occur intermittently over a longer period. The effects will therefore be temporary and relatively localized.

Studies have shown that cetaceans only react to industrial noise when it is well above the ambient noise level (Richardson *et al.* 1995). Figure 6.2 shows the overlaps between the frequencies of marine industrial noise and sounds produced and perceived by various marine mammals. Figure 6.2 indicates that echolocation by cetaceans involves much higher frequencies than those of Project noise and therefore is not likely to overlap with Project noise. Frequencies used for communication by odontocete cetaceans also overlap very little with Project noise. The lower frequencies of sounds produced by large baleen whales and seals overlap or lie within those of the drilling and other Project noises. The Project noise will add incrementally to the large amount of ambient and shipping noise at frequencies that also overlap with those used by cetaceans for communication. EnCana will, however, gradually increase pile driving noise, by building up to the necessary intensity over a period of time. Independent trained wildlife observers will note any observations of abnormal behavior by marine mammals during pile driving activity.

Development Drilling

Drilling noise from rigs is less intense than that of routine shipping (refer to Section 2.7.2). Cetacean sightings from drillships and drilling rigs lend support to these studies. In particular, cetaceans and pinnipeds were observed close to platforms for the SOEP Tier I drilling program, particularly from drilling rigs at Venture and Thebaud (SEEMAG 1999b).

Based on experience during construction at the SOEP site and other studies, the short duration of pile driving activity and the limited magnitude of interaction (*i.e.*, relatively low numbers of whales in the study area), no significant adverse environmental effects on marine mammals during construction are likely.

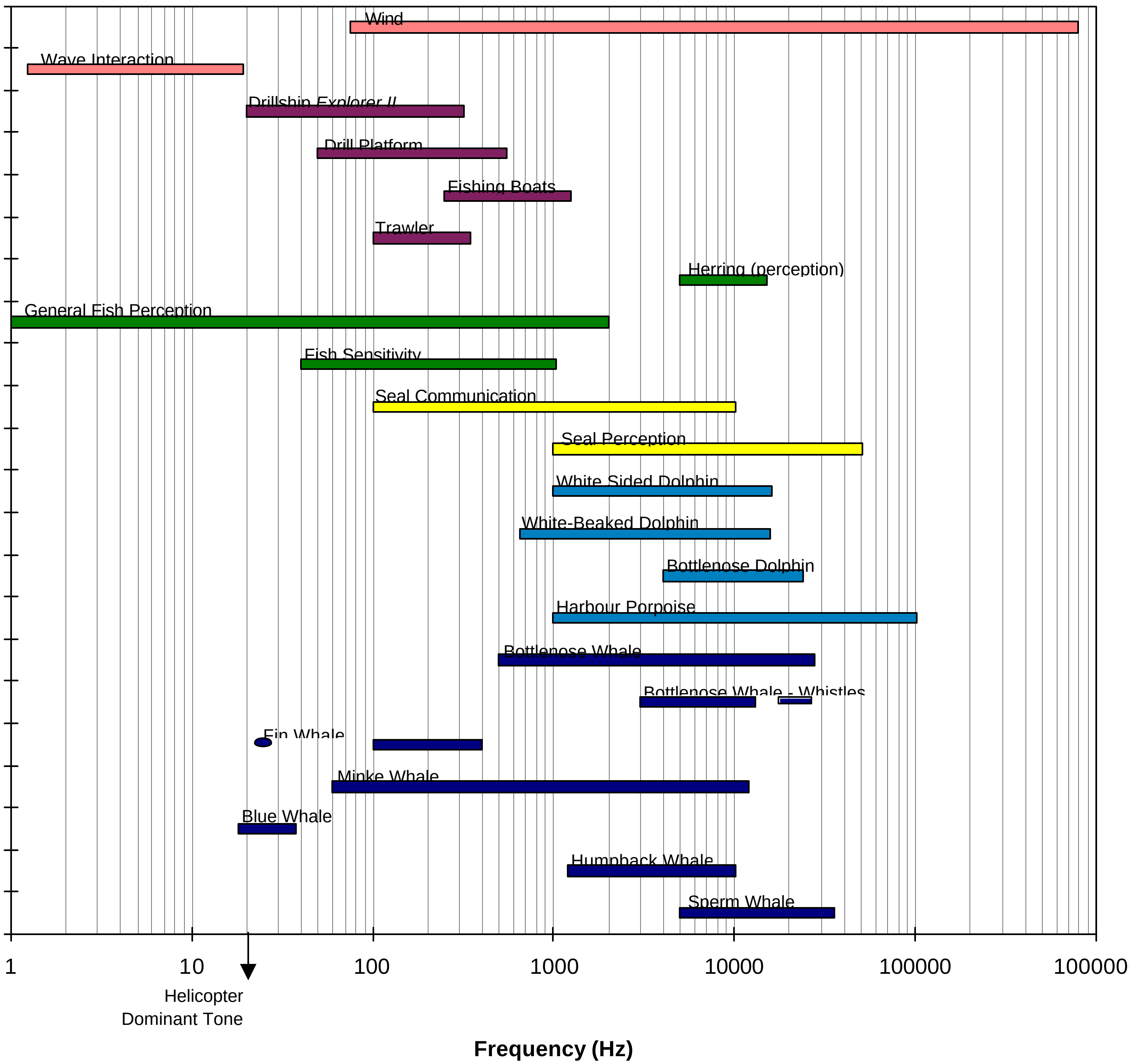


Figure 6.2 Generation of Marine Sounds and Reception of Sound by Marine Wildlife in the Ocean Environment

Operation

Presence of Structures

Localized increased marine productivity related to the reef effect of the platforms and unburied portion of pipeline may attract marine mammals, particularly those that feed on benthic fauna. Similarly, the 500 m safety zone and associated fishing exclusion around the platforms may result in higher densities of prey species also attracting marine mammals. Observations from the SOEP Offshore EEM program provides evidence of a potential reef effect as wildlife observers from the program reported that a pod of minke whales appeared to be using the platform to concentrate prey for hunting (SEEMAG 1999b). Mechanical noise generated on the platforms or by nearby vessels may cause seals and whales to avoid the area, although observations of attraction to platform and vessel noises have also been documented.

Vessel Traffic

Thomson *et al.* (2000) notes variable reactions of toothed and baleen whales to vessel traffic including avoidance, indifference and approach. The reaction of seals to vessels has not been as well studied. However, evidence suggests that seals in water are quite tolerant of infrequent vessel activity (Richardson *et al.* 1995). Reported ship collisions with whales are infrequent (Laist *et al.* 2000) and over the past 30 years, there have been no reported whale/vessel collisions associated with petroleum exploration in the Sable Island area. The greatest potential for collision occurs where shipping lanes traverse traditional areas of whale concentration, and where transit speeds are high. Where there is a regular pattern of ship movements within a specific area, such as supply vessel routes to and from platforms, resident marine mammals become familiar with the noise signature, direction, and speed of individual vessels and habituate to such vessels (Richardson *et al.* 1995). The risk for vessel collision from the Project is not expected to differ from that on other shallow areas of the Scotian Shelf where there are similar numbers of whales and vessel activity. Any whale sightings ahead of a vessel will require normal precautions. As well, EnCana has adopted a Code of Practice for the Gully which will minimize interactions with species such as the Northern Bottlenose Whale. Marine mammals also seem to habituate to the constant or predictable noise produced by high-flying aircraft such as those that will service the platforms (Norris and Reeves 1978).

Given the conditioning of marine mammals to offshore activity and the lack of adverse effects observed from the SOEP operations, adverse environmental effects during Project operation are predicted to be not significant. A minor positive effect in the form of increased food resources may result from the reef effect of the platforms and pipeline and no fishing within the 500 m safety zone.

Decommissioning

The activities associated with decommissioning are expected to be similar to those during construction. Any minor positive effects associated with a reef and refuge effect would end with the removal of infrastructure and cessation of the 500 m safety zone. The potential environmental effects of decommissioning are predicted to be not significant.

Malfunctions and Accidents

Unlike birds and sea otters, whales and seals are relatively unaffected by oiling (Geraci and St. Aubin 1990) although heavy oiling from major spills may result in some mortality (St. Aubin 1990). Although heavy oils could block respiratory passages, condensates (such as those associated with a raw gas blowout) are likely to impair breathing in ways that would tend to repel animals from the area before serious damage is done (Geraci 1990). Marine mammals are highly mobile and carry energy reserves that reflect their seasonal or "pulsed" feeding activities. Therefore, short-term exclusion from a particular area, due to an accidental event such as a hydrocarbon spill, would likely have no measurable effect.

Blowout models for the Project have produced initial condensate concentrations in seawater of <0.5 ppm (which would not be expected to "coat" baleen) and slick thickness of approximately 0.06 mm which rapidly diminish. Although surface condensate was found up to 10 km from the source as a result of the blowout of Shell Uniake G-72, 75% of its area was <2 µm and the rest was <6 µm thick. Also, hydrocarbons could be smelled up to 10 km from the source, however they were not machine-detectable even close to the source. Any effects on individuals could at most, be very local.

Preventive measures and emergency response plans will be in place to minimize the likelihood and possible consequences of a malfunction or accident. Oil spill trajectory modeling indicates that it is very unlikely that condensate from blowout or oil from other platform spills would reach breeding seals on Sable Island. Exposure of the air breathing animals to atmospheric concentrations of raw gas or acid gas within critical distances of a blowout (refer to Section 6.3.1) could cause adverse effects on individuals in those areas (*i.e.*, downwind and within the narrow plume). These effects are not likely to cause significant adverse effects on populations. No significant adverse effects on marine mammals are predicted to result from Project malfunctions or accidents.

6.3.5.5 Cumulative Effects Assessment

Studies of the dynamics of marine mammal ecosystems suggest that indirect human intervention, such as changes in fishing technology and management, can have important effects on marine mammals. Such interventions can involve overexploitation of marine mammals, altering the dynamics of their predators (Brodie and Beck 1983), or diminishment of the food base of marine mammals through overfishing (Trites *et al.* 1997). Other activities that may have an effect (*e.g.*, noise or other disturbances from industrial activity, trawlers, shipping, whale watching) are difficult to quantify and may involve habituation of animals over the long term (Richardson *et al.* 1990; Watkins 1986).

Activities that may contribute to the cumulative effects of the Project on marine mammal populations in the study area include past commercial sealing and whaling, vessel collisions, noise disturbances from vessel and aircraft traffic, oil and gas exploration and production and commercial fishing. Effects from these activities on marine mammals may be negative (*i.e.*, noise and collisions) or positive (*i.e.*, the small reef and refuge effect of platforms and unburied pipelines). Marine mammal populations may also have been positively affected by the establishment of the Whale Sanctuary in the outer Gully in 1994 and the Gully Area of Interest (candidate Marine Protected Area). In addition to these human influences, marine mammal populations in the study area are effected by natural factors, such as changes in prey and predator populations.

It is anticipated that marine mammals may be subject to incremental effects from future seismic and exploration activities that will be carried out in the study area and from the construction of the recently announced Blue Atlantic, Neptune and Hudson Energy projects that will traverse the study area. These activities are expected to have similar impulsive and chronic noise effects as predicted for the Project. The potential Project effects of impulsive underwater noise from platform construction (pile driving) are unlikely to overlap spatially and temporally with other impulsive noise sources (*e.g.*, seismic exploration) due to the short term and/or widely spread nature of these activities. Due to the predicted limited temporal and spatial extents of the effects of impulsive noise from these activities, it is expected that there would be enough unaffected areas elsewhere to which marine mammals could move to avoid any effect. Therefore, no significant cumulative effect from these activities is anticipated.

Installation of the SOEP platform at Alma will generate similar noise as the construction of the Deep Panuke Project (*e.g.*, pile driving). The construction of the Alma platform will be completed before Deep Panuke begins; therefore there will be no temporal overlap of this noise.

There may be some spatial and temporal overlap of Project vessel traffic with vessel traffic related to other activities in the region. However, marine mammals can habituate to chronic vessel noise (Richardson *et al.* 1990). In any event, these effects are short-term, of limited extent and reversible.

Apart from a brief period during pile driving, Project noise will not exceed that routinely produced by vessels, and thus will add little to the prevailing ambient situation. Therefore, no significant cumulative effects are anticipated to result from Project related vessel traffic during construction.

While a blowout of raw gas or acid gas could adversely affect marine mammals within a critical atmospheric zone of influence, it is not expected this would result in significant effects on populations. No potential future cumulative effects resulting from a malfunction or accident are predicted.

When compared to the historic human activity such as fishing and commercial shipping in the Sable Island area, the environmental effects associated with the Project, are considered to be low. In summary, no significant adverse cumulative effects on marine mammals are predicted to result from the Project.

6.3.5.6 Follow-up and Monitoring

EnCana will establish a marine mammal observation program for the Project. The protocol for the observation program will be established based on industry knowledge, on-site program development and consultation with regulators. Marine mammal observations will be taken by independent trained fisheries observers on Project facilities and vessels to ensure representative coverage of Project activities.

6.3.5.7 Sustainable Use of Renewable Resources

No significant adverse residual environmental effects on marine mammals are predicted, therefore, further assessment regarding sustainable use of renewable resources is not required.

6.3.5.8 Summary of Residual Environmental Effects

The large numbers of seals associated with Sable Island, and observations of whales within the regions indicates that some marine mammals will be present in the vicinity of the Project, as have been observed from SOEP structures. Project construction and operation activities will be similar to those of the existing SOEP activities; based on this experience, and on the wider evidence from other sources, it is predicted there will be no measurable adverse effect on marine mammals. No significant adverse effects on marine mammals is likely. A minor positive effect may be realized due to a potential increase in food resources related to the reef and refuge effect on fish. Tables 6.34 and 6.35 summarize the predicted residual environmental effects on marine mammals.

Table 6.34 Residual Environmental Effects Assessment Matrix: Marine Mammals

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effect	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/ Social-cultural and Economic Context		
CONSTRUCTION									
Well drilling	• Potential attraction or avoidance of marine mammals to Project site; noise (A)	• No mitigation recommended	1	2	3/2	R	2	N	3
Pile driving	• Potential attraction or avoidance of marine mammals to Project site; noise (A)	• Gradually increasing pile driving intensity • Independent wildlife observers to record abnormal mammal behavior	1	4	1/1	R	2	N	3
Vessel traffic/Pipe installation	• Collision; noise (A)	• Standard vessel operation procedures including avoidance measures	1	5	5/6	R	2	N	3
OPERATION									
Vessel traffic	• Collision; noise (A)	• Standard vessel operation procedures including avoidance measures	1	5	5/6	R	2	N	3
Presence of structures	• Possible attraction (A)	• No mitigation recommended	1	1	5/6	R	2	N	3
Fishery/safety exclusion zone	• Enhanced feeding opportunities (P)	• No mitigation recommended	1	5	5/6	R	2	P	3
MALFUNCTIONS AND ACCIDENTS									
Well blowout	• Oiling of species (A) • Respiration of air contaminants (H_2S and CH_4) (A)	• Routine maintenance and prevention measures • Implement AERCP and Spill Response Plan	1	4	1/0	R	2	N	2

Table 6.34 Residual Environmental Effects Assessment Matrix: Marine Mammals									
Project Activity	**Potential Positive (P) or Adverse (A) Environmental Effect**	**Mitigation**	**Significance Criteria for Environmental Effects**					**Residual Environmental Effect**	**Level of Confidence**
			Magnitude	**Geographic Extent**	**Duration/Frequency**	**Reversibility**	**Ecological/ Social-cultural and Economic Context**		

KEY

Magnitude: 1= Low: *e.g.*, specific group or habitat, localized, one generation or less, within natural variation; 2 = Medium: *e.g.*, portion of a population or habitat, 1 or 2 generations, rapid and unpredictable change, temporarily outside range of natural variability; 3 = High: *e.g.*, affecting a whole stock, population or habitat outside the range of natural variation.
Geographic Extent: 1=<500 m^2; 2=500 m^2 – 1 km^2; 3=1-10 km^2; 4=11-100 km^2; 5=101-1000 km^2; 6=>1000km^2
Duration: 1=<1month; 2=1-12 months; 3=13-36 months; 4=37-72 months; 5=>72 months
Frequency: 0= unlikely to occur; 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: R=Reversible; I=Irreversible
Ecological/Socio-cultural and Economic Context: 1=Pristine area; 2=Area affected by human activity; 3=Evidence of adverse effects
Residual Environmental Effect Rating: S=Significant Adverse Environmental Effect; N=Non-significant Adverse Environmental Effect; P=Positive Environmental Effect
Confidence: 1=Low level of confidence; 2=Medium level of confidence; 3=High level of confidence

Table 6.35 Residual Environmental Effects Summary: Marine Mammals (All phases)			
Phase	**Residual Environmental Effect Rating**	**Likelihood of Significant Adverse Effects**	
		Probability of Occurrence	**Scientific Certainty**
Construction	N	N/A	N/A
Operation	N/P	N/A	N/A
Decommissioning	N	N/A	N/A
Malfunctions and Accidents	N	N/A	N/A

KEY

Residual Effects Rating: S=Significant Adverse Environmental Effect; N=Non-significant Adverse Environmental Effect; P=Positive Environmental Effect
Probability of Occurrence: Based on professional judgement; 1 = Low; 2 = Medium; 3 = High; N/A = Not applicable (effect is not predicted to be significant)
Scientific Certainty: Based on scientific information and statistical analysis or professional judgement; 1 = Low level of confidence; 2 = Medium level of confidence; 3 = High level of confidence; N/A = Not applicable (effect is not predicted to be significant)

6.3.6 Marine Related Birds

6.3.6.1 Boundaries

Most bird species that frequent marine habitats around Nova Scotia are migratory. Temporal boundaries are variable, depending on the species, each having its own annual peak abundance along the coasts or in offshore waters. Some species breeding in the study area (*e.g.*, Roseate Tern) are considered at risk and may be particularly sensitive to development activities. However, all species that spend a significant portion of their non-breeding seasons in the study area may also be affected. While construction activities will occur intermittently at different locations (*i.e.*, the platforms and pipeline), operations will be continuous in subsequent years; therefore interactions between the Project and marine related birds could occur at any time during the life of the Project. The spatial boundary of interaction between Project activities and marine related birds is the footprint and zone of attractiveness, if any, of the platforms, pipeline and associated activities.

6.3.6.2 Residual Environmental Effects Evaluation Criteria

A **significant** adverse environmental effect is one that affects a marine related bird population or portion thereof in such a way as to cause a decline or change in abundance or distribution of the population over one or more generations such that natural recruitment may not re-establish the population to its original level, or avoidance of the area becomes permanent.

A **positive** effect may enhance a marine related bird population such that an increase is evident.

6.3.6.3 Potential Interactions, Issues and Concerns

Issues and concerns related to Project activities and potential interactions with marine related birds include:

- noise disturbance during construction, operation and decommissioning;
- attraction to platform/vessel lighting and flares;
- effects of discharges during construction, operation and decommissioning; and
- oiling of seabirds due to accidental events such as blowouts and/or chronic spills.

Potential interactions of the Project and marine related birds during decommissioning are expected to be similar to those of construction.

6.3.6.4 Analysis, Mitigation and Residual Environmental Effects

Construction

Installation of Structures

Noise associated with platform pile driving may cause pelagic seabirds that use the surface waters in the Deep Panuke Project area for foraging to avoid affected areas. This disturbance will be temporary (4-7 days) and relatively localized. Similarly, temporary mobilization and presence of a jack-up rig, and the drilling and completion of development wells may result in avoidance of a relatively small area during the construction period (approximately 450 days). However, previous experience at other installations indicates that birds are more likely to be attracted, rather than repelled by such activities. Observers on drilling rigs during SOEP Tier I drilling program observed many birds of various species (SEEMAG 1998), indicating that marine birds are not repelled by drilling noise on the Scotian Shelf.

Blasting (if required) will be conducted within 300 to 500 m of the shoreline in accordance with the Guidelines for the Use of Explosives in or near Canadian Fisheries Waters (Wright and Hopky, 1998). EnCana commits to submitting further details regarding proposed blasting as those details become available and will alert researchers on Country Island prior to blasting.

Pipelaying and trenching activities may disturb bird species in the areas where vessels are operating along the pipeline corridor. This activity has the potential to interact with a greater number of species than other construction activities, as it spans the inshore and pelagic environments. The duration of disturbance at one particular location along the route would be expected to occur for a relatively short period of time. The pipeline corridor runs approximately 2 km southwest of Country Island, where colonies of Leach's Storm-petrels, Common Terns, Arctic Terns, and endangered Roseate Terns nest. Although foraging grounds are vast, the time spent foraging may decrease due to the presence of the ships and associated noise disturbance. In accordance with the Code of Practice for Country Island, EnCana will maintain a 2 km buffer zone from Country Island at all times. Furthermore, no marine construction activities will occur near Country Island from May 1 to June 20 to avoid the period when Roseate Terns are prospecting for nest sites and laying eggs.

Pipelay vessels for the Project are expected to work in the vicinity of Country Island for approximately 2 days. The SOEP Nearshore EEM program included construction monitoring of terns and other seabirds. No measurable changes in bird behaviour or foraging patterns that could be attributed to construction activities were detected. Nesting and fledging of all terns, including Roseates on Country Island, were successful in 1999 compared to recent previous years (Smith *et al.* 2001); SOEP nearshore pipeline construction occurred during the breeding season that year (June). However, the breeding success of Roseate Terns is unpredictable and highly variable from year to year; therefore mitigative measures (*i.e.*, seasonal avoidance, buffer zone) will be undertaken as a precaution. These measures will be included in the Project EPP.

Helicopter Traffic

Helicopter traffic during construction could result in bird disturbance for short periods of time. Experimental disturbance of breeding tern colonies on Sable Island using close ATV drivebys and low-level fixed-wing aircraft overflights produced momentary "panic flights," but the birds settled quickly (Horn and Shepherd 1999). Nesting bird colonies on Sable Island will also be avoided as there will be no routine Project related activities interacting with the island. Landings will only occur in the event of an emergency. If landing is required, bird colonies will be avoided on advice from the island manager. EnCana has adapted a Code of Practice for Sable Island which includes restrictions for helicopter traffic.

Development Drilling

The temporary mobilization and presence of a drilling rig may result in avoidance of a relatively small area during drilling activities; however, birds are just as likely to be attracted by offshore vessels and rigs than the contrary (Wiese *et al.* 2001) (refer to potential effects on birds during operational phase). Drill waste and routine discharges from construction operations will be treated to the OWTG (NEB *et al.* 1996, and updates) prior to discharge. No significant effects from these discharges on birds in the Project area are anticipated.

With implementation of the proposed mitigative measures, no significant adverse environmental effects to marine related birds are predicted during construction.

Operation

Presence of Platforms

Potential effects of vessel and aircraft activity will be similar for operation as for construction. Seabird attraction to offshore vessels and rigs is widely documented (Wiese *et al.* 2001). Birds, such as gulls and tubenoses, can be attracted by macerated sewage and food waste, although this was not observed at the Cohasset Project. Concern has been expressed regarding the potential for fatal attraction of birds to lighting and flares on offshore rigs. Sage (1979) recounted several second-hand and anecdotal observations of numbers of birds incinerated by flying into rig flares in the North Sea. In contrast, Bourne (1979) concluded that there were relatively few deaths of birds in flares in the first 10 years of North Sea oil development and that most mortalities resulted from collisions and starvation of exhausted landbirds, often doomed by bad weather. Directed night watch studies by Hope-Jones (1980) observed no mortalities. Few seabird mortalities due to flares have been recorded at SOEP platforms (Hurley 2000).

Many transient landbirds on Sable Island are probably off their usual migration routes due to navigational error and offshore winds and storms (McLaren 1981b). Others may be normal migrants on the relatively short migration legs between Newfoundland and Nova Scotia or New England (Thomson *et al.* 2000). A particular concern might be potential deflection by rigs of Ipswich Sparrows from their small Sable Island "target". Stobo and McLaren (1985) noted that these migrating sparrows travel in good weather and with favourable wind conditions. Given this fact and the fact that, for flying birds, the island is in sight of the platform location, the probability of impact on the Ipswich Sparrow is considered negligible. Overall, the potential effects of the presence of Project related lighting and flares will be low.

Routine Operational Discharges

Small amounts of oil on the plumage of a seabird can cause death or decrease reproductive success (Peakall *et al.* 1987; Butler *et al.* 1988). Routine discharges, such as produced water and deck drainage, or small chronic spills that may contain oil, have the potential to oil birds as hydrocarbon sheens are often noted around platforms. Hydrocarbon dispersion from produced water has been modeled for the Project, with results presented in Appendix C. A worst case analysis indicates that if all the oil in the produced water rose to the surface, a layer of hydrocarbon of about 50 Fm would result near the discharge pipe; this layer would drop to less than 10 Fm at a distance of approximately 200 m. Such thin sheens are unlikely to produce any oiling of bird plumage. Oily water will be treated to reduce oil concentrations in accordance with the OWTG (NEB *et al.* 1996, and updates). EnCana will strive to meet a corporate target for dispersed oil concentration of 25 mg/L in produced water, which improves upon the 30-day weighted average of 30 mg/L specified in the OWTG. It is therefore unlikely that marine birds will contact enough oil to cause direct population effects through mortality or decreased reproductive success.

Decommissioning

The potential interactions of the Project and marine related birds during decommissioning are expected to be similar to those of construction. Therefore, no significant adverse environmental effects are predicted.

Malfunctions and Accidents

Contamination of surface water due to a production well blowout could present a risk to marine birds, particularly alcids, which spend most of their time on the surface of the water. In contrast, terns and gulls, that spend less time on the surface, are less likely to be effected by oiling (Gochfield 1979). The effects of a blowout on marine birds would be dependent on the size and timing of the event, weather conditions and the presence of seabirds in the area. Spill trajectory modeling has predicted that hydrocarbon slicks will generally move to the SSW under the influence of prevailing surface currents and generally away from Sable Island and its bird colonies. However, it should be noted that prevailing currents are not particularly strong and slick movements in the region may also be influenced by winds. Section 3 provides more information on spill probability and behaviour.

Accidental events resulting in a large release of oil (*i.e.*, 2,000 barrel spill in one day) would pose proportionately larger risk to marine birds than a small spill. However, the probability of such large spills or blowouts occurring is very low. The use of condensate as fuel on the platform and injection of surplus will reduce the possibility of a massive release of condensate (*e.g.*, from a subsea condensate pipeline rupture). Preventive procedures include standard engineering practices for offshore oil and gas development. Emergency response and contingency planning for the Project may include specific measures related to birds such as an oiled bird rescue effort on nearby shorelines.

EnCana has committed to documenting and reporting to the CNSOPB, all spills resulting from Deep Panuke activities, regardless of size. Measures will be in place to monitor for and reduce the occurrence of such events. If such an event occurs, procedures will be in place to respond to and investigate the occurrence and put in place any corrective appropriate action. In, addition, all vessels associated with the Deep Panuke Project will adhere to all applicable shipping regulations, including those related to discharge of ballast and bilge water.

Sampling of oil from beached birds on Sable Island was conducted between 1996 and 2000. Some of these birds were exposed to one or more of weathered crude, diesel, solvent, bunker or heavy fuel oils, or lube oil. Only one of 58 samples contained, along with lube and Bunker oil, a minor component of Cohasset crude, which may have been acquired by the drifting corpse (Z. Lucas, Sable Island Resident and Researcher, pers. comm. 2001). These results suggest that the contaminants to which the birds were exposed originated primarily from oiled tank washings from crude oil tankers, large ocean-going vessels powered by heavy fuel oil, and bilge discharges.

In the highly unlikely event of a blowout of raw gas, or the acid gas injection well, birds within several kilometres of atmospheric releases of H_2S and CH_4 may be adversely affected. Critical distances during blowout events for human health and safety are presented in Section 6.3.1.4. The effect on birds in the vicinity of the blowout will depend on the concentration of air contaminants, the meteorological conditions, and the ability of the birds to detect the reduced air quality and take evasive action. It is highly unlikely that such an event will affect bird populations so as to cause a significant effect.

In summary, the overall residual environmental effect on marine related birds due to malfunctions or accidents related to a large spill or blowout is not predicted to be significant.

6.3.6.5 Cumulative Environmental Effects Assessment

Other projects and activities that may interact to cause cumulative environmental effects on marine related birds in the study area include noise disturbance from vessel traffic and aircraft, oil and gas exploration and production, commercial shipping and commercial fishing, and oiling from illegal pumping of bilges by passing vessels and accidental spills from other sources. Marine related birds may also be affected by projects and activities occurring elsewhere in their migratory ranges. As well, marine related bird populations in the study area may be effected by changes in prey and predator populations.

Project construction may overlap temporally and spatially with construction of the Blue Atlantic, Neptune and Hudson Energy projects. This overlap is reduced, however, as Hudson Energy is on hold as of May, 2002 and the Blue Atlantic project is proposed to come onshore in Southwest Nova Scotia (*i.e.*, no spatial overlap in the nearshore).

The range of the Country Island Roseate Tern population extends into Southwest Nova Scotia, therefore there is potential geographical overlap for cumulative effects on this population, with the Blue Atlantic

Project. No adverse effects on Roseate Tern populations is predicted for the Deep Panuke Project. It is assumed that the Blue Atlantic Project will also be subject to similar stringent requirements to protect Roseate Tern populations in its Project areas, thus avoiding potential for cumulative effects.

Any remaining cumulative effects would be limited to vessel traffic and associated noise, lights, and routine discharges. These effects would be temporary and reversible. It is assumed that all projects occurring in the vicinity of Country Island (*i.e.*, Neptune) will abide by similar restrictions as the Deep Panuke Project thereby minimizing potential cumulative effects on nesting Roseate Tern colonies. As the effects of Project construction are considered reversible, no cumulative interaction of effects on marine related birds is anticipated between Project construction and these future projects.

Future seismic and exploration activities will be conducted within and outside EnCana's Panuke lease area, and EnCana will undertake future seismic exploration in the vicinity of the Panuke lease (unrelated to the Deep Panuke Project). Exploration drilling activities are generally short term (60 to 90 days) in any one area, are localized and not likely to result in significant effects on marine related birds. In addition to the temporary, localized nature of exploration drilling, the potential for cumulative effects with Deep Panuke are further limited by the widely dispersed nature of these activities and lack of spatial and temporal overlap once Project construction is completed. The CNSOPB (1998) predicted that potential effects on seabirds from future seismic exploration would be insignificant, considering no disturbance or mortality has been observed in the few studies undertaken in relation to seismic programs. Therefore, it is considered unlikely that known future seismic activities will interact cumulatively with Project activities. Similarly, Thomson *et al*. (2000) concluded that noise from future exploration drilling would not have cumulative effects on marine related birds, although concurrent drilling of exploration wells could increase noise levels at a number of sites.

Based on ongoing monitoring programs results for the SOEP, it is unlikely that any adverse effects due to construction or operation of the SOEP would interact cumulatively with the Deep Panuke Project. If birds are attracted to the lights or flares on the Deep Panuke platforms (during construction or operation), there is no evidence that such effects would compound those at other platforms or rigs in the study area (including SOEP Tier II platforms) to cause significant cumulative effects.

Project related vessel and aircraft traffic will add to existing and future vessel traffic in the study area, however, the amount of vessel traffic for the Project is minor compared to domestic and international shipping, tourism and fishing, and is not expected to create significant cumulative effects. Any cumulative effects of oiling from illegal bilge pumping and chronic spills would be additive and density dependent. As discussed under the environmental effects of operation, EnCana will put measures in place to manage small and large spills and resulting slicks associated will its Project activities. These measures will be outlined in EnCana's Spill Response Plan which is currently being reviewed by Environment Canada and DFO.

The proposed Sable Island Wind Turbine project is not predicted to have a significant effect on Sable Island bird populations, including the Roseate Tern population. Staff on Sable Island, in consultation with the Canadian Wildlife Service (CWS), the Sable Island Preservation Trust and the Meteorological Service of Canada will develop a monitoring plan to verify impact predictions (MSC 2002). Deep Panuke Project interactions with Sable Island bird populations will be minimal due to helicopter and vessel traffic avoidance of the island. Potential cumulative effects on breeding or rearing habitat for marine related birds on Sable Island will be mitigated by adherence to the Sable Island Emergency Contingency Plan (Canadian Coast Guard 1994) and EnCana's Code of Practice for Sable Island.

6.3.6.6 Follow-up and Monitoring

A marine bird monitoring program will be designed and implemented for the Project in consultation with Environment Canada and CWS. Provisions for the identification and verification of predicted effects and appropriate mitigative measures, specifically monitoring, will include: regular surveys from the platform, as well as daily morning searches for dead, oiled, or otherwise weakened birds on the platforms; and occasional (but systematic) observations at night to record the behaviour of birds near the flare and around the illuminated platforms. Periodic observations of seabirds from vessels en route to the site will also be conducted. Monitoring will be conducted by independent observers according to recognized scientific protocols. Ornithologists will be hired periodically to train observers, verify their observations and collaborate in specialized studies as required. EnCana has also contracted a resident independent biologist to carry out oiled bird surveys and specialized environmental programs on Sable Island. EnCana employees and contractors will adhere to approved/established procedures for handling injured or standed birds on vessels or offshore platforms. This protocol will be included in the EPP. If the Williams and Chardine (1999) protocol is to be employed for the release of storm-petrels stranded on boats or offshore structures, a permit will be required, under the *Migratory Birds Convention Act* and Regulations. EnCana, through consultation with the Canadian Wildlife Service, will also determine the most effective emergency response for dealing with oiled birds.

With respect to the Roseate Terns on Country Island, EnCana will collaborate with Environment Canada/CWS and Dalhousie University researchers on Country Island to monitor potential effects of pipelay activities on Roseate Terns. The follow-up program will likely include: a survey of Roseate Terns at all islands in the Country Island complex prior to commencement of pipelay activities; monitoring of Roseate Terns productivity in the years prior to and during pipelay activities; and monitoring of Roseate Tern foraging activities prior to, during, and after pipelay activities.

6.3.6.7 Sustainable Use of Renewable Resources

No significant adverse residual environmental effects on this VEC are predicted, therefore, further assessment regarding sustainable use of renewable resources is not required.

6.3.6.8 Summary of Residual Environmental Effects

The residual environmental effects on marine related birds, including cumulative environmental effects, are predicted to be not significant for construction and operation. A blowout or major spill is not predicted to affect birds on a population level and therefore is not expected to result in a significant adverse environmental effect. EnCana's AERCP will seek to minimize adverse effects in the unlikely event of such a spill; spill related environmental monitoring will seek to verify the magnitude of any impacts. The Project activities discussed above are not anticipated to interact with other past, present, or future projects or activities in a way that might cause significant cumulative effects. Tables 6.36 and 6.37 summarize the predicted residual environmental effects on marine related birds.

Table 6.36 Residual Environmental Effects Assessment Matrix: Marine Related Birds

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects: Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/ Social-cultural and Economic Context	Residual Environmental Effect	Level of Confidence
CONSTRUCTION									
Pile Driving	• Avoidance/disturbance due to noise (A)	• No mitigation required	1	2	1/1	R	2	N	3
Vessel/Helicopter traffic	• Avoidance/disturbance due to noise and presence of vessels/aircraft (A)	• Avoid colonies and high concentrations of birds in general; • Adhere to Codes of Practice for Country Island (including 2 km buffer zone) and Sable Island • Avoid pipelaying activities in the vicinity of Country Island from May 1 to June 20	1	2	2/4	R	2	N	3
Temporary mobilization, presence of jack-up rig, drilling of wells	• Avoidance/disturbance due to noise (A) • Attraction of birds to lights and flares (A)	• No mitigation recommended	1	2	2/6	R	2	N	3
Pipelaying/ trenching	• Avoidance/disturbance due to noise and vessel presence (A) • Attraction of birds to lights (A)	• Adhere to Code of Practice for Country Island (including 2 km buffer zone) • Avoid pipelaying activities in the vicinity of Country Island from May 1 to June 20	1	1	2/6	R	2	N	3

Table 6.36 Residual Environmental Effects Assessment Matrix: Marine Related Birds									
Project Activity	**Potential Positive (P) or Adverse (A) Environmental Effect**	**Mitigation**	**Significance Criteria for Environmental Effects**					**Residual Environmental Effect**	**Level of Confidence**
			Magnitude	**Geographic Extent**	**Duration/Frequency**	**Reversibility**	**Ecological/ Social-cultural and Economic Context**		
OPERATION									
Presence of platforms and other platform operations	• Attraction to lights and sewage (A) • Other routine discharges (*e.g.*, produced water, deck drainage) (A)	• Management of routine operational discharges according to OWTG • Procedures to avoid, monitor and investigate any small chronic spills	1	1	5/6	R	2	N	3
Flaring	• Attraction of birds to flare (A)	• Minimize need for flaring	1	1	1/2	R	2	N	3
Vessel and helicopter traffic	• Avoidance/Disturbance due to noise (A)	• Avoid colonies and high concentrations of birds in general • Adhere to Codes of Practice for Country Island (including 2 km buffer zone) and Sable Island	1	4	5/6	R	2	N	3
MALFUNCTIONS AND ACCIDENTS									
Well blowout	• Oiling of species (A) • Respiration of air contaminants (H_2S and CH_4) (A)	• Engineering and design standards • Implement AERCP and Spill Response Plan	2	3	1/0	R	2	N	3
Platform spills	• Oiling of species (A)	• Engineering and design standards • Implement AERCP and Spill Response Plan	1	3	1/1	R	2	N	3
Flaring	• Attraction of birds to flare (A)	• Minimize need for flaring	1	1	1/2	R	2	N	3

Table 6.36 Residual Environmental Effects Assessment Matrix: Marine Related Birds

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effect	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/ Social-cultural and Economic Context		

KEY

Magnitude: 1= Low: *e.g.*, specific group or habitat, localized, one generation or less, within natural variation; 2 = Medium: *e.g.*, portion of a population or habitat, 1 or 2 generations, rapid and unpredictable change, temporarily outside range of natural variability; 3 = High: *e.g.*, affecting a whole stock, population or habitat outside the range of natural variation.
Geographic Extent: 1=<500 m^2; 2=500 m^2 – 1 km^2; 3=1-10 km^2; 4=11-100 km^2; 5=101-1000 km^2; 6=>1000km^2
Duration: 1=<1month; 2=1-12 months; 3=13-36 months; 4=37-72 months; 5=>72 months
Frequency: 0= unlikely to occur; 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: R=Reversible; I=Irreversible
Ecological/Socio-cultural and Economic Context: 1=Pristine area; 2 = Area affected by human activity; 3=Evidence of adverse effects
Residual Environmental Effect Rating: S=Significant Adverse Environmental Effect; N=Non-significant Adverse Environmental Effect; P=Positive Environmental Effect
Confidence: 1=Low level of confidence; 2=Medium level of confidence; 3=High level of confidence

Table 6.37 Residual Environmental Effects Summary: Marine Related Birds (All phases)			
Phase	**Residual Environmental Effect Rating**	**Likelihood of Significant Adverse Effects**	
		Probability of Occurrence	**Scientific Certainty**
Construction	N	N/A	N/A
Operations	N	N/A	N/A
Decommissioning	N	N/A	N/A
Malfunctions and Accidents	N	N/A	N/A

KEY

Residual Effects Rating: S=Significant Adverse Environmental Effect; N=Non-significant Adverse Environmental Effect; P=Positive Environmental Effect
Probability of Occurrence: Based on professional judgement; 1 = Low; 2 = Medium; 3 = High; N/A = Not applicable (effect is not predicted to be significant)
Scientific Certainty: Based on scientific information and statistical analysis or professional judgement; 1 = Low level of confidence; 2 = Medium level of confidence; 3 = High level of confidence; N/A = Not applicable (effect is not predicted to be significant)

6.3.7 Sable Island

6.3.7.1 Boundaries

The temporal boundaries for the assessment of potential Project effects on Sable Island have been developed taking into consideration that disturbance from Project related vessel and helicopter traffic, or accidental events, could occur at any time during Project construction, operation and decommissioning. Therefore, the temporal boundaries are year-round throughout the life of the Project. The spatial boundary of the assessment is the Sable Island Migratory Bird Sanctuary which encompasses the entire island and includes the habitat contained within the sanctuary and the adjacent tidal waters.

The evaluation and discussion of the environmental effects of the Project on Sable Island is largely focused on habitat related issues rather than on resident and transient species such as seals and avifauna. The potential effects of the Project on these groups are discussed in Sections 6.3.5 and 6.3.6 of this report, respectively.

6.3.7.2 Residual Environmental Effects Evaluation Criteria

A **significant** adverse environmental effect is one that may alter habitat of Sable Island physically, chemically, or biologically, in quality or extent, to such a degree that there is a decline in species diversity within the habitat. This effect would be reflected by a decline in abundance and/or change in distribution of the flora and fauna communities within the Sable Island region, beyond which natural recruitment (reproduction and immigration from unaffected areas) would not return the affected population to its former level within several generations.

A **positive** effect may enhance the quality of Sable Island habitat and/or increase the area of valued habitat.

6.3.7.3 Potential Interactions, Issues and Concerns

Issues and concerns related to Project activities and potential interactions with Sable Island include:

- noise disturbance from Project related helicopter and vessel traffic could potentially affect wildlife use of habitat on the island;
- adverse effects to intertidal habitat, vegetation (including dune stability), and mammals and birds by contact with petroleum products in the event of an accidental spill reaching the shores of the island; and
- effects on Sable Island vegetation and wildlife due to air borne transmissions of contaminants due to acid gas flaring (SO_2) and injection well blowout (H_2S).

Fate and behavior modeling of accidental hydrocarbon spills (refer to Section 3.5) indicates that slicks would dissipate long before reaching Sable Island. It is therefore extremely unlikely that the island would be affected by a hydrocarbon spill.

6.3.7.4 Analysis, Mitigation and Residual Environmental Effects Prediction

Construction

Project construction activities will involve helicopter and vessel traffic; however there will be no routine landing of helicopters or vessels at Sable Island or any Project related activity in the immediate vicinity. The potential effects of helicopter traffic on Sable Island during emergencies and non-routine events are further detailed in the discussion of Malfunctions and Accidents.

Due to the lack of interaction between Project construction activities and Sable Island, and EnCana's adoption of a Code of Practice for Sable Island, no significant adverse environmental effects are predicted during the Project construction phase.

Operation

The potential environmental effects of routine Project related operations on Sable Island will be similar to those identified for construction activities. Routine emissions from the Project may be detectable on the island at the air quality monitoring station which will be established on the island in 2002. However, these emissions would cause only a minor increase in the ambient concentrations even during worst-case conditions, and a negligible increase at most in the long-term average concentrations. Routine emissions would cause no measurable effect on Sable Island vegetation or wildlife; therefore, the predicted environmental effects from Project operation are considered not significant.

Decommissioning

The potential environmental effects of Project related decommissioning activities on Sable Island will be similar to those identified for construction and operation activities. The predicted environmental effects from Project decommissioning are considered not significant.

Malfunctions and Accidents

Only during emergency or other non-routine situations (*i.e.*, servicing of EnCana's refueling facility on Sable Island) will aircraft or vessels land on the island. In the event that landing of vessels or aircraft or other activity is required near the island, EnCana's Code of Practice for Sable Island and the existing Sable Island Emergency Contingency Plan (Canadian Coast Guard 1994) will be adhered to. To prevent potential adverse environmental effects from vessel traffic, a buffer zone of 2 km surrounding Sable Island will be established for EnCana operations. If a landing on Sable Island is required (*i.e.*, at the existing helicopter refueling facility), helicopters will avoid flying over or landing in close proximity to large concentrations of horses and seals, and pilots will take advice from the island manager on positions of breeding tern colonies. In addition, landing approaches will be made at right angles to the long axis of the island, as steep as safely possible, to minimize the area of the island exposed to low-level flying. EnCana maintains a helicopter refueling facility on Sable Island. This facility is fully equipped for spill prevention, containment and mitigation.

Large scale releases of oil (condensate) due to Project accidents or malfunctions are highly unlikely (refer Section 3.2). Spill behaviour modeling concludes that Sable Island is not likely to be affected by an accidental hydrocarbon spill from the Panuke platform as slicks are predicted to generally move away from Sable Island in a SSW direction under the influence of prevailing surface currents. Even if conditions were such that a spill moved toward Sable Island, the slick is predicted to dissipate before it reached the island (refer to Section 3.5). A Spill Response Plan will reduce any adverse environmental effects in the unlikely event of a large spill. It is therefore predicted that there will be no adverse environmental effects on Sable Island due to hydrocarbon spills.

Flaring of acid gas at Deep Panuke during an accidental event or malfunction is predicted to occur during the life of the Project and could last from a few minutes to a maximum of five months in a extremely unlikely, worst case situation. Flaring will also occur while the acid gas management system is undergoing planned maintenance activities. Flaring of acid gas would result in the production of SO_2 that could interact with the vegetation on Sable Island. Assuming a worst case scenario, the maximum ground level concentration of SO_2 (less than 0.002 mg/m^3) is not high enough to cause mortality in plants or produce any visible symptoms of toxicity to plants. Long term continuous exposure of plants to the levels of SO_2 predicted could result in reduced plant growth rates for one season, assuming the coincidence of plant growing seasons. The conditions resulting in the maximum ground level concentration of SO_2 are extremely unlikely to persist; it is therefore predicted that no significant adverse effects are likely to occur to Sable Island vegetation. SO_2 concentrations at Sable Island from acid gas flaring at Deep Panuke would not be high enough to cause any health problems for wildlife on Sable Island. It has been noted that, "with few exceptions, chronic exposure of animals to sulphur dioxide does not produce observable effects at concentrations lower than 20 ppm (52.4 mg/m^3)" (Sullivan and Kreig 1992).

The levels of any acid aerosols potentially transported to Sable Island would be so low they would be considered insignificant, especially given the fact that Sable Island is not considered a sensitive zone to acid precipitation (D. Waugh, Environment Canada, pers. comm. 2001). In general, most acid aerosols generated on the platform will be deposited into the ocean where they will be quickly neutralized.

In the extremely unlikely event of a blowout of the acid gas injection well, it is predicted that wildlife on Sable Island could be exposed to a maximum 1-hour ground level concentration of 5.8 mg/m^3 of H_2S. The exposure, even if it did occur, would be transitory due to the likely short duration of the release. This would not cause any mortality or permanent adverse effects to the health of wildlife on Sable Island. Short term health effects could include irritation to the eyes and upper respiratory tract. The literature suggests that birds are more sensitive than mammals to the effects of low levels of H_2S exposure. These predicted effects would only occur under a long term release and worst case meteorological conditions which would not likely persist. As the hazard of H_2S exposure on Sable Island is extremely unlikely, and the exposure concentration is below observed lethal levels, it is concluded that no significant adverse effects are likely to occur to those animals resident on Sable Island.

6.3.7.5 Cumulative Effects Assessment

Sable Island has been affected over time by human activities, including past cultivation, introduction of non-indigenous species, creation of vehicle trails, establishment of structures and facilities (such as the helicopter refueling facility and marine safety installations), hydrocarbon exploration (*e.g.*, Mobil's C-67 well drilled in 1967), and human presence. The island has also been affected by spills from marine shipping and offshore hydrocarbon activities. Natural processes also continue to change the physical configuration of the island and, consequently, the habitat for various flora and fauna.

The Sable Island Wind Turbine Project is expected to be constructed in 2002. This will create some additional vessel traffic during construction and possibly some minor interactions with birds on the island during operation. Because of a lack of temporal overlap with the Deep Panuke Project during turbine construction, and limited or no interactions during the operational phase of the two projects, no adverse cumulative effects are predicted.

The routine activities associated with construction, operation, and decommissioning of the Project are not expected to significantly affect Sable Island. In particular, helicopter and vessel traffic, which could cause cumulative noise disturbance to wildlife on the island, will not approach Sable Island during routine activities, and mitigative measures will minimize any potential adverse effects of non-routine traffic. In addition, the relative locations of the SOEP Thebaud and Deep Panuke platforms are such that the air emission plumes will not normally overlap resulting in a contribution to Sable Island (*e.g.*, under worst case scenarios, each would contribute to less than 10% of the air quality criteria for the other platform). Therefore, the cumulative environmental effects of the Project in combination with other projects or activities that may effect, or are currently effecting, Sable Island are considered not significant.

6.3.7.6 Follow-up and Monitoring

In the event that Project related vessel or helicopter traffic must interact with Sable Island it will be done so in accordance with the Sable Island Code of Practice, and any observed adverse animal reactions, or other adverse effects associated with the traffic, will be recorded and reported to appropriate regulatory agencies. The resident biologist is under contract to report on any Project related interactions with Sable Island flora and fauna. In the case of an accidental hydrocarbon spill from the Project, it is highly unlikely that there would be any adverse effects on Sable Island. However, if such an interaction were to occur, then monitoring and follow-up will be undertaken to confirm clean-up and recovery.

EnCana supports the establishment of the Sable Island Air Monitoring Station through financial contributions and technical advice to the Environmental Studies Research Fund (ESRF) and participation on the related working groups.

6.3.7.7 Sustainable Use of Renewable Resources

No significant adverse residual environmental effects on this VEC are predicted, therefore, further assessment regarding sustainable use of renewable resources is not required.

6.3.7.8 Summary of Residual Environmental Effects

Vessel and helicopter avoidance of Sable Island will provide adequate mitigation against potential adverse effects of traffic. Spill trajectory modeling indicates that the distance and location of Sable Island in relation to the Project protects it from being adversely affected in the event of an accidental hydrocarbon spill. No significant adverse effects on Sable Island air quality, vegetation and wildlife are predicted during routine operation or accidental events. In summary, no significant adverse residual environmental effects on Sable Island are predicted as a result of Project activities. Tables 6.38 and 6.39 summarize the predicted residual environmental effects of the Project on Sable Island.

Table 6.38 Residual Environmental Effects Assessment Matrix: Sable Island

Project Activity	Potential Adverse Environmental Effect	Mitigation	Significance Criteria for Adverse Environmental Effects					Residual Environmental Effect	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/ Social-cultural and Economic Context		
CONSTRUCTION, OPERATION, DECOMMISSIONING									
Helicopter/vessel traffic (non-routine)	• Disturbance to wildlife (A)	• Avoid flying over Sable Island; maintain 2 km buffer from island for vessel traffic • Application of Sable Island Emergency Contingency Plan and Code of Practice for Sable Island	2	3	1/1	R	2	N	3
MALFUNCTIONS AND ACCIDENTS									
Flaring of acid gas	• Minor reduction of air quality on Sable Island (primarily SO_2 emissions)	• Routine maintenance and prevention measures • Flaring procedure in EPP	1	3	1/1	R	2	N	3
Injection well blowout	• Reduction of air quality on Sable Island (primarily H_2S emissions)	• Routine maintenance and prevention measures • Implement AERCP	1	3	2/0	R	2	N	3
Helicopter/vessel traffic	• Disturbance to wildlife (A)	• Avoid flying over Sable Island; maintain 2 km buffer from island for vessel traffic • Routine maintenance and prevention measures • Application of Sable Island Emergency Contingency Plan and Code of Practice for Sable Island	2	3	1/1	R	2	N	3

Table 6.38 Residual Environmental Effects Assessment Matrix: Sable Island

Project Activity	Potential Adverse Environmental Effect	Mitigation	Significance Criteria for Adverse Environmental Effects					Residual Environmental Effect	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/ Social-cultural and Economic Context		

KEY

Magnitude: 1= Low: *e.g.*, specific group or habitat, localized, one generation or less, within natural variation; 2 = Medium: *e.g.*, portion of a population or habitat, 1 or 2 generations, rapid and unpredictable change, temporarily outside range of natural variability; 3 = High: *e.g.*, affecting a whole stock, population or habitat outside the range of natural variation.
Geographic Extent: 1=<500 m^2; 2=500 m^2 – 1 km^2; 3=1-10 km^2; 4=11-100 km^2; 5=101-1000 km^2; 6=>1000km^2
Duration: 1=<1month; 2=1-12 months; 3=13-36 months; 4=37-72 months; 5=>72 months
Frequency: 0= unlikely to occur; 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: R=Reversible; I=Irreversible
Ecological/Socio-cultural and Economic Context: 1=Pristine area; 2=Area affected by human activity; 3=Evidence of adverse effects
Residual Environmental Effect Rating: S=Significant Adverse Environmental Effect; N=Non-significant Adverse Environmental Effect; P=Positive Environmental Effect
Confidence: 1=Low level of Confidence; 2=Medium level of Confidence; 3=High level of confidence

Table 6.39 Residual Environmental Effects Summary: Sable Island (All phases)			
Phase	Residual Environmental Effect Rating	Likelihood of Significant Adverse Effects	
		Probability of Occurrence	Scientific Uncertainty
Construction	N	N/A	N/A
Operation	N	N/A	N/A
Decommissioning	N	N/A	N/A
Malfunctions and Accidents	N	N/A	N/A

KEY

Residual Effects Rating: S=Significant Adverse Environmental Effect; N=Non-significant Adverse Environmental Effect; P=Positive Environmental Effect
Probability of Occurrence: Based on professional judgement; 1 = Low; 2 = Medium; 3 = High; N/A = Not applicable (effect is not predicted to be significant)
Scientific Uncertainty: Based on scientific information and statistical analysis or professional judgement; 1 = Low level of confidence; 2 = Medium level of confidence; 3 = High level of confidence; N/A = Not applicable (effect is not predicted to be significant)

6.3.8 Onshore Environment

6.3.8.1 Boundaries

The temporal boundaries for assessment of the onshore environment include the period of on-land construction of the pipeline and other facilities (approximately 3-4 months), and routine inspection and maintenance activities during operations. Temporal boundaries also include the eventual decommissioning of the pipeline and related facilities. The spatial assessment boundaries include the onshore study area shown on Figure 2.6. The final 25 m wide RoW will be selected from within this area.

6.3.8.2 Residual Environmental Effects Evaluation Criteria

A **significant** adverse environmental effect is one that results in a decline in abundance and/or change in distribution of one or more populations of species dependent upon affected habitat such that natural recruitment would not return the population(s) to their former level within several generations.

A **positive** effect is one that may enhance the quality or quantity of habitat.

6.3.8.3 Potential Interactions, Issues and Concerns

Linear RoW development for onshore oil and gas pipelines, power transmission lines and highways is not uncommon in Nova Scotia or elsewhere in Canada. Proven environmental protection planning and effective mitigation measures reduce or eliminate adverse environmental effects from such projects.

Issues and concerns related to Project activities and potential interactions with the onshore environment include:

- habitat alteration or disturbance from vegetation clearing and grubbing and overburden removal during pipeline construction;
- species avoidance of habitats within the Project area due to disturbance from noise and human presence during construction, routine maintenance of facilities and decommissioning and abandonment;
- erosion and sedimentation of wetlands and waterbodies due to ground disturbances during construction;
- alteration of the hydrologic regime due to trenching through wetlands;
- vehicle/wildlife collisions during construction/maintenance activities;
- noise disturbance to wildlife from helicopter operations;
- habitat alteration from vegetation control activities during operation; and
- effects on vegetation, wildlife and fish populations from accidental events including spills of fuel, lubricants or hydraulic fluid, forest fires and pipeline rupture.

6.3.8.4 Analysis, Mitigation, and Residual Environmental Effects Prediction

Construction

The principal environmental effects during construction will result from habitat disturbance and alteration during development of the RoW and associated facilities, as well as noise disturbance associated with human presence and equipment use. Approximately 7-8 ha of land will be required for the pipeline RoW, with an additional 0.20 ha for custody transfer/maintenance facilities. Pipeline construction work is highly transitory, thus adverse effects associated with noise and human presence will be localized at any particular working segment within the approximate 2-3 month period of pipeline construction. Effects associated with construction of other onshore facilities will also be localized and temporary.

The precise need for, and location of, temporary road access and work areas during construction, and permanent road and power access to the onshore facilities will be determined during final design. Road and utility corridor and work space will be located in consideration of environmental and engineering constraints and all applicable regulations and guidelines (refer to Section 2.3.3). The EPP will include protection measures approved for use in the province for the development of roads, highways, power line corridors and other developments in similar terrains. No significant adverse effects from road access, temporary work areas, or utility corridors are therefore expected.

The pipeline route will avoid wetlands and Betty's Cove Brook.

Rare Plants

Construction activities such as clearing and grubbing, trenching, and backfilling could cause the physical disturbance of rare plant habitat, particularly habitat for the northern commandra. A total of over 200 northern commandra shoots were found at two wetland locations within the study area. The pipeline RoW will avoid wetlands. If it is necessary to establish the RoW in close proximity to wetlands, mitigative measures will be employed to minimize effects on this species including:

- use of geotextile cloth or corduroy road to minimize disturbance to wetland substrates;
- retention of existing local drainage patterns;
- sediment control measures including debris traps and isolation of stockpiled soil from waterbodies; and
- stabilization and/or revegetation of disturbed areas immediately following construction.

Through avoidance of wetlands and implementation of the above noted measures, no significant adverse environmental effects on rare plants are predicted from construction activities.

Birds

The effects of clearing and grubbing are most severe when these activities are conducted during the period when most bird species are breeding (March to August). Clearing and grubbing at this time could result in direct mortality of eggs and unfledged nestlings. Clearing and grubbing outside of the breeding season will still result in removal of potential nesting habitat; however, birds have the option of establishing nests in adjacent areas. Noise and visual stimuli associated with construction activity can adversely affect birds in habitats adjacent to the pipeline RoW.

A study of the effects of highway construction on passerine species (JWEL 1998b) revealed that within 200 m of the highway, there was a slight reduction in bird abundance, but not a significant reduction in evidence of successful breeding activity. Clearing and grubbing activities will be undertaken outside the breeding season for most bird species (March to August) to minimize adverse effects. The Onshore Construction EPP will include this commitment and ensure compliance with the *Migratory Birds Convention Act* and Regulations for all relevant species including those that nest outside the March to August window.

A breeding bird survey conducted in June 2002 recorded no rare or sensitive bird species within the assessment area. Because there are no known rare or sensitive bird species nesting within the Project area, and through the implementation of appropriate mitigation measures, construction activities are not expected to result in any significant adverse environmental effects on rare or sensitive birds.

Mammals

Clearing and grubbing will result in the loss of vegetative cover that provides food and shelter for mammals. No rare or sensitive mammals were found within the assessment area, nor is there any sensitive mammal habitat present. Therefore, habitat loss associated with construction activity is not expected to have any significant adverse effect on local populations of mammals found within the assessment area.

Noise disturbance during construction may adversely affect deer at a deer wintering area (DWA) and bats at possible hibernation sites outside of the assessment area. White-tailed deer are normally very tolerant of human activity, however, when concentrated in a DWA, their mobility is impaired and their energy reserves are low. Disturbance at this time can result in large numbers of animals expending critical energy reserves, which in turn may cause increased mortality and reduced fecundity. The RoW will not provide increased access to the DWA by non-employees (*e.g.*, for hunting or use by recreational vehicles) since it runs adjacent to an existing gas pipeline, along the portion of the proposed pipeline route that borders the DWA. Blasting conducted during the winter months could disturb hibernating bats, resulting in increased energy expenditures which could cause higher rates of mortality as bats prematurely deplete their fat reserves. Thomas (1995) has shown that exposure of hibernating little brown bats to disturbances such as lights and noise resulted in increased activity that lasted up to 8.5 hours following the disturbance event.

Construction activities will be avoided within 200 m of the DWA from January to April if snow depths are greater than 30 cm) which will minimize adverse environmental effects associated with noise disturbance to white-tailed deer. An inspection of mine shafts in the area conducted in June 2002 revealed unlikely hibernaculae for little brown bats. Another survey will be conducted of mineshafts in the area in conjunction with the onshore topographic and geotechnical surveys. If bats are found to be using abandoned shafts in the area, EnCana will avoid onshore blasting from November to April, when hibernating bats could potentially be present.

Herpetiles

Three sites having high potential as four-toed salamander breeding habitat were found in the assessment area (within wetlands and habitat associated with Betty's Cove Brook). Clearing, grubbing, and trenching conducted in or near salamander breeding sites could result in habitat loss or direct mortality of adults, eggs, or larvae. A herpetile survey conducted in June 2002 revealed that no four-toed salamanders were present at these potential sites. Furthermore, the pipeline route will avoid wetlands within the study corridor. No significant adverse environmental effects to four-toed salamanders or wetlands from Project construction are therefore predicted.

Freshwater Habitat

The pipeline RoW will avoid crossing Bettys Cove Brook. Stream crossings, if required, (*i.e.*, for access road construction) will follow standard DFO and NSDEL guidelines for erosion and sediment control (*e.g.*, NSDOE 1998; DFO *et al.* 1981). As well, a habitat assessment will be undertaken at all crossing locations and site-specific mitigative plans will be developed and included in the Onshore Construction EPP, depending on the habitat characteristics at each site. Through the use of well-established mitigation measures including erosion and sediment control measures, no significant adverse environmental effects on freshwater habitat are predicted to result from Project construction.

Acid drainage risk is considered to be low, however, this will be confirmed in the pre-construction geotechnical survey of the pipeline corridor. In the unlikely event that acid generating bedrock is encountered during construction, excavated acid rock will be managed according to the *Sulphide Bearing Materials Disposal Regulations* and the Guidelines for Development on Slates in Nova Scotia (NSDOE and Environment Canada 1991), which include requirements for monitoring surface water runoff. M&NP's Acid Rock Drainage Construction Response Plan will also be consulted. Specific measures to address potential acid drainage will be included in the Onshore Construction EPP.

In summary, avoidance of wetlands and other sensitive habitat during final pipeline routing is the preferred mitigation for reducing effects on onshore species of concern. In the event that avoidance is not feasible, proven and readily available mitigative measures will be implemented to minimize construction related environmental effects on wetland habitat as well as other wildlife resources in the assessment area. This will include best practices to be followed with respect to clearing. For example, existing vegetation will be preserved where possible and vegetated buffer zones will be maintained as appropriate to protect resources at risk. Merchantable timber will be salvaged. Where possible, other vegetation will be used to create or restore lost habitat (*e.g.*, piling brush to create ruffed grouse habitat). Vegetative debris will be chipped on-site, away from surface waters, for use as mulch or compost feedstock. In general, burning of vegetative debris will be prohibited as a pollution prevention measure. Assuming incorporation of these mitigative measures, no significant adverse environmental effects on the onshore environment from Project construction are predicted.

Operation

Disturbance to wildlife and avoidance of habitat will persist throughout the operation phase, although Project activity levels will be greatly decreased compared to the construction phase. EnCana will take care to avoid use of invasive species in post-construction revegetation efforts and will place a clear priority on the use of native species. Vegetation management practices within the RoW and clearance around other facilities will be infrequently required during operations (*e.g.*, only done every several years and using mechanical means). Worker activity will be restricted to the RoW. While not prohibited, use of ATVs on the pipeline RoW will be discouraged through posting of warning signs along the RoW, and consultations with local ATV clubs. Any plan to limit access to wetlands by ATVs must consider the availability of other access routes. In the case of the wetlands in the Goldboro Industrial Park, access to these wetlands can currently by achieved along other pipeline corridors, and on numerous trails and access points off Sable Road.

Barriers consisting of large closely-placed boulders may be placed at major access points, such as on Route 316 and the Sable Road crossing point, to discourage access to the corridor. Similarly, any large boulders encountered during construction will be placed strategically along the pipeline RoW to reduce access to the extent possible to adjacent wetlands. The provision of gates, barriers and appropriate sized shrubs or any other such mitigation must be considered within the context of the development plan for the Goldboro Industrial Park as proposed by the Municipality of the District of Guysborough.

Assuming the incorporation of these mitigative measures, no significant adverse environmental effects from Project operation on the onshore environment are predicted.

Decommissioning

Pipeline decommissioning involves activities similar to construction. The pipeline will be cleaned and capped, and above-ground structures will be removed. Human presence and noise associated with decommissioning activities are not predicted to result in significant adverse environmental effects on the onshore environment. Following decommissioning, re-vegetation and lack of human disturbance may cause areas previously abandoned by wildlife, to be reused.

Malfunctions and Accidents

The principal environmental concerns associated with Project malfunctions and accidents are related to pipeline releases, spills of hazardous liquids, forest fires, or vehicle-wildlife interactions. An accidental release of gas from the onshore pipeline is extremely unlikely (refer to Section 3.3). An accidental pipeline release (leak, hole or rupture) would result in either dispersion or delayed ignition of the flammable gas (refer to Section 3.3). Gas release from a pipeline rupture would activate measures outlined in the AERCP and limit the duration and extent of the environmental effects. Forest fires resulting from gas ignition would be responded to immediately with local firefighting resources, and would likely be quickly controlled. Accidental discharge of natural gas would dissipate to the atmosphere rather than pooling as liquid and therefore is not expected to interact with freshwater habitat (*e.g.*, Betty's Cove Brook) or wetlands. The pipeline will be designed to industry and regulatory standards, tested during commissioning and periodically inspected thereafter to reduce risk of leaks or rupture.

The effects of a fuel or hazardous material spill are expected to be relatively localized and regional populations or rare species are not likely to be affected. In June 2002, herpetile surveys were conducted in areas identified as having high potential to harbour four-toed salamanders. The surveys did not reveal the presence of this species, suggesting that it is not present in the area. The only other rare species potentially present in close proximity to the pipeline is northern commandra. The number of northern commandra shoots present in the study area is estimated to be approximately 200 shoots. A botanical survey conducted in Guysborough County (JWEL 1998a) revealed the presence of an estimated 2,250 shoots of northern commandra at 11 locations. If all 200 northern commandra shoots were lost as a result of an accidental event, it would represent 9% of the known population in Guysborough County.

Vehicle collisions with wildlife such as white-tailed deer are considered highly unlikely due to the relatively short duration of activities that require vehicles. Vehicle operations, including vehicle speed, will be strictly enforced as part of the Project EPP.

None of these accidental events would affect regional populations of rare or sensitive species, or critical habitat. The residual adverse environmental effects of the Project related malfunctions and accidents on the onshore environment are therefore not predicted to be significant.

6.3.8.5 Cumulative Effects Assessment

Other projects and activities that may interact to cause cumulative environmental effects on the onshore environment include operation of the SOEP gas plant at Goldboro, operation/maintenance of the M&NP mainline natural gas transmission pipeline and the SOEP Point Tupper natural gas liquids pipeline, forestry operations and residential, commercial, and industrial development in and around Goldboro. The effects of these projects and activities may have included loss or alteration of habitat (due to clearing of vegetation), avoidance of habitat (due to noise from vehicles and equipment and human presence), and degradation of habitat quality (due to erosion, sedimentation, or accidental spills). These other projects and activities are expected to continue into the future. Air emissions associated with onshore facilities of the Deep Panuke Project are negligible, limited to emissions from construction equipment and emissions related to a pipeline rupture. The Project is therefore not predicted to contribute cumulatively to air emissions in the onshore area.

SOEP and M&NP conduct ongoing, routine inspections of their facilities to identify any adverse environmental effects of their activities. To date, no significant adverse environmental effects have been identified. It is anticipated that the SOEP mitigative measures will remain effective and these conditions will remain constant. No cumulative effects are therefore predicted with the Deep Panuke Project.

M&NP will also construct a custody transfer facility to accommodate the tie-in with the Deep Panuke pipeline. This facility will be located immediately adjacent to the EnCana onshore custody transfer and pipeline maintenance facility and will include similar size and type of structures. The construction and operation of the M&NP station is expected to coincide with that of the EnCana onshore facilities thus causing potential cumulative environmental effects (*e.g.*, noise, dust traffic). During construction, these effects will be short term (3-4 months), localized and similar in magnitude (*i.e.*, low) as other comparable construction projects. Both projects will be constructed in an area designated for industrial development. A small, incremental increase in traffic and noise from maintenance activities will result from the combination of both projects in close proximity; these effects will not be significant. It is expected therefore, that there will be no significant adverse cumulative effects from the combined construction and operation of the Deep Panuke and M&NP facilities.

Hudson Energy Company has proposed to construct a natural gas-fired power generation facility in Goldboro. Although site selection has yet to be finalized (project has been put on hold), the potential property is located approximately 600 m southwest of the SOEP gas plant site. Construction of the facility was anticipated to commence in 2003 prior to project suspension. Cumulative effects associated with the Hudson Energy project are anticipated to be similar to those described for the SOEP gas plant. The Neptune project is also anticipated to include a gas fired power generation facility somewhere within the industrial park area. Because these projects have not completed environmental assessments for their respective developments, it is difficult to predict cumulative effects should these projects both proceed to implementation. It is anticipated that the onshore component of the Deep Panuke Project (*i.e.*, pipeline, small metering and maintenance facility) will be small in comparison to the two much larger power generation facilities with respective pipelines or cables and water utilities. Both of these larger projects would be subject to a rigorous environmental approval process which would further investigate potential cumulative effects and impose operating conditions that would further serve to reduce the long term potential for cumulative effects in the Goldboro area.

Forestry activities are regulated by the provincial government while residential, commercial and industrial development in and around Goldboro is planned for and managed by local planning authorities. The cumulative effects of the proposed pipeline and local forest harvesting operations will be temporary. Habitats currently abundant in the area will develop on the disturbed sites (pipeline and clear-cuts), re-establishing avifaunal communities. The avifaunal communities on the clear-cuts will become similar to those of mature woodlands within 20 years. The avifaunal community on the pipeline RoW will be similar to that of the semi-barrens habitat, which currently occupies approximately 30% of the pipeline corridor. The cumulative effects of the pipeline construction and forestry operations will consist of an initial decrease in bird abundance, which is expected to recover as soon as shrub cover re-establishes, and a shift in species composition which in the clear-cut areas can be expected to return to conditions similar to the original forests within 20 years. The cumulative effects of these activities will be not significant.

Most of the onshore study area includes lands that have been zoned by the municipality for industrial development, therefore, the Project is considered a compatible land use. It is expected that the municipal authorities consider the potential cumulative effects, through regional planning, of development and the resulting changes to the environment. The potential for cumulative effects on species such as northern commandra will be reduced by the requirement of future proponents to conduct wetland evaluations in instances where wetlands are to be adversely affected by developments.

Given the very limited extent of the onshore components of the Deep Panuke Project, and their location adjacent to, or within, lands developed or designated by municipal authorities for future development, and avoidance of sensitive areas (*e.g.*, wetlands, Betty's Cove Brook), no significant adverse cumulative effects are predicted.

6.3.8.6 Follow-up and Monitoring

A breeding survey and herpetile survey, recommended in the EIS (DPA Volume 4) were conducted in June 2002 (refer to Section 6.3.8.4). A detailed habitat survey will be conducted along the onshore pipeline route when the final routing has been determined. Based on these survey results, the Onshore EPP will be refined to incorporate applicable mitigation measures to reduce potential effects on species of special status, if applicable.

Six mineshafts in the vicinity of Sable Road were inspected in early June 2002 and were found to not provide suitable habitat as hibernacula for little brown bats. A follow-up survey will be conducted of mineshafts in the area, in conjunction with the onshore topographic and geotechnical surveys.

A geotechnical study will be conducted over the selected corridor and will address identification of potential acidic bedrock areas along the corridor. This data will provide the basis for a mitigation plan to be included in the Onshore Construction EPP.

6.3.8.7 Sustainable Use of Renewable Resources

No significant adverse environmental effects, including cumulative environmental effects, are anticipated for the onshore environment as a result of the Project, therefore, further assessment regarding sustainable use of renewable resources is not required.

6.3.8.8 Summary of Residual Environmental Effects

The environmental assessment investigated a pipeline corridor within which the pipeline and any associated structures would be situated. The assessment identified several environmental constraints present within this corridor, including wetlands, a rare plant species (northern commandra) found in two of the wetlands, suitable habitat for an uncommon amphibian species (four-toed salamander), and possible hibernation sites for little brown bats. In June 2002, breeding bird and herpetile surveys were conducted within the pipeline corridor. These surveys indicated that there were no bird, reptile, or amphibian species at risk breeding in the corridor. Inspection of mine shafts in the area revealed unlikely hibernaculae for little brown bats.

EnCana has committed to clearing during the winter months in order to minimize adverse effects on migratory birds (*i.e.*, no clearing between March and August). In addition, EnCana is committed to avoiding wetlands, and Betty's Cove Brook. EnCana is also committed to not blasting during the time when little brown bats may be hibernating (November to April) if they are found to be present during follow-up investigations. These results and commitments will greatly reduce any adverse effects on terrestrial environmental constraints in the corridor. As such, no significant adverse environmental effects are predicted on the onshore environment.

Tables 6.40 and 6.41 summarize the predicted residual environmental effects of the Project on the onshore environment.

Table 6.40 Residual Environmental Effects Assessment Matrix: Onshore Environment

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Adverse Environmental Effects					Residual Environmental Effect	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/ Social-cultural and Economic Context		
CONSTRUCTION									
Onshore Construction	**Rare Plants** • Direct mortality (A) • Habitat alteration/loss (A)	• Avoidance of wetlands • Minimize area of disturbance in RoW • Flag rare plant locations adjacent to RoW, access, and other work areas • Adherence to Onshore Construction EPP	1	2	2/1	I	2	N	3
	Birds • Habitat alteration/loss (A) • Noise (A) • Human presence (A)	• Clearing and grubbing conducted outside the March to August breeding season • Short construction period • Restrict activities to RoW and designated work areas	1	2	2/1	R	2	N	3
	Mammals • Habitat loss (A) • Disturbance or displacement (A) • Mortality (A) • Human presence (A)	• Restrict activities to RoW and designated work areas • Short construction period	1	2	2/1	R	2	N	3

Table 6.40 Residual Environmental Effects Assessment Matrix: Onshore Environment									
Project Activity	**Potential Positive (P) or Adverse (A) Environmental Effect**	**Mitigation**	**Significance Criteria for Adverse Environmental Effects**					**Residual Environmental Effect**	**Level of Confidence**
			Magnitude	**Geographic Extent**	**Duration/Frequency**	**Reversibility**	**Ecological/ Social-cultural and Economic Context**		
	Deer Wintering Areas • Habitat loss (A) • Disturbance or displacement of deer (A) • Mortality (A) • Human presence (A)	• Site access and RoW to avoid DWA • Vehicle speed regulating and enforcement • Adherence to Onshore Construction EPP • Avoid working within 200 m of DWA when snow depths are greater than 30 cm	1	2	2/1	R	2	N	3
	Bat Hibernacula • Disturbance of hibernating bats (A)	• Conduct surveys of nearby mine workings for hibernating bats • If hibernating bats present, avoid blasting from November to March if practical	1	2	2/1	R	2	N	2
	Herpetiles • Direct mortality (A) • Habitat loss (A) • Sedimentation into wetlands (A)	• Avoidance of wetlands	1	2	2/1	R	2	N	3
	Wetlands • Habitat loss/alteration (A) • Increased erosion leading to sedimentation (A)	**As applicable:** • Avoidance of wetlands • Conduct wetland evaluation, for adjacent wetlands if required • Erosion and sediment control measures • Adherence to Onshore Construction EPP	1	1	2/1	R	1	N	3

Table 6.40 Residual Environmental Effects Assessment Matrix: Onshore Environment

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Adverse Environmental Effects: Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/ Social-cultural and Economic Context	Residual Environmental Effect	Level of Confidence
	Freshwater Habitat • Erosion and sedimentation (A) • Water quality degradation (A)	**As applicable:** • Avoid instream work during sensitive periods (May 15 to July 15) • Implement appropriate stream crossing techniques • Erosion and sediment control measures • Adhere to Onshore Construction EPP	1	1	2/1	R	2	N	3
OPERATION									
Vegetation control Inspection and testing of facilities and equipment	• Noise (A) • Increased human presence (A) • Wildlife disturbance (A)	• Workers restricted to access, RoW, and designated work areas • Adherence to Onshore EPP • Avoid use of herbicides, where practical and near wetlands • Schedule routine maintenance to non-critical periods for breeding birds and overwintering deer, where practical	1	1	1-2/1	R	2	N	3
Increased access	• Noise (A) • Increased human presence (A) • Wildlife disturbance (A)	• Workers restricted to access, RoW, and designated work areas • Controlled access/signage	1	2	5/6	R	2	N	3

Table 6.40 Residual Environmental Effects Assessment Matrix: Onshore Environment

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Adverse Environmental Effects					Residual Environmental Effect	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/ Social-cultural and Economic Context		
MALFUNCTIONS AND ACCIDENTS									
Pipeline rupture	• Wildlife/ vegetation mortality (A) • Habitat alteration/ destruction (A)	• Preventative maintenance and inspection • Implementation of AERCP • Adherence to Onshore EPP	2	2	1/1	R	2	N	2
Fuel or hazardous material spill	• Wildlife/ vegetation mortality (A) • Habitat degradation	• Preventative maintenance and inspection • Implementation of AERCP and Spill Response Plan • Adherence to Onshore EPP	1	1	1/1	R	2	N	3
Vehicle collisions	• Wildlife mortality (A)	• Adherence to onshore EPP for vehicle operations, including speeds	1	1	1/1	R	2	N	3
Forest fire	• Habitat alteration/ destruction (A)	• Implementation of AERCP	2	2	1/1	R	2	N	2

KEY

Magnitude: 1= Low: *e.g.*, specific group or habitat, localized, one generation or less, within natural variation; 2 = Medium: *e.g.*, portion of a population or habitat, 1 or 2 generations, rapid and unpredictable change, temporarily outside range of natural variability; 3 = High: *e.g.*, affecting a whole stock, population or habitat outside the range of natural variation.
Geographic Extent: 1=<500 m2; 2=500 m2 – 1 km2; 3=1-10 km2; 4=11-100 km2; 5=101-1000 km2; 6=>1000km2
Duration: 1=<1month; 2=1-12 months; 3=13-36 months; 4=37-72 months; 5=>72 months
Frequency: 0= unlikely to occur; 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: R=Reversible; I=Irreversible
Ecological/Socio-cultural and Economic Context: 1=Pristine area; 2= Area affected by human activity; 3=Evidence of adverse effects
Residual Environmental Effect Rating: S=Significant Adverse Environmental Effect; N=Non-significant Adverse Environmental Effect; P=Positive Environmental Effect
Confidence: 1=Low level of Confidence; 2=Medium level of Confidence; 3=High level of confidence

Table 6.41 Residual Environmental Effects Summary: Onshore Environment (All phases)			
Phase	**Residual Environmental Effect Rating**	**Likelihood of Significant Adverse Effects**	
		Probability of Occurrence	**Scientific Uncertainty**
Construction	N	N/A	N/A
Operations	N	N/A	N/A
Decommissioning	N	N/A	N/A
Malfunctions and Accidents	N	N/A	N/A
KEY **Residual Effects Rating:** S=Significant Adverse Environmental Effect; N=Non-significant Adverse Environmental Effect; P=Positive Environmental Effect **Probability of Occurrence**: Based on professional judgement; 1 = Low; 2 = Medium; 3 = High; N/A = Not applicable (effect is not predicted to be significant) **Scientific Uncertainty:** Based on scientific information and statistical analysis or professional judgement; 1 = Low level of confidence; 2 = Medium level of confidence; 3 = High level of confidence; N/A = Not applicable (effect is not predicted to be significant)			

6.3.9 Cumulative Effects Summary

The biophysical assessment adapts an integrated approach to the assessment of cumulative environmental effects, such that the overall assessment of residual environmental effects on each VEC includes the consideration of cumulative environmental effects (refer to Section 6.2 for methodology).

6.3.9.1 Air Quality

The ambient air quality in the study area, described in Section 6.1.1.2 reflects the influence of emissions from other past and current projects and activities occurring within or outside of the Project area. Other past and current sources of emissions within the study area include emissions from hydrocarbon exploration and production platforms, and engine emissions from vessels engaged in fishing, tourism, hydrocarbon exploration (including seismic and drilling activities), supply of hydrocarbon production facilities (*e.g.*, SOEP), military activities, and domestic and international shipping. It has been estimated that about 80% of Nova Scotia's air pollution originates outside the provincial borders, primarily in the industrial centre of North America (Province of Nova Scotia 2001). Pollutants transported from these industrial areas typically include sulphates, nitrates and ozone precursors. All quantities are significantly lower than the Nova Scotia air quality criteria. It is assumed, for the purposes of this assessment that these existing activities will continue to be carried out and to produce emissions at current levels.

It is anticipated that incremental emissions will result from future seismic and exploration activities that will be carried out in the study area and from the construction of the recently announced Blue Atlantic, Neptune, and Hudson Energy (currently on hold) projects that will traverse the study area. No cumulative interactions with the Sable Island Windpower project affecting air quality are anticipated.

Construction of onshore components of the Project and construction of onshore components of Neptune and Hudson Energy Projects may overlap temporally and spatially. However, the effects of emissions from construction of the Project (*e.g.*, dust, construction vehicle emissions) are small in geographic extent, short in duration, and reversible and will not cause significant cumulative effects with these other proposed projects. The cumulative effect of emissions from Project construction in combination with all existing (and ongoing) emission sources affecting the study area is not expected to be significant. There may be some temporal and/or spatial overlap of the Project construction emissions with emissions from other future exploration drilling activities outside of the Panuke lease but within the study area, and seismic exploration both on and outside the Panuke lease. These other future emissions, however, would be similar in scale to those of the Project construction, and are not expected to result in a significant cumulative adverse effect on air quality. No temporal overlap with construction of SOEI's platform at Alma is expected; therefore, no cumulative effects are anticipated as a result of construction phase activities.

The cumulative effect of operational emissions in combination with all existing (and ongoing) emission sources affecting the study area is not expected to be significant. Emissions from vessel traffic and flaring during Project operation are expected to be similar in extent, duration, and reversibility to those during construction. There may be spatial and temporal overlap between Project operations and construction activities for the Blue Atlantic Transmission System or the Neptune and Hudson Energy subsea cables in the future; however, any cumulative interaction is not expected to result in a significant adverse effect on air quality due to the low scale of the Project emissions. Project air emissions, including those from flaring and power generation on the platform, will be well within regulatory limits and generally outside of the zone of influence of air emissions generated by future projects such as hydrocarbon exploration on other leases, and the Blue Atlantic, Neptune and Hudson Energy Projects. In the areas where the Hudson and Neptune projects are expected to generate significant air emissions from operation of gas fired power generation facilities, along with the current operation of the SOEP gas plant (*i.e.*, Goldboro), Deep Panuke Project air emissions will be limited mainly to dust and construction vehicle emissions generated during installation of the onshore portion of the pipeline. The onshore portion of the Blue Atlantic project (*i.e.*, gas processing) is expected to be located at a significant distance from the Deep Panuke Project (*i.e.*, in southwest Nova Scotia). The Neptune and Hudson Energy projects are expected to use gas fired turbines which will minimize the generation of the long range transport of air pollutants (*e.g.*, SO_2) which could interact cumulatively with Deep Panuke Project air emissions. It is expected that Blue Atlantic gas processing operations will be required to meet all current and future emissions requirements (*e.g.*, SO_2 limits) which, in combination with its distance from the Project, will minimize the potential for significant cumulative effects with the Deep Panuke Project.

A visible flare plume from Thebaud has been reported. While quantitative determinations have not been made of the air quality impacts at Thebaud, the “sweet” SOEP gas is not expected to contain large volumes of pollutants (*e.g.*, SO_2) which could interact significantly with Deep Panuke offshore emissions. SOEP Tier II development may result in additional air emissions at Thebaud, however these emissions are not anticipated to overlap spatially with Deep Panuke emissions.

The Project will emit GHG (including CH_4 and CO_2) from power generation and other mobile and stationary sources. The issue of global warming and the role of GHG is an international issue. Canada has been actively involved in developing strategies to limit GHG emissions through mechanisms such as the VCR program. The estimated contribution of the Deep Panuke Project to total estimated GHG by all Canadian human-made sources is extremely small (0.03% of 1995 Canadian totals) (Environment Canada 1997). Since 1994, EnCana has achieved a cumulative reduction in GHG emissions of 2.5 million tonnes of CO_2 equivalent (to the end of 2000). This cumulative reduction amounts to approximately 14% of the total reductions reported by the oil and gas industry to CAPP through the VCR program. EnCana is committed, in the VCR program, to continuous improvement and has implemented a program to reduce GHG emissions throughout its operations through process optimization and technological improvements. The choice of acid gas injection incorporates permanent disposal of a significant quantity of CO_2 that would otherwise be emitted to the atmosphere. EnCana is committed to investigating other GHG reduction opportunities that arise during this Project.

The governments of Canada and Nova Scotia have agreed to an SO_2 emissions cap of 189,000 tonnes annually in Nova Scotia (Canada/Nova Scotia Agreement Respecting Acid Rain Reduction Program). This program is designed to limit sulphur emissions to prevent acid rain damage. A limit of 145,000 tonnes of this cap has been allocated to Nova Scotia Power Inc. in the provincial *Air Quality Regulations* under the *Environment Act*. The SO_2 emissions from the Deep Panuke Project are about 1,596 tonnes per year, or 1% of the cap.

The Government of Nova Scotia has issued an energy strategy for the province, Seizing the Opportunity: Nova Scotia’s Energy Strategy (2001), that includes, among other initiatives, the further reduction of SO_2 emissions in the province. The strategy requires a 25% reduction in SO_2 emissions by 2005, and a further 25% reduction by 2010. The EnCana sulphur management strategy results in permanent disposal of sulphur by-products to an underground reservoir, minimizing the release to the atmosphere; this is fully compatible with this part of the provincial energy strategy.

The potential environmental effects, including cumulative effects, of decommissioning would be similar to those of construction; no significant adverse effects are anticipated.

The potential future cumulative effects resulting from a malfunction or accident would be the same as those described previously in this section. Other than the extremely unlikely possibility of a significant adverse effect due to a surface or subsurface blowout, or pipe rupture at the platform, no significant adverse cumulative effects on air quality are predicted.

6.3.9.2 Water Quality

Past and existing projects and activities have, to varying degrees, affected marine water quality on the Scotian Shelf. These include domestic and international vessel traffic, oil and gas exploration and production, and fishing activity. The effects of these other past and present activities are reflected in the description of the existing (baseline) water quality conditions (described in Section 6.1). The existing data for the Project area do not indicate any particular water quality concerns, though occasional events, such as illegal discharges from passing vessels have been reported offshore Nova Scotia.

On-going and future projects and activities in the region which may affect marine water quality include: vessel traffic; the SOEP (existing and future development); offshore petroleum exploration drilling activity and seismic exploration; commercial fishing; and potentially, the future Blue Atlantic, Neptune and Hudson Energy projects. A number of these project activities have or would have similar discharges to the marine environment as the proposed Project, and thus, similar effects on marine water quality. Like the Deep Panuke Project, these other projects and activities will, however, also be subject to specific guidelines and regulations to prevent and minimize their environmental effects. These guidelines and regulations are regularly reviewed and refined to provide ever-increasing protection to the marine environment. In addition, developers are applying new methods and technology to reduce the potential for potential effects on the environment. The potential effects of the Deep Panuke Project on marine water quality are likely to be minor, localized and of relatively short-term duration. Given the widespread spatial and temporal distribution of these future projects and activities, there is limited potential for the effects of these actions to interact with those of the proposed Project. It is therefore not likely that the Deep Panuke Project will result in significant cumulative environmental effects in combination with other projects and activities.

6.3.9.3 Marine Benthos

Projects and activities in the study area that may interact cumulatively with marine benthos include past and present offshore platforms (Cohasset Project and SOEP), the SOEP pipeline, exploration drilling associated with offshore petroleum exploration and commercial fishing. While it is anticipated that marine benthos may be subject to incremental effects from future exploration activities in the study area, it is not anticipated that ongoing or future projects along the Scotian Shelf edge (including the proposed Blue Atlantic, and Hudson Energy projects) will contribute to cumulative effects.

Land-based sources of pollution were considered as a potential contribution to cumulative effects on benthos, particularly in the nearshore. Results of a survey completed for EnCana in 2001, however, found that in the nearshore Goldboro area, with the exception of one sample, the petroleum hydrocarbon concentrations were under the laboratory detection limit. This survey also found no evidence of contaminated sediments from old mine tailings, reported to possibly occur in the area.

Based on ongoing monitoring programs at SOEP, it is unlikely that any adverse effects due to construction or operation of the SOEP could interact cumulatively with Deep Panuke. The distance between the SOEP and Deep Panuke platforms (45 km to Thebaud and 23 km to the future platform at Alma) will further reduce the likelihood of cumulative effects on marine benthos. Similarly, no significant adverse effects on the benthos have been observed from the installation and presence of the SOEP pipeline, and none are anticipated with the Deep Panuke pipeline; therefore, no significant cumulative effects on benthos from the presence of the two pipelines are predicted.

Exploration drilling activities are generally short term (60 to 90 days) in any one area, are localized and not likely to result in significant effects on marine benthos. In addition to the temporary, localized nature of exploration drilling, the potential for cumulative effects with Deep Panuke are further limited by the widely dispersed nature of these activities and lack of spatial and temporal overlap. Previous development and exploration drilling for the Cohasset Project and Deep Panuke are concentrated closely within the immediate Project area and monitoring has indicated that benthic communities have for the most part returned to their pre-drilling state. Since localized disturbances of the benthos from the current Project are expected to be temporary (one to three years), there is no significant cumulative effect anticipated with regard to past drill waste discharges. Future exploration drilling conducted by EnCana within the Panuke licence will have similar effects as those of the proposed development drilling program and no significant cumulative effects are anticipated.

In conclusion, there is currently no evidence of incremental degradation of benthic communities from oil and gas activities on the Scotian Shelf. Effects from discharges, as evidenced from EEM results, have been relatively localized, temporary and unlikely to overlap spatially or temporally with other projects. EEM conducted for the Deep Panuke Project (including baseline monitoring) has, and will continue, to provide information that will (in conjunction with monitoring data from other projects), begin to detect any widespread, incremental environmental changes. The EEM will detect and assess Project-induced changes in the environment, providing essential feedback to operational managers who can effect any necessary modifications to operational activities or emissions.

Messieh *et al.* (1991) reported that fishing boats have trawled or dredged 4.3 million km of seabed on the eastern Canadian seaboard from 1985 to 1991. In this context, effects on benthos from drilling operations would result in negligible increases to the perturbation that already exists.

6.3.9.4 Marine Fish

Projects and activities in the study area that may interact cumulatively with marine fish at the Deep Panuke site include oil and gas exploration and production, commercial fishing and domestic and international shipping. In addition to these human activities, marine fish populations in the study area may be affected by natural factors, such as changes in prey and predator populations in areas within their natural range that are outside of the study area. However, it is not anticipated that ongoing or future projects or activities along the Scotian Shelf including the Blue Atlantic, Neptune and Hudson Energy projects) will contribute to cumulative effects.

Based on ongoing monitoring programs at the SOEP, it is unlikely that any adverse effects due to construction or operation of the SOEP could interact cumulatively with Deep Panuke. The distance between the SOEP and Deep Panuke platforms (45 km to Thebaud and 23 km to the future platform at Alma) will further reduce the likelihood of cumulative effects on marine fish. Similarly, no significant adverse effects on fish have been observed from the installation and presence of the SOEP pipeline, and none are anticipated with the Deep Panuke pipeline, therefore no significant cumulative effects on marine fish from the presence of the two pipelines are predicted.

Exploration drilling activities are generally short term (60 to 90 days) in any one area, localized and not likely to result in significant effects on marine fish. In addition to the temporary, localized, nature of exploration drilling, the potential for cumulative effects with Deep Panuke are further limited by the widely dispersed nature of these activities and lack of spatial and temporal overlap. Future seismic exploration in the study area could adversely affect fish, eggs, and larvae (CNSOPB 1998); however, these effects (which include avoidance and minor egg/larval mortality) are not considered to be significant. These effects could interact cumulatively with the Project; however, the effects related to seismic exploration are expected to be temporary and are not expected to result in significant cumulative adverse effects.

The Cohasset Project, currently in Phase I of decommissioning, lies approximately 12 km to the northwest of the Project site. No significant effects on fish populations have been observed thus far from this decommissioning operation, and no cumulative interactions with the Deep Panuke Project are anticipated.

The Project will add to the existing safety and fishing exclusion zones already established around other offshore platforms in the region (*i.e.*, Cohasset Project, SOEP). Fishing activity within these zones is restricted, possibly resulting in a minor positive cumulative effect on recruitment into marine fish populations, by providing a larger refuge area for spawning individuals. This positive effect could be offset by a localized reduction in water quality associated with routine discharges from operational platforms. Unburied portions of the pipeline will provide an additional reef effect similar to that created by the SOEP pipeline, potentially providing a minor cumulative positive environmental effect on fish.

The effects resulting from a malfunction or accident are likely to be short-lived and limited in spatial extent and are therefore unlikely to interact with effects from other projects and activities to cause significant cumulative effects on marine fish populations. Any effect would likely approximate normal variability or rapidly return to pre-spill levels. These effects would overlap spatially and temporally with the normal effects of the Project and other projects or activities. However, it is not likely that such a low probability event, would overlap either temporally or spatially with a spill from any other project or activity.

6.3.9.5 Marine Mammals (Seals and Whales)

Studies of the dynamics of marine mammal ecosystems suggest that indirect human intervention, such as changes in fishing technology and management, can have important effects on marine mammals. Such interventions can involve overexploitation of marine mammals, altering the dynamics of their predators (Brodie and Beck 1983), or diminishment of the food base of marine mammals through overfishing (Trites *et al.* 1997). Other activities that may have an effect (*e.g.*, noise or other disturbances from industrial activity, trawlers, shipping, whale watching) are difficult to quantify and may involve habituation of animals over the long term (Richardson *et al.* 1990; Watkins 1986).

Activities that may contribute to the cumulative effects of the Project on marine mammal populations in the study area include past commercial sealing and whaling, vessel collisions, noise disturbances from vessel and aircraft traffic, oil and gas exploration and production and commercial fishing. Effects from these activities on marine mammals may be negative (*i.e.*, noise and collisions) or positive (*i.e.*, the small reef and refuge effect of platforms and unburied pipelines). Marine mammal populations may also have been positively affected by the establishment of the Whale Sanctuary in the outer Gully in 1994 and the Gully Area of Interest (candidate Marine Protected Area). In addition to these human influences, marine mammal populations in the study area are effected by natural factors, such as changes in prey and predator populations.

It is anticipated that marine mammals may be subject to incremental effects from future seismic and exploration activities that will be carried out in the study area and from the construction of the recently announced Blue Atlantic, Neptune and Hudson Energy projects that will traverse the study area. These activities are expected to have similar impulsive and chronic noise effects as predicted for the Project. The potential Project effects of impulsive underwater noise from platform construction (pile driving) are unlikely to overlap spatially and temporally with other impulsive noise sources (*e.g.*, seismic exploration) due to the short term and/or widely spread nature of these activities. Due to the predicted limited temporal and spatial extents of the effects of impulsive noise from these activities, it is expected that there would be enough unaffected areas elsewhere to which marine mammals could move to avoid any effect. Therefore, no significant cumulative effect from these activities is anticipated.

Installation of the SOEP platform at Alma will generate similar noise as the construction of the Deep Panuke Project (*e.g.*, pile driving). The construction of the Alma platform will be completed before Deep Panuke begins; therefore there will be no temporal overlap of this noise.

There may be some spatial and temporal overlap of Project vessel traffic with vessel traffic related to other activities in the region. However, marine mammals can habituate to chronic vessel noise (Richardson *et al.* 1990). In any event, these effects are short-term, of limited extent and reversible. Apart from a brief period during pile driving, Project noise will not exceed that routinely produced by vessels, and thus will add little to the prevailing ambient situation. Therefore, no significant cumulative effects are anticipated to result from Project related vessel traffic during construction.

While a blowout of raw gas or acid gas could adversely affect marine mammals within a critical atmospheric zone of influence, it is not expected this would result in significant effects on populations. No potential future cumulative effects resulting from a malfunction or accident are predicted.

When compared to the historic human activity such as fishing and commercial shipping in the Sable Island area, the environmental effects associated with the Project, are considered to be low. In summary, no significant adverse cumulative effects on marine mammals are predicted to result from the Project.

6.3.9.6 Marine Related Birds

Other projects and activities that may interact to cause cumulative environmental effects on marine related birds in the study area include noise disturbance from vessel traffic and aircraft, oil and gas exploration and production, commercial shipping and commercial fishing, and oiling from illegal pumping of bilges by passing vessels and accidental spills from other sources. Marine related birds may also be affected by projects and activities occurring elsewhere in their migratory ranges. As well, marine related bird populations in the study area may be effected by changes in prey and predator populations.

Project construction may overlap temporally and spatially with construction of the Blue Atlantic, Neptune and Hudson Energy projects. This overlap is reduced, however, as Hudson Energy is on hold as of May, 2002 and the Blue Atlantic project is proposed to come onshore in Southwest Nova Scotia (*i.e.*, no spatial overlap in the nearshore).

The range of the Country Island Roseate Tern population extends into Southwest Nova Scotia, therefore there is potential geographical overlap for cumulative effects on this population, with the Blue Atlantic Project. No adverse effects on Roseate Tern populations is predicted for the Deep Panuke Project. It is assumed that the Blue Atlantic project will also be subject to similarly stringent requirements to protect Roseate Tern populations in its Project area thus avoiding potential for cumulative effects.

Any remaining cumulative effects would be limited to vessel traffic and associated noise, lights, and routine discharges. These effects would be temporary and reversible. It is assumed that all projects occurring in the vicinity of Country Island (*i.e.*, Neptune) will abide by similar restrictions as the Deep Panuke Project thereby minimizing potential cumulative effects on nesting Roseate tern colonies. As the effects of Project construction are considered reversible, no cumulative interaction of effects on marine related birds is anticipated between Project construction and these future projects.

Future seismic and exploration activities will be conducted within and outside EnCana's Panuke lease area, and EnCana will undertake future seismic exploration in the vicinity of the Panuke lease (unrelated to the Deep Panuke Project). Exploration drilling activities are generally short term (60 to 90 days) in any one area, are localized and not likely to result in significant effects on marine related birds. In addition to the temporary, localized nature of exploration drilling, the potential for cumulative effects with Deep Panuke are further limited by the widely dispersed nature of these activities and lack of spatial and temporal overlap once Project construction is completed. The CNSOPB (1998) predicted that potential effects on seabirds from future seismic exploration would be insignificant, considering no disturbance or mortality has been observed in the few studies undertaken in relation to seismic programs. Therefore, it is considered unlikely that known future seismic activities will interact cumulatively with Project activities. Similarly, Thomson *et al.* (2000) concluded that noise from future exploration drilling would not have cumulative effects on marine related birds, although concurrent drilling of exploration wells could increase noise levels at a number of sites.

Based on ongoing monitoring programs results for the SOEP, it is unlikely that any adverse effects due to construction or operation of the SOEP would interact cumulatively with the Deep Panuke Project. If birds are attracted to the lights or flares on the Deep Panuke platforms (during construction or operation), there is no evidence that such effects would compound those at other platforms or rigs in the study area (including SOEP Tier II platforms) to cause significant cumulative effects.

Project related vessel and aircraft traffic will add to existing and future vessel traffic in the study area, however, the amount of vessel traffic for the Project is minor compared to domestic and international shipping, tourism and fishing, and is not expected to create significant cumulative effects. Any cumulative effects of oiling from illegal bilge pumping and chronic spills would be additive and density dependent. As discussed under the environmental effects of operation, EnCana will have measures in place to reduce small chronic spills associated will its Project activities.

The proposed Sable Island Wind Turbine project is not predicted to have a significant effect on Sable Island bird populations, including the Roseate Tern population. Staff on Sable Island, in consultation with the Canadian Wildlife Service (CWS), the Sable Island Preservation Trust and the Meteorological Service of Canada will develop a monitoring plan to verify impact predictions (MSC 2002). Deep Panuke Project interactions with Sable Island bird populations will be minimal due to helicopter and vessel traffic avoidance of the island. Potential cumulative effects on breeding or rearing habitat for marine related birds on Sable Island will be mitigated by adherence to the Sable Island Emergency Contingency Plan (Canadian Coast Guard 1994) and EnCana's Code of Practice for Sable Island.

6.3.9.7 Sable Island

Sable Island has been affected over time by human activities, including past cultivation, introduction of non-indigenous species, creation of vehicle trails, establishment of structures and facilities (such as the helicopter refueling facility and marine safety installations), hydrocarbon exploration (*e.g.*, Mobil's C-67 well drilled in 1967), and human presence. The island has also been affected by spills from marine shipping and offshore hydrocarbon activities. Natural processes also continue to change the physical configuration of the island and, consequently, the habitat for various flora and fauna.

The Sable Island Wind Turbine Project is expected to be constructed in 2002. This will create some additional vessel traffic during construction and possibly some minor interactions with birds on the island during operation. Because of a lack of temporal overlap with the Deep Panuke Project during turbine construction, and limited or no interactions during the operational phase of the two projects, no adverse cumulative effects are predicted.

The routine activities associated with construction, operation, and decommissioning of the Project are not expected to significantly affect Sable Island. In particular, helicopter and vessel traffic, which could cause cumulative noise disturbance to wildlife on the island, will not approach Sable Island during routine activities, and mitigative measures will minimize any potential adverse effects of non-routine traffic. In addition, the relative locations of the SOEP Thebaud and Deep Panuke platforms are such that the air emission plumes will not normally overlap resulting in a contribution to Sable Island (*e.g.*, under worst case scenarios, each would contribute to less than 10% of the air quality criteria for the other platform). Therefore, the cumulative environmental effects of the Project in combination with other projects or activities that may effect, or are currently effecting, Sable Island are considered not significant.

6.3.9.8 Onshore Environment

Other projects and activities that may interact to cause cumulative environmental effects on the onshore environment include operation of the SOEP gas plant at Goldboro, operation/maintenance of the M&NP mainline natural gas transmission pipeline and the SOEP Point Tupper natural gas liquids pipeline, forestry operations and residential, commercial, and industrial development in and around Goldboro. The effects of these projects and activities may have included loss or alteration of habitat (due to clearing of vegetation), avoidance of habitat (due to noise from vehicles and equipment and human presence), and degradation of habitat quality (due to erosion, sedimentation, or accidental spills). These other projects and activities are expected to continue into the future. Air emissions associated with onshore facilities of the Deep Panuke Project are negligible, limited to emissions from construction equipment and emissions related to a pipeline rupture. The Project is therefore not predicted to contribute cumulatively to air emissions in the onshore area.

SOEP and M&NP conduct ongoing, routine inspections of their facilities to identify any adverse environmental effects of their activities. To date, no significant adverse environmental effects have been identified. It is anticipated that the SOEP mitigative measures will remain effective and these conditions will remain constant. No cumulative effects are therefore predicted with the Deep Panuke Project.

M&NP will also construct a custody transfer facility to accommodate the tie-in with the Deep Panuke pipeline. This facility will be located immediately adjacent to the EnCana onshore custody transfer and pipeline maintenance facility and will include similar size and type of structures. The construction and operation of the M&NP station is expected to coincide with that of the EnCana onshore facilities thus causing potential cumulative environmental effects (*e.g.*, noise, dust traffic). During construction, these effects will be short term (3-4 months), localized and similar in magnitude (*i.e.*, low) as other comparable construction projects. Both projects will be constructed in an area designated for industrial development. A small, incremental increase in traffic and noise from maintenance activities will result from the combination of both projects in close proximity; these effects will not be significant. It is expected therefore, that there will be no significant adverse cumulative effects from the combined construction and operation of the Deep Panuke and M&NP facilities.

Hudson Energy Company has proposed to construct a natural gas-fired power generation facility in Goldboro. Although site selection has yet to be finalized (project has been put on hold), the potential property is located approximately 600 m southwest of the SOEP gas plant site. Construction of the facility was anticipated to commence in 2003 prior to project suspension. Cumulative effects associated with the Hudson Energy project are anticipated to be similar to those described for the SOEP gas plant. The Neptune project is also anticipated to include a gas fired power generation facility somewhere within the industrial park area. Because these projects have not completed environmental assessments for their respective developments, it is difficult to predict cumulative effects should these projects both proceed to implementation. It is anticipated that the onshore component of the Deep Panuke Project (*i.e.*, pipeline, small metering and maintenance facility) will be small in comparison to the two much larger power generation facilities with respective pipelines or cables and water utilities. Both of these larger projects would be subject to a rigorous environmental approval process which would further investigate potential cumulative effects and impose operating conditions that would further serve to reduce the long term potential for cumulative effects in the Goldboro area.

Forestry activities are regulated by the provincial government while residential, commercial and industrial development in and around Goldoboro is planned for and managed by local planning authorities. The cumulative effects of the proposed pipeline and local forest harvesting operations will be temporary. Habitats currently abundant in the area will develop on the disturbed sites (pipeline and clear-cuts), re-establishing avifaunal communities. The avifaunal communities on the clear-cuts will become similar to those of mature woodlands within 20 years. The avifaunal community on the pipeline RoW will be similar to that of the semi-barrens habitat, which currently occupies approximately 30% of the pipeline corridor. The cumulative effects of the pipeline construction and forestry operations will consist of an initial decrease in bird abundance, which is expected to recover as soon as shrub cover re-establishes, and a shift in species composition which in the clear-cut areas can be expected to return to conditions similar to the original forests within 20 years. The cumulative effects of these activities will be not significant.

Most of the onshore study area includes lands that have been zoned by the municipality for industrial development, therefore, the Project is considered a compatible land use. It is expected that the municipal authorities consider the potential cumulative effects, through regional planning, of development and the resulting changes to the environment. The potential for cumulative effects on species such as norther commandra will be reduced by the requirement of future proponents to conduct wetland evaluations in instances where wetlands are to be adversely affected by developments.

Given the very limited extent of the onshore components of the Deep Panuke Project, and their location adjacent to, or within, lands developed or designated by municipal authorities for future development, and avoidance of sensitive areas (*e.g.*, wetlands, Betty's Cove Brook), no significant adverse cumulative effects are predicted.

7 SOCIOECONOMIC ASSESSMENT

7.1 Approach and Methodologies

Socio-economic assessment is a process that is executed from the inception of project planning to project termination or abandonment. The socio-economic assessment of the Project focuses on those matters that are of real concern to the various groups, who may, in one way or another, be affected by some facet of the Project. At the same time, it addresses issues identified by those professionals with experience in similar projects and issues that must be addressed to meet regulatory requirements. The process involved consultation, networking within the area of interest, semi-structured interviews, meetings and open houses, and participant observation. The issues that have been identified are derived from:

- interviews with key individuals knowledgeable about the study area;
- consultation with the public;
- Scope of the Environmental Assessment (CNSOPB *et al.* 2001b);
- reference to the work undertaken for the SOEP;
- work undertaken by EnCana for this study; and
- the technical expertise of the Study Team.

Given the nature of the Project and the distribution of its likely effects, the analysis of the socio-economic effects was undertaken by reference to five distinct geographical areas, namely:

- Canada and the Province of Nova Scotia;
- Halifax Regional Municipality;
- Service Communities, or those communities within less than one hour's commuting distance of the landfall location, that might provide services during the development and production phases of the Project (*i.e.*, Guysborough, Sherbrooke and Antigonish);
- Guysborough County and the communities in proximity to the selected landfall location; and
- the offshore area.

The linkages that exist between the Project and each of the areas identified above are summarized in Table 7.1.

Table 7.1 Project Linkages to Impacts

Issue/Concern	Guysborough District & Landfall Area		Service Communities: Guysborough, Sherbrooke and Antigonish		Halifax Regional Municipality		Offshore Area	
	Project Linkage	Stakeholders	Project Linkage	Stakeholders	Project Linkage	Stakeholders	Project Linkage	Stakeholders
THE ECONOMY								
Employment	• construction • operational expenditures	• those seeking employment • municipality	• construction • operational expenditures	• those seeking employment • municipalities	• construction • operational expenditures	• those seeking employment • municipality	• offshore activity	• employees
Business Opportunities	• investment	• businesses • municipality	• investment	• businesses • municipalities	• investment	• businesses • municipality	• offshore activity	• businesses
Training	• Need for skills	• residents • educational sectors	• need for skills	• residents • educational sector	• need for skills	• educational sector • those hoping to gain entry to the industry	• need for skills	• employees • educational sector
Property Tax Base	• Onshore pipeline development	• municipality • residents	No Linkage	—	• development and property occupation	• municipality	No Linkage	—
Economic Stability & Growth	• construction • expansion of industrial sector	• municipality • businesses • GCRDA	• construction • expansion of industrial sector	• municipality • businesses	• construction • expansion of industrial sector	• municipality • businesses	• offshore activity	• businesses
Aquaculture and the Fishery (Inshore/Offshore)	• pipelines • accidental events	• inshore fishers • divers	No Linkage	—	No Linkage	—	• offshore construction operations	• offshore fishers
Tourism	• industrial infrastructure	• tourist operators • residents	No Linkage	—	No Linkage	—	• offshore activity	• recreational boaters • visitors to Sable Island
THE ENVIRONMENT								
Water Quality	• construction	• beneficiaries of clean water	No Linkage	—	No Linkage	—	No Linkage[1]	• offshore fishery
Air Quality	No Linkage	—	No Linkage	—	No Linkage	—	• gas production facilities	• employees • other persons located offshore
INFRASTRUCTURE								
Roads	• construction traffic	• residents • road users	• construction traffic	• road users	• construction traffic	• road users	No Linkage	—
Wharves	• construction traffic	• local users	No Linkage	—	• offshore servicing	• municipality • port / facility operators	No Linkage	—
Emergency Services	• accidents	• employees • local residents • emergency service providers	• accidents	• employees • emergency services	• accidents	• emergency facilities	• accidents	• employees • emergency facilities
SOCIAL FACTORS								
Land and Water Use	• construction	• local land owners and users • municipality	No Linkage	—	• construction • operation	• local land & property owners • municipality	• pipelines • platforms • accidents	• other offshore water users
Marine Archaeological Resources	• construction	• Nova Scotian Museum • recreational divers	No Linkage	—	No Linkage	—	No Linkage	—
Land Based Archaeological Resources	• construction	• First Nations and Aboriginal people • Nova Scotian Museum	No Linkage	—	No Linkage	—	No Linkage	—
Current Land and Resource Use for First Nation's and Aboriginal Purposes	• construction	• First Nations and Aboriginal peoples	No Linkage	—	No Linkage	—	No Linkage	—
Public Health and Safety	• construction • accidental events	• municipality • employees • residents	No Linkage	—	No Linkage	—	• construction • accidental events	• employees • other offshore water uses

Note: 1. As referenced in the text there are discharges from the platforms to the marine waters. The analysis related to these discharges is being addressed in Section 6. To the extent that there is no significant impact on commercial fish species, there is no socio-economic linkage.

The methods used in socio-economic assessment range from the very informal to the highly structured. The methodologies used for this Project included the application of a structured economic model that detailed the economic consequences of the Project on both Canada and the Province of Nova Scotia and more informal consultative techniques. The assessment also drew on secondary sources of information, (*e.g.*, demographic and economic data from Statistics Canada, information on infrastructure from provincial and municipal agencies *etc.*), attained information directly from those groups and interests within the study area, and drew on the technical expertise of the Study Team.

Other activities included:

- review of published literature, unpublished reports and data from government agencies and departments, universities and research institutions and other relevant offshore operators;
- interviews with individuals with knowledge of specific topics, *e.g.*, those with an understanding of how SOEP changed the socio-economic context of the study area;
- telephone surveys; and
- team meetings to ensure the efficient exchange of information.

The socio-economic analysis involved the following steps as shown in Figure 7.1.

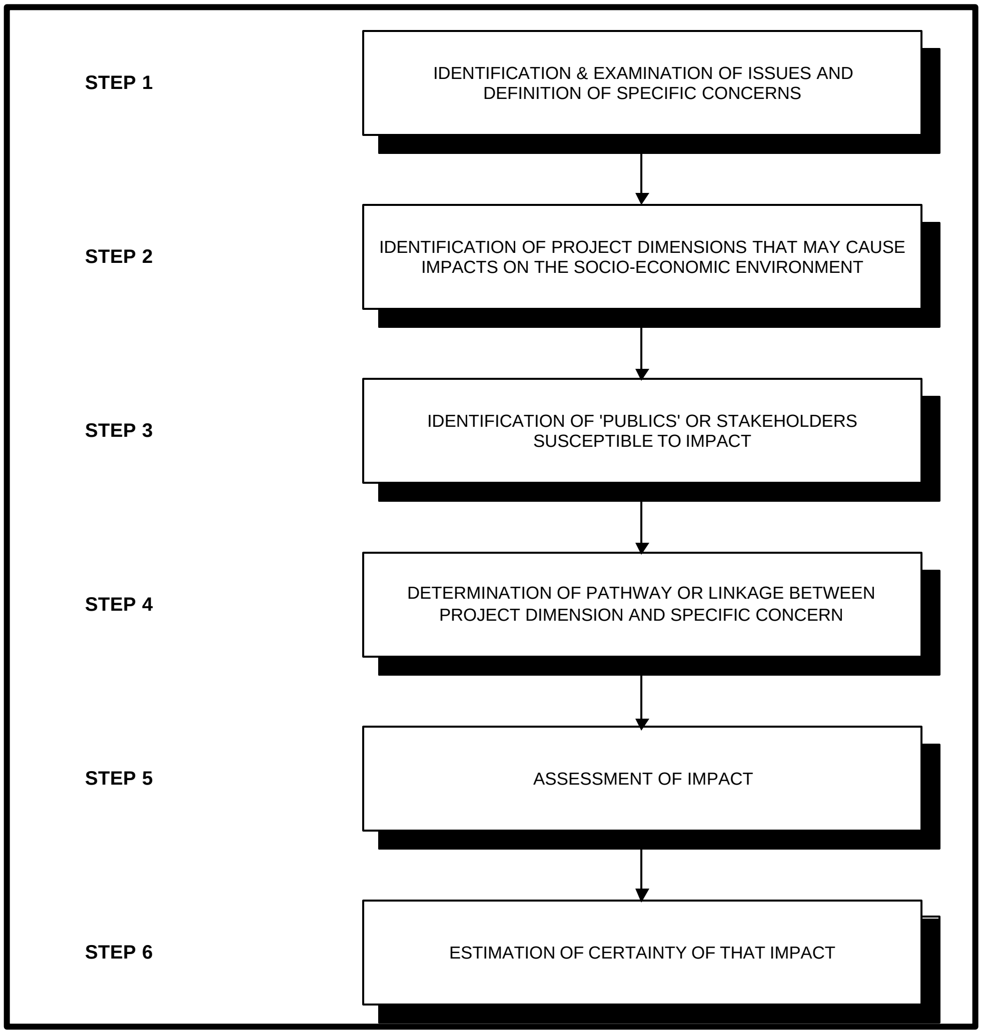


Figure 7.1 Socio-economic Assessment Methodology

Section 2(1)(a) of the *CEAA* defines an environmental effect as:

> *any change that the project may cause in the environment, including any effect of any such change on health and socio-economic conditions, on physical and cultural heritage, on the current use of lands and resources for traditional purposes by aboriginal persons, or on any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.*

The socio-economic assessment for the Deep Panuke Project focuses on socio-economic impacts associated with a Project-induced change in the environment.

Section 16(1)(a) of *CEAA* states that every assessment shall include a consideration of "any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out". Cumulative impacts can arise from the consequences of a single project, or from the effects of different projects whose area of influence overlaps. The assessment of cumulative socio-economic impacts is inherently concerned both with the processes of socio-economic change and the growth-induced effects of a project. In this regard, it is essential to note that the socio-economic status of any area is never static. It evolves in response to many factors, local, regional and international.

At this time, the landfall area, the regional area encompassing the District of Guysborough and the Strait of Canso, and the Province of Nova Scotia are each responding to the new and accelerating demands being placed on labour and infrastructure by the current initiatives of the oil and gas sector. The development of the SOEP gas plant and associated pipeline infrastructure that serves the plant has changed the economic base of the municipality. SOEP and the M&NP project have changed the expectations of the communities within the area with respect to further industrial investment. Important initiatives, for example, have been undertaken by the Municipality to encourage industrial development to locate adjacent to the gas plant.

Cumulative socio-economic impact assessment involves systematic consideration of how a project might interact with the broader socio-economic changes that are occurring within an area. For example, the interaction between two or more projects may generate the need for new infrastructure or initiate significant changes in the socio-economic dynamics of the area. The development of a new economic sector would certainly have widespread consequences, and this Project represents an important milestone in the development of an offshore industry in Nova Scotia. The government of Nova Scotia, however, does recognize that:

> *Successful development of the offshore oil and gas industry requires more discoveries, which in turn requires more information on the resource potential. The first priority is to encourage exploration* (NSDNR 2001b).

This study identifies the anticipated impacts of this Project on the provincial economy, its importance to the Halifax Regional Municipality and its relevance to further economic development in Northeast Nova Scotia. It takes into account both the changes that have occurred as a consequence of projects executed in the recent past, current activity in the offshore, those projects that my be taking place concurrently and the plans of the Municipality of the District of Guysborough.

7.2 Socio-economic Context

7.2.1 Provincial Profile

7.2.1.1 The Economy

Nova Scotia has a long and varied social and economic history originating with the First Nations and Aboriginal people who relied on the resources of the land and waters and traveled widely throughout the Province. As the province was settled by Europeans, the colony rapidly developed as a maritime economic power. The 20^{th} century brought further change. Fishing, forestry and mining remain the economic mainstay of many rural communities, but, today the tertiary sector accounts for 75.5% of the economy and close to 50% of GDP is directly attributable to the export of goods and services. Despite the low contribution of the primary sector to GDP, there is a considerable value added to fishery, forestry and mining products through manufacturing and processing before they leave the province.

The oil and gas industry contributes to the provincial economy in several ways including:

- **Expenditures**: these include the exploration, development and production spending required to find, extract, process and transport oil, natural gas and associated gas product. The resultant infrastructure becomes part of the "capital stock" of the province. To March 31, 2001, SOEP had spent $2.5 billion, of which $846 million (34%) was Nova Scotia content (SOEI 2001b). On the exploration side, petroleum companies have been issued permits for work totalling $1.03 billion in actual and proposed expenditures (NS Petroleum Directorate 2001b).

- **Employment**: exploration, development and production have generated thousands of person-years of permanent and temporary employment for Nova Scotians. The Cohasset Project, for example, provided 3,727 persons years of employment over its lifetime (PanCanadian 2001b), and to March 2001, the SOEP had provided 4,265 persons (SOEI 2001b).

- **Royalties:** gas production is subject to a royalty structure initially based on gross revenues, with a move to net revenues as a project matures; the system is designed to encourage "risk taking" by offering lower royalties for the first project in any new area; and

- **Research & Development (R&D), Education and Technology Transfer**: as part of the regulatory requirements, petroleum companies must transfer knowledge, skills and technology to Nova Scotian individuals and firms. For example, since 1995, SOEP has spent over $45 million in R&D, education and technology transfer initiatives in the province (SOEI 2001c).

One indication of the effect of this sector on the provincial economy is reflected by the Department of Finance's estimate that the SOEP alone would account for 2.2% of the provincial economy by the end of 2001, if it met its production targets (NS Petroleum Directorate 2001a); this is roughly the contribution of the agriculture and fishing industries combined. New oil and gas projects will augment this contribution.

7.2.1.2 Population and Employment

The provincial population in 2000 was 940,996; this represented an increase of 5.8% since 1986 (NS Department of Finance 2000). In 1999, the provincial labour force was 452,000, an increase of 40.8% over 25 years. This growth was primarily in the private sector (NS Department of Finance 2001); over the same period public sector employment as a percentage of total employment declined.

Nova Scotia has a lower participation rate (*i.e.*, the ratio of the labour force (employed persons and those looking for work) to the population over 15 years old), than the Canadian average. In 2000, this rate was 61.0% versus 65.6% in Canada. The unemployment rate in Nova Scotia is also a higher than the Canadian average. In 1999, the provincial unemployment rate was 9.6% compared to 7.6% nationally. At the same time unemployment in the Halifax metropolitan region was 6.7%, which was the lowest rate east of the Ottawa-Hull region.

Table 7.2 provides data with respect to the number of people of Aboriginal origin and descent living in Guysborough County and in the province as a whole in 1996. As indicated by Statistics Canada:

> *There are different ways to define the aboriginal population. Data presented in this table* (Population by Aboriginal Group, 1996 Census, http://www.statcan.ca:80/english/Pgdb/People/Population/demo39a.htm) *are for those who identified with one or more Aboriginal groups (North American Indian, Metis, or Inuit). Also included are those who did not identify with an Aboriginal group, but who reported that they were Registered/ Treaty Indians or Band/First Nations members. The 1996 Census also provides information on those who reported Aboriginal ethnic origin/ancestry. Depending on the application, data on either identity or ethic origin/ancestry may be appropriate for defining the aboriginal population.*

Table 7.2 Aboriginal People in Nova Scotia and Guysborough County				
	Guysborough County	**Guysborough Municipal District**	**St. Mary's Municipal District**	**Nova Scotia**
Aboriginal (North American Indians, Metis, and Inuit) persons:	50	20	25	12,380
Speakers of Mi'kmaq	0	0	0	4,455
Persons who indicated aboriginal among their ethnic origins	240	45	85	26,795
Source: Statistics Canada, 1996				

As of 1996, there were 11,340 registered First Nation's people in the province, 210 Inuit and 860 Metis (total 12,380) (Statistics Canada will not release any 2001 data on ethnic origin or Aboriginal populations until January, 2003). Of the registered First Nation's peoples, approximately 3,700 live off reserve; over 2,000 of these live in HRM where there is the greatest access to employment. The registered Mi'kmaq population in Nova Scotia is represented by 13 band councils and two tribal councils: the Confederacy of Mainland Mi'kmaq and the Union of Nova Scotia Indians. There are no Mi'kmaq reserves in the immediate vicinity of the landfall (Appendix B, SEIS (DPA Volume 5)).

As shown in Table 7.2, there were, in 1996, a considerable number of people (*i.e.*, 26,795) who indicated Aboriginal among their ethnic origins. If 6,745 registered Mi'kmaq live on reserves, over 20,000 people of aboriginal origin, including registered First Nation's peoples living off reserve, live in the towns and rural areas of Nova Scotia. The Native Council of Nova Scotia was established in 1974 to represent the social, economic and cultural interests of Aboriginal peoples living off reserve.

Table 7.2 indicates that in 1996, some 240 people of Aboriginal descent lived in Guysborough County; 45 in the Municipality of the District of Guysborough, 85 in the Municipality of the District of St. Mary's and the balance in the incorporated towns of Mulgrave and Canso.

7.2.1.3 Infrastructure

Infrastructure is the network of public and private facilities (*e.g.*, roads, marine wharves, water and sewage systems, housing) needed to support economic and social development. The Project will place demands on such infrastructure, particularly during the construction phase. During this phase, an increased use of roads, marine terminals and commercial air facilities can be anticipated. These increased activities will have economic benefits for those directly employed in associated service industries, including, for example, those employed in transportation related activities (*i.e.*, shipping, terminal operators, stevedoring, retail and commercial fuel suppliers, equipment sales) and other related services. An increased use of air services, including helicopters, can also be anticipated.

Housing stock is a critical and valued component of the infrastructure needed for sustained economic growth. Over the past five years, HRM has experienced an increase in both the number of housing starts and in house prices. The continued demand for housing is fueling residential development in areas around the metropolitan core (*e.g.,* in Bedford, Timberlea, St. Margaret's Bay, Cole Harbour and Porter's Lake). There has also been a significant increase in the number of rental apartment units, including high-end apartment units, coming onto the market.

7.2.1.4 Education and Health Services

The Maritime Region has proportionally more of its young people enrolled in institutions of higher education than any other part of Canada. This is, in part, a reflection of the number of universities and colleges that serve the region. Nova Scotia has eleven post-secondary colleges and universities, in addition to the 14 campuses of the NSCC system. Together these offer a wide range of courses to approximately 30,000 full-time students. A further 13,500 people access the NSCC's continuing education and customised training programs. Although many of the jobs associated with the offshore require very specialised expertise, substantive experience, or both, a number of initiatives have been taken by both government and industry to ensure that those who seek employment within this sector can access pertinent training programs in Nova Scotia.

A number of hospitals in the province provide primary and secondary care within a specific service area. Two of these, the Queen Elizabeth II Health Services Centre and the IWK Health Centre, provide tertiary care; both are located in HRM. The former would be the primary facility to respond to the needs of a serious industrial accident.

Emergency Health Services Nova Scotia (EHS) is a division of the Nova Scotia Department of Health. EHS is responsible for the continuing development, implementation, monitoring and evaluation of pre-hospital emergency health services in the province. The EHS network provides 911 service across the province and operates the air medical transport program that flies out of the Halifax International Airport.

Emergency responses, other than a health emergency, are co-ordinated through the provincial Emergency Measures Organization (EMO), also initiated through the 911 emergency number province-wide. The EMO has developed a Special Hazards Response Unit (SHRU) to address special hazard situations outside HRM. EMO in the Central Zone has worked with M&NP to develop procedures related to emergencies that may involve the natural gas pipeline.

Police services within the study area are provided by the Royal Canadian Mounted Police (RCMP) and the Halifax Regional Police Service. Fire services consist of both full time and volunteer fire brigades. These services are also mobilized through the provincial 911 emergency number (NSDNR 2001a).

The federal and provincial governments have established procedures and support infrastructures to respond to offshore emergency events. Those companies operating offshore are also required to have demonstrated capability to respond to any event that may arise as a result from their activities offshore (*i.e.,* Emergency Response Procedures (ERP) and Emergency Response Teams (ERTs)). The agencies that have jurisdiction with respect to offshore emergency support include the CNSOPB, Canadian Coast Guard, and Environment Canada.

7.2.2 Halifax Regional Municipality (HRM)

The HRM is the administrative and transportation hub of Nova Scotia, the location of many federal government departments and agencies, and the metropolitan centre of the Maritime Region. In 1996, the population of HRM was reported to be 352,153; this is now estimated to be 367,502, an increase of over 4%.

HRM has the largest economy in the province. Population, labour force and employment have all grown through the 1990s. The labour force is highly educated. The energy sector, the film industry, and information technology companies have all played a part in making Halifax the centre of information technology in eastern Canada. Growth in each of these areas has, in turn, spun secondary growth in the service sector and fueled pressure for accommodation. The municipality has accommodated this economic growth and has identified additional lands for industrial, commercial and residential expansion.

7.2.3 Guysborough County

The pipeline transporting natural gas from the Deep Panuke production platform will come onshore near Goldboro, adjacent to the main subsea pipeline from the SOEP Thebaud platform. Guysborough County, located in the northeastern part of the province, comprises four administrative areas: the District of Guysborough; the District of St. Mary's; the Town of Canso; and the Town of Mulgrave. In 2001, the area had a population of approximately 10,500.

The Mi'kmaq people were the original inhabitants of the area, but there are no First Nations' settlements located in the County of Guysborough (Appendix B, SEIS (DPA Volume 5)). As detailed in Section 7.2.1.2, approximately 240 people of Aboriginal origin live in the area.

7.2.3.1 Economy

Guysborough County is distinctly rural. Its economy has been dependent upon fisheries and forestry, and intermittently upon mining. More recently the area has seen an expansion in its service sector, including a growth in tourism related employment.

From 1995-1997 and throughout construction of SOEP, the Guysborough area was subject to study and survey. Many hotels, B&Bs, and retail and service outlets enjoyed a temporary benefit from the visiting crews, who were resident in the area for weeks at a time. Approximately 70 homes within a 40 km radius of the plant site provided accommodation to over 100 workers (SOEI 1999). The associated expenditures, as well as the wages and salaries paid to local personnel employed on site, were a direct financial benefit to the local area. These temporary benefits lasted the duration of the construction. Of the 76 personnel who now work at the SOEP gas facilities in Goldboro, Point Tupper and offshore, it is estimated that 23 are originally from Guysborough County (SOEI 1999).

The SOEP gas plant and the associated pipeline infrastructure, and the accelerating interest that is being expressed in offshore exploration and development has profoundly changed how the Municipality of the District of Guysborough views the future. The developments that have occurred are seen as the foundation for further industrial development both on lands identified for industrial purposes at Goldboro and at the Melford Industrial Land Reserve on the west side of the Strait of Canso. The development of this Project adds additional infrastructure and provides a second source of natural gas thereby strengthening security of supply.

7.2.3.2 Inshore Fisheries and Aquaculture

Today's East Coast fishery reflects a complex relationship between fish stocks, the equipment required to catch specific species, and the communities who derive their livelihood from this resource base. There is a considerable degree of specialization. In contrast, for example, to the boats that primarily fish inshore, fleets that access offshore stocks use different equipment, stay at sea for longer periods of time, and generally work out of larger ports that can provide the necessary supporting infrastructure.

Most of the relevant fisheries data is aggregated for all of Guysborough County, or the DFO statistical districts that encompass the county. The inshore fisheries study area was selected to extend approximately 30 km on either side of the proposed pipeline landfall in Goldboro (*i.e.*, from Berry Head to the St. Mary's River estuary). This area is within DFO Statistical Districts 16 and 17.

The coastal waters of Guysborough County support fisheries for groundfish, pelagic species and invertebrates. In 1999, 257 fishing vessels were registered in Guysborough County. The fishery directly employed 598 people, 345 full-time and 253 part-time (Boudreau and SRSF 2001; DFO 2001c.

Table 7.3 lists ports in the study area in 1999, with the number of registered vessels, full-time, part-time and core fishermen in each. Recent overall numbers of vessels have remained fairly steady, though some vessels' home ports may shift from year to year (K. Brickley, Fisheries and Oceans Canada, pers. comm. 2001).

Table 7.3 Numbers of Fishermen by Port, 1999

Port	Vessels (<34.9 ft, unless otherwise noted)	Full-time	Part-time	Core
Bickerton West	2	3	1	1
Coddles Harbour	3	5	2	2
Country Harbour	2 (<34.9 ft), 1 (45-64.9 ft.)		2	1
Drum Head	5	8	1	3
Fisherman's Harbour	3	5	5	3
Isaac's Harbour	3	3	1	1
New Harbour	5 (<34.9 ft), 1 (35-44.9 ft)	9	5	
Port Bickerton	5 (<34.9 ft), 2 (35-44.9 ft)	16	11	9
Port Hilford	2	3	0	2
Seal Cove		2	1	
Sonora	9	11	29	6
Stormont		3	0	
Wine Harbour	3 (<34.9 ft), 1 (35-44.9 ft)	3	2	3
Total	49	88	60	

(Source: DFO 2001d; Boudreau and SRSF 2001)

Most inshore fisheries in the study area operate between April and October. Landed values for 2000 in District 16 were $724,000 for the inshore fishery, and $15,635,000 for the "offshore" fleet of vessels >65 ft in length; the latter represents the northern shrimp catch from off Greenland (DFO 2001b). For District 17, the reported values for the inshore fishery were $8,240,000; no catch was reported for the "offshore" vessels (DFO 2001b). The landed inshore value for District 17 reflected an increase in the valuable snow crab catch taken by "inshore" vessels.

Apart from the northern shrimp fishery, almost all the fishery revenue is derived from inshore waters, and from vessels classed as inshore, even if their catches were made far from shore. There are a total of 157 inshore lobster licences in Statistical Districts 16 and 17; this fishery is considered the most stable of the fisheries in the referenced Districts. Nevertheless, to ensure the future of the fishery, the lobster fishermen in the county, with others on the eastern shore, initiated a four-year conservation plan in 1998, enforced by DFO, to increase egg production in eastern Nova Scotia. The Project study area falls within Lobster Fishing Areas 31b and 32, where the season opens on April 19 and closes June 20. Although the total weights landed decreased substantially over the past decade, the total landed value from Guysborough County increased from $2.2 million in 1990 to $2.9 million in 1999.

Sea urchins are harvested for their roe; Japan is the principal market. Harvesting is not restricted by season, but generally occurs from September to March. In the 1999-2000 season, there were 10 active and 5 inactive urchin licences in Guysborough County.

Crab, shrimp and soft-shell clams have all increased the value of the invertebrate fishery.

Snow (queen) Crab Fishery

DFO expects the 2002 inshore and offshore season for snow (queen) crab to take place between June 1 and October 31. Since a quota system is in place, most boats finish well before the formal end of the season. In 2001, for example, 80% of the quota for the temporary allocations for Guysborough County fishers had been caught by early September (M. Eagles, Fisheries and Oceans Canada, pers. comm., 2001). The 1999 value of snow crab landings allocated to the inshore in Statistical District 17 was $513,000; no landings were recorded for District 16, but this reflects the lack of a buyer within this District rather than an absence of fishermen. In Crab Fishing Area (CFA) 24, the catch more than tripled between 1999 and 2000 to a total of 4,300 t; in 2001 it fell to 4,043 t (DFO 2002).

Pelagic Fisheries

Bluefin tuna have been fished off Canso since 1980, with catches fluctuating from very good to poor, but peaking in 1995 with a landed value of over $2 million. In 1999, landings exceeded 34,425 kg, and were valued at $569,511. There are several swordfish and shark licences held in Guysborough County. The majority of catches are made in the Country Harbour and Ecum Secum areas. Mackerel, alewives and herring are fished opportunistically along the coast, primarily for bait.

Revenues and Earnings

To estimate the probable number of secondary jobs generated by Guysborough County fisheries, Boudreau and SRSF (2001) calculated that one full-time, or two part-time fishing positions, would create four spin-off jobs. They estimated the number of such jobs as 1,886, which represents 25% of the County's total employment (Boudreau and SRSF 2001).

First Nations and Aboriginal Fisheries

The Membertou Corporate Division has estimated that the net value of the aboriginal fishery in Nova Scotia was $15,678,000 or 3% of the total fishery for the Scotia-Fundy Region in 1999 (Membertou Corporate Division 2002). As more long-term "Marshall Agreements" are reached, the commercial value of this fishery will grow. Licences and permits are held by a number of bands for lobster, snow crab, bluefin tuna, sea urchin, and blue shark. The First Nations and Aboriginal commercial fishery that takes place in the central region of 4W will be, in the opinion of the Membertou Corporate Division, the region of greatest concern for the Aboriginal community. The following groups have access to commercial fisheries in 4W:

- Chapel Island Band: 1 snow crab licence and 1 snow crab temporary permit;
- Indian Brook Band: sea urchin licence, 4 LFA lobster licences and a snow crab licence;
- Membertou Band: a Bluefin tuna permit;
- Millbrook Band: 2 sea urchin licences, 2 lobster licences and a snow crab licence; and
- Native Council of Nova Scotia: 2 lobster licences, 1 blue shark licence, and 1 snow crab licence.

There are no First Nations aquaculture sites in the county.

Aquaculture

Across Nova Scotia, the value of aquaculture production has increased from $5.4 million in 1990 to over $50 million in 1999, an increase of over 800% in a decade; approximately 90%, or $30 million, comes from the Scotia-Fundy Region. Growth is expected to continue, but not at the same rate (DFO 2000a). There are currently 32 active aquaculture leases in Guysborough County.

Cultivation of blue mussels is the most successful form of aquaculture in both Country Harbour and Guysborough County (Boudreau and SRSF 2001). Steelhead salmon are produced in Guysborough County on a seasonal basis, but not in Country Harbour. Yearling rainbow trout are placed in ocean cages in the spring, fed and reared through the summer, and harvested during the fall (Boudreau and SRSF 2001). The cultivation of scallops is a relatively new initiative, but there are no active scallop leases located within Country Harbour.

7.2.4 Landfall Communities

The landfall area for the purposes of the SEIS (DPA Volume 5) includes those communities in closest proximity to the landfall location whose residents might be directly or indirectly affected by the Project; this includes the Isaac's Harbour Area and the Port Bickerton Area.

7.2.4.1 Isaac's Harbour Area

This area includes the communities of Goldboro, Isaac's Harbour, Drum Head, Seal Harbour and Coddles Harbour, Stormont, Middle Country Harbour, and Crossroads Country Harbour. Roads in the area are two lane; the main routes are paved, but some of the side roads are not. A 12-vehicle ferry crosses Country Harbour near its mouth providing an important link between the Isaac's Harbour area and the Port Bickerton Area.

In 1996, the population of this area was approximately 855, a decline of 10% from the 1991 census. The labour force was 325, of whom 235 were employed. The unemployment rate at the time was 27.6%. The average family income was $32,193. The most important sources of employment were logging and forestry. Fishing, though of central importance to the economy, did not directly involve large numbers of people.

Land Use

The proposed routing for the pipeline from landfall to the tie-in location is largely through lands that have been disturbed in the recent past, or are grown over with alder scrub. No active agriculture or logging takes place on any of these lands. There are no active mineral workings in the vicinity of the proposed pipeline corridor, but there are lands that are subject to mineral licences including licences on property that extends across the proposed pipeline route. A licence conveys the right to explore, but not to work, unless permission for surface access is granted from the landowner.

Current Land and Resource Use for First Nations' and Aboriginal Purposes

There is evidence that the Mi'kmaq historically frequented areas in the vicinity of Country Harbour and Isaacs Harbour. Today there are no First Nation's communities in the County of Guysborough, but there are some 240 people of Aboriginal descent living in the county (refer to Section 7.2.1.2).

Over the past six years, several parties, including SOEI and M&NP, have developed a plant and infrastructure at Goldboro on lands in proximity to the proposed pipeline corridor. As an integral part of its work program, EnCana has executed field programs and undertaken extensive consultation with many people in the area. EnCana has also met with Aboriginal leaders about this Project. There has, however, been no evidence to date that First Nations or Aboriginal people currently use lands and waters in or near the proposed RoW for traditional purposes such as hunting, trapping and gathering; this is confirmed in Appendix B (p. 20) of the SEIS (DPA Volume 5) prepared by the Membertou Corporate Division (2002):

> *1. There was a comprehensive TEK done relative to the SOEI pipeline route to its fractionation plant. In that survey, it was reported that there were no impacts to the traditional use of lands due to the fact that the site was very far removed from the Mi'kmaq population. Based upon those findings, the Membertou Corporate Division believes that no TEK will be required.*
>
> *2. The construction of the Deep Panuke land based pipeline is only 3 km. Coupled with the above noted explanation, this very short pipeline route should not pose any concerns.*

Further, there is no local indication or information that the lands in the vicinity of the proposed pipeline route are currently being used for traditional purposes by those people of Aboriginal descent living in Guysborough County. EnCana is continuing to consult with the CMM and Native Council of Nova Scotia in regard to use of lands and water for traditional purposes in the vicinity of landfall.

Features of Archaeological Interest

The initial marine and terrestrial archaeological work in the area was undertaken for the SOEP. Three shipwrecks, for example, were identified in the immediate vicinity of the nearshore pipeline and landfall:

- Saladin (1844);
- Finchley (1884); and
- Foundation Masson (1975)

This research also identified 16 cultural resources sites within the nearshore, landfall, and gas processing plant area. The sites range from reported pre-contact finds to twentieth century mining activities. Of these known sites, nine are within the vicinity of the proposed landfall and pipeline for this Project.

EnCana conducted a geophysical survey along the proposed pipeline corridor during September – October, 2001 and May 2002. With one exception, there were no shipwrecks identified in the survey area (500 m on either side of the proposed pipeline route). CHS charting indicates that a wreck, likely the Foundation Masson (1975), lies at a point 250 m to the north of KP1.4, about 100 m from the charted position of the wreck. It is noted that the stated accuracy of the CHS charting is 100 m. The Foundation Masson (1975) is not considered of historical significance by the Nova Scotia Museum (S.Powell, Assistant Curator, Archaeology, Nova Scotia Museum, pers. comm. 2002).

There are, however, two archaeological concerns associated with the lands immediately along the shore; these are:

- the potential for pre-contact archaeological resources (*i.e.*, associated with the people who inhabited the area before the arrival of the Europeans) along the shores in proximity to the proposed landfall; and
- the potential for Black royalist resources in and around Webbs Cove.

The above factors will be further addressed during the detailed routing of the pipeline in the vicinity of the landfall.

Education and Health Services

While students from the Isaac's Harbour area attend the Riverview Consolidated School in New Harbour for grades primary to six, junior and senior high school students can choose to attend school in Sherbrooke, Guysborough or Canso.

Isaac's Harbour has a small medical facility, but it is not continually staffed. Primary care services are available at the Guysborough Medical Clinic and the Guysborough Memorial Hospital. Most residents, however, access basic medical care at St. Martha's Regional Hospital in Antigonish. Tertiary services are provided in Halifax.

7.2.4.2 Greater Bickerton Area

The communities of Port Bickerton, Bickerton West, Fisherman's Harbour and the community of Harpellville have been grouped together and profiled as the Greater Bickerton area. Traditionally, fishing and forestry, including some processing associated with both industries, were the principal economic activities. Today, the local economy involves a balance between the natural resource sector and the tertiary sector.

In 1996, the population of this area was approximately 635. The labour force was 275, of whom 215 were employed. The unemployment rate at the time of the census was 23.6%, which was considerably higher than the provincial unemployment rate at that time of 13.3%. The manufacturing sector (*i.e.*, fish processing), provided the most important source of employment. The average family income was $46,612.

7.2.5 Service Communities

Service communities are those larger communities within an hour's commuting distance of the landfall area that provide services to those in the landfall areas and that may be accessed by those involved in the development or operation of the Project. The following three communities are described: Guysborough, Sherbrooke and Antigonish.

7.2.5.1 Guysborough

The community of Guysborough (population approximately 500) is situated on the western shore of Guysborough Harbour, at the head of Chedabucto Bay, and is the administrative centre of the Municipality of the District of Guysborough. It is located approximately 25 km from the landfall site. The traditional economic activities in the area were agriculture, forestry, shipbuilding, and fishing.

Today, Guysborough is primarily a service-oriented community serving the needs of the surrounding rural area.

In 1996, the labour force in Guysborough was 190 of which 160 were employed. The unemployment rate at the time of the census was 15.8%. The average family income in Guysborough was $41,198. The main sources of employment were in government services and in the retail sector. Other employment sectors included: logging and forestry; the accommodation, food and beverage sector; and health and social services.

The Strait Area School Board provided education to grades primary through 12 in two facilities: the Chedabucto Education Centre and Guysborough Academy. The recent development of Chedabucto Education Centre totally replaces the senior high school and has involved the complete refurbishment of the primary school.

The Guysborough Memorial Hospital is a two physician, 10 bed acute care facility. It operates a 24-hour emergency room and provides secondary care to a catchment area of approximately 3,600 residents within Eastern Guysborough County.

7.2.5.2 Sherbrooke

Sherbrooke (population 625), located on the St. Mary's River, is the administrative centre of the District of St. Mary's and the site of the historic village, a major tourist attraction.

The community is the local service centre for the surrounding rural area and provides for the immediate needs of local inhabitants with respect to medical, educational, government services and retail facilities. It is located approximately 25 km from Goldboro.

The unemployment rate at the time of the census was 23.6%, considerably higher than the provincial unemployment rate at that time of 13.3%. The average family income was $35,709. The most important sources of employment were in retail, education, and the construction industries. The fishing and trapping and logging and forestry sectors each account for 5% each.

Two schools in Sherbrooke offer grades primary through grade 12. Primary medical services can be accessed locally at the St. Mary's Memorial Hospital.

7.2.5.3 Town of Antigonish

Today, Antigonish is the government, business, shopping, educational, medical and cultural centre for eastern mainland Nova Scotia. In 1996, the town's population was approximately 4,860.

The unemployment rate was 10% at the time of the census, which was substantially lower than the provincial unemployment rate of 13.3%. The average family income in Antigonish was reported as $52,024, significantly higher than the provincial average of $46,110. The most important sources of employment are education, health and social services. The wholesale trade industries, accommodation, food and beverage and government services also contribute to the employment profile.

St. Francis Xavier University, established in Antigonish in 1855, plays an important role in the economy of the town and attracts students from across Canada and beyond. The St. Martha's Hospital has provided medical services to the region since 1906.

7.2.6 The Offshore

The development of the offshore facilities and the associated pipeline to Goldboro is occurring in, or in proximity to, waters which are used for several purposes including near and offshore fishing, research, commercial shipping, military training activity, further exploratory drilling, and producing gas fields. The ocean floor is the location not only of the SOEP pipeline and associated gathering system, but also of communication cables.

7.2.6.1 The Fishery

DFO sets a Total Allowable Catch (TAC) for each fish and invertebrate stock within the Canadian 200 mile economic management zone. The TAC is then distributed among individual fishermen, groups of fishermen, or fishing companies by a system of catch quotas. The TAC and quotas are established based upon a stock assessment process involving detailed analysis of the fishery and data received from research cruises that are independent of the fishery. Management areas differ for fish and invertebrate fisheries.

DFO maintains two main databases on fishery success: catch-and-effort and landings systems. Similar data systems are maintained for all species, regardless of management regimes.

In 1999, the landed value of commercially harvested fish and marine plants in the Scotia-Fundy fisheries management sector was $592 million from landings of 311,000 tonnes. That same year, the wholesale value of fish and fish products produced in the region was estimated at $1.4 billion. The United States is the biggest market, accounting for some 70% of Scotia-Fundy's fisheries export sales (DFO 2000c).

Figure 7.2 delineates the Northwest Atlantic Fisheries Organization (NAFO) unit areas relative to the Deep Panuke Project. The histograms on the map show the average catch per unit area, by main species groups. In 4Wf, surrounding the platform, the main catch is scallop and crab. Crab, shrimp, and other invertebrates dominate the catch along the pipeline route in 4We, while closer to shore, the catch is made up largely of finfish. A mix of invertebrates and estuarial/small pelagic fish dominates in 4Wd, but in 4Wk the catch is almost entirely finfish.

Groundfish Fishery

Despite the closures that have occurred, the groundfish fishery has not improved on the eastern Scotian Shelf. Stocks of cod, haddock, white hake, and cusk remain at very low levels and removals are kept as low as possible. Pollock stocks, though in comparatively better condition, remain low. The central Shelf silver hake stock, fished primarily in Division 4W, is at a low level and catches will be kept low until the strength of recruiting year-classes improves. Halibut abundance is also low. Most redfish caught in Division 4W are part of the stock that is also resident in the Laurentian Channel. Redfish biomass is expected to decline gradually over the next few years. Stocks of small flatfish species all show indications of potential recovery, but it is too soon to relax restrictions on removals. Since the fishing moratorium in 1993, very little groundfish has been taken within 10 km of the platform location, though some fishing occurs along the pipeline route, especially in summer.

Large Pelagic Fishery

Drift longlines are the primary method used to catch the large pelagics, such as swordfish, tuna, and shark. Tuna are taken both along the Shelf break and in the nearshore waters of eastern Guysborough County, from Country Harbour to Canso. Fishing for tuna concentrates closer to shore after August, including an area to the east of the proposed pipeline, between Country Harbour and Tor Bay. Fishing for swordfish remains concentrated along the Shelf edge and in Emerald Basin. A fishery for shark occurs in the deep waters off the Shelf edge in all seasons. Little activity takes place within 50 km of the Deep Panuke platform site.

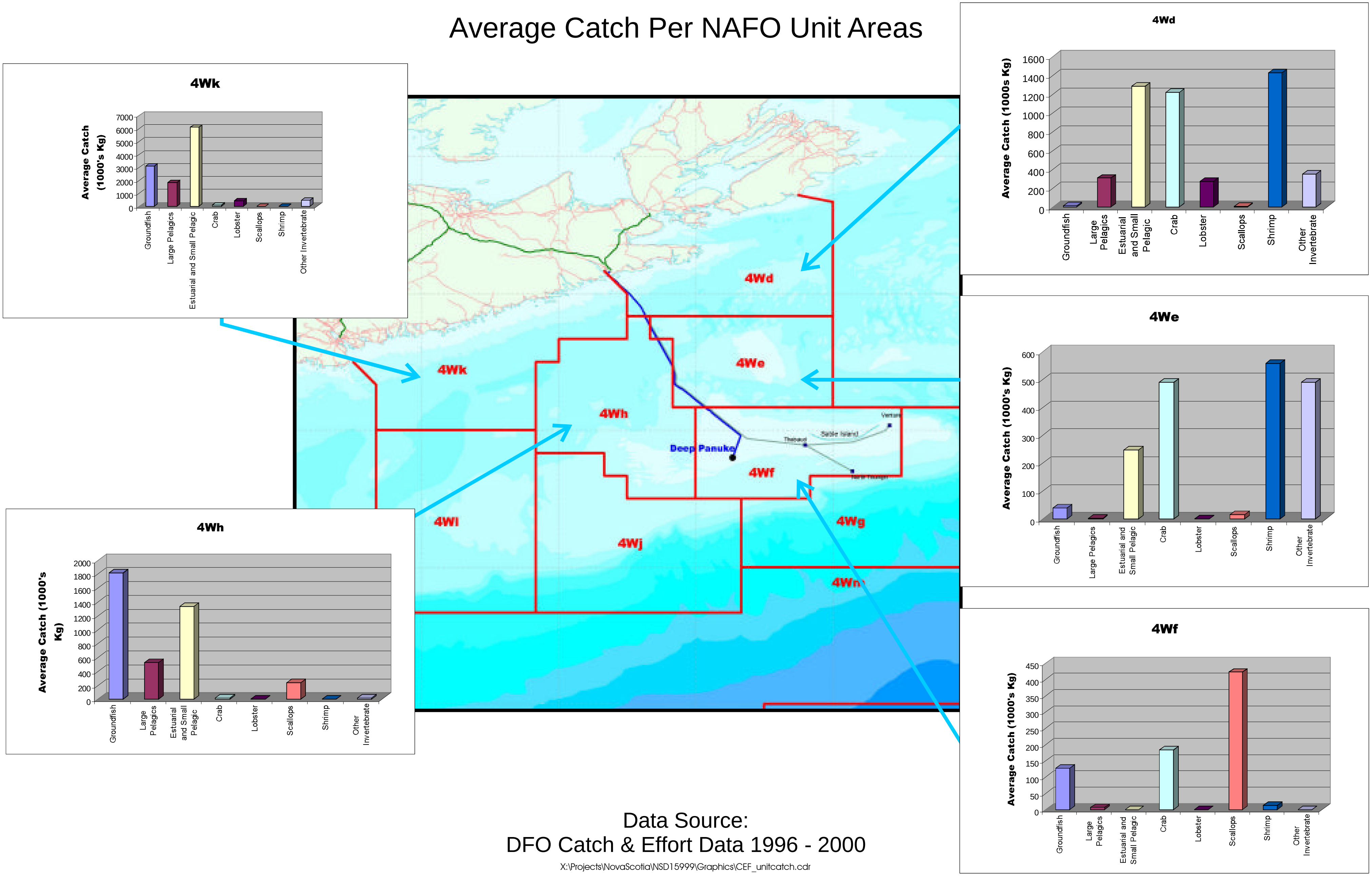
Small Pelagic Fishery

Herring and mackerel are the principal small pelagic species fished commercially on and around the Sable Island Bank. The stocks are in reasonable condition, and there are few restrictions placed on the fishery. Herring is the only species fished close to the proposed pipeline route by larger vessels that report fishing locations; this fishery takes place primarily in the spring. No small pelagics fishing activity occurs near the Deep Panuke platform site.

Figure 7.2

Deep Panuke Project

Average Catch Per NAFO Unit Areas



Data Source:
DFO Catch & Effort Data 1996 - 2000

X:\Projects\NovaScotia\NSD15999\Graphics\CEF_unitcatch.cdr

Invertebrate Fishery

The major invertebrate fisheries within the offshore study area are the scallop, crab, clams, and shrimp fisheries. Each species group is fished in distinct areas on the Scotian Shelf, and there is little overlap. These areas have remained relatively constant over the last five years. Scallop is the most important invertebrate fishery on the Sable Island Bank taking place approximately 35 km to the west and south of the Deep Panuke site. Shrimp and crab are fished between the platform location and the shore.

Trends in the Offshore Fisheries, Landings and Values

The overall value of Scotia-Fundy commercial fisheries landings increased annually from 1996 to 1999, rising 12.4% from 1998 to 1999 alone. Both the landed weights and the dollar value of invertebrates have steadily increased since 1987, while the value of groundfish has declined. Inshore lobster makes up the greater proportion of invertebrate landings, and in 1999 comprised almost half the overall total value (DFO 2000b). The 1999 total landed value was $592 million.

On the Eastern Scotian Shelf, including Banquereau and Sable Island Banks, scallop landed value has trended upward for the past decade; landed value in 1999 at $7,578,000 was almost double that of 1990.

"Emerging fisheries" are those that take new or non-traditional species; these fisheries are in either an exploratory or early commercial stage of development. Emerging species in various stages of development include bloodworms, whelks, hagfish, and Jonah, rock, and stone crab. The emerging species landings in Scotia-Fundy were worth $13.2 million in 1998 (DFO 2000a).

Location of Offshore Catch Landings

The greatest portion of the areas total offshore catch, 23.2%, is landed by the Lunenburg fleet. Canso receives the greatest amount of the snow crab catch. Statistical Fishing District 17, closest to the pipeline landfall, receives the second greatest amount of offshore crab catch caught by "inshore" boats (*i.e.,* those less than 65 feet long). The Scotian Shelf fisheries are commercially important to Nova Scotia and to individual coastal communities.

7.2.6.2 Sable Island

Sable Island is approximately 50 km from the proposed Project platform site. The Sable Island Preservation Trust was incorporated in December, 1998, to "ensure the long term conservation of Sable Island". The Trust currently maintains a staffed environmental monitoring and emergency base on the island. The number of people on Sable Island at any given time varies, but 4-7 people are employed full-time at the monitoring station. Seasonally, this can increase to 30 when scientists arrive to monitor migration patterns and to execute related research work.

7.2.6.3 Commercial Shipping

Offshore Nova Scotia accommodates considerable commercial shipping traffic destined to and from the eastern seaboard of the US and from the Great Lakes and Europe. Under *Eastern Canada Vessel Traffic Services Zone Regulations,* commercial shipping must follow dedicated routes and procedures upon nearing Halifax Harbour and the Strait of Canso. Outside of these controlled areas, mariners have discretion as to the selection of their preferred routing subject to proper navigation and seamanship practices.

7.2.6.4 Offshore Development Projects

The SOEP currently has one central staffed platform complex at the Thebaud field (approximately 45 km from the proposed Deep Panuke site), two satellite platforms, and the subsea pipeline gathering system and pipeline to Goldboro. Three other satellite platforms are being designed. When an operator has more than one offshore program underway, supply operations will be co-ordinated between the operations. Given the changing nature of the operations and the requirements of supplies, the number of supply boats operating in the vicinity of the Sable Island area will vary, but will seldom be less than six and may be as many as 12.

A producing operation, such as the Thebaud platform, would typically be supplied by support vessels two or three times a week. During drilling and development operations, however, this number would be significantly larger as substantially more material is required (bulk materials such as drilling fluids, bulk solids, (*e.g.*, barite, cement) and fuel, are often required in large volumes). Support of this nature might require up to six supply runs per week.

7.2.6.5 Offshore Exploration

The exploration for oil and gas in the waters off Nova Scotia continues to gain momentum. To date, 59 licences, valued at $1.56 billion, have been purchased in the offshore area, and more than 180 exploration wells have been drilled. Geophysical research programs and exploratory drilling related to these bids add to the shipping and related activity taking place offshore, but the activity is spread across a vast area, not concentrated in a single area or corridor.

7.2.6.6 Military Activity

Maritime Forces Atlantic conduct training and operations in various areas designated as Operations Areas (Ops Areas) off the coast of Nova Scotia. Ops Area India extends across much of the subsea pipeline route from the Deep Panuke site to landfall at Goldboro. The site of the Deep Panuke platforms are not located within a designated Ops Area (DFO 2001e). It is understood that there are several offshore sites where, in the past, munitions have been dumped. It was confirmed by DND, CFB Halifax, that the Project facilities are not located in proximity to any known sites with Unexploded Ordnance (UXO). Shallow geophysical surveys undertaken at the Deep Panuke site and along the pipeline route confirmed this.

7.2.6.7 Offshore Pipelines and Cables

A communications cable links Sable Island to the mainland of Nova Scotia. The proposed subsea pipeline will cross the route of this cable. Recent editions of the Canadian Hydrographic Service Nautical charts also show a number of abandoned subsea cables, or sections of abandoned subsea cables, in the vicinity of the pipeline route and the Deep Panuke platforms. Other than the Sable Island communication cable, the subsea cables in this area are no longer operative (DFO 2001a).

7.3 Socio-economic Impact Assessment

7.3.1 National and Provincial: Benefits and Impacts

Key provincial and national issues relate to the consequences of the Project at a macro-economic rather than a local level. These include the determination of:

- potential business and employment opportunities that will be generated during the development and production phases of the Project; and
- economic impacts to Nova Scotia and to Canada from purchases of goods, services and labour by the Project.

Estimates have been prepared of the potential business and employment opportunities and economic impacts that could be expected from the Project. These estimates provide a reasonable assessment of Nova Scotian and Canadian content and a realistic indication of potential opportunities, given recent experience with other similar developments and the current structure of the two economies. EnCana estimates a development cost of approximately $1.1 billion (2002 dollars) including all contingencies. Table 7.4 provides a breakdown of this cost by component.

Table 7.4 Development Phase Cost Summary by Component	
Component	**Total Cost ($ million)**
1. Engineering/Project management	$127
2. Offshore structures	$474
3. Drilling/completions	$178
4. Pipelines	$242
5. Offshore hook-up and commissioning	$41
6. Miscellaneous	$38
Total	**$1100**

7.3.1.1 Development Phase Opportunities and Impacts

This section details the employment opportunities and economic impacts arising from Project development expenditures. The analysis is conducted from the provincial as well as the national perspective, but the main emphasis, is on potential opportunities for Nova Scotia. Project development involves the installation of facilities and equipment to produce natural gas from the offshore installations with transport to landfall at Goldboro. The Project will not have significant onshore facilities; gas processing will occur offshore with market-ready gas transferred directly to M&NP facilities in Goldboro.

Materials and Labour Requirements

Project development involves approximately 2,805 person-years of direct employment (+/-25%). Employment requirements are presented in terms of person-years (equivalent of one person working a full year, or 2,080 hours). Generally, during construction, the number of jobs is greater than the number of person-years, as most people are employed for less than one year. To translate person-years into jobs, a multiplication factor of 1.35 may be used (SOEP 1996c) based on the types of activities and the average duration of jobs required.

Development Phase - Provincial Economic Impacts

Direct Project impacts are that portion of Project expenditures captured in an economy (*e.g.,* materials produced and purchased, margins on materials imported, wages and salaries, and jobs filled by local people). Direct Project development phase impacts in Nova Scotia are estimated at $80 million in material purchases and $117 million in wages and salaries. In total, Nova Scotia content is estimated to be about 18% of the total $1.1 billion of Project development expenditures on materials and labour. The $117 million in wages and salaries involves 1,441 person-years of employment, or roughly 1946 jobs over the three-year development phase. It is important to note that all of these jobs would not occur in one year nor would they last the duration of the development phase.

As a result of development expenditures, provincial GDP (at market prices) is estimated to increase by $181 million. The GDP multiplier is estimated at 0.16, meaning that for every dollar of Project development expenditures on labour and materials, 16 cents in new GDP is estimated to be generated in the Province. Household income is estimated to increase by $154 million, $117 million directly and $37 million through the multiplier process. The household income multiplier is estimated at 0.14, meaning that for every dollar of Project development expenditures on labour and materials, 14 cents in new household income would be generated in Nova Scotia. These multipliers do not include induced impacts on household income.

Approximately 3,220 jobs are estimated to be created, 1,946 directly and 1,274 through the multiplier process. The employment multiplier (calculated as the total change in employment divided by total direct employment) is estimated at 1.65. That is, for every direct Project job, it is estimated that 0.65 additional spin-off jobs would be generated. This does not include induced impacts on employment.

Development Phase - National Economic Impacts

Direct Project impacts in Canada (including Nova Scotia) are estimated to be $146 million in material purchases and $129 million in wages and salaries. Canada is estimated to receive about 25% of the total $1.1 billion on Project development expenditures. The $129 million in wages and salaries estimated for Canadian labour involves 1,566 person-years of work, or roughly 2,114 jobs, spread over the development phase (2002-2005). As a result of development expenditures, Canadian Direct and Indirect GDP are estimated to increase by about $242 million, household income by $197 million, and employment (in the form of jobs) by 4,259.

7.3.1.2 Production Phase Opportunities and Impacts

Production activities are broadly divided into logistics, production and General and Administrative (G&A). The analysis is conducted from the provincial as well as the national perspective; however, the main emphasis is on potential opportunities for Nova Scotia. Project production involves collection of raw gas, processing, and transportation of market-ready gas to the landfall at Goldboro. The production phase is assumed to run for 11.5 years, from 2005 through 2017.

Materials and Labour Requirements

The production phase expenditures are assumed to be $60 million annually (over $31 million for materials and services and $29 million for labour), for total production expenditures of $690 million ($357 million for materials and services and $333 million for labour) over an 11.5 year period.

Project operation is assumed to require 184 person years (+/-25%) and 116 person-years (+/-25%) of work hired on a contract basis, for a total of 300 person years annually. This translates to 3,445 person-years of employment over the 11.5 year production period.

Production Phase - Provincial Economic Impacts

Direct Project impacts in Nova Scotia are estimated to be $164 million in material purchases and $301 million in wages and salaries. In total, Nova Scotia is expected to capture about 67% of the $690 million Project production phase expenditure on materials and labour. The $301 million in wages and salaries involves 3,159 person-years of work, or roughly 312 jobs (assuming a person-year to job factor of 1.35 for contract labour). The contract person-years are averaged over the entire production phase and it is unlikely that all would be required equally in every year or that any contract positions would last the duration of the production phase.

As a result of production expenditures, provincial GDP is estimated to increase by $400 million. The GDP multiplier is estimated at 0.58, meaning that for every dollar of Project production expenditure on labour and materials, 58 cents in new GDP would likely be generated in the Province. This figure is exclusive of induced impacts. Household income is estimated to increase by $342 million, $301 million directly, and $41 million through the multiplier process. The household income multiplier is estimated at 0.50, meaning that for every dollar of Project production expenditures on labour and materials, 50 cents in new household income would be generated in Nova Scotia.

An estimated 480 jobs would likely be created, 312 directly and 168 through the multiplier process. The employment multiplier (calculated as the total change in employment divided by total direct employment) is estimated at 1.5. That is, for every direct Project job, an estimated 0.5 additional spin-off jobs would be generated. This analysis does not include induced effects in either income or jobs.

The production phase impacts are larger as a percentage of expenditure than the development phase impacts. The differences are a result of higher Nova Scotian content estimates for the production phase.

Production Phase - National Economic Impacts

Direct Project impacts in Canada (including Nova Scotia) are estimated to be $292 million in materials purchases and $330 million in wages and salaries. In total, Canada would likely receive about 90% of the total $690 million on Project production phase expenditures on materials and labour. Approximately 10%, or $69 million of Project production phase expenditures, is estimated to be spent on imported materials and labour.

The $330 million in wages and salaries that is estimated for Canadian labour involves 300 person-years of work, or roughly 337 jobs (assuming a person-year to job factor of 1.35 for contract labour), spread annually over the production phase. As a result of production phase expenditures, Canadian direct and indirect GDP is estimated to increase by $583 million, household income to increase by $464 million and employment (in the form of jobs) by 722.

7.3.2 Halifax Regional Municipality: Benefits and Impacts

7.3.2.1 Employment

HRM is the administrative and commercial centre of the province and has accommodated the needs of the oil and gas industry and the companies and organizations that service and represent the industry, including a wide range of professional services. The oil and gas sector is increasingly recognized as important to the economy of the metropolitan area and this trend is likely to continue.

The Project will generate 1,441 person years of employment over three years during the development phase and 3,159 person years of employment during the 11.5 years of production. Apart from the employment generated offshore and in the vicinity of the landfall, particularly during construction, the greatest portion of the economic benefit will accrue to the HRM. These benefits include both direct and indirect employment. EnCana has established an operating presence and a Project office in Halifax; together these offices employ several hundred people. As the Project evolves, staffing needs will change. The design and engineering work will, in large part, be undertaken in HRM. Given the availability of wharf space and marine expertise, some of the construction and marine services may also take place at one or more of the facilities that exist within the HRM. Decisions with respect to the allocation of many key contracts will not be made for some time, but substantial employment benefits can be expected to accrue to the city in part because of the expertise and resources that exist in the area.

7.3.2.2 Business Opportunities

The oil and gas industry requires a wide range of services including marine-related support, consulting engineers, lawyers and other specialists and support services as an integral part of day to day operations. Some services will be provided by specialist firms that have been established in the city for a long time, some will be provided by firms that have been attracted to the region because of the growing presence of the oil and gas sector, and some will come from the new skills acquired by local firms aiming to compete for business in the oil and gas sector. The Project will provide direct and indirect contractual opportunities to those firms, including First Nations' and Aboriginal firms, that have expanded to meet the needs of this sector and to new firms that are striving to establish a base in the city.

7.3.2.3 Training

The catalyst for training is the need for skilled tradesmen during the development and production phases of the Project. The adequacy of the provincial labour force to meet the demands of the oil and gas sector has been a subject of discussion for several years. It is apparent, however, that government, educational establishments and industry have worked together to determine needs and to establish training programs. EnCana has played a lead role in several of these initiatives. Regardless of available training programs, there will still be shortages of skilled personnel, particularly those with the appropriate levels of experience to assume responsibility for certain tasks. This is a reflection of the nature of the oil and gas industry as much as it is a deficiency in educational program availability. Those trained in local programs and who gain experience with the industry in Nova Scotia can expect to work elsewhere in Canada or the world during their professional career. Training therefore becomes a long-term benefit, because the skills acquired during Project development and production can be used elsewhere on comparable projects. EnCana will continue to work with the NSCC to ensure that necessary training programs are in place to meet its anticipated needs.

7.3.2.4 Property Tax Base

Property occupied by EnCana in the HRM (*e.g.*, the offshore supply base and office space) is subject to assessment and occupancy tax. Any increase in the space taken, therefore, provides a direct benefit to the municipality.

7.3.2.5 Economic Stability and Growth

As noted above, the oil and gas sector has become an important growth sector in the HRM. The fact that EnCana is seeking authorization to develop the Deep Panuke Project substantiates the understanding that the oil and gas industry will be present in the region for the long-term. By making a commitment to proceed with the applications to develop the Project as well as conducting the FEED study, EnCana demonstrates confidence in the future. This translates into wider business confidence in the region.

7.3.2.6 Roads

The principle source of Project impact on the road network of the HRM will occur during construction from the transportation of materials and the movement of the labour force to construction sites. It is not known at this time where the offshore structures will be built, nor where the pipe will be coated or stored. It is probable that some aspects of this work will be done within the HRM and the roads serving this region will accommodate more vehicles, including heavy loads. Although the road system serving the city will certainly accommodate any traffic associated with construction in the region, some concern has been expressed that further investigation is required to improve and expand the region's infrastructure, including the road system, to better accommodate additional urban growth.

7.3.2.7 Wharves

As stated above, it is not known at this time where the offshore structures will be built or assembled, nor where the pipe will be coated or stored. These activities will require appropriate wharfage and deep water. Further wharf facilities capable of handling purpose designed offshore support vessels with deeper drafts and specialized loading facilities may also be required. Capacity for all of these activities does exist within HRM, and EnCana already operates a supply base in the area. Such developments will generate economic benefits through the increased use of existing capacity and the generation of employment opportunities.

7.3.2.8 Emergency Services

Accidents and emergencies can occur at any time. The parties most directly involved in any work-related accident are the employees and emergency services. It is anticipated that in the event of any serious accident or injury during development, production or decommissioning of any facilities, injured personnel would be transported to the Queen Elizabeth II Health Services Centre in HRM, which is fully equipped to provide tertiary care. With the appropriate safety plans in place, the occurrence of a serious accident is unlikely, but any eventuality could be accommodated.

7.3.2.9 Land Use

Office space and commercial and industrial areas in the city will be required to support Project activities. Such requirements will be accommodated within existing office buildings and areas designated for commercial and marine purposes. Such activities facilitate the intent of the land use planning strategy to encourage economic development. This increased activity represents a defined Project benefit.

7.3.2.10 Public Health and Safety

The development of the Project as defined has no consequences for public health and safety in the HRM. No further analysis of this topic has been conducted with respect to this area.

7.3.2.11 Archaeological and Heritage Resources

The development of the Project as defined has no consequences on archaeological and heritage resources in HRM. No further analysis of this topic has been conducted with respect to this area.

7.3.2.12 Current Land and Resource Use for First Nations and Aboriginal Purposes

The development of the Project as defined has no consequences on current land and resource use for First Nations and Aboriginal purposes in HRM. No further analysis of this topic has been conducted with respect to this area.

7.3.2.13 Mitigation

Project design has taken into account environmental and socio-economic factors of interest or concern. Good engineering practices will further minimize the likelihood of adverse impacts. The following specific mitigative measures have been recommended with respect to Project activities in HRM:

- EnCana will continue to work with the NSCC to ensure that necessary training programs are in place to meet their anticipated labour needs; and
- EnCana will continue to provide information to the business community, including the First Nations' and Aboriginal business community, about the procurement process, the forthcoming development and operational activities and the opportunities associated with such activities.

7.3.2.14 Summary of Residual Impacts

As summarized in Table 7.5, HRM will derive substantial benefit from the development and operation of the Project including:

- employment during development and operation;
- business opportunities during development and operation;
- workforce training during development and operation;
- increased revenue from property taxes during development and operation; and
- activities and investment that will facilitate economic stability and growth in the region.

7.3.3 Service Communities: Guysborough, Sherbrooke and Antigonish: Benefits and Impacts

7.3.3.1 Employment

The service communities of Guysborough, Sherbrooke and Antigonish are within less than an hour's commuting distance of the landfall area and may provide services during Project development and operation. The residents of these communities are interested in employment that may be available either directly from the Project or indirectly through contractors or other businesses that benefit from Project activities. While it is certain that the construction of the subsea and onshore pipeline and the subsequent production phase will bring some employment benefit, there will be no plant construction at Goldboro and no requirement for a permanent operational presence in the area.

7.3.3.2 Business Opportunities

Business opportunities are generated in response to investment and the likelihood of new employment. As noted above, there will be some employment during Project construction, but it will be limited in duration. The bringing ashore of a second source of natural gas, however, reflects the gradual diversification in, and security of, supply that is essential to future industrial development in the region. This in turn will provide opportunities for businesses in Guysborough, Sherbrooke and Antigonish.

7.3.3.3 Training

Although training is a topic of interest, there appears to be some understanding that training for key trades is available through community colleges and trade unions. EnCana is working with the NSCC to ensure that training programs are in place to meet their anticipated labour requirements. Training is a benefit that can be attributed to the development and production phases of the Project. It is also a benefit that extends beyond the life of the Project because those trained can work on other comparable projects.

Table 7.5 Halifax Regional Municipality: Residual Impacts

ISSUES/CONCERNS	STAKEHOLDERS	PROJECT IMPACT SOURCE	LINKAGE TO PROJECT	RESIDUAL IMPACT	DEGREE OF CERTAINTY
			THE ECONOMY		
Employment	• Those seeking employment • Non-government organizations	• Development and production expenditures	• The Project is a source of both direct and indirect employment during development and production	Employment benefit during development	Benefit is certain
				Employment benefit during production	Benefit is certain
				Insignificant benefits during decommissioning	Impact is of low certainty
Business Opportunities	• Businesses • HRM	• Development and production expenditures	• Project investment is a catalyst for further economic expenditures	Development will bring benefit	Benefit is certain
				Production will bring benefit	Benefit is certain
				Insignificant impact during decommissioning	Impact is of low certainty
Training	• Those who look necessary skills • Education sector	• Development and production expenditures • Labour needs	• EnCana skill needs	Benefit during development	Benefit is certain
				Benefit during production	Benefit is certain
				No impact during decommissioning	Impact is certain
Property Tax Base	• HRM	• Occupancy of property	• All office space and other Project related spaces subject to assessment and related property taxes	Development will bring benefit	Benefit is certain
				Production will bring benefit	Benefit is certain
				Insignificant impact during decommissioning	Impact is of low certainty
Economic Stability/Growth	• Business community • HRM	• Development and production expenditures • Expansion of industrial sector	• Expansion of oil and gas sector	Development will bring benefit	Benefit is certain
				Production will bring benefit	Benefit is certain
				Decommissioning will have an insignificant impact	Impact is of low certainty
Aquaculture and the Fishery	• None	• Construction of the marine facilities	• No Linkage	N/A	N/A

Table 7.5 Halifax Regional Municipality: Residual Impacts

ISSUES/CONCERNS	STAKEHOLDERS	PROJECT IMPACT SOURCE	LINKAGE TO PROJECT	RESIDUAL IMPACT	DEGREE OF CERTAINTY
Tourism	• None	• Construction of industrial infrastructure	• No Linkage	N/A	N/A
THE ENVIRONMENT					
Water Quality	• None	• Construction of the nearshore and onshore pipelines	• No Linkage	N/A	N/A
Air Quality	• None	• Gas treatment	• No Linkage	N/A	N/A
INFRASTRUCTURE					
Roads	• Road Users • HRM • NSTPW	• Construction traffic	• Use of public roads by construction vehicles	Development will have no impact	Impact is certain
				Production will have no impact	Impact is certain
				Decommissioning will have no impact	Impact is certain
Wharfs	• Operators of wharf space	• Construction and operational activities	• Use of wharfs	Development will bring benefits	Benefit is of low certainty
				Production will being benefits	Benefit is of low certainty
				Decommissioning will have insignificant impact	Impact is of low certainty
Emergency Services	• Employees • Emergency service providers	• Accidental events	• Accidental events during development and production	Development will have an insignificant impact	Impact is certain
				Production will have an insignificant impact	Impact is certain
				Decommissioning will have an insignificant impact	Impact is certain

7.3.3.4 Economic Stability and Growth

The fact that a second offshore project is seeking development authorization in northeastern Nova Scotia is more important to economic stability and growth in the service communities than the local employment that will be generated by the Project itself. The proposed development of the Project is concrete evidence that the investment in infrastructure made by M&NP is attracting other users. The availability of a second source of market-ready gas increases marketable volumes and ensures a secure, long-term supply. It also indicates that the provincial offshore industry is maturing and that northeastern Nova Scotia is playing a key role in that process.

7.3.3.5 Roads

The only source of Project impact on the road network will occur during construction from the transportation of materials and the movement of the labour force to construction sites. As the pipe lay-down area has not yet been selected, the routes that will carry the construction loads cannot be identified. Goldboro, however, will be the destination of the materials required to construct the onshore pipeline. The routes that serve Goldsboro, as well as one or more of the service communities, include Route 316, Highway 7 and the TransCanada Highway. Apart from the increase in traffic at Goldboro, there may be a temporary increase in traffic along sections of these routes during the construction period. It is not anticipated that Project related traffic movements will be of a magnitude to cause disruptions to traffic flow or to pose a hazard to public safety. There will be no impact on the road system during Project operation or decommissioning.

7.3.3.6 Emergency Services

There are small hospital facilities located in Guysborough and Sherbrooke and a larger facility, St. Martha's Hospital, in Antigonish. Given the location of Project related construction activities in the vicinity of Goldboro, it is likely that in the event of an emergency, those injured would first be taken to St. Martha's Hospital. In the case of very serious injury, or multiple events, those injured would likely be transferred to the Queen Elizabeth II Health Services Centre in Halifax. With the appropriate safety plans in place, the impact of any Project related accidental event on emergency facilities in Guysborough, Sherbrooke and Antigonish would be insignificant.

7.3.3.7 Public Health and Safety

The development of the Project as defined has no consequences for public health and safety in the communities of Guysborough, Sherbrooke and Antigonish. No further analysis of this topic has been conducted with respect to this area.

7.3.3.8 Archaeological and Heritage Resources

The development of the Project as defined has no consequences on archaeological and heritage resources in the communities of Guysborough, Sherbrooke and Antigonish. No further analysis of this topic has been conducted with respect to this area.

7.3.3.9 Current Land and Resource Use for First Nations and Aboriginal Purposes

The development of the Project as defined has no consequences on current land and resource use for First Nations and Aboriginal purposes in the communities of Guysborough, Sherbrooke and Antigonish. No further analysis of this topic has been conducted with respect to this area.

7.3.3.10 Recommended Mitigation

Project design has taken into account environmental and socio-economic factors of interest or concern. Good engineering practices will further minimize the likelihood of adverse impacts. In addition, the following mitigative measures have been recommended:

- communication with service communities and/or Chambers of Commerce to ensure information on business opportunities is made available early in the bidding process; and
- continued work with the NSCC to ensure that the necessary training programs are in place to meet anticipated labour requirements.

7.3.3.11 Summary of Residual Impacts

As summarized in Table 7.6, the service communities of Guysborough, Sherbrooke and Antigonish will derive the following benefits from the Project:

- employment during construction;
- business opportunities during construction;
- workforce training during construction and operation; and
- activities and investment that will facilitate economic stability and growth.

Table 7.6 Service Communities: Guysborough, Sherbrooke and Antigonish: Residual Impacts

ISSUES/CONCERNS	STAKEHOLDERS	PROJECT IMPACT SOURCE	LINKAGE TO PROJECT	RESIDUAL IMPACT	DEGREE OF CERTAINTY
THE ECONOMY					
Employment	• Those seeking employment • Municipalities	• Development and production expenditures	• Need for labour	Some benefit during development	Benefit is certain
				Some benefit during production	Benefit is certain
				Some benefit during decommissioning	Benefit is of low certainty
Business Opportunities	• Businesses • Municipalities	• Development and production expenditures	• Project investment as a catalyst for further economic expenditures	Development will bring some benefit	Benefit is certain
				Production will bring little benefit	Benefit is certain
				Some benefit during decommissioning	Benefit is of low certainty
Training	• Those who lack necessary skills • Education sector	• Development and production expenditures • Labour needs	• EnCana's skill needs	Benefit during development	Benefit is certain
				Benefit during production	Benefit is certain
				Insignificant impact during decommissioning	Impact is certain
Property Tax Base	• None	• Occupancy of property	• No Linkage	N/A	N/A
Economic Stability/Growth	• Businesses • Municipalities	• Development and production expenditures	• Expansion of oil and gas sector • Security of gas supply	Development will have some benefit	Benefit is certain
				Production will have some benefit	Benefit is certain
				Decommissioning will have an insignificant impact	Impact is of certainty
Aquaculture and the Fishery	• None	• Construction of the marine facilities	• No Linkage	N/A	N/A
Tourism	• None	• Construction of industrial infrastructure in the area	• No Linkage	N/A	N/A

Table 7.6 Service Communities: Guysborough, Sherbrooke and Antigonish: Residual Impacts

ISSUES/CONCERNS	STAKEHOLDERS	PROJECT IMPACT SOURCE	LINKAGE TO PROJECT	RESIDUAL IMPACT	DEGREE OF CERTAINTY
THE ENVIRONMENT					
Water Pollution	• None	• Construction of the nearshore and onshore pipelines	• No Linkage	N/A	N/A
Air Pollution	• None	• Gas treatment	• No Linkage	N/A	N/A
INFRASTRUCTURE					
Roads	• Road users • Municipalities • NSDoT&PW	• Construction traffic	• Use of public roads by construction vehicles	Development will have an insignificant impact	Impact is certain
				Production will have no impact	Impact is certain
				Decommissioning will have no impact	Impact is certain
Wharfs	• None	• Construction activity	• No Linkage	N/A	N/A
Emergency Services	• Employees • Emergency service providers	• Accidents Events	• Accidental events during development and production	Development will have an insignificant impact	Impact is certain
				Production will have an insignificant impact	Impact is certain
				Decommissioning will have an insignificant impact	Impact is certain
SOCIAL					
Land and Water Use	• None	• Development and production activities	• No Linkage	N/A	N/A
Current Land and Resource Use for First Nations' and Aboriginal Purposes	• None	• Development and production activities	• No Linkage	N/A	N/A
Archaeological and Heritage Resources	• None	• Pipeline construction	• No Linkage	N/A	N/A
Public Health and Safety	• None	• Development and production activities	• Accidental events during construction and operation	N/A	N/A

7.3.4 Guysborough County and Landfall Communities: Benefits and Impacts

7.3.4.1 Employment

The pipeline transporting natural gas from the Deep Panuke site will come ashore at Goldboro in Guysborough County, Nova Scotia. Based on information received during the public consultation process, the priority of many in Guysborough County and eastern Nova Scotia is employment and secondly, other economic benefits that may be generated by the Project. This Project builds on the infrastructure that is in place. Since the Project's development will not involve the construction of a new plant at Goldboro, there will be no permanent operational presence by EnCana in the local area. Pipeline construction, both onshore and offshore, will take place over the course of one construction season. The maximum employment that will be generated by the construction of the onshore pipeline is unlikely to exceed 50. Nevertheless the Project will generate a wide range of activities in support of both development and operation. These employment opportunities, both offshore and in HRM, will be open to all qualified applicants including those from the Goldboro area.

7.3.4.2 Business Opportunities

The bringing ashore of a second source of natural gas reflects the gradual diversification in, and security of, the supply of natural gas that is important to future industrial development in the area and elsewhere in the region. The Project will increase the development momentum in the area and secure Goldboro's position as the first natural gas landfall location in the province. The Project, for example, is one of the reasons for the proposed expansion in the capacity of the M&NP main transmission line. The anticipated immediate and direct business opportunities associated with the Project at landfall will be small, but the wider opportunities associated with the Project and with other developments that may rely on the gas supply will be greater.

7.3.4.3 Training

The catalyst for training is the requirement for skilled personnel during Project development and production. EnCana is working with the NSCC to ensure that the necessary training programs are in place to meet their anticipated labour requirements. Those trained in local programs and who gain experience with the industry in Nova Scotia can expect to work elsewhere during their careers. Training therefore becomes a long-term benefit, because the skills acquired are transferable between projects.

7.3.4.4 Property Tax Base

The lands used for the development of the onshore pipeline from landfall to the tie-in with M&NP mainline, a distance of 3-4 km, will be subject to taxation. The Municipality of the District of Guysborough will receive these revenues which represent a source of income for the municipality. As indicated in Section 4.2.1.3 of the SEIS (DPA Volume 5), no agreement has yet been reached with respect to the province's assessment of the gas plant and the existing pipeline infrastructure. The outcome of these negotiations will have a bearing on the assessment of the proposed new infrastructure and on the property taxes that will be collected by the municipality. Based on current assessment rates for SOEP and M&NP infrastructure, the estimated assessment value for the proposed infrastructure would be in the vicinity of $5.5 million. This in turn would generate a tax benefit for the municipality of approximately $84,000 annually.

7.3.4.5 Economic Stability and Growth

The Municipality of the District of Guysborough and surrounding areas have accommodated substantial economic investment over the last few years. There is also considerable optimism that this area will attract further industrial and residential development. However, municipal representatives have indicated on several occasions that they would prefer to see the development of an onshore sour gas treatment plant at Goldboro, rather than the offshore treatment proposed for Deep Panuke. This option, it is argued, would bring more employment and local investment to the area during construction and operation.

The technical reasons for treating the sour gas offshore are significant and are addressed in the Development Plan (DPA Volume 2) and Section 2.10 of the CSR. While it is acknowledged that an additional onshore plant would generate more local construction employment and increased tax revenues, long-term employment during operation would likely be minimal. This Project adds not only quantity, but also security, to the supply of natural gas at Goldboro. Goldboro may not be the only landfall to be developed in Nova Scotia over the longer term, but it has the advantage of being the first, and therefore is a competitive option for many offshore players. At the same time the municipality is successfully generating interest in the industrial lands adjacent the gas plant. In this context, the Project augments and supports the foundation for economic stability and growth in the immediate area. This is a distinct and important Project benefit.

7.3.4.6 Aquaculture and the Inshore Fisheries

Construction, particularly trenching, potential blasting, and burial of the marine pipeline in the nearshore area, is a potential source of impact on aquaculture and the inshore fishery. Construction activities will cause releases of sediment into the water column and disturbance to the seafloor within a relatively narrow band along the pipeline RoW. Thus, the effects on fishing in inshore waters, particularly for lobster and rock crab, will likely be restricted to individual fishers who fish in specific areas according to tradition and interpersonal agreements. Access to sea urchins within the potentially affected zone is restricted to an individual leaseholder. As a result, individual compensation arrangements will be negotiated between EnCana and those potentially affected by construction activities.

Experience with the SOEP and other comparable projects has shown that measurable sediment increases during trenching and blasting are restricted to distances of less than one km from the construction zone. The aquaculture sites located in Country Harbour are well outside the construction zone and are unlikely to be affected. Changes to the sea bottom, both physical and biological, will be confined to a narrow zone; regrowth of marine plants, followed by recolonization by infauna and epifauna, will occur within a few years (refer to Section 6.3.3). The disturbed area, compared to the total fish habitat available, is insignificant.

Construction of the pipeline will result in a small temporary loss of productive fish habitat, but the size and duration of this loss will not result in significant adverse effects on the inshore fishery. EnCana is committed to developing a compensation program in consultation with fisheries interests prior to construction activities. This program will be consistent with the Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity (C-NOPB and CNSOPB 2002). EnCana has also committed to the establishment of a fisheries lisison committee similar to that which operated successfully during SOEP construction, closer to the date of construction. No effects on aquaculture are anticipated.

7.3.4.7 Tourism

Development of additional industrial infrastructure in an essentially rural area may have an impact on tourism. There are currently two principal categories of visitors to this part of the Eastern Shore: those whose primary destination is the historic village museum in Sherbrooke; and those who visit the area to fish, hunt, canoe, walk or to enjoy the natural attributes of the area. A telephone survey of tourism operators conducted in the fall of 2001 (refer to Section 4.2.1.2 of the SEIS (DPA Volume 5)) suggested that the SOEP had increased the public awareness of the area among potential visitors, and they anticipated that the proposed Project would do the same. None of the respondents thought that the SOEP had caused any direct positive or negative impacts on tourism in the area.

While onshore construction of the Project may lead to a temporary increase in occupancy rates for a few Bed and Breakfast establishments, the demand for such accommodation will be substantially less than was the case during the construction of the SOEP gas plant and associated works. Consequently, it is anticipated that the Project will have minimal effects on area tourism.

7.3.4.8 Water Quality

Water quality in the area may be affected by siltation during construction of the nearshore and onshore pipeline, subsequent works on the pipeline during Project operation and by an accidental event involving the pipeline. The construction of the nearshore pipeline will disturb the nearshore benthos. The extent and severity of any resulting sedimentation will depend on alignment of the pipe, the nature of the seafloor, currents and the duration and type of dredging. Construction, however, will be of limited duration and once the pipeline is in place, there will be no further sedimentation. Onshore construction could cause sediment run-off, including potential acidic run-off, to reach streams and/or the marine environment. However, sediment controls are an integral part of normal construction practices and the sedimentation of freshwater or the marine environment from uncontrolled run-off is unlikely. Additional information on Project effects on water quality in the study area is included in Section 6.3.2. No significant adverse effects are predicted on water quality.

7.3.4.9 Air Quality

The principle source of Project related air emissions will be from the offshore processing facility. Given the distance of the facility from shore there will be no interaction between the Project and the Municipality of the District of Guysborough with respect to air quality. No significant adverse effects are predicted for the airshed of the landfall communities (refer to Section 6.3.1).

7.3.4.10 Roads

The principle source of Project impact on the road network will occur during construction as a result of materials transported and the movement of the labour force to construction sites. Construction of the onshore pipeline to the tie-in with the M&NP mainline will involve the use of specialized machinery and transportation of pipe to the RoW. Some of these materials may be transported to the Goldboro wharf by barge and then transported by road to construction sites. The onshore pipe lengths may also be transported from a pipe laydown area by road. The location of the pipe laydown area has not yet been determined. Therefore, is not possible to determine which routes will be used, other than those that access the construction area at Goldboro, such as Highway 316. Given the limited length of the onshore pipeline (3-4 km), pipe-hauling activities will likely last no more than a few days. Some disruption of traffic flow on Route 316 is likely to occur during the short period when pipes are being moved to construction sites. Any inconvenience to local residents will be minimized through notification to the municipality or other pertinent agencies of anticipated traffic disruptions, thus allowing appropriate traffic management techniques to be applied, if warranted.

7.3.4.11 Wharves

The principal source of impact on wharves in the area would occur during construction as the result of the movement of equipment and material. The Goldboro wharf was completely reconstructed by SOEI during gas plant construction. This wharf is available to EnCana should the need arise.

7.3.4.12 Emergency Services

Goldboro is a distinctly rural community and local emergency services are minimal. A paramedic base with two ambulances in Country Harbour serves an area that includes the communities of Goshen, Stormont, Goldboro, Isaac's Harbour, Drum Head, Seal Harbour and New Harbour. The SOEP has augmented the local emergency resources both directly and indirectly. For example, an increase in the local fire tax levy for District 7 has enabled the Harbourview Volunteer Fire Station to obtain new equipment. Due to their proximity to the gas plant, the SOEP has also provided the Harbourview group with a "Jaws of Life". These local resources would be available to respond to any Project related emergency in the vicinity of Goldboro. EnCana will also prepare the necessary safety plans to address all eventualities that may arise during construction and operation. The company will work with local emergency authorities to ensure that response teams are appropriately trained and equipped to address all accidents and emergency incidents.

7.3.4.13 Land Use

Construction of the pipeline from landfall to the tie-in with the M&NP mainline has the potential to disrupt land use. The routing of the pipeline from landfall to the tie-in location is largely through lands that have been disturbed in the past. No active logging is taking place on any land along the proposed RoW. The proposed RoW crosses an area designated by the Guysborough County Regional Development Authority (GCRDA) and the municipality as the Goldboro Industrial Park. The final RoW routing will be negotiated with the municipality to ensure minimal disruption to potential industrial development sites.

Although there are no active mineral workings in the vicinity of the proposed pipeline corridor, there are lands subject to mineral licences (refer to Figure 4.15 of SEIS (DPA Volume 5)) including licences on property that extends across the proposed pipeline corridor. Access through all lands will be negotiated with the landowner, including, where appropriate, the Crown. It will also be necessary to notify and consult with those parties that hold mineral licences.

7.3.4.14 Current Land and Resource Use for First Nations' and Aboriginal Purposes

As indicated in Section 7.2.4.1, there is evidence that the Mi'kmaq historically frequented the lands and waters around the landfall. Today, however, there are no First Nation's communities in the County of Guysborough and no indication that First Nation's or Aboriginal people use land and waters in or near the proposed RoW for traditional purposes such as hunting, trapping and gathering. In the absence of evidence of any current use (Membertou Corporate Division 2002), it is predicted that there will be no impact from Project activities on the use of land for traditional purposes by the First Nations and Aboriginal peoples.

As referenced in Section 7.2.3.2, First Nations and Aboriginal peoples have acquired licences to fish in the nearshore and offshore waters, including licences to fish in waters in proximity to the pipeline and its landfall. Consideration of the effects, if any, on such commercial licences is addressed in Sections 7.3.4.6 and 7.3.5.2 of this document (refer also to Sections 7.4.1.6 and 7.5.1.6 of the SEIS (DPA Volume 5)).

7.3.4.15 Archaeological Resources

As indicated in Section 7.2.4.1, three shipwrecks were identified in the immediate vicinity of the nearshore pipeline and landfall; several other wrecks are located in the approaches to Country Harbour. The Curator of Special Places at the Nova Scotia Museum has indicated that these wrecks have historical value. To the extent possible, the proposed pipeline will be routed to avoid interaction with any of these wrecks. The Nova Scotia Museum will be informed of all route modifications. Once the nearshore pipeline route has been finalized and any mitigative action recommended by the Curator of Special Places taken, impacts on marine archaeological resources during Project Construction will be insignificant. There will be no impact on these resources during Project operation or decommissioning.

Construction activities associated with pipeline construction from landfall to connection with the M&NP transmission main may have an effect on land-based archeological resources. A range of heritage resources has been identified near the proposed pipeline RoW. These pre-contact and historic archaeological resources include nine sites within the vicinity of the proposed landfall; none are located within the pipeline corridor. A field survey conducted in the fall of 2001 within the pipeline study corridor did not identify any additional archeological sites.

As there may potentially be pre-contact sites in the vicinity of the pipeline landfall or RoW that have not yet been identified, mitigative measures will be required in the event that such sites are encountered during construction. These measures include:

- inspection of the RoW by an archaeologist, in association with an Aboriginal representative prior to initiation of any ground disturbing activities;
- delivery of a heritage resource awareness program for construction personnel; and
- monitoring by an archaeologist, in association with an Aboriginal representative, of construction activities at any locations as having a high potential for archaeological resources.

Through implementation of the above mitigative measures, the effects of construction activities on land-based archaeological resources will be insignificant. There will be no impact on such resources during Project operation or decommissioning.

7.3.4.16 Public Health and Safety

Public health and safety at and in the vicinity of the landfall might be affected during development, production and decommissioning by an accidental event or, during production by emissions. Due to the nature of the Project (*i.e.*, offshore processing), the assessment of the onshore effects of changes to air quality are confined to routine construction emissions (*e.g.*, grading, vehicle emissions and dust) (refer to Section 6.3.1). The preparation and enforcement of the construction EPP to ensure that all construction activities are undertaken in an environmentally acceptable fashion will ensure that emissions generated during normal construction activities are kept to acceptable levels.

Accidental events are unpredictable. As indicted in Section 7.4.3.3 of the SEIS (DPA Volume 5), EnCana will prepare the necessary safety plans to address all eventualities that may arise and will work with the local authorities to ensure that the response teams are appropriately trained and equipped to address all accidents and emergency events.

7.3.4.17 Recommended Mitigation

The routing and design of the nearshore and onshore pipeline and related facilities has taken into account relevant environmental and socio-economic factors. For example, nearshore pipeline routing and the landfall site have been selected to avoid and historically important marine wrecks and valued pre-contact sites. Following is a summary of specific mitigative measures that EnCana will implement as appropriate:

- encourage its contractors and subcontractors during construction to work with local agencies to hire labour from the District of Guysborough;
- work with the Municipality of the District of Guysborough to ensure that information on contracts and business opportunities is made available to those local parties who could provide the required services;

- continue to work with the NSCC to ensure that the necessary training programs are in place to meet anticipated needs for trained labour;
- negotiate compensation agreements to mitigate any demonstrable economic losses resulting from spills, gear and vessel damage and lost opportunity for fishing ;
- use appropriate measures (*e.g.*, silt curtains) to minimize the movement of sedimentation and potential acidic runoff;
- prepare an EPP;
- notify the Municipality of the District of Guysborough and other pertinent agencies and the EILC whenever construction activities will disrupt traffic flow on Route 316 during construction;
- work with local emergency authorities to ensure that response teams are appropriately trained and equipped to address all accidents and emergency incidents;
- work with the Municipality of the District of Guysborough to ensure that pipeline routing through designated industrial lands is acceptable;
- notify and consult with landowners and holders of mineral licences with respect to pipeline routing;
- liaise with the Curator of Special Places at the Nova Scotia Museum to determine what, if any, mitigative actions are required to protect the identified marine wrecks;
- conduct, with an archaeologist and an Aboriginal representative, an inspection of the right-of-way after the survey line is marked to identify archaeological sites;
- deliver an awareness program with respect to archaeological sites for construction related personnel; and
- conduct monitoring of construction activities at sites that have potential for archaeological resources.

7.3.4.18 Summary of Residual Impacts

As summarized in Table 7.7, Guysborough County and, more specifically, the landfall communities will derive the following benefits from the Project:

- a second source of gas which will contribute to economic stability and growth;
- training benefits during development and production;
- employment benefit during development;
- some benefit to businesses during development; and
- new property taxes.

Table 7.7 Guysborough County / Landfall Communities: Residual Impacts

ISSUES/CONCERNS	STAKEHOLDERS	PROJECT IMPACT SOURCE	LINKAGE TO PROJECT	RESIDUAL IMPACT	DEGREE OF CERTAINTY
THE ECONOMY					
Employment	• Those seeking employment • Municipality	• Development and production expenditures	• The Project is a source of both direct and indirect employment during development and production	Some benefit during development	Benefit is certain
				Some benefit during production	Benefit is certain
				Some benefit during decommissioning	Benefit is of low certainty
Business Opportunities	• Businesses • Municipality	• Development and production expenditures	• Project investment as a catalyst for further economic expenditures	Development will have some benefit	Benefit is certain
				Production will bring little benefit	Benefit is certain
				Decommissioning may bring some small benefit	Benefit is of low certainty
Training	• Those who lack the necessary skills	• Development and production expenditures • Labour needs	• EnCana's skill needs	Benefit during development	Benefit is certain
				Benefit during production	Benefit is certain
				Insignificant impact during decommissioning	Impact is certain
Property Tax Base	• Municipality • Residents of the area	• Onshore pipeline infrastructure	• Onshore pipeline will be subject to assessment and related property taxes	No impact during development	N/A
				Production will bring benefit	Benefit is certain
				Benefits will cease when the Project is decommissioned	Impact is of certain
Economic Stability/Growth	• Businesses • Municipality • GCRDA	• Development and production expenditures • Expansion of industrial sector	• Expansion of oil and gas sector • Security of supply	Development will bring benefit	Benefit is certain
				Production will bring benefit	Benefit is certain
				Decommissioning will have an insignificant impact	Impact is of low certainty

Table 7.7 Guysborough County / Landfall Communities: Residual Impacts

ISSUES/CONCERNS	STAKEHOLDERS	PROJECT IMPACT SOURCE	LINKAGE TO PROJECT	RESIDUAL IMPACT	DEGREE OF CERTAINTY
Aquaculture and Inshore Fishery	• Those involved in aquaculture or the inshore fishery	• Development of the nearshore pipeline • Accidents	• Activities that cause sedimentation	Development will have an insignificant impac	Impact is certain
				Production will have no impact	Impact is certain
				Decommissioning will have no impact	Impact is certain
Tourism	• Residents who feel that industrial development is incompatible with tourism in the area • Tourist operators	• Development of industrial infrastructure in the area	• Incompatibility of activities	Development will have no impact	Impact is certain
				Production will have no impact	Impact is certain
				Decommissioning will have no impact	Impact is certain
			THE ENVIRONMENT		
Water Quality	• Residents of the area • Stakeholders who have made an investment dependent on clean water	• Construction of the nearshore and onshore pipelines	• The generation of sedimentation and/or the release of effluents	Development will have an insignificant impact	Impact is certain
				Production will have no impact	Impact is certain
				Decommissioning will have no impact	Impact is certain
Air Quality	• Residents of the area	• Gas treatment	• Release of gases to the atmosphere during operation. Given the distance between the offshore treatment facilities and the area in question, there is no linkage	N/A	N/A

Table 7.7 Guysborough County / Landfall Communities: Residual Impacts

ISSUES/CONCERNS	STAKEHOLDERS	PROJECT IMPACT SOURCE	LINKAGE TO PROJECT	RESIDUAL IMPACT	DEGREE OF CERTAINTY
INFRASTRUCTURE					
Roads	• Users of Route 316 and other roads serving the landfall area • Municipality • NSDOT&PW	• Construction traffic	• Use of public roads by construction vehicles	Development will have an insignificant impact	Impact is certain
				Production will have no impact	Impact is certain
				Decommissioning will have no impact	Impact is certain
Wharfs	• Users of any wharf used by the Project	• Construction traffic	• Use of public wharfs during construction activity	Development will have an insignificant impact	Impact is certain
				Production will have no impact	Impact is certain
				Abandonment will have no impact	Impact is of low certainty
Emergency Services	• Employees • Local residents • Emergency service providers	• Accidental events	• Accidental events during development and production	Development will have an insignificant impact	Impact is certain
				Production will have an insignificant impact	Impact is certain
				Decommissioning will have no impact	Impact is certain
SOCIAL					
Land and Water Use	• Land owners and users • Municipality	• Development of the onshore pipeline	• Lands used for pipeline construction and operation	Insignificant impact on land use during development	Impact is certain
				Insignificant impact on land use during production	Impact is certain
				Decommissioning will have no impact on land use	Impact is certain
Current Land and Resource Use for First Nations' and Aboriginal Purposes	• Aboriginal peoples	• Development and production activities	• Disturbance of lands	Development will have no impact	Impact is certain
				Production will have no impact	Impact is certain
				Decommissioning will have no impact	Impact is certain

Table 7.7 Guysborough County / Landfall Communities: Residual Impacts

ISSUES/CONCERNS	STAKEHOLDERS	PROJECT IMPACT SOURCE	LINKAGE TO PROJECT	RESIDUAL IMPACT	DEGREE OF CERTAINTY
Marine Archaeology	• Those who value wrecks and other historic artifacts in the coastal waters	• Pipeline construction in inshore waters	• Trenching during the laying of the subsea pipeline	Development will have an insignificant impact	Impact is certain
				Production and decommissioning will have no impact	Impact is certain
Archaeological sites onshore	• Those who value historic artifacts	• Onshore pipeline construction	• Trenching and related activities associated with pipeline construction	Development will have an insignificant impact	Impact is certain
				The operation and abandonment of the Project facilities will have no impact	Impact is certain
Public Health and Safety	• Employees • Residents • Fishermen	• Construction activities • Accidental events	• Accidental events during construction and operation	Development will have an insignificant impact	Impact is certain
				Production will have an insignificant impact	Impact is certain
				Decommissioning will have an insignificant impact	Impact is certain

Potential Project related impacts include:

- effects on the inshore fishery from siltation during construction;
- effects on water quality from siltation and potentially from acidic runoff during construction;
- disruptions to traffic movement on Route 316 during construction;
- use of any wharf used during construction;
- emergency services in the event of an emergency during construction or operation;
- disturbance to the use of land during construction;
- disturbance to shipwrecks during construction; and
- disturbance of archaeological sites during construction.

While the Project has the potential to generate a number of impacts, with appropriate engineering design and implementation of mitigation measures, the adverse impacts on the Municipality of the District of Guysborough and the landfall communities will be insignificant.

7.3.5 The Offshore Area: Benefits and Impacts

7.3.5.1 Employment

Employment will be generated offshore through both the development and production phases of the Project. This will involve those employed in the construction and operation of the Project facilities and those who provide support to these activities. The latter includes those who provide transportation, both helicopters and service vessels, and those onshore whose services and goods are essential to the offshore undertakings (refer to Tables 6.29 and 6.50 of the SEIS (DPA Volume 5)). The required labour will involve a wide range of skills and experience and will be drawn from, and therefore will bring benefit to, communities throughout Nova Scotia.

7.3.5.2 Offshore Fishery

The offshore fishery is of economic importance to communities throughout Nova Scotia, but is of particular value to ports in southwest Nova Scotia from Lunenburg to Digby. All anticipated environmental perturbations from routine Project activities, and the effects of malfunctions and accidents will be contained within NAFO Division 4W. Although over 60% of the total catch from this area is landed in Canso and Lunenburg (refer to Table 4.17 of the SEIS (DPA Volume 5)), catch, particularly snow crab, are important to other parts of Nova Scotia including ports in southwest Guysborough County. The location of the offshore pipeline may also affect some fishing activities, particularly those for fixed gear (*e.g.*, snow crab). Fishing in the immediate vicinity of the platform (500 m) would be restricted over the life of the Project. Pipeline development would temporarily restrict fishing in the vicinity of the pipelay vessel (refer to Section 2.4.3). Because of the spatial extent of the area accessed by most of the fisheries, a small displacement is not likely to result in a measurable economic loss. The low fish productivity near the Deep Panuke sites (refer to Section 6.1.2.2, Figures 4.20, 4.21, 4.22, 4.23 and 4.24 in the SEIS (DPA Volume 5)) indicates that there will be no significant economic impact on the offshore fishing industry as a result of the Project.

7.3.5.3 Current Offshore Resource Use for First Nations and Aboriginal Purposes

As indicated in Section 7.2.3.2, and in Appendix B of the SEIS (DPA Volume 5), the First Nation's commercial fishery has grown considerably in the past decade. Substantial growth has also taken place in the fishery conducted by the off reserve Aboriginal population. As DFO enters into further long-term Marshall Agreements, the commercial value of the Aboriginal fishery will undoubtedly grow further. The First Nations and Aboriginal peoples are also expanding into new fisheries such as commercial swordfish, bluefin tuna and offshore lobster and Jonah crab.

As detailed with respect to the offshore fishery above, the location of the offshore pipeline may affect some fishing activities, particularly those for snow crab and scallop. Fishing in the immediate vicinity of the platform (500 m) would be restricted (*i.e.*, complete loss of access) over the life of the Project. Pipeline development would temporarily restrict fishing in the vicinity of the pipelay vessel. The timing and locations of these restrictions would be published in a Notice to Mariners. Because of the spatial extent of the area accessed by most of the fisheries, a small displacement is not likely to result in a measurable economic loss. The low fish productivity near the Deep Panuke sites (refer to Figures 4.20, 4.21, 4.22, 4.23 and 4.24 in the SEIS (DPA Volume 5)), indicates that there will be no significant economic impact on the offshore commercial fishing industry, including the commercial fishery conducted by the First Nations and Aboriginal peoples, as a result of the Project.

7.3.5.4 Offshore Cables

The proposed subsea pipeline will cross the Sable Island communication cable, the only active subsea cable in the vicinity. The routing design will consider the location of the cable, and it is not anticipated that the Project will have any effect on the operation of the cable. EnCana will notify and consult with all involved parties prior to and during the construction of the proposed pipeline. Recent editions of the CHS Nautical Charts indicate a number of abandoned subsea cables, or sections of abandoned subsea cables, in the vicinity of the pipeline route and the Deep Panuke wellhead location. These, however, do not pose any impediment to Project construction or operation.

7.3.5.5 Other Offshore Activities

As detailed in Sections 7.2.6.2 to 7.2.6.7, several activities occur offshore including research on Sable Island, military training activity, commercial shipping and other offshore activities including exploration. Sable Island, approximately 50 km from the Deep Panuke site, is administered by the Sable Island Preservation Trust. The Trust staffs a monitoring and emergency base on the island and, on occasion, accommodates visits from tourists. Sable Island is identified as a VEC in the biophysical assessment (refer to Section 6.3.7); routine activities associated with construction, operation and decommissioning of the Project are not expected to adversely affect Sable Island.

Under the *Eastern Canada Vessel Traffic Services Zone Regulations*, commercial shipping must follow defined routes upon nearing Halifax Harbour and the Strait of Canso. Outside of these controlled areas, mariners have discretion as to the selection of their preferred routing, subject to proper navigation and seamanship practices. The platforms would be charted and commercial vessels would note the defined 500 m safety zone and keep their distance.

Currently, three producing platforms are associated with the SOEP, and three others are in the design phase. All are, or will be, located at some distance from the proposed Deep Panuke development. Seismic activity and exploratory drilling will occur along wide areas of the Scotian Shelf.

Maritimes Forces Atlantic conduct training and operations in various areas designated as Operations Areas. As detailed in Section 7.2.6.6, one such area, Ops Area India, extends across much of the proposed pipeline route. However, the platforms are outside of this area. DND will be notified of the pipeline routing to ensure that military training activities pose no threat to pipeline integrity.

Project facilities will be charted and there will be a 500 m safety exclusion zone identified around the platforms. It is predicted that the Project will have no socio-economic impacts on Sable Island, commercial shipping, other oil and gas production and exploration activities or military training.

7.3.5.6 Public Health and Safety

Public health and safety at and in the vicinity of the offshore production platforms could potentially be affected during development, production and decommissioning by an accidental event or, during operation, by emissions. The latter include emissions associated with electronic and magnetic fields and radiofrequency and microwave radiation. Air quality is considered a VEC because of its intrinsic value to human and ecosystem health and is addressed as such in Section 6.3.1.

The conditions leading to emissions will be regulated by operating procedures and the industrial hygiene practices of EnCana to ensure compliance with applicable air quality guidelines. Electric and magnetic field levels around electrical devices will be measured to ensure compliance with health and safety standards such as those established by the American Conference of Governmental Industrial Hygienists for monitoring radiation and magnetic fields (ACGIH 2001). Any installations emitting radio frequency and microwave radiation will also be designed and constructed to meet the relevant safety guidelines and standards and will be monitored during commissioning and operating to ensure that worker health and safety is protected. The detailed analysis of the effects of the Project on air quality, including Project malfunctions and accidents, has been conducted using a modeling approach (refer to Section 6.3.1). A range of safety measures will form an integral part of EnCana's Safety, Emergency and Contingency Planning procedures (refer to Section 4).

Project malfunctions and accidents, including the extremely unlikely occurrence of a surface or subsurface blowout of a production well, or injection well, pose a hazard to human health and safety. The greatest danger would be to persons aboard the platforms at Deep Panuke, or aboard vessels within 4 km in the worst case scenario. The mitigation for such events is to reduce the potential for occurrences. A detailed Safety Case analysis will be undertaken by EnCana to ensure that appropriate engineering design and materials procurement procedures are incorporated to ensure a safe facility. Training to promote safe operations will also be an integral part of Project operations.

Provided the mitigative measures detailed in the EPP are implemented, no significant adverse effects on human health and safety are expected from the development and operation of the Project. Routine operations can be conducted to ensure that emissions are well within air quality guidelines, and therefore will avoid impacts on human health and safety. Although extremely unlikely, there is the potential for significant adverse effects to occur in the event of a blowout of the injection or production well. Design, inspection, maintenance and integrity assurance programs will be in place to prevent such events from occurring. Proven engineering techniques are available to present these events and will be employed for the Project. All safety procedures will be documented and in place prior to the commencement of routine operations.

7.3.5.7 Recommended Mitigation

Project design has taken into account environmental and socio-economic factors of interest or concern. Good engineering practices will further minimize the likelihood of adverse impacts. The following is a summary of the specific mitigative measures that EnCana will implement:

- compensate fishers to mitigate any demonstrable economic losses resulting from spills, gear and vessel damage and lost opportunity for fishing;
- notify DND of the pipeline routing to ensure that military training activities pose no threats to the integrity of Project facilities and in regard to the location of UXOs;
- adhere to the practices stated in the EPP;
- provide "Notice to Mariners" to minimize impacts on fishing and marine activities; and
- execute a comprehensive training program and monitor electric and magnetic fields and microwave radiation to meet relevant safety guidelines and standards.

7.3.5.8 Summary of Residual Impacts

As summarized in Table 7.8, the Project will generate the following benefits:

- employment during Project development and production;
- business opportunities during Project development and production;
- training benefits to those who seek the requisite skills to work offshore during Project development and production; and
- investment in the offshore which will contribute to economic stability and growth and confidence in the future of the oil and gas sector.

Table 7.8 Offshore: Residual Impacts

ISSUES/CONCERNS	STAKEHOLDERS	PROJECT IMPACT SOURCE	LINKAGE TO PROJECT	RESIDUAL IMPACT	DEGREE OF CERTAINTY
THE ECONOMY					
Employment	• Those seeking employment	• Development and production expenditures	• Offshore activities	Employment benefit during development	Benefit is certain
				Employment benefit during production	Benefit is certain
				Insignificant impact during decommissioning	Impact is of low certainty
Business Opportunities	• Businesses	• Development and production expenditures	• Requirement for services and materials offshore	Development will bring benefit	Benefit is certain
				Production will bring benefit	Benefit is certain
				Decommissioning will bring some small benefit	Impact is of low certainty
Training	• Those who lack the necessary skills • Education sector	• Development and production expenditures • Labour needs	• EnCana's skill needs	Benefit during development	Benefit is certain
				Benefit during production	Benefit is certain
				Insignificant impact during decommissioning	Impact is certain
Property Tax Base	• None	• Investment in land and onshore pipeline infrastructure	No Linkage	N/A	N/A

Table 7.8 Offshore: Residual Impacts

ISSUES/CONCERNS	STAKEHOLDERS	PROJECT IMPACT SOURCE	LINKAGE TO PROJECT	RESIDUAL IMPACT	DEGREE OF CERTAINTY
Economic Stability/Growth	• Businesses	• Development and production expenditures	• Expansion of oil and gas sector	Benefit during development	Benefit is certain
				Benefit during production	Benefit is certain
				Insignificant impact during decommissioning	Impact is of low certainty
Offshore Fishery	• Those involved in offshore fishery	• Offshore activities	• Development and operation of the offshore platforms and pipeline	Insignificant impact during development	Impact is certain
				Insignificant impact during production	Impact is certain
				No impact during decommissioning	Impact is certain
Tourism	• Recreational boaters • Visitors to Sable Island	• Offshore activities	• Development and operation of the offshore platforms and pipeline	No impact during development	Impact is certain
				No impact during production	Impact is certain
				No impact during decommissioning	Impact is certain
THE ENVIRONMENT					
Water Quality	• Offshore fishery	• Development and operation of offshore facilities	• Generation and release of effluents	Refer to Section 6.3.2	N/A

Table 7.8 Offshore: Residual Impacts

ISSUES/CONCERNS	STAKEHOLDERS	PROJECT IMPACT SOURCE	LINKAGE TO PROJECT	RESIDUAL IMPACT	DEGREE OF CERTAINTY
Air Quality	• Employees • Other persons located offshore	• Gas production facilities	• Release of gases to the atmosphere during operation	Refer to Section 6.3.1	N/A
INFRASTRUCTURE					
Subsea Cables	• Owners of cables	• Construction activities	• Subsea pipeline	Development will have no impact	Impact is certain
				Production will have no impact	Impact is certain
				Decommissioning will have no impact	Impact is certain
SOCIAL					
Other Offshore Activities	• Users	• Pipelines and associated facilities	• Development and operational activities	No impact on other offshore activities during development	Impact is certain
				No impact on other offshore activities during production	Impact is certain
				Decommissioning will have no impact on other offshore activities	Impact is certain
Public Health and Safety	• Employees • Other persons offshore	• Development and operation of offshore facilities	• Accidental events	Insignificant impact during development	Impact is certain
				Insignificant impact during production	Impact is certain
				Insignificant impact during decommissioning	Impact is certain

Together the above factors will contribute significant benefits to the province and to communities throughout the province.

Given the large geographic area in which other offshore activities occur, including the offshore fishery, there appears to be little or no conflict in spatial usage, as long as the parties involved communicate and record their activities on the appropriate charts. No residual socio-economic impacts have been identified.

7.4 Cumulative Effects Summary

The consequences of the development and production phases of the Deep Panuke Project will be positive. The Project will inject monies into the national and provincial economies and will generate both direct and indirect employment. Hundreds will be employed from the inception of the design process to the construction and installation of the offshore facilities; lesser numbers will be required at any one time during the operation phase, but much of the employment generated at that time will be of a more permanent nature. Despite tightening employment markets in Nova Scotia with respect to specific employment categories, there will be no large influx of people associated with either the design or development phase, and no resulting shortages or demands for new facilities and support services. The total increase in personnel in Nova Scotia will be primarily located in the HRM and will be small enough that existing facilities and services will be able to accommodate it.

The Project will have different consequences for different communities. Benefits will accrue at the national and provincial levels, and in varying ways to HRM, the service communities and the landfall area. The Project represents an important step in the establishment and growth of the oil and gas sector in Nova Scotia, and its development generates both growth and change throughout the region.

7.4.1 Cumulative Impacts in HRM

The development and operation of the Project will bring considerable benefits in terms of both employment and business opportunities to the HRM. At the same time, this increase in economic activity will exert pressure on the housing market and the infrastructure required to service economic and demographic growth. The regional authority is responsible for the preparation of development plans to ensure that new investment is accommodated in a rational manner. As indicated in Section 7.2.1.3 and in Section 4.1.4.4 of the SEIS (DPA Volume 5), the municipality has experienced an increase both in the number of housing starts and costs in recent years. This trend is likely to continue if the oil and gas sector continues to expand.

As detailed in Sections 7.3.2.10, 7.3.2.11 and 7.3.2.12 and in Table 7.5, there are no linkages between the Project and public health and safety, archaeological and heritage resources or First Nation's and

Aboriginal land and resource use in HRM. As there are no effects of the Project on any one of these issues, there can be no cumulative effects arising from the interaction of the Project with other developments with respect to these issues in HRM. The effects of the environment on the Project as further discussed in Section 8 will not act cumulatively with any facet of the Project in HRM.

Although the pressures of several projects occurring in the same time frame (*e.g.*, Tier II of the SOEP expansion of the M&NP transmission line, Hudson Energy Company's power generation facility and the Deep Panuke Project), against the background of increased exploration and related activity, should not be minimized, the municipal authority and other agencies are supportive of the investment that is occurring. The challenge is for the responsible agencies at all government levels to plan for the necessary infrastructure improvements and extensions.

7.4.2 Cumulative Impacts in Service Communities

The Project will bring another source of natural gas to Goldboro and thereby strengthen the presence of the oil and gas sector in northeastern Nova Scotia. There are indications that this process is already underway. The Hudson Energy Company, for example, had proposed to develop an 832 MW combined cycle, natural gas-fired power generation facility at Goldboro and to transport power to New York City by an offshore, subsea 500 kV high voltage direct current (HVDC) cable. Construction was scheduled to start in early 2003, with generation and transmission of electricity occurring in mid-2005. This project would represent the first gas using industrial plant to be located at Goldboro, and as such would generate considerable local and regional benefits. As of May 2002, however, this project was put on hold.

Each of the service communities (*i.e.*, Guysborough, Sherbrooke and Antigonish) is striving to diversify its economic base and to lever the oil and gas sector to this end. The Project, in association with other industrial initiatives, will serve to further the long-term objectives of these communities.

As detailed in Sections 7.3.3.7, 7.3.3.8 and 7.3.3.9 and in Table 7.6, there are no linkages between the Project and public health and safety, archaeological and heritage resources or First Nation's or Aboriginal land and resource use. As there are no effects of the Project on any one of these issues, there can be no cumulative effects arising from the interaction of the Project with other developments with respect to these issues in the service communities of Guysborough, Sherbrooke and Antigonish. The effects of the environment on the Project as further discussed in Section 8 will not act cumulatively with any facet of the Project in the service communities of Guysborough, Sherbrooke and Antigonish.

7.4.3 Cumulative Impacts at Landfall

Goldboro has experienced and accommodated the development of the SOEP gas plant and associated infrastructure, and the M&NP main transmission pipeline. These projects were the catalysts for the designation of industrial lands adjacent the gas plant. Much has therefore changed in the area over the past five years.

To date, only one proposed project, an 832 MW combined-cycle, natural gas-fired power generation facility, by the Hudson Energy Company has been publicly disclosed. This project, which is currently on hold, if implemented, would transport power to New York City. If the proponent starts construction in early 2003, construction activity both onshore and offshore may overlap with construction of the Deep Panuke Project. It can be anticipated that the development and operation of such a plant would generate a demand for considerable labour during construction and a lesser amount during project operation. Because of the socio-economic impact assessment of the project has not yet been completed, it is difficult to predict the cumulative socio-economic effects. There would certainly be cumulative effects associated with employment, with the use of local infrastructure, and with the inshore fishery associated with the construction phase. These would have to be detailed by the Hudson Energy Company in their socio-economic assessment. There would be little or no cumulative interactions between the operational phases of the Deep Panuke Project and the Hudson Energy Project.

As detailed in Section 7.3.4 and in Table 7.7, there are linkages between the Project and public health and safety, archaeological and heritage resources, both marine and land, and First Nation's and Aboriginal land and water use in the landfall communities.

The Project will not have a significant effect on public health and safety during construction and operation. As detailed above, only one proposed project that may occur in the same time frame as the Project has been publicly disclosed. There are, however, no details of the construction techniques, mitigative measures, environmental protection plans or safety plans publicly available for review. It must, therefore, be assumed that the regulatory authorities will require comparable standards to those proposed by EnCana. The application of such measures, in conjunction with the implementation of those proposed by EnCana, will ensure that the cumulative effects on the health and safety of the employees, residents and fishers in the area during construction and operation of the projects remains not significant.

The Project will not have a significant effect on archaeological and heritage resources during construction, and will have no effect during Project operation and subsequent abandonment. The mitigative actions proposed by EnCana to protect any archaeological finds, in conjunction with those that would be required of the Hudson Energy Company, will ensure that the cumulative effect of the Project's construction on archaeological and heritage resources remains not significant.

As the Project is predicted to have no effect on First Nation and Aboriginal land and resource use in the vicinity of the landfall, it is unlikely that the project proposed by the Hudson Energy Company would have an effect on such uses. EnCana continues to consult with the Native Council of Nova Scotia with respect to their use of land and water, if any, in the vicinity of the landfall. It is therefore unlikely that the consequences of the projects being developed and operated in the same timeframes will interact cumulatively to affect such uses.

The effects of the environment as further discussed in Section 8 will not cumulatively act with any facet of the Project in the landfall area.

There are no definitive plans for any other industrial development and no evidence that there has been, or is, speculative applications for residential or commercial development in the area. The GCRDA, however, is considering improvements to the infrastructure that serves the area, including the development of a rail corridor. The Deep Panuke Project does bring a second source of natural gas to the area and is an important step towards the foundation of an industrial node at Goldboro. This is in keeping with the stated objectives of the Municipality of the District of Guysborough.

Concern has been expressed that the proposed nearshore pipeline will be routed in waters that are of value to the inshore fishery. With the completion of the Deep Panuke Project, two pipelines will be coming onshore at Goldboro. Routing of the Deep Panuke pipeline (subsea and onshore) maximizes use of existing pipeline corridors, an approach that is consistent with the provincial energy strategy. If the Hudson Energy project proceeds, a high voltage power cable will also be located in nearshore waters. As indicated in Section 7.4.1.6 of the SEIS (DPA Volume 5), local fishermen who have leases in the area have expressed concern about the potential incremental loss of habitat as a consequence of these and any future pipelines and cables. Current issues, and any concerns that may arise as a result of future activity, must be addressed by the parties involved and, in part, by the agencies (municipal, provincial and federal), who are responsible for monitoring and managing the future use of the lands and waters in this area.

Based on the information compiled, including data on previous projects and the stated objectives of the municipality, the contribution of the Project to cumulative affects at the landfall location will likely be insignificant.

7.4.4 Cumulative Socio-Economic Impacts Offshore

From a socio-economic perspective, there is sufficient geographical area on the Scotian Shelf to accommodate many diverse activities. SOEP Tier I (*i.e.*, the Thebaud North Triumph and Venture fields), are currently producing an average of 550 MMscfd of natural gas per day. Tier II of the development plan involves the potential development of the reservoirs at the Alma field, followed by the development of the South Venture and Glenelg fields. Although the development and production of the latter fields will occur, in part, in time frames that parallel the Project schedule resulting in more activity on the Scotian Shelf, no cumulative socio-economic effects between SOEP Tier II and this Project are anticipated.

As detailed in Section 7.3.5.7 and in Table 7.8, there is a linkage between the Project and public health and safety in the offshore area. If all mitigative measures detailed in the EPP are implemented, the Project will not have a significant effect on public health and safety during the development, operation and eventual decommissioning of the facilities. As detailed, there are several projects and activities that may occur offshore in equivalent timeframes. There are, however, no details of their construction techniques, proposed mitigative measures, environmental protection plans or safety plans publicly available for review. It must therefore be assumed that the regulatory authorities will require comparable standards to those proposed by EnCana. The application of such measures, in conjunction with those proposed by EnCana, will ensure that the cumulative effects on the health and safety of employees and other persons offshore during construction, operation and decommissioning of the Project remains not significant.

The consideration of the Project's effects on marine wrecks is addressed in the context of the nearshore waters adjacent landfall.

Two projects that have recently been submitted to the regulatory process may interact with the Deep Panuke Project. These are the Sable Island Wind Turbine Project proposed by the Meteorological Service of Canada and the Hudson Energy Company's proposal to develop a power plant as detailed above. The Sable Island Wind Turbine Project would involve the delivery, installation and operation of a wind energy system to provide 37.5 kW of wind power to Sable Island. No cumulative socio-economic effects between this project and the Deep Panuke Project are anticipated.

Cable routing for the Hudson Energy Company's subsea 500 kV HVDC cable is on hold, but it is anticipated to include crossings of submarine fibre optic cables and pipelines.

Two other projects have been publicly announced. These are the Blue Atlantic Transmission System proposed by El Paso Corporation and the Neptune Regional Transmission System (RTS™). The former includes the development of an offshore natural gas distribution system that would bring natural gas and associated liquids to shore in Nova Scotia, most likely somewhere in southwestern Nova Scotia, and after processing, transport market-ready gas to New York. The intent of Neptune RTS™ is to connect Atlantic Canada and Maine to energy markets in the northeastern United states through a subsea, HVDC cable. No firm details are yet available with respect to either of these projects. It is, however, reasonable, to anticipate that construction activities would include pipe and cable laying, possible trenching, vessel traffic and onshore construction in Nova Scotia. There may be some temporal and spatial overlap of some of these activities with the Deep Panuke Project. If one or both occur in the same timeline, there may be competing demands for labour and associated services particularly through construction.

With respect to other ongoing offshore uses, Project activities are sufficiently distant from the users and visitors to Sable Island that no interaction or interference is likely between those accessing and working/visiting either area. Similarly from the information provided in Sections 7.2.6.1 and 7.3.5.2 with respect to the offshore fishery, little commercial fishery takes place in proximity to the offshore Project facilities. Construction may pose temporary insignificant impacts, but the operation of the facilities will have no significant impact on this important commercial activity.

Future activities offshore, including further exploratory activity will not pose an impediment to the safe development and operation of the Project. Similarly the Project will not inhibit further exploration and development.

7.4.5 Summary of Socio-Economic Cumulative Benefits and Impacts

The development and operation of the Deep Panuke Project relies on the exploration and development offshore that has occurred in the past. At the same time it represents the realization of the second project to bring natural gas to shore in Nova Scotia. This evolution of the oil and gas sector involves investment by many players, the involvement of all levels of government in new and challenging decision making processes, and the adaptation and development of traditional sectors of employment. In essence, the development of a new economic sector involves substantive change and adaptation. The availability of a new source of energy will, over time, lead to a new balance in energy usage in the province as a portion of industrial, commercial and residential users switch to natural gas from other sources of fuel. The availability of natural gas will also attract new investments to the province. Other industrial initiatives, such as those identified in the preceding sections, may follow.

More specifically, the following socio-economic cumulative impacts have been identified:

- pressure on the housing market and the infrastructure required to service economic and demographic growth in HRM;
- the catalytic role that the Project will play over the long term in strengthening the availability of natural gas in both northeastern Nova Scotia and throughout the province; and
- future development at Goldboro will need to be managed in accordance with municipal plans for the industrial park and surrounding lands.

By establishing a second pipeline between the offshore gas fields on the Scotian Shelf and the Nova Scotian mainland, the Project will provide further opportunities for Nova Scotians and other Canadians to participate in, and benefit from, the offshore oil and gas industry, thereby contributing to the economies of Nova Scotia and Canada.

8 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

The physical environment of the Deep Panuke site, including sea state, ocean currents, ice, winds, waves and weather variables is described in Section 6.1 (refer to Section 5.1 of the EIS (DPA Volume 4) for additional detail). The Deep Panuke Project facilities will be designed and installed with the most recent meteorological, climatological, oceanographic and geotechnical data available to the designers. The design will allow for natural occurrences that can reasonably be expected in the vicinity of the facilities. For example, physical considerations such as ice accretion will be built into any loadings calculated for above-surface structures. EnCana has been conducting meteorological and oceanographic monitoring that will continue during drilling operations to anticipate severe weather conditions and waves. EnCana will also undertake a Physical Environmental Monitoring Program to identify environmental conditions of concern for Project operations. This data has also been incorporated into design criteria for the Project.

8.1 Climate Change

Increasing concentrations of greenhouse gases in the atmosphere are believed to be causing global warming (IPCC 1990; IPCC 1995). Increased temperatures may contribute to an increase in ocean volume (*i.e.*, sea level rise). Although estimates vary, global sea level rise is expected to be +0.5 m by 2100 (Wigley and Raper 1992; IPCC 1995; Forbes *et al.* 1997). Other atmospheric changes relating to climate change may include increased storm intensity (Emanuel 1987) and other changes relevant to coastal stability such as surface winds, ocean waves, storm surges and ice conditions (Forbes *et al.* 1997).

Rising relative sea levels have prevailed in most parts of Atlantic Canada south of the Gulf of St. Lawrence for the past few thousand years. In the Halifax area, relative sea level has risen at least 40 m in the past 10 000 years (Shaw *et al.* 1993; Stea *et al.* 1994).

The design of the structures incorporates an adequate factor of safety to deal with anticipated changes in weather severity during the lifetime of the project, including storms and sea level rise associated with climate change. The platform design wind speed includes a peak wind speed associated with a hurricane. The 100-year return wind speed based on site specific measurements at Cohasset project field was increased by a factor of 1.2 to arrive at the platform design wind speed of 41.6 m/sec as 1 minute mean at 10 m above mean sea level for the Cohasset Project. The design wind speed for the Cohasset Project is being used as the design wind speed for the Deep Panuke Project. The applicable CSA/API structural design Load and Resistance Factors with prescribed load combinations inherently cover a certain degree of uncertainties.

It is unlikely that climate change due to global warming will have a significant effect on the Project.

8.2 Icebergs and Sea Ice Impacts

Icebergs originate from glaciers in Greenland. Appendix D of the EIS (DPA Volume 4) contains maps of iceberg sightings and frequency of sea ice in the study area. They drift with the Labrador Current and typically decay on the Grand Banks of Newfoundland. Iceberg sightings data based on the reports of the International Ice Patrol for the period 1960 to 2000 indicate the occurrence of one iceberg in the medium size class (16-45 m height above water; 61-120 m width or length) just off Cape Canso and one of a small iceberg (5-15 m height above water; 15-60 m width or length) on the western end of Sable Bank.

At the Deep Panuke site, the frequency of occurrence of ice is less than 1%. Taking into account the water depth at the Project location, the possibility of an interaction between the platforms and an iceberg is remote. In the coastal area around Country Harbour, the frequency of occurrence of ice could be up to 33% during the first week of March and between 1% and 15% in February and the rest of March. The 30-year median of the predominant ice type is new or grey-white ice (less than 30 cm thick) in February, grey ice (less than 15 cm thick) during the 1st week of March, and first year ice (up to 70 cm thick) for the rest of March (Environment Canada 2000). The pipeline design and trenching in the nearshore area will take into account the potential for sea ice.

8.3 Superstructure Icing

Saltwater icing is probable from November through April. The freezing of salt spray results when the following combined conditions occur; air temperature is below -1.8EC; sea temperatures are below 6EC; and, wind speeds are greater than 10 m/s. As indicated in Section 6.1.1.3, severe icing can create loading and stress on the platform. This was taken into consideration in developing the Project design. Physical considerations such as ice accretion will be built into any loadings calculated for above-surface structures. EnCana's Physical Environment Monitoring Plan (refer to Appendix D) will help predict icing conditions and initiate the implementation of ice management as required. No significant adverse effects due to superstructure icing are likely.

8.4 Extreme Water Levels

As a coastal reference location, maximum annual water levels in Halifax suggest a 100 year storm surge in the order of 0.7 m. The 100 year return wave crest height in the study area is 16.3 m, with a total extreme sea level above chart datum estimated at 18.6 m. EnCana has been conducting a meteorological and oceanographic monitoring program to anticipate severe weather conditions and waves. This program will continue during drilling operations. The data collected has been incorporated into design criteria for the Project (refer to DPA Volume 2, Section 5.3), therefore no significant adverse effects related to extreme water levels are predicted.

8.5 Tsunamis

A tsunami is a long period wave created by large scale movement of the seafloor from submarine earthquake, landslide, or volcanic eruption. At sea, tsunamis travel as a shallow water wave with a small height (>1 m) and usually go unnoticed. On reaching shallow water, speed diminishes but the energy in the wave remains constant, hence the wave height must increase. Tsunamis are damaging in shallow coastal areas. The probability of a tsunami event is estimated to be extremely low (around 1 in 10,000 years). In addition, at the Deep Panuke location, the environmental load generated by a maximum wave height of 23.7 m is much higher than an environmental load generated by tsunamis. Therefore, more emphasis is placed on frequent environmental loads. No significant adverse effects from tsunamis on the Project are predicted.

8.6 Seismicity

Specific earthquake zones and faults in the study area are reasonably well known (Mobil Oil Canada Ltd. 1983; LASMO 1990b; SOEP 1996a). Of particular relevance is seismicity studies and design criteria from the Cohasset Project (LASMO 1990b).

There have been recorded instances where injection of gas and/or water have led to the occurrence of very small to moderate earthquakes at oil and natural gas pools. These have occurred in areas where the injection wells were located near existing natural faults and the injecting fluids caused a local increase in pressure which allowed the fault to move. For the Deep Panuke Project, the proposed injection zones do not have any major faults nearby. In addition, the injection zone being sought is one large enough that the injection of acid gas and surplus condensate would not increase the local pressure beyond the fracture strength of the encasing rock. It is extremely unlikely that injection of waste products will cause even a minor earth tremor.

The American Petroleum Institute (API) has a minimum design threshold for seismic events noted in their Recommended Practice for Planning, Designing, and Constructing Fixed Offshore Platforms – Load and Resistance Factor Design (API 1993). If the seismic load in an area is less than this threshold, API does not require the seismic load to be included in the overall design criteria for the structures. Although the design criteria for seismic events in the Project area is below the API threshold, EnCana will include seismic criteria in the overall design criteria for the Project (refer to DPA Volume 2, Section 5.3). If required, seismic analysis will be performed during detailed design using the applicable code, API RP2A. Site specific seismic data will be expedited and applied to all the platform analyses including the utility/accommodation platform. It should be noted that seismic load conditions are less than the extreme environmental (wind, current, wave, snow, and ice) load conditions. Therefore, no significant adverse effects on the Project due to seismicity are predicted.

8.7 Sediment Transport and Seabed Stability

Section 5.1.6.5 of the EIS (DPA Volume 4) describes the gravity-driven and water-driven sediment transport processes on the Sable Island Bank. Geotechnical investigations on the Sable Island Bank reveal overconsolidated sediments with high shear strengths. The physical properties of the sediments there indicate previous loading of the area, creating good foundation conditions for offshore development. However, the Sable Island Bank is interpreted to be a region of active sediment transport, with the intensity of transport increasing as water depth decreases. Main design considerations in these zones include scour and/or deposition around footings, and migration of sand ridges over footings.

Scour (bottom erosion) results from a disturbance to the local flow field of the water column caused by the placement of a structure on the seabed. The presence of the structure leads to an increase both in the speed of the flow in the vicinity of the structure and in the turbulent intensity of the flow due to the generation of vorices from the structure. From the Cohasset Project, EnCana has extensive data from ROV surveys in relation to scour around platforms in the Deep Panuke area. This monitoring was conducted on a regular basis and after any major storm event. This data was used when establishing scour design parameter for the Deep Panuke platforms, with the maximum total scour predicted to be 5 m.

In addition, periodic monitoring of all platform footings and pipelines will be carried out, especially during the winter storm season. There are therefore no significant adverse effects predicted on the Project related to sediment transport and seabed stability.

8.8 Biofouling

Colonization of subsea structures by epifaunal animals and plants (biofouling) is considered a nuisance and, if not addressed, can eventually become a hazard. Epifauna organisms make visual inspections more difficult, increase hydrodynamic loading, contribute to fatigue and corrosion, and may interfere with corrosion protection systems (Edyvean *et al.* 1985). It is necessary to determine potential marine growth thickness to design underwater structures in order to determine the increase in the effective dimensions and surface roughness of underwater structural members to calculate hydrodynamic loading. Utilizing ROVs LASMO/EnCana Corporation has collected marine growth data at the Panuke and Cohasset oil production sites since 1992. With the data collected, marine biologists were able to establish an "equivalent hard marine growth" thickness for the vicinity of the Deep Panuke development site. These equivalent thicknesses form the basis for the prediction of the trend in marine growth over time. This information has been used as the basis for the design marine growth for the Deep Panuke Project. In addition to incorporating marine growth in design criteria, procedures have also been in development to remove the biofouling, including periodic removal using diver or ROV deployed brushes or high pressure water jets (Welaptega Consulting 1993). Such a biofouling management plan involves regular surveys during which the extent of fouling is compared to engineering criteria to determine loadings and to evaluate the need for removal measures.

EnCana will monitor biofouling of the platform jackets during annual underwater ROV inspection surveys. Marine growth will be removed by hydrojetting if the equivalent marine growth thickness approaches the design threshold. Typically, a natural reduction of biofouling levels is observed during winter months. Sodium hypochlorite will be used to control biofouling of seawater intakes and discharge caissons and the seawater piping systems. The level of residual free chlorine being discharged will normally be less than 0.25 ppm. The Deep Panuke facilities will not use marine antifouling coatings on the jackets.

8.9 Summary

Project facilities will be designed and installed based on the appropriate environmental design criteria to ensure the safety and integrity of these facilities during severe environmental conditions. All Project facilities are constructed with the most recent meteorological, climatological, oceanographic and geotechnical data available to the designers. The design of the structures incorporates an adequate factor of safety to deal with anticipated changes in weather severity during the lifetime of the Project, including storms and sea level rise associated with climate change. The platform design wind speed includes a peak wind speed associated with a hurricane. The 100-year return wind speed based on site specific measurements at Cohasset project field was increased by a factor of 1.2 to arrive at the platform design wind speed of 41.6 m/sec as 1 minute mean at 10 m above mean sea level for the Cohasset Project. The design wind speed for the Cohasset Project is being used as the design wind speed for the Deep Panuke Project. The applicable CSA/API structural design Load and Resistance Factors with prescribed load combinations inherently cover a certain degree of uncertainties. Monitoring and/or contingency planning will also serve to minimize any adverse effects. Effects of the environment on the Project are therefore predicted to not be significant.

9 SUMMARY AND CONCLUSIONS

EnCana Corporation (EnCana) proposes to develop the Deep Panuke Offshore Gas Development Project (the Project). The Project is intended to develop a significant natural gas reservoir located offshore on the Scotian Shelf, approximately 175 km southeast of Goldboro, Nova Scotia (NS), and 250 km southeast of Halifax. The Project will enable EnCana to exercise its rights under, and obtain economic benefit from, the licences issued to it under the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act* and *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation (Nova Scotia) Act* (Accord Acts). The proximity of the Deep Panuke discovery to existing infrastructure serving growing energy markets in Canada and the United States is one of the foundations of the Project.

Current Project design consists of three bottom-founded platforms in a water depth of approximately 40 m. The wellhead platform will be dedicated to dry wellheads, the wellhead control system, and production manifolds. The production platform will contain all power generation and processing equipment; this equipment is designed to process 400 MMscfd of natural gas at peak production with turndown capabilities as the Deep Panuke field declines. A third platform, the accommodations (utility/quarters) platform, will contain utilities, a helicopter landing pad, refueling station and crew accommodations. The three platforms will be interconnected by pedestrian/service bridges.

The gas processing system will consist of equipment necessary for separation, measurement, dehydration, and hydrocarbon dew point control. Deep Panuke is considered to be a sour gas reserve with raw gas containing approximately 0.2% hydrogen sulphide (H_2S). Gas sweetening equipment will, therefore, also be required. Full gas processing will be conducted offshore through application of an amine unit to remove H_2S and carbon dioxide (CO_2) (acid gas). The acid gas will be injected under compression to a dedicated disposal well in an approved geological formation. Condensate produced during offshore processing will be consumed on the production platform as the primary fuel; any surplus condensate will be injected into a disposal well.

Market-ready gas will be produced offshore and transported via subsea pipeline to Goldboro, Nova Scotia to an interconnection with the Maritimes & Northeast Pipeline (M&NP) main transmission pipeline for transport to markets in Canada and the Northeast United States. EnCana's onshore facilities will consist of the physical components necessary for interconnection of EnCana's natural gas pipeline with M&NP facilities. The production life of the Project is anticipated to be 11.5 years, with a design life of 25 years. A full description of the Project including reservoir description, Project components, Project activities and schedule are presented in Section 2. Alternatives to the described Project, and alternative means of carrying out the Project, are presented in Section 2.10.

The cost of Project construction is estimated to be $1.1 billion. The annual operating cost of the Project is estimated to be $60 million, of which just over $31 million will be material purchasing. Project development is anticipated to involve 2,805 person years of work (approximately 3,787 short term jobs of which 40% are estimated to accrue to Nova Scotians). The production phase is estimated to generate an average of 3,159 person years of employment over the life of the Project (approximately 312 jobs, 91% of which are estimated to accrue to Nova Scotians). Regional and local economic benefits are presented in Section 6.2.2.

It is anticipated that the proposed Project will produce minor routine emissions and discharges typical of other oil and gas projects currently proposed and/or operating in the Canadian offshore including: air emissions from power generation and routine flaring; drilling waste; produced water; deck drainage; sewage; noise; and light. EnCana will strive to reduce all wastes and discharges in order to promote efficient operation. EnCana will ensure compliance with all applicable regulations and company standards for discharge limits including those specified in the OWTG (NEB *et al.* 1996, and updates). Routine Project emissions and discharges are described in Section 2.7, with atmospheric emissions and produced water dispersion modeling results presented in Appendix C.

EnCana has reviewed the various potential malfunctions and accidental events that may occur during the Project including platform spills, malfunction of the acid gas management system, blowouts and pipeline ruptures. Spill risk has been modeled to determine the probability and extent of such events. EnCana has incorporated design features and procedures to virtually eliminate or minimize the risk of major releases. EnCana will also develop and implement safety, spill response and contingency plans to reduce adverse environmental effects in the unlikely event of such incidents. Potential accidents and malfunctions, spill risk and probability, and spill release behavior are presented in Section 3. Emergency response and contingency planning commitments are described in Section 4 and Appendix D.

The biophysical impact assessment (Section 6) focused on environmental issues of greatest concern, known as Valued Environmental Components (VECs). An issues scoping process was undertaken to identify VECs most appropriate for this assessment. This scoping included: stakeholder consultation; regulatory issues and guidelines; research; and professional judgement of the Study Team.

As a key component of Project planning and assessment, EnCana has conducted an extensive program of public consultation with stakeholder groups, and discussions with First Nations and Aboriginal groups. This program and ongoing initiatives are summarized in Section 5. The objectives of this program are to: provide information about the Project in a timely fashion; provide opportunities for identification of issues and concerns; seek technical advice; and develop mutually beneficial relationships throughout the life of the Project. The public consultation program focused on key stakeholder groups including: regulatory agencies; local municipalities and regional development authorities; nearshore fishing interests; offshore fishing interests; residents and businesses in the Guysborough County area; scientists; environmental non-governmental organizations; and the general public. Dialogue with several First Nations and Aboriginal organizations has also been initiated to determine Project related issues and concerns among their members. Issues and concerns identified through the consultation and discussion process have been considered in Project planning, design and the impact assessment.

Based on the results of issues scoping, the following VECs were selected for the assessment:

- Air Quality;
- Marine Water Quality;
- Marine Benthos;
- Marine Fish;
- Marine Mammals (Whales and Seals);
- Marine Related Birds
- Sable Island; and
- Onshore Environment.

EnCana is committed to a high level of environmental protection through Project design and mitigation measures. Some of these key voluntary environmental management features proposed for the Project include:

- injection of waste acid gas into a secure geological formation to greatly reduce potential atmospheric emissions of greenhouse gases and sulphur compounds;
- a target for dispersed oil in produced water discharges lower than regulatory requirements;
- no marine discharge of non-aqueous drill muds and associated cuttings;
- energy conservation measures including waste heat recovery and use of produced condensate for offshore power generation;
- the use of an existing offshore pipeline corridor;
- a pipeline designed to minimize interference with fishing activity;
- no nearshore pipeline construction during the lobster fishing season (April 19 to June 20) which also covers with the period when the endangered Roseate Tern typically prospects for nests and lays eggs on nearby Country Island (May 1 – June 20);
- routing of the onshore portion of pipeline to avoid sensitive areas such as wetlands and major stream crossings; and
- implementing codes of practice for environmentally sensitive areas - Sable Island, Country Island and the Gully.

EnCana will also implement several environmental management documents such as: Environmental Management Plan; Environmental Protection Plans; Environmental Effects Monitoring Plan; Waste Management Plan; Chemical Management Plan; Spill Response Plan; Alert/Emergency Response Contingency Plan; Fisheries Compensation Plan; and Decommissioning Plan.

In general, any potential adverse environmental effects from routine Project activities will be short-term, highly localized, and/or of extremely low magnitude. Non-significant adverse effects include: impacts on air quality from routine air emissions; impacts on water quality from routine effluents; temporary disturbance to benthic habitat from WBM drill waste discharges and pipeline installation; and minor habitat loss and disturbance associated with installation of the onshore pipeline and facilities. These effects can be effectively mitigated to non-significant levels through the application of technically and economically feasible measures, standard offshore oil and gas industry procedures, and adherence to regulatory guidelines (refer to Table 9.1). The effects from routine Project construction, operation and decommissioning activities are therefore predicted to be non-significant for all VECs.

In the unlikely event of a well blowout or piping break resulting in the release of large amounts of raw gas or acid gas, significant adverse effects on air quality may occur. Such an event could have health and safety consequences for platform workers and passengers on vessels downwind. Design prevention measures, rendering such an event extremely unlikely, and emergency response contingency planning, will further reduce the likelihood that workers or others would be seriously affected by emissions. In general, spill modeling indicates that accidental releases of hydrocarbon from the Project will dissipate quickly without widespread effects; for example, a spill from a blowout would not reach Sable Island.

The socio-economic impact assessment focused on socio-economic issues of greatest concern: the economy; environment; infrastructure; and social factors. These issues are considered for each of the potentially affected geographical areas, including: the Halifax Regional Municipality (HRM); service and landfall communities; and the offshore area. Mitigation is proposed where appropriate, to reduce potential adverse socio-economic impacts (refer to Table 9.1).

The proposed Project will bring significant benefits to the economy of Nova Scotia, specifically 3,220 direct and indirect jobs and a $154 million contribution to household income during development. The Project will also bring considerable socio-economic benefits to HRM. It is not considered likely that the Project will cause significant adverse socio-economic effects, provided proposed mitigation measures noted in this report are implemented. To enhance the benefits that may accrue, particularly to the landfall areas and service communities, EnCana will establish a procedure to notify the municipalities, Chambers of Commerce and appropriate regional development authorities, prior to and during the construction period, of the products and services that are required. The Project is not likely to cause significant adverse socio-economic effects; it will, however, bring significant socio-economic benefits to the province.

Effects of the environment on the Project are therefore not considered to be significant. Project facilities will be designed and installed based on the appropriate environmental design criteria to ensure the safety and the integrity of these facilities during severe environmental conditions. Monitoring and/or contingency planning will also serve to minimize any adverse effects.

Table 9.1 summarizes the environmental commitments made by EnCana in its DPA and CSR to ensure there will be no significant adverse residual environmental effects as a result of the Deep Panuke Project.

EnCana will honour all the commitments made in the Deep Panuke Offshore Gas Development Environmental Impact Statement (EIS), Socio-Economic Impact Statement (SEIS), Public Consultation Report, and Responses to Comments from Regulatory and Public Review (Addendum 1). EnCana will comply will all applicable laws and regulations and also the specific Codes and Guidelines specified in the EIS, SEIS, Public Consultation Report, and Addendum 1. Table 9.1 does not include the entire list of commitments, but only describes those commitments that are not merely compliance with law or standard practice (as described in the documents). In addition, where a commitment has been made to develop an EPP, for example, the commitment is to develop it in accordance with information on EnCana's proposed environmental management documents (Appendix D) presented in this document.

Table 9.1 Deep Panuke Project Summary of Commitments
Onshore Pipeline Routing and Construction, and RoW Management
• The onshore pipeline route will avoid environmentally sensitive areas such as wetlands and will not cross Betty's Cove Brook.
• EnCana will consult with the Municipality of the District of Guysborough in determining the location of the onshore facilities as well as the onshore pipeline route.
• The working width for construction activities, a combination of the 25 m wide permanent right-of-way (RoW) and a 25 m wide temporary work room (TWR), will be acquired in consultation with the affected landowners. The TWR will be increased to 75 m wide at landfall for a total of 100 m working width.
• The Onshore Construction EPP will generally address environmental constraints on the pipeline route and expected mitigation. The EPP will be included in the Request for Quote for the onshore pipeline installation package and will include the following: • Erosion and sediment control measures to prevent sediment-laden runoff and potential acidic run-off from reaching streams and/or marine waters. NSDEL erosion and sediment control measures will be referenced. The plan will incorporate a monitoring program where warranted. • Mitigation of acid rock drainage in the event that sulphide-bearing bedrock is encountered. A geotechnical study will be conducted to identify potential acidic bedrock areas, providing the basis for mitigation. M&NP's Acid Rock Drainage Construction Response Plan and Guidelines for Development on Slates in Nova Scotia (NSDOE and Environment Canada 1991) will be consulted as well as applicable regulations. EnCana will minimize encounters with acid bearing rock through routing and avoidance. • Clearing operations will be confined to the working width (RoW and TWR). Existing vegetation will be preserved where possible and a vegetated buffer zone will be maintained as appropriate to protect resources at risk. Merchantable timber will be salvaged. Vegetative debris will be chipped on-site, away from surface waters, for use as mulch or compost feedstock. Burning of vegetative debris will be prohibited as a pollution prevention measure. • Watercourse assessments will be conducted if the pipeline or any other facility, such as an access road, will cross a

Table 9.1 Deep Panuke Project Summary of Commitments
watercourse. This assessment would include a pre-construction survey to evaluate fish habitat and resources in the area of the crossing. The results will be forwarded to NSDEL along with an application for Water Approval. • Mitigation procedures for blasting within 500 m of a well. Procedures would include interviewing the well owner prior to construction, and collecting and archiving water samples for comparison of water chemistry. • The open end of the pipeline section will be capped at night to prevent any material from infilling the pipe and/or the ingress of small animals. • Rare plant locations adjacent to RoW, access locations, and other areas will be flagged. • Workers and activities will be restricted to the RoW and designated work areas. • The construction period will be minimized. • Controlled access/signage. • Strict vehicle speed regulation and enforcement.
• Following installation of the onshore pipeline, the working width (RoW and TWR) will be restored. The working width will be stabilized, seeded and allowed to revegetate. EnCana will use native species in revegetation efforts and avoid use of invasive species. Construction debris will be transported to an approved disposal site.
• Clearing will be undertaken, where feasible, outside the breeding season for most bird species (*i.e.*, between March and August).
• Deer wintering areas will be avoided. Construction activities conducted within 200 m of deer wintering areas will not occur, if feasible, between January and April if snow depths are greater than 30 cm.
• While not prohibited, use of ATVs on the pipeline RoW will be discouraged through posting of warning signs along the RoW, and consultations with local ATV clubs.
• Vegetation management will be conducted mainly by mechanical means and will be confined to the RoW. Herbicide use will be restricted to fenced valve sites and meter stations and will involve low application rates of compounds with low persistence and low ecological toxicity. Herbicides will not be used within close proximity (*e.g.*, 30 m) of watercourses or wetlands.
• There will be no change in the landfall location that would take it outside the study corridor identified in the CSR. There is virtually no potential change in the pipeline route that would cause the onshore portion of the pipeline to be greater than 5 km in length.
• Dust suppression techniques will be used if required.
• If blasting is required for the Project, EnCana will consult with affected landowners.
• EnCana will have the onshore pipeline RoW inspected by an archaeologist, in association with an Aboriginal representative, after the survey line is marked and prior to any ground disturbance activities.
• A professional archaeologist and an aboriginal representative will be on site during onshore pipeline construction, and if a site is encountered, work will be halted and the Nova Scotia Museum will be contacted.
Subsea Pipeline Routing and Construction
• A survey vessel with ROV will undertake pre-lay and as-laid surveys of the pipeline route.
• EnCana will consult with fishers and other impacted stakeholders on the offshore pipeline route.
• EnCana will take into consideration the location of existing subsea cables when routing the pipeline. EnCana will notify and consult with all involved parties prior to and during construction of the proposed pipeline.
• While laying in close proximity to the SOEP pipeline, a temporary exclusion zone will be set up to eliminate the risk of damage. In addition, if an anchored vessel is used and if the anchor cables cross the SOEP pipeline, a buoy will be placed on the anchor cable to prevent the cable from falling onto or damaging the SOEP pipeline, should the cable break.
• EnCana will ensure that DND is made aware of the pipeline routing to ensure that military training activities pose no threats to the integrity of the facility.
• The pipeline will be designed to withstand impacts from conventional mobile fishing gear in accordance with the Det Norske Veritas (DNV) Guideline No. 13, Interference between Trawl Gear and Pipelines, September, 1997.
• The pipeline design and trenching in the nearshore area will take into account the potential for sea ice.
• Known marine archaeological sites will be avoided.
• A professional archaeologist and an aboriginal representative will be on call during subsea pipeline construction; if a previously unidentified wreck or subsea archaeological site is encountered, work will be halted and the Curator of Special Places at the Nova Scotia Museum will be contacted.

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• No pipeline construction activities will take place in the nearshore area during the lobster fishing season (April 19 – June 20) which also coincides with the period when the endangered roseate tern typically prospects for nests and lays eggs on Country Island (May 1 – June 20). EnCana will also maintain a 2 km buffer zone from Country Island at all times as per the EnCana Code of Practice for Country Island (Appendix E).
• Silt curtains will be employed during nearshore dredging
• If blasting is required for pipeline installation, it will be conducted in accordance with all applicable regulations, and with the Guidelines for Use of Explosives In or Near Canadian Fisheries Waters (Wright and Hopky 1998).
• Hydrostatic testing of the pipeline will include the following: • The pipeline will be hydrostatically tested during commissioning using treated seawater which will be drawn from a location near the landing site in Goldboro. The chemicals to be used will be screened through the Offshore Chemical Selection Guidelines. • A study, consisting of two components, will be undertaken to assess the impact of the selected hydrostatic testing chemicals discharged into the marine environment. A lab-based toxicity bioassay program (first study component) will be undertaken, which will employ samples of the proposed chemical diluted in seawater to emulate the mixture of chemicals and concentrations proposed for the hydrostatic test program. The results will be applied in a plume dispersion model (second study component) to confirm that there will be minimal impact to the marine environment around the platform. Prior to undertaking this study, the parameters and scope of the bioassay study will be discussed with Environment Canada and DFO. • Hydrostatic test fluids will not be discharged into the nearshore environment.
Vessel and Helicopter Traffic
• Standard vessel operations procedures, including avoidance measures, will be adhered to.
• Vessel activities associated with the Deep Panuke Project will adhere to all applicable shipping regulations, including those with respect to the discharge of bilge/ballast water.
• Guidelines for Project aircraft and vessels operating in the vicinity of Sable Island and Country Island will be incorporated into the Project EPP as per respective EnCana Codes of Practice.
• Helicopters will avoid colonies and high concentrations of birds.
• To avoid potential adverse effects caused by vessel traffic, a buffer zone (approximately 2 km) surrounding Sable Island will be established for the Project. The Project will comply with the Sable Island Emergency Contingency Plan (Canadian Coast Guard 1985) and flying over the island will be avoided except in emergency or other non-routine situations (*e.g.*, emergency refueling) as per EnCana's Code of Practice for Sable Island.
• If a landing on Sable Island is required (*i.e.*, at the existing helicopter refueling facility), helicopters will avoid flying over or landing in close proximity to large concentrations of horses and seals, and pilots will take advice from the Island manager on the position of breeding tern colonies. In addition, landing approaches will be made at right angles to the long axis of the Island and be as steep as safely possible to minimize the area of the island exposed to low-level flying.
• If non-routine Project related vessel or helicopter traffic must interact with Sable Island, any observed adverse animal reactions, or other adverse effects associated with the traffic, will be recorded and reported to appropriate regulatory agencies.
Safety Zone
• A safety zone for the Project will be established 500 m around all platforms (and drilling rig when it is on location), in accordance with the Nova Scotia Offshore Area Petroleum Production and Conservation Regulations. Fishing activity will be prohibited within this zone. The need and extent of the Project's safety zone will be determined in consultation with regulators and the fishing industry.
• A copy of the offshore site plan will be sent to the Canadian Hydrographic Service to update charts. Notices to Mariners will be issued.
Decommissioning
• Requirements for eventual removal of facilities will be taken into consideration in Project design (*e.g.*, the potential presence of contaminants).
• Prior to the start of the decommissioning and abandonment phase, a risk assessment and other required studies will be conducted to verify and validate the assumptions made during the design phase.
• Decommissioning and abandonment will be performed in accordance with the regulatory requirements applicable at the time, and in consultation with appropriate regulatory agencies.

Table 9.1 Deep Panuke Project Summary of Commitments
• The decommissioning plan developed for the Project will provide detailed procedures for decommissioning onshore facilities. The plan will include a full review of options for decommissioning and will be developed in consultation with regulators and key stakeholders, including fisheries interests. The plan will specify the following: • Pipelines will be surveyed, and any parts posing an environmental hazard will be recovered. • Wells will be abandoned in compliance with applicable drilling regulations and according to standard industry practices. The subsea pipeline will be abandoned in place after it is flushed internally and filled with seawater, with its ends capped. • Water in the jacket legs will be tested to determine disposal alternatives. • Onshore facilities will be removed and the land restored in accordance with applicable regulations. Buried onshore pipelines will be flushed, capped and abandoned in place. Onshore pipeline RoWs will be allowed to return to their natural vegetative state by natural succession. Any above ground structures associated with onshore pipelines will be removed.
Engineering Design
• EnCana will adhere to the Nova Scotia Offshore Petroleum Regulations and the associated CSA codes to the extent applicable. Appropriate exemptions may be sought after review with the Certifying Authority (CA) for the CNSOPB.
• Project activities will be conducted in accordance with all applicable laws and regulations.
• All Project equipment will meet industry standards and be certified as safe and fit for its intended use. Equipment will be operated and maintained in accordance with documented procedures, with regular inspection and maintenance programs.
• Once final engineering design has been completed, appropriate regulatory agencies will be contacted to identify specific permitting requirements, if any.
• EnCana will reduce H_2S to "as low as reasonably practicable" (ALARP) before discharging produced water (current design is 1-2 ppm).
• Equipment, valves, and potential areas where hydrocarbon or chemicals could leak will be assessed to determine the need for secondary containment.
• It is intended to collect the currently available seismic data for the Deep Panuke site. The fourth generation data will be expedited for the site, and seismic hazard assessment will be performed as per CSA S471. A probability level of 0.0004 per year will be used. Adjustment will be made to convert the data from rock to actual Deep Panuke soil for the pile foundation. A scour allowance of 5 m will be used in the analysis of the platform structures. If spectral hazard parameters are available for the Deep Panuke site, then a probabilistic analysis based on spectral data will be used to determine structural response to the earthquake.
• A study to evaluate fugitive emissions will be conducted during detailed design. Equipment and procedures to reduce these releases to ALARP will be incorporated in the design.
• Engineering assumptions and options that are agreed upon and incorporated into final design and construction will be translated into operations and maintenance manuals for personnel use at the operations phase.
• Once installed, equipment will be operated and maintained in accordance with documented processes and procedures. EnCana will submit inspection and monitoring programs, a maintenance program and a weight control program to the CA for approval.
• Necessary critical spares will be maintained should equipment change-out be required.
• Stacks and flares will be designed to ensure that any air emissions of concern to worker health and safety will be discharged safely with exposures minimized to acceptable levels.
• The flare will be designed to reduce the potential for liquid carry-over.
• The flare stack will be designed to optimize plume dispersion (especially its height).
• EnCana will design and shield electrical devices that may generate electric and magnetic fields (EMF) to minimize worker exposure, and measure EMF levels around electrical devices to ensure compliance with health and safety standards (ACGIH 2001 and Health Canada's Safety Code 6).
• EnCana will design and construct devices that may generate radiofrequency and microwave radiation to meet relevant safety guidelines and standards, and monitor these devices during commissioning to ensure worker health and safety is protected (ACGIH 2001 and Health Canada's Safety Code 6).
• Water intake will be designed and built at sufficient depth to reduce the entrainment of marine organisms (*e.g.*, 10-15 m below surface).

Table 9.1 Deep Panuke Project Summary of Commitments
Chemical Selection and Use
• EnCana will develop a Chemical Management Plan to ensure that Project operations comply with the Offshore Chemical Selection Guidelines.
• EnCana intends to use water-based muds (WBM) where it is technically practical.
• All constituents of WBM and OBM systems will be reviewed and approved for use under the CNSOPB's Offshore Chemical Selection Guidelines process, and will adhere to EnCana's Chemical Management Plan.
• The Deep Panuke facility will not use marine antifouling coatings on the structures.
• Change-out of the amine solvent will be subject to the EPP.
Safety Protection Systems and Preventative Maintenance (*e.g.*, design features and procedures)
• A detailed Safety Case analysis will be undertaken by EnCana to ensure that appropriate engineering design and materials procurement procedures are incorporated to ensure a safe facility. A comprehensive training program and state-of-the-art detection systems will alert the facility in the case of an accident. Environmental and safety protection systems will be in place (*e.g.*, leak detection, emergency shutdown valves, blowout prevention safeguards, *etc.*).
• A Project Safety Plan will be developed and implemented that will ensure efficient and safe activities in all Project phases. The Safety Plan includes environmental risk assessments that will affect the design of the Project and develop the best design option to minimize environmental impact. The Project Safety Plan will be built upon a "Hazards and Effects Management Process" (HEMP).
Emergency Response/Contingency Planning
• EnCana will develop and implement an Emergency Response Contingency Plan (AERCP) for all potential malfunctions and accidents. This plan will specifically address the minimization of blowout potential. Procedures will be developed to respond to a blowout that will include warning and alarm systems. These procedures will be based on the conservative assumptions (*i.e.*, most protective) from the air quality analysis.
• The Sable Island Emergency Contingency Plan will be adhered to.
• EnCana's AERCP provides emergency response command and control functions for both onshore and offshore emergency situations, and is currently being used in its East Coast operations activities. The AERCP will be updated for the Deep Panuke Project in compliance with applicable guidelines. This includes response to onshore pipeline releases including those potentially accompanied by fire and subsequent forest fire.
• EnCana will review and update its Hydrogen Sulphide Contingency Plan and Spill Response Plan for construction and operations of the Deep Panuke Project.
• The operational EPP will contain chemical handling and storage procedures to ensure all fuel, chemicals and wastes will be handled in a manner that minimizes or eliminates routine spillage and accidents.
• EnCana's Spill Response Plan will be submitted to the appropriate regulators for review and approval. It will contain detailed measures for preparing for and responding to spills, including the use of clean-up equipment, training of personnel, and identification of personnel to direct cleanup efforts, lines of communication and organizations that could assist cleanup operations. All spills will be reported routinely to regulatory authorities as per Spill Response Plan Notifications.
• Spills of petroleum products (or other chemicals) will be cleaned up immediately and reported in accordance with regulations. Oil absorbent pads and "oil dry" compounds will be available at all times in spill kits located at strategic sites on the platforms, to remove petroleum products from deck surfaces. The used absorbent materials and any other oily wastes will be placed in sealed containers and returned to shore for treatment and disposal at an approved waste management facility.
• It will be the responsibility of all EnCana employees and contractors to report any accidents, incidents or spills to the Offshore Installation Manager for immediate action in accordance with the EPP.
• The standby vessel in the field will also be tasked as part of their regular duties to observe and report any spills from the facilities.
• The control room would be staffed 24 hours a day, seven days a week monitoring the facilities.
• An open-drain system supplemented by spill trays will ensure that small spills/leaks are contained.
• Sheens caused by discharges will be recorded by operations personnel on the platform as a component of ECM. An industry-accepted sheen index will be used to estimate the quantity of oil observed on the water surface.

Table 9.1 Deep Panuke Project Summary of Commitments
Environmental Protection Planning and Environmental Performance
• EnCana's Environmental, Health and Safety Management System and its associated plans will be followed for the Deep Panuke Project.
• EnCana will, in consultation with regulators and key stakeholders, develop onshore and offshore construction EPPs to address Project construction, drilling, production and decommissioning. The EPP will reflect the commitments made in the CSR and regulatory conditions of approval. The EPP will be strictly adhered to.
• EnCana will provide copies of applicable management system documentation (and revisions) to the appropriate regulatory authorities for review.
• Environmental performance will be reviewed at least annually during the life of the Project.
• EnCana has adopted Codes of Practice for Sable Island, Country Island, and the Gully.
• A WHMIS program will be in place, and all employees will be WHMIS-trained.
• Protection of historic/cultural resources such as shipwrecks will be addressed in the Offshore Construction EPP.
• EnCana will continue to support internally and externally funded research and development initiatives relevant to EnCana's operations, financially, technically and with in-kind contributions.
• EnCana is a participant in the Voluntary Challenge and Registry (VCR) and will incorporate this Project into the overall VCR strategy. EnCana will consider all reasonable opportunities to reduce emissions from the Deep Panuke Project. Project emissions during the construction phase will be quantified in the annual VCR report.
• Environmental Awareness Training for employees and contractor personnel is a component of EnCana's Environmental Management System.
Emissions and Waste Management
• The treatment and disposal of wastes will be in accordance with the Offshore Waste Treatment Guidelines (OWTG) and EnCana's environmental protection policies.
• A Waste Management Plan (WMP) will be developed (as part of the EPP) to address all phases of the Project. The goal of the plan will be to minimize offshore waste and identify mitigative measures. The WMP will contain provisions for waste and wastewater treatment.
• To the extent reasonably practical, both the volumes of wastes being discharged and the concentration of contaminants in the environment will be minimized.
• All runoff collected from the open drains system will be treated to meet applicable regulations prior to discharge. All liquids collected in the closed drain system will be pumped back through the facility for separation and removal of hydrocarbons.
• During the operation phase, deck drainage will be collected and treated according to the OWTG. Drainage from equipment areas on platforms will be directed through a header system to a collection tank to an oil/water separator treatment unit on the production platform. Petroleum hydrocarbons and sludge in the oil/water separator will be transferred into containers for shipment to shore for disposal. The water from the oil/water separator will be treated using cartridge-style water polishers and tested prior to discharge to ensure compliance with the applicable discharge criteria.
• Every reasonable effort will be made to prevent chemical contamination on decks, which could be entrained into deck drainage. Storage areas for totes containing chemicals and petroleum products will have secondary containment to prevent discharge onto deck surfaces. Absorbents will be used to remove residual hydrocarbons from decks. Spill containment equipment will be available to address emergency spills.
• Bilge/ballast water will be treated as necessary to meet applicable guidelines prior to discharge.
• Fluids (*e.g.*, well treatment fluids, well completion and workover fluids) will be treated to meet applicable guidelines prior to ocean discharge.
• WBM and WBM-associated cuttings will be disposed of overboard, as permitted by the OWTG. Bulk releases on WBM will be minimized by batch drilling where possible.
• Non-aqueous drilling fluids (*i.e.*, synthetic-oil-based mud (SBM) and/or enhanced mineral oil-based mud (EMOBM)) and associated cuttings will not be discharged overboard for this Project. If the use of these muds is required, the whole mud will be returned to the shore for reconditioning or disposal, while the cuttings will be disposed of by either injection into a disposal zone, or onshore treatment and disposal through skip-and-ship methods at an approved facility.

Table 9.1 Deep Panuke Project Summary of Commitments
• Produced water will be treated, tested and discharged overboard according to the OWTG. The OWTG specify an oil in water concentration limit of 30 mg/L (30 day average). EnCana will strive to meet a target dispersed oil in water concentration of 25 mg/L (30 day average) for produced water.
• Seawater used for indirect cooling will be mixed with produced water before discharge. Total residual chlorine in seawater used in indirect cooling will not normally exceed 0.25 mg/L.
• Sanitary and food wastes will be macerated to a particle size of 6 mm or less and disposed of overboard.
• Solid waste will be sorted and disposed of onshore in accordance with applicable regulations and standards. Waste materials will be recycled where possible.
• Hazardous wastes for onshore disposal will be accumulated in suitable containers and placed in appropriate shipping containers for return to shore for disposal and collected by licenced waste haulers. Applicable regulations and standards will be followed when handling and transporting hazardous waste, and staff will be appropriately trained to do so. A NSDEL-approved hazardous waste contractor will be selected for the disposal of hazardous wastes, and will be regularly audited by EnCana personnel for compliance with regulations
• Formation water (produced water) will be collected during drilling of the production wells, and these samples submitted for chemical analysis. The produced water treatment and disposal system will be reviewed following this analysis to ensure the system addresses the specific constituents found in the formation water.
• Surveys of gamma radiation will be conducted for the presence of naturally occurring radioactive material (NORM), as required.
• Maintenance of the injection equipment will normally be carried out during scheduled shut-down. Various options such as flaring and platform shut-down will be considered in discussion with the regulators for dealing with acid gas.
• Wastes accumulated at the onshore pigging station will be collected by tanker truck and removed to an approved waste disposal facility. Prior to shipping, these wastes will be tested to determine the concentrations of organic and inorganic compounds. The testing will identify whether the wastes qualify as hazardous substances and identify the appropriate documentation for transport and means of disposal.
Atmospheric Emissions
• Atmospheric discharges will be tested periodically to verify the efficiency of the systems.
• A camera system will provide continuous visual monitoring of the flare.
• EnCana is committed to an immediate response to an unplanned change to flaring mode. It is proposed that within seven days of the mode shift, a written response would be submitted to the CNSOPB outlining the options, actions and schedule for resumption of normal operating mode. These procedures will be outlined in the Project flaring procedures to be included in the EPP.
• EnCana will work with the appropriate regulatory authorities to develop the required reporting mechanism and parameters regarding Project air emissions.
• EnCana will continually strive to reduce flaring to optimize process efficiency and to improve environmental performance.
• EnCana will develop flaring mitigation procedures in the EPP to reduce, where practical, the temporary and localized emissions and potential effects associated with flaring events during construction and start-up. Procedures will specify: • procedures during perforating/well testing to minimize smoky plumes; • safe zones for vessels to occupy during the test flares; • go/no go zones for vessels; • safety gear and procedures on board platforms and vessels; • wind direction forecast requirements such as the need to be sure of sustained wind directions during the test; • visibility and other weather requirements; • real-time requirements to monitor the efficiency of the flare and downwind effects; • reporting requirements to document the safe conduct of the work and potential improvements; and • notification procedures for shipping, staff, and environmental staff.
• Test flaring will be conducted according to the flare mitigation procedures included in the EPPs. Well test flaring will be scheduled with respect to weather conditions and the presence of marine craft and service vessels to the extent practical. Notifications to Mariners will be issued.

Table 9.1 Deep Panuke Project Summary of Commitments
Monitoring and Follow-up Studies
• Prior to the Project proceeding, EnCana will develop an Environmental Monitoring Plan.
• EnCana will develop a scientifically-sound Environmental Effects Monitoring (EEM) program to detect and assess Project-induced changes in the environment, providing essential feedback to operational managers to provide an early warning mechanism, so that necessary changes can be made to operational activities or discharges. EEM goals will be defined and the program designed through the regulatory approvals process, and consultation with the CNSOPB, regulators and stakeholders. The results of the EEM program will be reviewed on an annual basis and adaptations to the program will be made as necessary.
• EnCana is committed to making EEM results publicly available and supports the archiving of environmental monitoring data in a regional database.
• EnCana supports the creation of a regional EEM mechanism, which includes regulators, industry and other stakeholders.
• The subsea pipeline will be monitored as part of the certification and inspection process. Part of this information will be made available to the EEM as appropriate.
• Consultations with DFO and Environment Canada regarding HADD and Disposal at Sea permits, respectively, will occur once engineering design and installation methods have been finalized.
• Environmental compliance monitoring (ECM) will primarily involve monitoring for conformance with discharge limits. ECM procedures will be clearly defined in the EPP.
• A Physical Environmental Monitoring Program will be developed and implemented with reference to applicable regulations and guidelines. The Plan will include four main programs: • Weather and seastate data collection program; • Current measurement program; • Surface ocean wave measurement program; and • Weather forecasting.
• EnCana will monitor biofouling of the platform jackets during scheduled underwater ROV inspection surveys. Marine growth will be removed by hydrojetting if the equivalent marine growth thickness approaches the design threshold. Sodium hypochlorite will be used to control biofouling of seawater intakes and discharge caissons. The residual free chlorine concentration at the outlet under normal operating conditions will be below 0.25 ppm.
• Prior to construction of the onshore pipeline, a seabed survey will be performed along the pipeline route and at the platform site to provide further data to mitigate effects on marine communities near Project facilities.
• EnCana will support oiled bird surveys on Sable Island by an independent biologist.
• In the case of an accidental hydrocarbon spill from the Project, it is highly unlikely that there would be any adverse effects on Sable Island. However, if such an interaction were to occur, then monitoring and follow-up will be undertaken to confirm clean-up and recovery.
• A survey of the mine workings in the landfall area will be conducted to determine if suitable hibernation habitat for little brown bats is present and EnCana will mitigate as detailed in this CSR.
• Prior to construction, a herpetile survey will be conducted to determine if four-toed salamanders are present in the areas identified as having high potential for breeding habitat and EnCana will mitigate as detailed in this CSR. Note: A herpetile survey was conducted in June 2002; no four-toed salamanders were found to be present.
• Prior to construction, a breeding bird survey will be conducted along the selected pipeline RoW during late May to June to determine whether any rare or sensitive bird species are present and EnCana will mitigate as detailed in this CSR. Note: Breeding Bird Survey was completed in June 2002; no rare species identified.
• EnCana will provide an awareness program with respect to archaeological sites for construction-related personnel.
• EnCana will conduct archaeological monitoring of construction activities at sites that have potential for archaeological finds.
Interactions with Fisheries
• Fishers will be notified well in advance of pipelay operations through Notices to Mariners, and by direct contact with key fisheries representatives. Local fishing vessels that meet the requirements of the CNSOPB and Transport Canada will be used to carry out ECM (*e.g.*, turbidity measurements) during dredging or as chase boats during pipelay operations (if required).

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- EnCana will require a fisheries exclusion zone in the immediate vicinity of the platform (500 m) over the life of the Project, and temporarily at specific locations along the pipeline route as the installation progresses.
- EnCana is committed to developing a compensation program in consultation with fishing interests prior to construction activities. This program will be consistent with the "Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity" (March 2002) prepared by the C-NOPB and CNSOPB. The program will be designed to assess the extent of impact to potential claimants and the extent of the claim. The document will also contain an outline of the procedures for making and assessing claims and an appeals process for disputed claims.
- In the event that EnCana's activities damage the environment or cause others to suffer loss or damage, EnCana will address its liability through compliance with legislated compensation schemes.
- In the event of an interaction between the Project and a fishery it would be managed through a combination of measures, which could include Notice to Mariners, the use of fisheries observers, and consultation with local fishers.
- Both the proposed pipeline routing and the construction techniques will be discussed with fishers as part of the consultation process.
- Independent and trained observers representing fishing interests will conduct marine bird and mammal observations on Deep Panuke facilities and vessels beyond that required by law, as determined necessary by EnCana.

Socio-economic Commitments

- EnCana will continue to provide information on its planned activities, the opportunities associated with them, and the procurement process to the business community, including the First Nations and Aboriginal business community, on a regular basis.
- EnCana will continue to work with the Nova Scotia Community College system to ensure that the necessary training programs are in place to meet their anticipated needs for trained labour, and that those who attain employment offshore are fully trained.
- EnCana will communicate with the identified communities and/or Chambers of Commerce to ensure that information on possible contracts or business opportunities are made available to those parties who could provide the required services, early in the bidding process.
- EnCana will encourage its contractors and subcontractors during construction in the Goldboro area to work with local agencies to seek labour from the District of Guysborough.
- EnCana will notify the Municipality of the District of Guysborough, other pertinent agencies (*e.g.*, the School Board responsible for the bussing local children) and the Energy Industry Liaison Committee whenever construction will disrupt traffic flow on Route 316 so that appropriate traffic management techniques can be applied.
- EnCana will report as requested to the Energy Industry Liaison Committee established by the Municipality of the District of Guysborough.

Stakeholder and Aboriginal Consultation

- EnCana's public communications and consultation program will continue through all phases of the Project.
- Ongoing consultation activities will include the following components:
  - Ongoing liaison with nearshore fishers through open forum meetings, coordinated through local fishers and the Guysborough County Inshore Fisherman's Association;
  - creation of a locally-based nearshore fisheries liaison committee at a time closer to construction;
  - meetings with offshore fisheries representatives as needed;
  - continued liaison with ENGOs as appropriate;
  - continued meetings with First Nations groups;
  - ongoing discussions with local municipalities and regional development authorities;
  - continued participation on NS Petroleum Fisheries Liaison Group (NSPFLG);
  - participation on the Energy Industry Liaison Committee as requested by the Municipality of the District of Guysborough;
  - distribution of newsletters updating the Project status to Guysborough County residents, other stakeholders and other interested members of the public;
  - provision of information provided through the Project website;
  - provision of background information sheets on specific aspects of the Project;
  - maintenance of a toll-free number where people can register concerns or ask for information; and
  - continued opportunities for further comment during the regulatory process.

Table 9.1 Deep Panuke Project Summary of Commitments
• EnCana will: • ensure that public input is communicated to members of the Project team, the objective being to ensure that public comments are addressed in the process of making key decisions about the Project. EnCana is committed to communication and discussion around public and stakeholder concerns and the development of mutually beneficial relationships. • continue to support the Sable Island Preservation Trust. • meet with stakeholders to discuss pipeline routing when more detailed information is available. • meet with stakeholders to consult on construction techniques. • work toward developing an agreement on principles of cooperation with fisheries interests. • maintain ongoing consultation with the municipality regarding pipeline routing in the Industrial Park. • continue to seek advice from stakeholders regarding most effective and efficient means of ongoing consultation and communication. • collaborate with other operators through CAPP on future cumulative effects initiatives. • participate with DFO through CAPP in an integrated ocean management and planning program. • fund offshore training initiative through NSCC. • make information available on labour requirements and training needs as it becomes available.
• EnCana will contact all vessels approaching the 500 m safety zone.
• EnCana is committed to work collaboratively with other project developers when they are ready to proceed with their projects.
• Ongoing consultation activities will include discussions with stakeholders affected by blasting.
• EnCana will consult with DND regarding the location of known UXO (Unexploded Ordnance) areas.

In conclusion, the Deep Panuke Project is not likely to have significant adverse effects on the environment. The Project will contribute to the development of the offshore oil and gas industry in Atlantic Canada by establishing a viable facility and operation that will reduce adverse environmental effects to acceptable levels through the use of technically and economically feasible design and mitigation measures.

10 REFERENCES CITED

10.1 Literature Cited

Aas, E. and J. Klungsryr. 1998. PAH metabolites in bile and EROD activity in North Sea fish. Mar. Environ. Res., 46(1-5): 229-232.

Aas E., T. Baussant, L. Balk, B. Liewenborg and O.K. Andersen. 2000. PAH metabolites in bile, cytochrome P4501A and DNA adducts as environmental risk parameters for chronic oil exposure: a laboratory experiment with atlantic cod. Aquatic Toxicology 51(2): 241-258.

Abitibi-Price. 1990. Underwater pipeline survey video. Stephenville, NF.

American Council of Governmental Industrial Hygienists (ACGIH). 2001. 2001 TLVs and BEIs – Threshold limit values for chemical substances and physical agents and biological exposure.

Amos, C.L. and J.T. Judge. 1991. Sediment transport on the eastern Canadian continental shelf. Continental Shelf Research 11(8-10): 1037-1068.

Amos, C.L. and O.C. Nadeau. 1988. Surficial sediments of the outer banks, Scotia Shelf, Canada. Canadian Journal of Earth Science, 25: 1923-1944.

Andrade, Y. and J.W. Loder. 1997. Connective descent simulations of drilling discharges on Georges and Sable Island Banks. Can. Tech. Rep. Hydrog. Ocean. Sci. 185:83 pp.

Argus, G.W. and K.M. Pryer. 1990. Rare Vascular Plants in Canada: Our Natural Heritage. Canadian Museum of Nature. Ottawa, ON.

Atlantic Canada Conservation Data Centre (ACCDC). 2000. Species rarity ranks: Nova Scotia freshwater fish, October, 2000. Internet Publication: http://www.accdc.com/dataNS/fwfishns.htm.

Atlantic Petroleum Institute (API). 1993. Recommended Practice for Planning, Designing, and Constructing Fixed Offshore Platforms – Load and Resistance Factor Design.

AUMS. 1987a. Fish activity around North Sea oil platforms. Unpublished Report by Aberdeen University Marine Studies Ltd, 46 pp.

AUMS. 1987b. Fish activity around North Sea oil platforms. Phase II: A survey of Transocean 3. Unpublished Report by Aberdeen University Marine Studies Ltd. 19 pp.

AUMS. 1989. Investigation into the flavour and tissue hydrocarbon content of fish caught at an oil production platform. Unpublished report by Aberdeen University Marine Studies Ltd for UKOOA. 78 pp.

Bagarinao, T. and R.D. Vetter. 1989. Sulphide tolerance and detoxification in shallow water marine fishes. Mar. Biol. 103: 291-302.

Bakke, T., J.A. Berger, K. Naer, F. Oreld, L.O. Reierson and K. Byrne. 1989. Long-term recolonization and chemical changes in sediments contaminated with oil-based drill cuttings. pp: 521-544. *In*: Englehardt, F.R., J.P. Ray and A.N. Gillam (eds.). Drilling Wastes. Elsenier Applied Science, London. 867 pp.

Beanlands, G.E. and N.P. Duinker. 1983. An ecological framework for environmental impact assessment in Canada. Institute for Resource and Environmental Studies. Dalhousie University, Halifax, NS and Federal Environmental Assessment Review Office.

Bercha Engineering Limited. 2002. PanCanadian Deep Panuke Onshore Pipeline Quantitative Risk Analysis. Calgary, AB.

Bercha International Inc. 2001. Alternative oil spill occurrence estimators for the Beaufort and Chukchi Seas - Fault tree method. Interim draft report to Department of the Interior, Minerals Management Service, Alaska OCS Region, Anchorage, Alaska, USA. July 23, 2001.

Beyer J., R.K. Bechmann, I.C. Taban, E. Aas, W. Reichert E. Seljeskog and S. Sanni. 2001. Biomarker measurements in long term exposures of a model fish to produced water components (PAHS and alkylphenols) Report AM-01/007. 28 pp.

BIO Biochem Database. 2001. Biochemical database maintained by the Department of Fisheries and Oceans, Bedford Institute of Oceanography, Dartmouth, NS.

Bohnsack J.A. and Sutherland 1985. Artificial reef research: a review with recommendations for priorities: Bull Mar Sci. 37: 11-39.

Boudreau, V. and Social Research for Sustainable Fisheries (SRSF). 2001. Fishing for a living: a profile of the Guysborough County inshore fisheries. Canso, NS. Internet Publication: http://www.gcifa.ns.ca/Docs/fishing.doc.

Bourne, W.R.P. 1979. Birds and gas flares. Mar. Poll. Bull. 10: 124-125.

Bowen, W.D., R. Mohn, and J. McMillan. 1999. Grey seal population on Sable Island; sustained exponential growth of a large mammal population. National Marine Mammal Peer Review Committee. Montreal, QC, 1-5 Feb. 1999. WP9/1999.

Breeze, H., D.G. Fenton. R.J. Rutherford and M.A. Silva. 2002. The Scotian Shelf: An ecological overview for ocean planning. Can. Tech. Rep. Fish. Aquat. Sci. 2393.

Brendehaug, J., S. Johnsen, K.H. Bryne, A.L. Gjøse, T.H. Eide, E. Aamot. 1992. Toxicity testing and chemical characterisation of produced water - a preliminary study. pp. 245-256. *In:* Ray, J.P. and F.R. Engelhardt (eds.). Produced water: Technological/Environmental Issues and Solutions, Plenum Press, NY.

Brodie, P. 1975. Cetacean energetics, an overview of intraspecific size variation. Ecology 56: 152-161.

Brodie, P. and B. Beck. 1983. Predation by sharks on the grey seal (Halichoerus grypus) in eastern Canada. Can. J. Fish. Aquat. Sci. 40: 267-271.

Brodie, P., D. Sameoto, and R. Sheldon. 1978. Population densities of euphausiids off Nova Scotia as indicated by net samples, whale stomach contents, and sonar. Limnology and Oceanography 23: 1264-1267.

Buerkle, U. 1975a. Underwater noise at an offshore oil drilling operation in the Bay of Fundy.

Buerkle, U. 1975b. Sound generated by the oil/gas drilling rig in the Bay of Fundy.

Butler, R.G., A. Harfenist, F.A. Leighton and D.B. Peakall. 1988. Impact of sublethal oil and emulsion exposure on the reproductive success of Leach's storm-petrels: short and long term effects. J. Appl. Ecol. 2:125-143.

Camus L., E. Aas, and J.B. Borseth. 1998. Ethoxyresorufin-o-deethylase activity and fixed wavelength fluorescence detection of PAHs metabolites in bile turbot (*Scophthalmus maximus* L.) exposed to a dispersed topped crude oil in a continuous flow system. Mar. Env. Res. 46: 29-32.

Canada-Nova Scotia Offshore Petroleum Board (CNSOPB). 2002. Compensation Guidelines Respecting Damage Relating to Petroleum Activity. March 2002.

Canada-Nova Scotia Offshore Petroleum Board (CNSOPB), National Energy Board (NEB), Fisheries and Oceans Canada (DFO), Environment Canada (EC), Industry Canada (IC), Canadian Environmental Assessment Agency (CEA Agency) and Nova Scotia Department of Environment and Labour (NSDEL). 2001a. Memorandum of Understanding on Environmental Assessment Process for the Deep Panuke Project. December, 2001.

Canada-Nova Scotia Offshore Petroleum Board (CNSOPB), National Energy Board (NEB), Fisheries and Oceans Canada (DFO), Environment Canada (EC), Industry Canada (IC), Canadian Environmental Assessment Agency (CEA Agency) and Nova Scotia Department of Environment and Labour (NSDEL). 2001b. Scope of the Environmental Assessment for the Proposed PanCanadian Petroleum Limited (EnCana) Deep Panuke Gas Development Project. December 18, 2001. Revised February 15, 2002.

Canada-Nova Scotia Offshore Petroleum Board (CNSOPB). 2000a. Policy on Oil Based Muds.

CNSOPB. 2000b. Strategic Environmental Assessment: Parcels # 1-8. Call for Bids NS00-1. Halifax, NS. 31 pp.

CNSOPB. 1998. Class Environmental Screening for Seismic Exploration on the Scotian Shelf. 12 pp.

Canadian Association of Petroleum Producers (CAPP). 2000. Global Climate Change Voluntary Challenge Guide. CAPP Pub. #2000-004, June 2000.

Canadian Coast Guard. 1994. Sable Island Emergency Contingency Plan. May, 1994. Transport Canada Coast Guard Maritimes Dartmouth, NS.

Canadian Environmental Assessment Agency (CEA Agency). 1999a. Cumulative Effects Assessment Practitioners Guide. Prepared by Canadian Environmental Assessment Working Group and AXYS Environmental Consulting Ltd.

CEA Agency. 1999b. Addressing Cumulative Environmental Effects under the *Canadian Environmental Assessment Act*. Operational Policy Statement OPS-EPO/3-1999.

CEA Agency. 1994. Responsible Authority's Guide to the *Canadian Environmental Assessment Act*. November 1994.

Catling, P.M., B. Freedman and Z. Lucas 1984. The vegetation and phytogeography of Nova Scotia. Proc. N.S. Inst. Sci. 34: 181-247.

Cohen, M.J. and S. Dijkgtaff. 1961. Hearing and Sound Production *In:* Waterman, T.H. (ed.). The Physiology of Crustacea Vol. II Senses Organs, Integration and Behaviour. Academic Press, NY.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian Species at Risk. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. May 2002.

Cranford P.J., L. Kenneth, J.W. Loder, T.G. Milligan, D.K. Muschenheim and J. Payne. 2001. Scientific considerations and research results relevant to the review of the offshore waste treatment guidelines. Can. Tech. Rep. Fish. Aquat. Sci. 2364.

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

Cranford, P.J. and J. Grant. 1990. Particle clearance and absorption of phytoplankton and detritus by the sea scallop (*Placoten magellanicus*) (Gmelin). J. Exp. Mar. Biol. Ecol. 137:105-121.

Culkin, F. 1965. The major constituents of seawater. *In:* J.P. Riley and G. Skirrow (eds.). Chemical Oceanography. Academic Press, London

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

Department of Fisheries and Oceans. 2002. Small craft harbours – harbour information. Internet Publication: http://www.dfo-mpo.gc.ca/sch/hbrinfo_e.htm.

DFO. 2001a. Canadian Hydrographic Service, Chart Number 4013 – G, Canso Bank and Adjacent Areas / DECCA , 2001-04-13.

DFO. 2001b. Catch and Effort Database, Commercial Data Division. Department of Fisheries and Oceans, Maritime Region.

DFO. 2001c. Entitlements Database, Fisheries Management Division. Department of Fisheries and Oceans, Maritime Region.

DFO. 2000a. Fisheries and Aquaculture Overview and Outlook: Scotia-Fundy Fisheries, December 2000. Internet Publication: http://www.mar.dfo-mpo.gc.ca/communications/maritimes/newmediae/overview.htm.

DFO. 2000b. Northern shrimp on the Eastern Scotian Shelf. DFO Science Stock Status Report. C3-15 (2000): 6.

DFO. 2000c. Updates on selected Scotian Shelf groundfish stocks in 2000. DFO science stock status report. A3-35 (2000): 43.

DFO. 1998. The Gully Science Review. G. Harrison and D. Fenton (eds.). 236 pp.

DFO. 1995. Freshwater Intake End-of-Pipe Fish Screen Guideline. Communication Directorate, Department of Fisheries and Oceans.

DFO. 1986. Policy for the Management of Fish Habitat. Ottawa, ON.

DFO, Nova Scotia Department of Environment (NSDOE), and Nova Scotia Department of Transportation and Communications. 1981. Province of Nova Scotia Environmental Construction Practice Specifications.

E&P Forum. 1996. Quantitative Risk Assessment (QRA) Data Sheet Directory. The Oil Industry International Exploration and Production Forum, 25-28 Old Burlington Street, London.

Edyvean, R.G.J., L.A. Terry, and G.B Picken. 1985. Marine fouling and its effects on offshore structures in the North Sea – a review. Internal Bioremediation Bulletin 21:4.

Environment Canada. 2000. Frequency of Sea Ice (1969-1998). Canadian Ice Services Archive. Internet Publication: http://ice-glaces.ec.gc.ca.

Environment Canada. 1997. Trends in Canada's Greenhouse Gas Emissions (1990-1995).

Erskine, A.J. 1992. Atlas of Breeding Birds of The Maritime Provinces. Nimbus Publishing and the Nova Scotia Museum, Halifax, NS. 270 pp.

Faucher, A. and L.S. Weilgart. 1992. Critical marine mammal habitat in offshore waters: the need for protection. pp. 75-78. *In:* Willison, J.H.M. *et al.* (eds.) Science and the Management of Protected Areas. Elsevier, Amsterdam.

Fenchel, T. 1969. The ecology of marine microbenthos IV. Structure and function of the benthic ecosystem, its chemical and physical factors and the microfaunal communities with special reference to the protozoa. Ophelia 6: 1-182.

Forbes, D.L., J. Shaw, and R.B. Taylor. 1997. Climate change impacts in the coastal zone of Atlantic Canada. *In:* Shaw, R.W. (ed.). Climate Variability and Climate Change in Atlantic Canada. Proceedings of a Workshop Halifax, Nova Scotia, 3-6 December 1996. Environment Canada.

Fournier, R.O., J. Marra, R. Bohrer and M.Van Det. 1977. Plankton dynamics and nutrient enrichment of the Scotian Shelf. J. Fish. Res. Board. Can. 34:1000-1018.

Frank, K.T., R.K. Mohn and J.E. Simon. 1997. Assessment of 4TVW haddock in 1996. DFO Can. Stock Assess. Sec. Res. Doc. 97/107.

Fuller, S. 1998. Atlas of Rare, Threatened and Infrequent Fauna of Nova Scotia. Nova Scotia Museum of Natural History, Halifax, NS.

Geraci, J.R. 1990. Physiologic and toxic effects on cetaceans. pp 167-197. *In:* Geraci, J.R. and D.J. St. Aubin. (eds.). Sea Mammals and Oil: Confronting the Risks. Academic Press, San Diego. 282 pp.

Geraci, J.R. and D.J. St. Aubin. 1990. Sea mammals and oil: confronting the risks. Academic Press, San Diego. 282 pp.

Glickman, A.H., L.F. Tischler and W.H. Ford. 1999. An evaluation of protective concentrations for hydrogen sulphide in produced water discharged in California outer continental shelf ocean waters. Soc. Petrol. Producers, SPE 52701.

Gochfield, M. 1979. Prevalence of oiled plumage of terns and skimmer on western Long Island, New York: baseline data prior to petroleum exploration. Envir. Pollut. 20: 123-161.

Gordon, D.C., P.J. Cranford, C.G. Hannah, J.W. Loder, T.G. Milligan, D.K. Muschenheim and Y. She. 2000. Modeling the transport and effects on scallops of water-based drilling mud from potential hydrocarbon exploration on Georges Bank. Can. Tech. Rep. Fish. Aquat. Sci. 2317: 116 pp.

Gowans, S. 1999. Social organization and population structure of the northern bottlenose whales in the Gully. PhD thesis, Dalhousie University, Halifax, NS.

Greene, C.R. 1998. Preliminary Data Report 205-1.

Halliday, R.G., D.E. Themelis, C.E. Dale, and G.D. Harrison. 1995. Oceanographic conditions off the Scotian Shelf during mesopelagic resource inventory cruises, 1984-89. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2327.

Hammill, M.O., and G.B. Stenson 2000. Estimated prey production by harp seals (*Phoca groenlandica*), hooded seals (*Phoca groenlandica*), grey seals (*Halichoerus grypus*) and harbour seals (*Phoca vitulina*) in Atlantic Canada. J. NW Atl. Fish. Sci. 26: 1-23.

Hannah C.G., J. Shore, J.W. Loder, and C.E. Naimie. 2001. Seasonal circulation on the Western and Central Scotian Shelf. J. Phys. Ocean. 31.

Hannah, C.G., Y. Shen, J.W. Loder and D.K. Muschenheim. 1995. Bblt: formulation and exploratory application of a benthic boundary layer transport model. Can. Tech. Rep. Hydrogr. Ocean Sci. 166 vi +52 pp.

Harris, L.E., and R.L. Stephenson. 1999. Compilation of available information regarding the Scotian Shelf herring spawning component. Canadian Stock Assessment Secretariat Research Document 99/181.

Hennigar, T.W. 1976. Water resources and environmental geology of Sable Island, Nova Scotia. Report No. 76-1. Province of Nova Scotia. Department of Environment.

Herman, A.W., D.D. Sameoto and A.R. Longhurst. 1981. Vertical and horizontal distribution patterns of copepods near the Shelf Break south of Nova Scotia. Can. J. Fish. Aquat. Sci. 38: 1065-76.

Hilchey, J.D., D.B. Cann, and J.I. MacDougall. 1964. Soil survey of Guysborough County, Nova Scotia. Canada Department of Agriculture/Nova Scotia Department of Agriculture and Marketing. Nova Scotia Soil Survey Report No. 14. Ottawa, ON. 55 pp.

Hooker, S.K., and R.W. Baird. 1999. A Fea's Petrel off Nova Scotia: the first record for Canada. Birders Journal 6: 245-248.

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

Horn, A.G. and P. Shepherd. 1999. Sable Island tern project: 1998 final report. Unpublished report prepared for Sable Offshore Energy, Inc.

Howard, P.H., and W.M. Meylan (eds.). 1997. Handbook of Physical Chemical Properties of Organic Chemicals. Lewis Publishers, NY.

Hudson Energy Company. 2001. Hudson Energy Company Nova Scotia to New York Power Project Description. December 2001.

Huettmann, F., and A.W. Diamond. 2000. Seabird migration in the Canadian northwest Atlantic Ocean: moulting locations and movement patterns of immature birds. Can. J. Zool. 78: 624-647.

Hurley, G.V. 2000. Nearshore and offshore environmental effects monitoring at the Sable Offshore Energy Project. *In:* Gordon, D.C., Jr., L.D. Griffiths, G.V. Hurley, A.L. Muecke, D.K. Muschenheim and P.G. Wells (eds.). 2000. Understanding the environmental effects of offshore hydrocarbon development. Can. Tech. Rep. Fish. Aquat. Sci. 2311.

Husky Oil. 2000. White Rose Oilfield Comprehensive Study. Prepared by Jacques Whitford Environment Limited for Husky Oil Operations Limited and Petro-Canada.

ICIT. 1991. Survey of fish distribution and contamination. Report of Heriot-Watt University's International Centre for Island Technology to the Scottish Fishermen's Federation.

Intergovernmental Panel on Climate Change (IPCC). 1995. IPCC Second Assessment Synthesis of Scientific-Technical Information Relevant to Interpreting Article 2 of the UN Framework Convention on Climate Change. IPCC Secretariat, WMO, Geneva. 28 pp.

IPCC. 1990. Climate Change: the IPCC Scientific Assessment. Report prepared for IPCC by Working Group 1. Houghton, J.T, Jenkins, G.J. and Ephraums, J.J. (eds.). Cambridge University Press. 365 pp.

Jacques Whitford Environment Limited (JWEL). 2002. Environmental Study for the Deep Panuke Submarine Pipeline and Well Site. Prepared for EnCana Corporation.

JWEL. 2000a. Environmental Study Well H-08. Prepared for PanCanadian Petroleum Limited.

JWEL. 2000b. Environmental Study Cohasset and Panuke Fields. Prepared for PanCanadian Petroleum Limited.

JWEL. 2000c. Natural Attenuation Program Meteorological Services of Canada Atlantic Branch Facilities. Sable Island, Nova Scotia. Project No. 9800-14. Prepared for Public Works and Government Services of Canada. June 27, 2000.

JWEL. 1998a. Proposed Natural Gas Liquids Pipeline Project Environmental Field Surveys - 25 m Easement. Prepared for Sable Offshore Energy Inc.

JWEL. 1998b. Northumberland Strait Crossing Project Terrestrial Environmental Effects Monitoring Program. 1997 Results. Prepared for Northumberland Strait Crossing Inc.

John Parsons & Associates Biological Consultants. 1999. Oil Based Drilling Muds Environmental Monitoring Program at Cohasset. Shellfish Tainting Study 1993 to 1999 Program Results. Prepared for LASMO Nova Scotia Limited.

John Parsons & Associates Biological Consultants. 1994. Cohasset Oil Based Drilling Muds Environmental Monitoring Program LASMO Nova Scotia Limited. 1993 Program Results. Prepared for LASMO Nova Scotia Limited.

Johnsen, S., A. Smith, J. Brendehaug, H. Riksheim, and A.L. Gjøse. 1994. Identification of sources of acute toxicity in produced water. SPE paper 27138. SPE Int. Conference on Health, Safety and Environment in Oil and Gas Exploration and Production, Jacarta.

Keevin, T.M., and G.L. Hempton. 1997. The Environmental Effects of Underwater Explosions with methods to mitigate impacts U.S. Army Corps of Engineers St. Louis District 1222, Spruce Street St. Louis, Missouri 63103-2833 August 1997.

Kenney, R.D. 1994. Distribution charts of marine mammals on the Scotian Shelf, 1966 through 1992. Appendix 2, pp. 44-89. *In:* R.R. Reeves and M.W. Brown. Marine mammals and the Canadian Patrol Frigate Shock Trials: a literature review and recommendations for mitigating the impacts. Report to National Defence Headquarters, Ottawa. 105 pp.

Ketten, D. 2000. Cetacean ears. pp. 43-108. *In:* Whitlow, W., N. Popper, and R. Fay (eds.). Hearing by Whales and Dolphins. Springer Publication.

Krause, P.R., C.W. Osenberg, and R.J. Schmitt. 1992. Effects of produced water on early life stages of a sea urchin: stage-specific responses and delayed expression. pp. 431-444. *In:* Ray, J.P. and F.R. Englehardt. Produced Water: Technological/Environmetnal Issues and Solutions Plenum Press, NY.

Kulka, D.W. and W.T. Stobo. 1981. Winter distribution and feeding of mackerel on the Scotian Shelf and outer Georges Bank with reference to the winter distribution of other finfish species. Can. Tech. Rep. Fish. Aquat. Sci: 1038. 38 pp.

Laist, D., A. Knowlton, M. Mead, A. Collet, and M. Podesta. 2000. Collisions between ships and whales. Marine Mammal Science 17: 35-75.

LASMO Nova Scotia Limited (LASMO). 1990a. Initial Environmental Evaluation for the Panuke/Cohasset Development. LASMO Nova Scotia Limited. Prepared by Jacques Whitford Environment Ltd.

LASMO. 1990b. Part 1: Oceanographic and Meterological Design Criteria. Prepared by MacLaren Plansearch (1991) Limited. *In:* Cohasset-Panuke Development Project Environmental Design Criteria Data Book.

Lee, K. 2000. Environmental assessment of potential produced water impacts and developments in oil spill countermeasures. *In:* Gordon, D.C., Jr., L.D. Griffiths, G.V. Hurley, A.L. Muecke, D.K. Muschenheim and P.G. Wells (eds.). 2000. Understanding the environmental effects of offshore hydrocarbon development. Can. Tech. Rep. Fish. Aquat. Sci. 2311.

Li, M.F. and J.W. Cormick. 1982. Studies of recent mortalities of the sea urchin (*Strongylocentrotus droebachiensis*) in Nova Scotia. ICES Biological Committee. ICES CM 1982/L:46 8 pp.

Leonard, M., A. Boyne, and S. Boates. In review. Status and recovery of Roseate Terns (*Sterna dougallii*) in Nova Scotia. Proc. NS Inst. Sci.

Lock, A.R., R. Brown and S. Gerriets. 1994. Gazetteer of Marine Birds in Atlantic Canada: an Atlas of Seabird Vulnerability to Oil Pollution. Canadian Wildlife Service, Environmental Conservation Branch, Environment Canada, Atlantic Region.

Lucas, Z. and S. Hooker. 2000 Cetacean strandings on Sable Island, Nova Scotia, 1970-1998. Can. Field-Nat. 114: 45-61.

Lucas, Z., and P.Y. Daoust. In review. Large increase of numbers of harp seals (*Phoca groenlandica*) and hooded seals (*Cystophora crista*) on Sable Island, Nova Scotia, since 1995. Polar Biology.

Markle, D.F., M. J. Dadswell, and R.G. Halliday. 1988. Demersal fish and decapod crustacean fauna of the upper continental slope off Nova Scotia from LaHave to St. Pierre Banks. Can. J. Zoology 66: 1952-1960.

Martec. 1984. Report on the Environmental Program Associated with the Blowout at Shell *et.al.* Uniacke G-72. Report for Shell Canada Resources Limited.

Mathers E.M., D.F. Houlihan and M.J. Cunningham. 1992a. Nucleic acid concentrations and enzyme activities as correlates of growth rate of the saithe *Pollachius virens*: growth-rate estimates of open-sea fish. Mar. Biol. 112: 363-369.

Mathers E.M., D.F. Houlihan and M.J. Cunningham. 1992b. Estimation of saithe *Pollachius virens* growth rates around the Beryl oil platforms in the North Sea: a comparison of methods. Mar. Ecol. Prog. Ser. 86: 31-40.

May, D. N. 1978. Handbook of Noise Assessment. VanNostrand Reinhold Company, Toronto, ON.

McAlpine, D.F. 2001. Status and conservation of sea turtles in Canadian waters. Presentation at the Nova Scotia Leatherback Turtle Working Group Workshop. DalTech, Halifax NS, 23 March 2001.

McLaren, I.A. 1981a. The birds of Sable Island. Proc. N.S. Inst. Sci. 31: 1-84.

McLaren, I.A. 1981b. The incidence of vagrant landbirds on Nova Scotian islands. Auk 98: 243-257.

McLaren, I.A., S. Brault, J. Harwood, and D. Vardy. 2001. Report of the eminent panel on seal management. DFO/6201. Cat. No.:Fs23-405/2001E.

Meier, S., T.E. Andersen, L. Hasselberg, O.S. Kjesbu, J. Klungsøyr, and A. Svardal. 2002. Hormonal effects of C4-C7 alkylphenols on cod (*Gadus morhua*). Fisken Og Havet. 68 pp.

Messieh, S.N., T.W. Rowell, D.L. Peer and P.J. Cranford. 1991. The effects of trawling, dredging and ocean dumping on the eastern Canadian continental shelf seabed. Cont. Shelf Res. 11: 1237-63.

Meteorological Service of Canada (MSC). 2002. Sable Island Wind Turbine Project. Environmental Assessment Screening Document. Draft for comments. Meteorological Service of Canada – Atlantic Region, Environment Canada. January 2002.

Meterological Service of Canada (MSC). 2001. Canadian Climate Normals. Internet Publication: http://www.msc-smc.ec.gc.ca/climate_normals/show_stations_e.cfm? province=NS.

Mobil Oil Canada Ltd. 1983. Venture Development Project Environmental Impact Statement. Volume IIIb. Biophysical Assessment. 415 pp.

Montgomery, R.M., P.R. Parrish, S.D. Friedman. 1987. Effects of produced (formation) water on mysids (*Mysidopsis bahia*). 8th Annual SETAC Meeting, Pensacola, FL, USA.

Myers, R.A., and N.J. Barrowman. 1996. Is fish recomitment related to spawner abundance? Fish Bull. 94:707-724.

National Energy Board (NEB), Canada-Newfoundland Offshore Petroleum Board (CNOPB), Canada-Nova Scotia Offshore Petroleum Board (CNSOPB). 1999. Guidelines Respecting the Selection of Chemicals Intended to be used in Conjunction with Offshore Drilling and Production Activities on Frontier Lands.

National Energy Board (NEB), Canada-Newfoundland Offshore Petroleum Board (C-NOPB), and Canada-Nova Scotia Offshore Petroleum Board (CNSOPB). 1996. Offshore Waste Treatment Guidelines. Updated 2002.

NEB and CEA Agency. 1996. Report of the Joint Review Panel for the Express Pipeline Project.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service. 1991. Recovery plan for U.S. population of loggerhead turtles. National Marine Fisheries Service, Washington, DC.

National Wetlands Working Group. 1987. The Canadian Wetland Classification System. Ecological Land Classification Series No. 21.

Neff, J.M. 1990. Composition and fate of petroleum and spill-treating agents in the marine environment. pp 1-33 *In:* J.R. Geraci and D.J. St. Aubin (eds.). Sea Mammals and Oil: Confronting the Risks. Academic Press, San Diego.

Norris, K.S. and R. R. Reeves (eds.). 1978. Report on a workshop on problems related to humpback whales (*Megaptera novaeangliae*) in Hawaii. Rep. From Sea Life, Inc. Maka puu Pt. HI, for US Marine Mammal Comm. Washington, MMC-77/03 (NTIS PB-280794). 90 pp.

Nova Scotia Department of Environment. 1989. Guidelines for Environmental Noise Measurement and Assessment. Halifax, NS.

Nova Scotia Department of Environment and Environment Canada. 1991. Guidelines for Development on Slates in Nova Scotia. April 1991.

Nova Scotia Department of Finance. 2000. Nova Scotia statistical review 2000. Internet Publication: http://www.gov.ns.ca/finance/publish/statsrev/sr2000.pdf.

Nova Scotia Department of Finance. 2001. Nova Scotia Labour Market Review. Internet Publication: http://www.gov.ns.ca.

Nova Scotia Department of Natural Resources (NSDNR). 2001a. General status ranks of wild species in Nova Scotia. Internet Publication: http://www.gov.ns.ca/natr/wildlife/genstatus/ranks.asp.

NSDNR. 2001b. Nova Scotia’s energy strategy: seizing the opportunity, Volume 2. Halifax, NS.

NSDNR. 2001c. Emergency measures organization, central zone - non-emergency numbers. Truro NS.

Nova Scotia Museum of Natural History (NSM). 1997. Natural History of Nova Scotia. Internet Publication: http://museum.gov.ns.ca/mnh/nature/nhns/index.htm.

Nova Scotia Petroleum Directorate. 2001a. Nova Scotia oil and gas industry. Internet Publication: http://www.gov.ns.ca/petro/nsoilgasindustry/economicimpact_page2.htm.

Nova Scotia Petroleum Directorate. 2001b. Offshore activity update spring 2001. Internet Publication: http://www.gov.ns.ca/petro/documents/OffshoreUpdatespring2001.pdf

O'Boyle, R.N., M. Sinclair, R.J. Conover, K.H. Mann, and A.C. Kohler. 1982. Temporal and spatial distribution of ichthyoplankton communities of the Scotian Shelf in relation to the biological, hydrographic and physiographic features. ICES Symposium on biological productivity of continental shelves in the temperate zone of the North Atlantic.

Offutt, G.C. 1970. Acoustic stimulus perception by the American lobster *Homarus americanus* (Decapoda). Experientia 26:1276-1278.

OLF. 1998. Produced water discharges to the North Sea. Fate and effects in the water column. Summary Report.

O'Reilly, G.A., M.A. MacDonald, D.J. Kantak, and M.C. Corey. 1992. Granite and Metasediment-hosted Mineral Deposites of Southwestern Nova Scotia. Field Excursion C-3 Guidebook. Geological Association of Canada/Mineralogical Association of Canada Joint Annual Meeting. Wolfville, NS. 91 pp.

Palka, D. 2001. Density estimates of cetaceans and turtles in two strata on the Scotian Shelf, version 2. Unpublished contract MS prepared for DFO, Bedford Institute.

PanCanadian Petroleum Ltd. (PanCanadian) 2001a. Deep Panuke Offshore Gas Development: Project Description. July 2001.

PanCanadian. 2001b. Canada/Nova Scotia benefits 2000 annual report-Cohasset-Panuke Project decommissioning and exploration drilling. Halifax, NS. April 2001.

Peakall, D.B., P.G. Wells and D. Mackay. 1987. A hazard assessment of chemically dispersed oil spills and seabirds. Mar. Environ. Res. 22:91-106.

Pearson, W.H., J.R. Skalski, S.R. Sulkin and C.I. Malme. 1988. Effects of seismic releases on the global larvae of the Dungeness crab (*Cancer magister*). Report by Batelle Memorial Institute for the State of California Department of Fish and Game.

Petrie, B., K. Drinkwater, D. Gregory, R. Pettipas and A. Sandstorm. 1996. Temperature and salinity atlas for the Scotian Shelf and Gulf of Maine. Can. Tech. R. Fish. Aquat. Sci. 171.

Petroleum Communication Foundation. 2000. Sour gas: questions and answers. Internet Publication: http://www.pcf.ab.ca.

Picken G., M. Baine, L. Heaps and J. Side. 2000. Rigs to reefs in the North Sea. Pp: 331-342. In: A. Jensen, K. Collins and A. Lockwood (*eds.*). Artificial reefs in European Seas. ISBN 0-7923-5845-7. Kluwer Academic Publishers.

Pronych, G. and A. Wilson. 1993. Atlas of Rare Vascular Plants in Nova Scotia. Nova Scotia Museum of Natural History Curatorial Report No. 78.

Querbach, K., G. Maillet, P. Cranford, C. Taggart, K. Lee, and J. Grant. 2000. Toxicity of produced water to the early life stages of haddock, American lobster and sea scallop. *In*: Gordon, D.C., Jr., L.D. Griffiths, G.V. Hurley, A.L. Muecke, D.K. Muschenheim and P.G. Wells (eds.). 2000. Understanding the environmental effects of offshore hydrocarbon development. Can. Tech. Rep. Fish. Aquat. Sci. 2311.

Raimondi, P.T. and R.J. Schmitt. 1992. Effects of produced water on settlement of larvae: field tests using led abalone. Pp. 415-430. In: Ray, J.P. and F.R. Englehardt. Produced Water: Technological/Environmental Issues and Solutions. Plenum Press, NY.

Reeves, R.R. and M.W. Brown. 1994. Marine Mammals and the Canadian Patrol Frigate Shock Trials: A Literature Review and Recommendations for Mitigating the Impacts. Report to National Defence Headquarters, Ottawa, ON. 105 pp.

Richardson, W. J., C.R. Green Jr., C.I. Malme, and D.H. Thompson. 1995. Marine Mammals and Noise. Academic Press, San Diego. 576 pp.

Richardson, W.J., B Whrsig and C.R. Greene, Jr. 1990. Reactions of bowhead whales, Balaena mysticetus, to drilling and dredging noise in the Canadian Beaufort Sea. Mar. Environ. Res. 29(2):135-60.

Richardson, W.J., C.R. Greene, J.P. Hickie, R.A. Davis and D.H. Thomson. 1989. Effects of offshore petroleum operations on cold water marine mammals: A literature review. 2nd edition. American Petroleum Institute Publication No. 4475. Washington, DC. 385 pp.

Riley, D.C. 1984. Post-mortem report. Uniacke well blowout incident. Fisheries and Oceans Canada.

Sable Offshore Energy Inc. (SOEI). 2001a. Environmental Effects Monitoring Program. Annual Report. 2000. Gas Plant – Goldboro, Nova Scotia. Prepared by Jacques Whitford Environment Limited.

SOEI. 2001b. Canada/Nova Scotia benefits 2001 first quarter report. Halifax, NS.

SOEI. 2001c. Nova Scotia benefits. Internet Publication: http://www.soep.com.

SOEI. 2000. Sable Offshore Energy Project Environmental Effects Monitoring Program. Baseline Report. Gas Plant – Goldboro, Nova Scotia. Prepared by Jacques Whitford Environment Limited.

SOEI. 1999. Impact. Halifax, NS. pp 1-5.

SOEI. 1997. Responses to Information Requests. IR #3.13.

Sable Offshore Energy Incorporated Environmental Effects Monitoring Advisory Group (SEEMAG). 2001a. Summary of monitoring results from Tier 1. Meeting minutes from April 4-5, 2001.

SEEMAG. 2001b. Summary of monitoring results from Tier 1. Meeting minutes from November 8, 2001.

SEEMAG. 1999a. Meeting Minutes from November 24 and 25, 1999.

SEEMAG. 1999b. Offshore Environmental Effects Monitoring Program. Meeting minutes from June 22-23, 1999.

SEEMAG. 1998. Offshore Environmental Effects Monitoring Program Report. Minutes from October 21, 1998.

Sable Offshore Energy Project (SOEP). 1996a. Environmental Impact Statement. Volume 3. Prepared by MacLaren Plansearch (1991) Limited.

SOEP. 1996b. Gas Plant and Nearshore Pipeline Assessment. Environmental Impact Statement Volume 2. Prepared by MacLaren Plansearch (1991) Limited.

SOEP. 1996c. Natural Gas Liquids Pipeline and Liquids Facilities Assessment. Environmental Impact Statement. Addendum 3. Prepared by Washburn and Gillis Associates Ltd.

Sage, B. 1979. Flareup over North Sea birds. New Scientist 15 Feb. 1979.

Sauer, T.C. Jr., T.J. Ward, J.S. Brown, S. O'Neil, M.J. Wade. 1992. Identification of toxicity in low-TDS produced water. pp. 209-222. *In:* Ray, J.P. and F.R. Engelhardt (eds.). Produced water: Technological/Environmental Issues and Solutions. Plenum Press, NY.

Scarratt, D.J. 1968. An artificial reef for lobsters. J. Fish. Res. Bd. Can. 25:2683-2960.

Scheibling, R.E. and A.W. Hennigar. 1997. Recurrent outbreaks of disease in sea urchins: Strongylocentrotus droebachiensis along the Atlantic coast of Nova Scotia: Evidence for a link with large-scale meterologic and oceanographic events. Marine Ecology Progress Series 152: 155-165.

Schiff, K.C., D.J. Reish, J.W. Anderson, S.M. Bay. 1992. A comparative evaluation of produced water toxicity. pp. 199-207. *In:* Ray, J.P. and F.R. Engelhardt (eds.). Produced water: Technological/ Environmental Issues and Solutions. Plenum Press, NY.

Scott, F.W. 1994. Provisional annotated list of plant and animal species considered to be rare in Nova Scotia. Nova Scotia Museum of Natural History. Halifax, NS.

Scott, W.B. and M.G. Scott. 1988. Atlantic fishes of Canada. Can. Bull. Fish. Aquati. Sci. 219: 731 pp.

Scrivener, J.C.E. 1971. Agonistic behavioiur of the American lobster, *Homarus americanus* (Milne-Edwards) Fish. Res. Board Can. Tech. Rep. 235: 128 pp.

Shackell, N. 2000. Ichthyoplankton communities on the Eastern Scotian Shelf. I*n:* O'Boyle, R. (ed.). 2000. Proceedings of a Workshop on the Ecosystem Considerations for the Eastern Scotian Shelf Integrated Management (ESSIM) Area: Bedford Institute of Oceanography, 19-23 June, 2000. CSAS Proceedings Series 2000/14.

Shackell, N.L. and K.T. Frank. 2000. Larvae fish diversity on the Scotian Shelf. Can. J. Fish. Aquat. 57: 1747-1760.

Shaw, J. R.B. Taylor and D.L. Forbes. 1993. Impact of the Holocene transgression on the Atlantic coastline of Nova Scotia. GJographie physique et Quaternaire 47:221-238.

Shoop, R.R. and R.D. Kenney. 1992. Seasonal distributions and abundance of loggerhead and leatherback sea turtles in waters of the northeastern United States. Herpetological Monograph. 6: 43-67.

Smith, T.E., M. Leonard, M. Jensen, and A. Boyne. 2001. Restoration of Roseate Terns (*Sterna dougalli*) to Country Island, Nova Scotia. Unpublished report to the Endangered Species Recovery Fund. World Wildlife Fund Canada.

Soldal A.V., O. Humborstad, S. Lokkeborg, I. Svellingen and T. Jorgensen (1999) Etterlatte oljeplattformer som kunstige fisherev. Fisken og Havet. Published by the institute of Marine Research. ISSN 0071-5638.

Sommerville, H.J. D. Bennett, J.N. Davenport, M.S. Holt, A. Lynes, A. Mahieu, B. McCourt, J.G. Parker, R.R. Stephenson, R.J. Watkinson and T.G. Wilkinson. 1987. Environmental effects of produced water from North Sea oil operations. Mar. Poll. Bull. 18: 549-58.

St. Aubin, D.J. 1990. Physiologic and toxic effects on pinnipeds. pp 103-127 *In:* Geraci, J.R. and D.J. St. Aubin (eds.). Sea Mammals and Oil: Confronting the Risks. Academic Press, San Diego.

Stea, R.R., R. Boyd, G.B.J. Fader, R.C. Courtney, D.B. Scott, and S.S. Pecore. 1994. Morphology and seismic stratigraphy of the inner continental shelf off Nova Scotia, Canada: evidence for a –65 m lowstand between 11,650 and 11, 250 C^{14} yr BP. Marine Geology 117:135-54.

Stephenson, R.L., M.J. Power, J.B. Sochasky, F.J. Fife, G.D. Melvin, S. Gavaris, T.D. Iles and F. Page. 1995. Evaluation of the stock status of 4WX herring. DFO Atl. Fish. Res. Doc. No 95/83.

Stobo, W.T., and I.A. McLaren 1985. The Ipswich Sparrow. Proc. N.S. Inst. Sci., Vol. 27, Suppl. 2. 105 pp.

Strosher, M., 1996. Final Investigations of Flare Gas Emissions in Alberta. Final Report to: Environment Canada, Conservation and Protection, the Alberta Energy and Utilities Board, and the Canadian Association of Petroleum Producers by Environmental Technologies Alberta Research Council. November 1996.

Sullivan, J.B. and G.R. Kreig (eds.). 1992. Hazardous Materials Toxicology Clinical Principals of Environmental Health. Williams and Wilkins, Baltimore, MD.

Sutcliffe, W. and P. Brodie. 1977. Whale distribution in Nova Scotia Waters. Fisheries and Marine Service Tech. Rept. 722: 83 pp.

Taylor, D. 2000. Hibernia's production phase offshore environmental effects monitoring program. p.32-39. *In:* Gordon, D.C., Jr., L.D. Griffiths, G.V. Hurley, A.L. Muecke, D.K. Muschenheim and P.G. Wells (eds.). 2000. Understanding the environmental effects of offshore hydrocarbon development. Can. Tech. Rep. Fish. Aquat. Sci. 2311.

Thomas, D.W. 1995. Hibernating bats are sensitive to nontactile human disturbance. J. Mammology. 76(3): 940-946.

Thomson, D.H., R.A. Davis, R. Belore, E. Gonzalez, J. Christian, V.D. Moulton, and R.E. Harris. 2000. Environmental Assessment of Exploration Drilling Off Nova Scotia. Report prepared for Canada – Nova Scotia Offshore Petroleum Board and Mobil Oil Canada Properties, Shell Canada Ltd., Imperial Oil Resources Ltd., Gulf Canada Resources Ltd., Chevron Canada Resources, EnCana Petroleum Ltd., Murphy Oil Company Ltd., and Norsk Hydro Canada Oil & Gas Inc.

Trites, A.W., V. Christiansen, and D. Pauly. 1997. Competition between fisheries and marine mammals for prey and primary production in the Pacific Ocean. J. Northw. Atl. Fish. Sci. 22: 173-187.

Tufts, R.W. 1986. Birds of Nova Scotia. Third Edition. Nimbus Publishing, Nova Scotia Museum, Halifax, NS. 478 pp.

Turner, B.D. 1970. Workbook of Atmospheric Dispersion Estimates. Environmental Protection Agency. Office of Air Programs.

Turnpenny, A.W.H. and J.R. Nedwell. 1994. The effects on marine fish, diving mammals and birds of underwater sound generated by seismic surveys. Report by Fawley Aquatic Research Laboratories Ltd. for United Kingdom Offshore Operators Association Limited. London. 40 pp.

United States Fish and Wildlife Service (USFWS) and National Marine Fisheries Service. 1992. Recovery plan for the Kemp's ridley sea turtle, *Lepidochelys kempii*. National Marine Fisheries Service, St. Petersberg, FA.

Walker, J.I. and L. Wilson. 1984. Experiments in the development of marine weather forecasting techniques off the East Coast. Presented at the 18th Annual Congress of the Canadian Meteorological and Oceanographic Society, Halifax, NS. June, 1984.

Watkins, W. 1986. Whale Reactions to Human Activities in Cape Cod Waters. Mar. Mam. Sci. 2: 251-262.

Welaptega Consulting. 1993. Biofouling Management Considerations for the Hibernia Development. Final Report for Hibernia Management and Development Company. 141 pp.

Whitehead, H., Bowen, D., Hooker, S. and S. Gowans. 1998. Marine mammals of the Gully. pp. 161-189. *In:* G. Harrison and D. Fenton (eds.). The Gully: Science Review. Fisheries and Oceans Canada.

Whitehead, H., A. Faucher, S. Gowans and McCarrey, S. 1997a. Status of the northern bottlenose whale, *Hyperoodon ampullatus*, in the Gully, Nova Scotia. Can. Field-Nat. 111: 287-292.

Whitehead, H., Gowans, S., Faucher, A. and McCarrey, S.W. 1997b. Population analysis of northern bottlenose whales in the Gully, Nova Scotia. Mar. Mamm. Sci. 13: 173-185.

Whitehead, H., S. Brennan and D. Grover. 1992. Distribution and behaviour of male sperm whales on the Scotian Shelf, Canada. Can. J. Zool. 70: 912-918.

Wiese, F.K., W.A. Montevecchi, G.K. Davoren, F. Huettmann, A.W. Diamond, and J. Linke. 2001. Seabirds at risk around offshore oil platforms in the north-west Atlantic. Mar. Poll. Bull. Draft April 23, 2001.

Wigley, T.M.L and S.C.B. Raper. 1992. Implications for climate and sea level of revised IPCC emission scenarios. Nature 357:293-300.

Wildish, D.J., A.J. Wilson and H. Akagi. 1977. Avoidance by herring of suspended sediment from dredge spoil dumping.

Williams, U. and J.W. Chardine. 1998. The Leach's Storm-Petrel: General information and handling instructions. Unpublished information paper for offshore oil companies. 5 pp.

Wilson, J.R.S. 1975. Salinity and the major elements of seawater. pp. 356-413. *In:* Riley, J.P. and G. Skirrow (eds.). Chemical Oceanography, 2nd edition, Academic Press, London.

Woodburn, K.B. and W.T. Stott. Undated. Methyldiethanolamine and formulation additive A: Environmental fate and toxicity data. Toxicology and Environmental Research and Consulting. The Dow Chemical Company.

World Wildlife Fund (WWF). 1986. The Sable Gully. Internet Publication: http://www.wwfcanada.org/en/newsroom/pdf/01_10_20_Gully.pdf

Wright, B. 1989. The Fauna of Sable Island. Nova Scotia Museum Curatorial Report No. 68.

Wright, D.G. and G.F. Hopky. 1998. Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters. Can. Tech. Rep. Fish. Aquat. Sci. 2107.

Zitko, V. and W.G. Carson. 1974. Avoidance of organic solvents and substituted phenols by juvenile Atlantic salmon.

10.2 Personal Communications

Bowen, D., Department of Fisheries and Oceans, Halifax, NS. 2001.

Brett, J. Local Nature Cinematographer. 2002.

Brodie, P. Marine Researcher. Halifax, NS. 2001.

Brickley, K. Director, Statistical Services. Fisheries and Oceans Ottawa, ON. 2002.

Clark, C. Sea turtle expert and organizer of the 1996 Atlantic Leatherback Sea Turtle Workshop. 2001.

Eagles, M. Senior Advisor, Invertebrates. Fisheries and Oceans Canada, Resource Management, Dartmouth, NS. 2001.

James, M. Leatherback Working Group. 2001.

Leonard, M. Research Scientist. Dalhousie University, Halifax, NS. 2001.

Lucas, Z. Researcher and Resident, Sable Island, NS. 2001

Powell, S. Assistant Curator, Archaeology, Nova Scotia Museum. Halifax, NS. 2002.

Theriault, E. Environmental Advisor, Canada-Nova Scotia Offshore Petroleum Board. Halifax, NS. 2001.

Turnpenny, A. Managing Director, Fawley Aquatic Research Laboratories Ltd. Southampton, UK. 2002.

Waugh, D. Environment Canada. Dartmouth, NS. 2001.

GLOSSARY

Acid gas: By-product of sour gas processing; primarily composed of hydrogen sulphide and carbon dioxide.

Acid rain: Natural rain or snow containing sulphuric acid and nitric acid which is created when industrial pollutants, especially sulphur dioxide and nitrogen oxides, undergo chemical changes in the environment.

Advection: The process of, or referring to, the transport of one fluid mass (air, water) by the movement of another.

AERCP: Acronym for EnCana's Alert/Emergency Response Contingency Plan

Alcids: A group of shorebirds, predominantly of northern coasts, including auks, puffins, murres and guillemots.

Anthropogenic: Derived or resulting from human activity.

Artificial reef: An underwater artificial structure that provides habitat similar to that provided by a natural reef.

Artificial reef effect: The effect generated by the placement of an undersea structure in an area where previously there were no similar habitats. Benthic organisms colonize the structure and, subsequently, fish and other organisms are attached to it in search of food.

AVC: Acronym for annular velocity control.

Ballast water: Water in the tanks on a vessel (for example, tanker) to maintain sea-going stability.

Barite: A common mineral (barium sulphate) associated with lead ores; used as a weighting material for drilling because of its high specific gravity.

Bathymetry: Measurement of ocean water depth.

bbl: Abbreviation for barrel.

Benthos: Organisms living on, in or attached to the sea bottom; includes both animals and plants.

Bentonite: A kind of absorbent clay, used especially as a filler.

BIO: Bedford Institute of Oceanography, Dartmouth, Nova Scotia.

Biocide: A chemical agent that destroys pests.

Biofouling: The encrustation of submerged structures by barnacles and molluscs, seaweeds and other marine life; also known as marine fouling.

Biogenic: Derived or resulting from biological activity; the biogenic theory explains the origins of petroleum.

Blowout: An uncontrolled flow of gas, oil or other fluids from a well.

BOP: Acronym for blowout preventer.

BOPD: Abbreviation for barrels of oil per day.

Caisson: A large-diameter pipe, closed at the top and open at the bottom, projecting down from an offshore structure or platform to a predetermined depth into the sea.

Casing: Steel pipe used in oil and gas wells to seal off fluids from the borehole and to prevent the walls of the hole from sloughing or caving. There may be several strings of casing in a well, one inside the other.

CEAA: Acronym for *Canadian Environmental Assessment Act*.

CEA Agency: Acronym for Canadian Environmental Assessment Agency.

Cetacean: Any of various aquatic, chiefly marine mammals of the order cetacea, including the whales, dolphins, and porpoises, characterized by a nearly hairless body, anterior limbs modified into broad flippers, vegestigial posterior limbs, and a flat notched tail.

CFA: Crab Fishing Area.

Chemical Oxygen Demand: Result in which water is depleted of dissolved oxygen due to chemical reactions in the water column.

CHS: Acronym for Canadian Hydrographic Service.

CMM: Acronym for Confederacy of Mainland Mi'kmaq.

CMP: Acronym for Chemical Management Plan.

CNSOPB: Acronym for Canada-Nova Scotia Offshore Petroleum Board.

CO_2: Abbreviation for carbon dioxide.

COD: Acronym for Chemical Oxygen Demand.

Completion: The process of finishing a well so that it is ready to produce oil or gas.

Compressor: A machine used to boost gas pressure to move it through pipelines or other facilities.

Condensate: Liquid hydrocarbons that are produced with natural gas and that separate from the gas as a result of decreases in temperature and pressure; API (American Petroleum Institute) specific gravity generally is 50° to 120° and colour varies from water white to straw to bluish.

Continental shelf: Gently sloping, shallowly submerged marginal zone of the continents extending from the shore to an abrupt increase in bottom inclination; greatest average depth less than 183 m, slope generally less than 1 to 1000, local relief less than 18.3 m, width ranging from very narrow to more than 320 km.

Copepod: Small, aquatic crustacean of the class Copepoda, many of which occur in plankton.

COR Acronym for cuttings oil retention, referring to the amount of oil content on associated with oil based drilling fluids.

COSEWIC: Acronym for Committee on Status of Endangered Wildlife in Canada.

Cuttings: Chips and small fragments of rock that are brought to the surface by the drilling mud as it circulates.

Cyclonic passages: Low pressure system moving through an area.

dB: Decibel, a unit for expressing the relative intensity of sound.

dBA: Decibels on the A-rated network.

Decommissioning: Preparing facilities for abandonment at the end of Project life.

Demersal: Referring to animals, usually fish, associated with but not living on the sea bottom.

Development drilling: Drilling and bringing into production additional wells on a lease following the drilling of the discovery well.

Development well: A well drilled in or adjacent to a proven part of a pool to optimize petroleum production.

DFO: Acronym for Fisheries and Oceans Canada.

Diurnal: Related to daily activity, active during daylight hours.

DPA: Acronym for Development Plan Application.

Drilling mud: A special mixture of clay, water, and chemical additives pumped down the wellbore through the drill pipe and drill bit to cool the rapidly rotating bit, lubricate the drill pipe as it turns in the wellbore, and carry rock cuttings to the surface. Drilling mud may be water-based or oil-based.

ECM: Acronym for environmental compliance monitoring.

EEM: Acronym for Environmental Effects Monitoring.

EEMP: Acronym for Environmental Effects Monitoring Plan.

Effect: An observable and measurable response of a population, individual or a biotic factor to an external source of disturbance.

Effluents: The liquid waste discharges of sewage and industrial processing.

EILC: Acronym for Energy Industry Liaison Committee.

EIS: Acronym for Environmental Impact Statement.

Endangered: Descriptive of a species that is in danger of extinction within all or part of its range (the region to which it is native).

ENGO: Acronym for environmental non-government organization.

Environmental Impact Statement (EIS): A document that attempts to predict the effects of a major development might have on the human and natural environments of a given geographic area. An EIS is prepared to enable industry, government and the public to consider the environmental costs and benefits of a development project. Based on the information contained in the EIS, decisions can be made on whether to proceed with the development project.

Epibenthic: Referring to organisms living on the seabottom.

Epifauna: Referring to benthic animals living attached to or crawling over the seabottom.

EPP: Acronym for Environmental Protection Plan

Erosion: The group of processes whereby earthy or rock material is loosened or dissolved and removed from any part of the earth's surface. The mechanical wear and transportation are effected by running water, waves, moving ice, or winds, which use rock fragments to pound or grind other rocks to powder or sand.

Estuary: That area of a coastal embayment which is under the influence of both fresh water and salt water.

Euphausiid: Small shrimp-like zooplankton commonly known as krill.

FEED: Acronym for front end engineering and design.

Field: The geographic area encompassing a group of one or more underground petroleum pools sharing the same or related infrastructure.

Filter Feeders: Animals which strain suspended food particles from the surrounding water.

Flare: An arrangement of piping and burners used to dispose of surplus combustible vapours (by burning).

Flaring: Disposal of surplus combustible vapours by burning at the discharge of the flare tower.

Flowline: A pipeline that takes fluids from a single well or a series of wells to a gathering centre.

Formation: A designated subsurface layer that is composed throughout of substantially the same kind of rock or rock types.

Fouling: The encrustation of submerged structures by barnacles, molluscs and other marine life.

Glacial Till: Nonsorted, nonstratified sediment carried or deposited by a glacier.

Greenhouse gases: A wide variety of gases that trap heat near the Earth's surface, preventing its escape into space; greenhouse gases, such as carbon dioxide, methane, nitrous oxide and water vapour, occur naturally or result from human activities such as the burning of fossil fuels.

Grey Water: Water that has been used for washing, showers or laundry, or in the galley and contains no hydrocarbons or high concentrations of chemicals.

Gyre: Circular movement of water masses.

H_2S: Abbreviation for hydrogen sulphide.

HDD: Acronym for horizontal directional drilling, a pipeline instillation method in which pipe is installed through a drilled hole below the seabed along a predetermined pathway.

Hydrocarbon: A chemical compound composed of hydrogen and carbon atoms.

Hydrogen sulphide: A naturally occurring, highly toxic gas with the odor of rotten eggs.

Infauna: Benthic organisms that dig into the seabed or construct tubes or burrows.

Indicator Species: Species that are typical or "indicative" of specific habitats, physical conditions or particular bodies of water.

Injection well: A well used for injecting air, steam or fluids into an underground formation.

Intertidal: The area of the seafloor between extreme low water spring tides and extreme high water spring tides.

Inversion: An interchanging of objects, situations, or conditions.

Invertebrates: Refers to organisms lacking a backbone or spinal column (*e.g.*, worms, insects).

Jacket: A supporting structure for an offshore platform held in place by concentric piles through the legs; a colloquial term for a steel lattice type of supporting structure.

Jackup Drilling Unit: An offshore drilling structure with tubular or derrick legs supporting the deck and hull. A jackup rig is towed or propelled to a location with its legs up. Once the legs are firmly positioned on the seafloor, the deck and hull height are adjusted and leveled.

Juvenile: Fish past the larvae stage of development but not yet large enough to be caught in the commercial fishery.

km: Abbreviation for kilometre.

km^2: Abbreviation for square kilometre.

kPa: Abbreviation for kiloPascal.

kW: Abbreviation for kilowatts.

L: Abbreviation for litre.

Larva: The first immature phases of many animals after hatching of eggs and prior to assuming the adult form and habitat.

LC_{50}: Acronym for the concentration of a toxicant necessary to kill 50% of the test organisms in a standard time period.

Lipophilic: Having an affinity for, tending to combine with, or capable of dissolving, lipids.

Lithology: The physical character of a rock.

m: Abbreviation for metre.

m^2: Abbreviation for square metre.

m^3: Abbreviation for cubic metre.

Mitigative measure: A procedure designed to reduce or negate the possible harmful effects of a substance or process on a species, habitat or environment.

Methane: The simplest hydrocarbon and the main component of natural gas.

mm: Abbreviation for millimetre.

MMS: Acronym for US Minerals Management Services.

MMscfd: Abbreviation for million standard cubic feet per day; measurement of petroleum flow.

Natural gas: A gaseous form of petroleum consisting predominantly of mixtures of hydrocarbon gases, the more common of which are methane, ethane, propane, butanes, pentanes, hexanes and heptanes.

Natural gas liquids: Liquids obtained during natural gas production and processing; they include ethane, propane, butane, and condensate.

NEB: Acronym for National Energy Board.

NO_2: Abbreviation for nitrogen dioxide.

NSCC: Acronym for Nova Scotia Community College.

OWTG: Acronym for Offshore Waste Treatment Guidelines (NEB *et al.* 1996 and updates).

Pelagic: Living or feeding in the water column as opposed to on or associated with the seabottom.

PEMP: Acronym for Physical Environmental Management Plan.

Petroleum: Oil and natural gas.

Phytoplankton: Planktonic (that is, floating or swimming) photosynthesizing organisms that are mostly single-celled, although some are colonial; some are capable of swimming, while other are incapable of independent motion; see plankton.

Pig: A spherical or cylindrical device inserted in a pipe or pipeline to clean, clear or inspect the inside of the pipe or to signal the passage of a fluid inside the pipeline.

Pile: A long very heavy timber, steel or reinforced concrete post that has been driven, jacked, jetted or drilled into the ground to support a load.

Plankton: Organisms living in water that are not capable of swimming vigorously enough to move independently of water movements; includes phytoplankton (plants) and zooplankton (animals).

Plume: A dispersed cloud of gas or liquid emanating from a source.

Pool: A natural underground reservoir containing an accumulation of petroleum.

ppb: Abbreviation for parts per billion.

ppm: Abbreviation for parts per million.

Produced water: Water associated with oil and gas reservoirs that is produced along with the oil and gas; also referred to as formation water or brine effluent.

Production casing: The last string of casing set in a well; production casing is tubular steel pipe connected by threads and couplings that lines the total length of the wellbore to ensure safe control of production, prevent water from entering the wellbore and keep rock formations from "sloughing" into the wellbore.

Production well: A borehole drilled and completed for the purpose of extracting crude oil or natural gas.

Raw gas: Gas as it is drawn from the earth; unprocessed.

Renewable resource: Those that can regenerate after harvesting and can be potentially exploited forever (*e.g.*, fish, trees, etc).

Reservoir: A subsurface, porous, permeable rock body in which oil or gas has accumulated; most reservoir rocks are limestone, dolomites, sandstones, or a combination of these.

Residual effect: The effect of a procedure on a component of the environment, or the environment itself, which persists after the implementation of mitigating measures.

Riser: A flowline carrying oil or gas from the seabed to the deck of a production platform.

ROV: Acronym for remotely operated vehicle.

SBM: Acronym for synthetic-based mud.

SC-SSSV: Acronym for surface-controlled subsurface safety valve, the primary blowout prevention mechanism within the wellbore.

Sediment: Solid fragments of inorganic or organic material that come from weathering of a rock.

SEIS: Acronym for Socio-Economic Impact Statement.

Seismic: Pertaining to, characteristics of, or produced by earthquakes or earth vibration, as seismic disturbances.

Seismic survey: Refers to study done to gather and record patterns of induced shock wave reflections from underground layers of rock which are used to create detailed models of the underlying geological structure.

SO_2: Acronym for sulphur dioxide.

Sour gas: Gas containing hydrogen sulphide in measurable concentrations; also referred to as acid gas.

SPM: Acronym for suspended particulate matter.

SSIV: Acronym for subsurface isolation valve which is located on the subsea pipeline approximately 500 m from the platform to stop gas flow in the event of an accidental release.

Substrate: An underlying layer; surface on which an organism grows or is attached.

Surface casing: The first string of casing put into a well; it is cemented into place and serves to shut out shallow water formations and as a foundation for well control.

Surficial: Characteristic of, pertaining to, formed on, situated at, or occurring on the earth's surface; especially, consisting of unconsolidated residual, alluvial, or glacial deposits lying on the bedrock.

Sweet gas: Gas that has naturally low levels of hydrogen sulphide or has been processed to reduce these levels to make it suitable as market gas.

Sweeten: Remove hydrogen sulphide and carbon dioxide from sour gas to make it marketable.

TEG: Acronym for tri-ethylene glycol.

TPH: Acronym for total petroleum hydrocarbons.

UNSI: Acronym for Union of Nova Scotia Indians.

Vertebrates: Refers to organisms having a backbone or spinal column, not invertebrate.

Water-based mud: A drilling mud in which the continuous phase is water.

WBM: Acronym for water-based drilling muds.

Wellbore: A hole drilled or bored into the earth, usually cased with metal pipe, for the production of oil or gas.

Well completion: The final sealing-off of a drilled well from the borehole with valving, safety and flow-control devices, following final cementing and perforation of the casing at the producing zone and removal of the drilling apparatus from the borehole.

Wellhead: The equipment used to maintain surface control of a well.

WHMIS: Acronym for Workplace Hazardous Materials Information Systems.

WMP: Acronym for EnCana's Waste Management Plan

Zooplankton: Tiny animals that occur in the water column; they include protozoans, small crustaceans and larval stages of larger organisms; see plankton.

APPENDIX A

MEMORANDUM OF UNDERSTANDING ON ENVIRONMENTAL ASSESSMENT PROCESS FOR THE DEEP PANUKE PROJECT

Execution Copy

MEMORANDUM OF UNDERSTANDING ON ENVIRONMENTAL ASSESSMENT PROCESS FOR THE DEEP PANUKE PROJECT

BETWEEN:

CANADA-NOVA SCOTIA OFFSHORE PETROLEUM BOARD
(CNSOPB)

AND

NATIONAL ENERGY BOARD
(NEB)

AND

DEPARTMENT OF FISHERIES AND OCEANS
(DFO)

AND

ENVIRONMENT CANADA
(EC)

AND

INDUSTRY CANADA
(IC)

AND

CANADIAN ENVIRONMENTAL ASSESSMENT AGENCY
(CEA AGENCY)

AND

PROVINCE OF NOVA SCOTIA
AS REPRESENTED BY
NOVA SCOTIA DEPARTMENT OF ENVIRONMENT & LABOUR
(PROVINCE)

WHEREAS PanCanadian Petroleum Limited (the Proponent) proposes to develop natural gas resources from the Deep Panuke gas field in the Nova Scotia offshore which development includes drilling, production, fabrication, processing, operating and transportation activities offshore and transportation of gas and condensate onshore (the Project); and

WHEREAS the Project involves the construction of a platform, artificial island or any other physical work for the production of oil and gas, where the platform, island or work is located offshore in salt water or fresh water as described in the federal *Comprehensive Study List Regulations* and therefore is subject to a Comprehensive Study and the *Canadian Environmental Assessment Act* (CEAA); and

WHEREAS the Proponent has filed documentation with the CEA Agency, the CNSOPB and the NEB to initiate the environmental assessment process (EA process) under CEAA, which information was filed on the 23rd day of July, 2001; and

WHEREAS the CNSOPB, NEB, DFO, EC and IC are or may be Responsible Authorities in relation to the environmental assessment under the CEAA; and

WHEREAS the Province has or may have responsibilities regarding the assessment of environmental effects for the onshore portion of the Project under the Nova Scotia *Environment Act* (NSEA); and

WHEREAS the Parties share an interest in taking actions that promote sustainable development; and

WHEREAS the Parties wish to avoid unnecessary duplication and promote environmental assessment efficiency; and

WHEREAS the Parties wish to ensure that the public is aware of the EA process and the opportunities for public input; and

WHEREAS the Parties recognize that further discussions will be required should any Responsible Authority or the federal Minister of the Environment decide, at the commencement or at any time during the course of the EA process, that the Project should be assessed by a review panel or mediator, or where the Province determines that a further assessment of the environmental effects of the Project is required.

THEREFORE the Parties agree, should the assessment of the Project pursuant to the CEAA proceed by way of a comprehensive study and the Proponent be delegated the comprehensive study and the preparation of a report, they will coordinate their respective processes and responsibilities regarding the assessment of the environmental effects of the Project as described below:

1. For the purposes of this Memorandum of Understanding (MOU),

"Comprehensive Study" has the same meaning as set out in section 2 of the CEAA;

"Comprehensive Study Report" (CSR) means the report to be prepared in accordance with paragraph 21(a) of the CEAA and also includes, for the purpose of the NSEA, a consideration of any additional matters identified in accordance with section 8 of this MOU;

"Expert Federal Authority" means any federal departments or agencies which possesses specialist or expert information or knowledge that is relevant to the environmental assessment of the Project;

"Parties" means the signatories to this MOU;

"Responsible Authority" has the same meaning as set out in section 2 of the CEAA.

2. The purpose of this MOU is to coordinate the responsibilities of the Parties regarding the assessment of the environmental effects of the Project. The Parties intend to coordinate the EA process to include a consideration of factors identified in accordance with sections 6 to 8 of this MOU.

3. The CNSOPB will act as the lead Responsible Authority under the CEAA and coordinate this process for federal purposes. The Province will coordinate the process for provincial purposes. The Parties will work together to establish reasonable and appropriate timetables and schedules.

4. The Parties will hold further discussions on ways to ensure the public and aboriginal persons are aware of the EA process and have opportunities for public input to achieve this result.

5. The Parties intend to consult amongst themselves and coordinate any public announcements with respect to the assessment of the environmental effects of this Project, including any announcements that further environmental assessment by way of a review panel or mediation is required.

6. The Parties, after considering comments from the public on this MOU and the scope of assessment, will finalize the terms and conditions outlined in this agreement and will decide on the scope of the assessment.

7. For the purpose of complying with the requirements of the CEAA, the assessment will include a consideration of the factors listed in subsections 16(1) and 16(2) of the CEAA, and of any other matters relevant to the environmental assessment of this Project that the federal Minister of Environment, in consultation with the Responsible Authorities, may require to be considered.

8. For the purpose of coordinating the responsibilities of all the Parties regarding the assessment of the environmental effects of the Project, the assessment will also include a consideration of any additional matters relevant to the assessment of the environmental effects of the Project under the NSEA that are identified by the Province.

9. The final scope of the environmental assessment will be forwarded by the CNSOPB to the Proponent.

10. The Responsible Authorities intend, pursuant to subsection 17(1) of the CEAA, to delegate the comprehensive study and the preparation of the report referred to in paragraph 21(a) of the CEAA to the Proponent. The Parties also intend to request the Proponent to consider any additional matters identified with section 8 of this MOU, and to report in the CSR on the said consideration.

11. A draft CSR will be submitted by the Proponent to the Parties and Expert Federal Authorities for review and comment.

12. Written Comments on the draft CSR will be provided by the Parties and Expert Federal Authorities to the CNSOPB and the CNSOPB will forward them to the Proponent. The CNSOPB will coordinate comments by the Responsible Authorities and Expert Federal Authorities and will arrange for the provision of those comments to the Proponent. The Province will coordinate provincial comments and will provide them to the CNSOPB for forwarding to the Proponent.

13. The Proponent will submit a revised CSR, as appropriate. The Parties, in consultation with the Expert Federal Authorities, will review the CSR to ensure its completeness in consideration of their respective legislative requirements. The Province will coordinate provincial comments of the review of the revised CSR.

14. Once the Parties are satisfied that the CSR is complete, the CSR shall be forwarded to the federal Minister of the Environment and the CEA Agency. The CEA Agency will invite public comment on the conclusions, recommendations and any other aspect of the CSR, in accordance with section 22 of the CEAA.

15. Notices of the commencement of respective regulatory public hearings by the CNSOPB and NEB will be published after the final CSR is submitted to the federal Minister of Environment. Notices of the commencement of regulatory public hearings by the Province will be published after the final CSR is submitted to the provincial Minister of Environment and Labour.

16. Once and if the federal Minister of the Environment takes the decision pursuant to subparagraph 23(a) of the CEAA, the CNSOPB agrees the CSR will form part of the Development Plan Application (DPA) filed by the Proponent to the CNSOPB under the DPA approval process.

17. The CNSOPB will maintain a public registry as required under the CEAA and establish a website for the registry (http://www.cnsopb.ns.ca/deeppanuke). The Province will provide information on its Environmental Assessment Branch website (http://www.gov.ns.ca/enla/ess/ea) as to the federal contact for the review of documentation.

18. The CNSOPB in consultation with the other Parties will arrange for the Proponent to establish local repositories where the public may access documentation in relation to the review.

19. The provisions of this MOU shall not restrict the decision-making authority or fetter the discretion of statutory decision-makers.

20. The Parties may amend this MOU upon the agreement of all Parties. A Party, without the consent of the other Parties, upon thirty (30) days notice may withdraw from this MOU and complete an independent EA process.

21. This MOU is not intended to be a legally binding instrument or give rise to any legal rights not otherwise held by the Parties.

22**.** This MOU may be executed in several counterparts, each of which so executed shall be deemed to be an original, and such counterparts together shall constitute one and the same original agreement.

IN WITNESS WHEREOF the Parties have signed this MOU on the dates indicated below.

Original signed by:

_____________________	Dec 14, 2001	_____________________
J.E. (Jim) Dickey Chief Executive Officer Canada- Nova Scotia Offshore Petroleum Board	Date	Witness

Original signed by:

_____________________	Dec 17, 2001	_____________________
Gaétan Caron Chief Operating Officer National Energy Board	Date	Witness

Original signed by:

_____________________	Dec 14, 2001	_____________________
Neil A. Bellefontaine Regional Director-General Department of Fisheries and Oceans	Date	Witness

Original signed by:

_____________________	Dec 17, 2001	_____________________
Garth Bangay Director General, Atlantic Region Environment Canada	Date	Witness

Original signed by:

_____________________	Dec 17, 2001	_____________________
F. George Richard Deputy Executive Regional Director, Atlantic Region Industry Canada	Date	Witness

Original signed by:

_____________________	Dec 17, 2001	_____________________
Paul Bernier Vice President, Program Delivery Canadian Environmental Assessment Agency	Date	Witness

Original signed by:

_____________________	Dec 14, 2001	_____________________
Kevin McNamara Deputy Minister, Department of Environment and Labour	Date	Witness

Province of Nova Scotia

APPENDIX B

SCOPE OF THE ENVIRONMENTAL ASSESSMENT
FOR THE PROPOSED PANCANADIAN ENERGY CORPORATION
(PANCANADIAN) DEEP PANUKE GAS DEVELOPMENT PROJECT
DECEMBER 18, 2001 (REVISED FEBRUARY 15, 2002)

Scope of the Environmental Assessment
For the
Proposed PanCanadian Energy Corporation (PanCanadian)
Deep Panuke Gas Development Project

December 18, 2001
(Revised February 15, 2002)

Scope of the Environmental Assessment
for the
Proposed PanCanadian Energy Corporation (PanCanadian)
Deep Panuke Project

1. Definitions

In this document,

“Environment” means the components of the earth and includes:

(a) Land, water, air and all layers of the atmosphere;
(b) All organic and inorganic matter and living organisms;
(c) The interacting natural systems that include components referred to in paragraphs (a) and (b); and
(d) The socio-economic, health, cultural and other items referred to in the definition of environmental effect.

“Environmental effect" means:

(a) Any change that a Project may cause in the environment, including any effect on socio-economic conditions, on health, on physical and cultural heritage, on the current use of lands and resources for traditional purposes by aboriginal persons, or on any structure, site or thing including that of historical, archaeological, paleontological or architectural significance; and
(b) Any change to a Project that may be caused by the environment.

2. Scope of the Project

The project to be assessed will include undertakings proposed by the proponent, or likely to be carried out in relation to the physical works proposed by the proponent, such as:

- Construction, operation, decommissioning and abandonment of:

  - Three new bottom-founded platform(s) accommodating the gas processing system and power generation, utilities, a helicopter landing pad, a refueling station and crew accommodations. The platforms will be interconnected by pedestrian / service bridges.

  - An offshore gas processing system consisting of:
    - Separation, measurement, dehydration, and hydrocarbon dew point control equipment; and
    - Full acid gas processing consisting of an amine unit to remove hydrogen sulphide (H_2S) and carbon dioxide (CO_2) from produced, raw, gas, and piping, compression and wellhead facilities associated with an acid gas injection / disposal well.

- A sub-sea gas pipeline from the platform to the coastline, and an onshore portion, to transport natural gas to Goldboro, Nova Scotia interconnecting with the Maritimes & Northeast Pipeline (M&NP) main transmission pipeline for further transport to markets in Canada and the Northeast United States.

- Onshore facilities consisting of the physical components necessary for interconnection of PanCanadian's natural gas pipeline with M&NP's facilities, including:
    - Metering and quality monitoring equipment;
    - Pressure control facilities (manifolding station);
    - Pig (smart and cleaning) launcher/receiver facilities, as required; and
    - A small building housing Supervisory Control and Data Acquisition Systems (SCADA) and other monitoring equipment for the pipeline.

- Ancillary undertakings in relation to the physical works identified above, including:
    - Dredging, trenching, blasting and other activities related to pipeline installation and construction, including activities for the management of the dredged sediments;
    - Development and injection well drilling;
    - Sub-sea gathering lines;
    - Support vessel and aircraft (e.g. helicopter) operations and facilities;
    - Installation and operation of communications equipment;
    - Various temporary construction work areas;
    - Transportation and installation of onshore fabricated components;
    - Equipment lay-down areas; and
    - Access roads.

3. Factors to be Considered

The assessment will include a consideration of the following factors as described in subsections 16(1) and (2) of the *Canadian Environmental Assessment Act*:

Factors to be considered in accordance with subsection 16(1) are:

- The environmental effects of the project, including the environmental effects of malfunctions or accidents that may occur in connection with the project and any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out;
- The significance of the environmental effects;
- Comments from the public that are received in accordance with the *Canadian Environmental Assessment Act* and its regulations; and

- Measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the project.

In accordance with paragraph 16(1)(e) of the *Canadian Environmental Assessment Act*, the assessment will also include a consideration of the need for the project and alternatives to the project.

Factors to be considered in accordance with subsection 16(2) are:

- The purpose of the project;
- Alternative means of carrying out the project that are technically and economically feasible and the environmental effects of any such alternative means;
- The need for, and the requirements of, any follow-up program in respect of the project; and
- The capacity of renewable resources that are likely to be significantly affected by the project to meet the needs of the present and those of the future.

The likelihood and significance of predicted adverse environmental effects should be considered in the context of sustainable development principles, as set forth in the *Canadian Environmental Assessment Act* and other legislation. Measures proposed for mitigating adverse environmental effects should be considered in a hierarchical sequence with a clear priority on avoidance of adverse environmental effects.

It is recognized that environmental assessment is conducted at the early phases of project planning when alternative means of carrying out the project are under study and project details have yet to be finalized. As set out in this scope document, alternative means of carrying out the project must be considered in the environmental assessment.

It is expected that the project, and alternative means of carrying out the project, will reflect a consideration of sustainable development principles, incorporate the applicable best management practices and make provision for compliance with applicable legislative requirements. It is further expected that the consideration of alternative means will facilitate identification of site, configuration, design and management options that would be preferable in terms of avoiding or minimizing adverse environmental effects.

4. Scope of the Factors to be Considered

The review will consider the potential effects of the proposed project within spatial and temporal boundaries that encompass the periods and areas during and within which the proposed project may potentially interact with, and have an effect on, components of the environment. Relevant factors in determining boundaries include such things as ocean currents, wind conditions, and species migration patterns.

Table: Summary of CSR Considerations

The following is a list of environments, ecosystem components, project activities and environmental influences that, as a minimum, the Comprehensive Study Report (CSR) must consider. The list is not intended to be exhaustive and is provided solely to guide the proponent as to the type of content expected in the CSR. The proponent should carefully examine this list and expand upon it where necessary. For further guidance, the proponent should also carefully examine the detailed comments provided by the various agencies and public in response to the Scope document.

Major Environments	• Marine (Offshore) Physical, Biological and Chemical • Coastal and Nearshore Physical, Biological and Chemical (e.g. inter-tidal communities, aquaculture) • Onshore Aquatic and Terrestrial • Atmospheric • Geologic (geomorphology, marine sediments, sediment quality)
Ecosystem Components (candidate Valued Ecosystem Components, to be considered in all relevant environments)	<u>Environmental</u> • Air quality • Water quality • Sediment quality • Soil capability and quality • Fish and fish habitat • Mammals • Archaeological and heritage resources • Benthos • Vegetation (plants, trees, forests, kelp, rockweed, seaweed, etc.) • Plankton • Amphibians and reptiles • Birds and bird habitat • Special places (Sable Island, the Gully and other environmentally sensitive or protected areas) • Species at risk • Groundwater resources • Surface water resources • Wetlands and wetland functions <u>Socio-Economic</u> • Land use (parks and other recreational uses, forestry, agriculture, mineral tenures, gravel resources, landfills, proximity to residential areas, future development plans, access management, crossing of contaminated areas) • Public Health and Safety (project emissions and effluents, radio wave emissions from communications

	equipment, noise, dust, pipeline integrity, fire, water supplies, sewage treatment) • Use of Marine Resources (commercial fisheries and commercial fishing exclusion zones, aquaculture, commercial and recreational navigation, oil and gas, communications and submarine cables, maritime defense, marine science and technology) • Mi'kmaq Interests (hunting and traditional or commercial fishing, cultural sites)
Project Activities (possible causes of environmental effects)	• Normal and fugitive air emissions (e.g. greenhouse gases (CO_2, methane), H_2S, SO_2, NO_X, VOCs) • Marine discharges (e.g. produced water, drill fluids and cuttings, biocides, grey water, black water, galley waste) • Acid gas injection • Offshore storage and use of condensate • Electromagnetic emissions (radio) • Noise (underwater and atmospheric) • Onshore waste disposal • Erosion and sedimentation • Vessel traffic • Aircraft activity • Dredging / trenching / blasting and dredge material disposal • Malfunctions and accidental events (e.g. spills or leaks of hydrocarbons or chemicals, blowouts, injection well malfunctions)
Environmental Influences (factors which could affect the project design or operation)	• Meteorology and oceanography (e.g. extreme winds, waves, currents and precipitation, fog, freezing spray) • Seismic activity • Ice climate • Corrosion • Sinkholes

APPENDIX C

DISPERSION MODELING

DISCHARGE MODELING

This Appendix summarizes the methodology and results of the discharge modeling conducted for atmospheric emissions (Section 1) and produced water (Section 2).

1 ATMOSPHERIC MODELING

The following describes the modeling methodology used to determine the behavior of atmospheric emissions generated by the Project. A discussion of modeling results is presented in Section 6.3.1 of the CSR.

1.1 Atmospheric Dispersion Model

The main model selected for use in this assessment is the Industrial Source Complex (ISC) model that was developed for the US Environmental Protection Agency (EPA). The latest version of the model is version three combined with the improved algorithms for building downwash calculations, and designated as ISC-PRIME. The ISC models have been accepted in Nova Scotia and other provinces for regulatory compliance and permitting applications. The model is recommended by some provinces, and is the recommended model of choice of the US EPA.

The model was used to generate one hour, twenty-four hour, and annual averages of ground-level concentrations (GLC). Options were set to automatically find the maximum GLC for each and all receptors for each of the averaging times.

For the analysis of worst-case impacts of abnormal events (*i.e.*, blowouts), the US EPA SCREEN3 dispersion model was used. This model is recommended for this type of application because it is conservative and searches a broad range of weather conditions to find the maximum concentrations that might occur. The model provides one-hour concentration predictions.

1.1.1 Meteorological Data

The ISC model requires certain meteorological elements:

- wind speed
- wind direction
- air temperature
- mixing height
- atmospheric stability

The nearest Atmospheric Environment Branch (AEB) weather station with continuous high-quality observations of the required elements is the station on Sable Island. Continuous data for the period 1986-1990 were obtained from AEB, processed by them to the format required by the ISC model.

The meteorology offshore is not the same as over land. In particular, the water surface does not heat as much during the day, and the cold water surface prevents the air from becoming unstable. The cold surface favours stable dispersion conditions.

The processed weather dataset relies upon a stability typing scheme (Pasquill-Gifford) developed for over land conditions. Over land, if the solar radiation is high and the windspeed is low, the method predicts unstable conditions. The heating of the land by the sun heats the air in turn, leading to thermal buoyancy in the air. Over land, this is the situation characterized by looping plumes and variable speed winds, a situation favouring rapid dispersion. At night, clear sky conditions lead to the reverse condition – a loss of thermal radiation to space, cooling the surface and the air at the surface and the occurrence of very stable conditions which restrict dispersion. For high windspeeds, or for overcast conditions, the atmosphere tends to be dominated by mechanical turbulence and the temperature structure approaches neutral. In offshore areas, the nighttime stable condition would be correctly predicted, as would the neutral condition during high windspeeds. The problem with the method is in the estimation of unstable conditions that are actually stable conditions. The low windspeed occurrence of very unstable and unstable categories (A or B) is predicted by the model where the cold water surface would actually have resulted in stable conditions (E or F).

In order to correct for this, the dataset was edited and the very unstable situations were redesignated as very stable situations (A to F) and the moderately unstable situations redesignated to moderately stable (B to E). The frequency distribution was shifted as tabulated in Table 1. It is important to note two things about this adjustment. First it is likely to be conservative, in that the adjustment will likely overestimate the occurrence of restricted dispersion conditions. Second the total adjustment comprises 2.74% of the data. It does affect the maximum ground-level concentrations, but has marginal effect on the 24 hour and annual averages.

Table 1 Stability Category Frequency Adjustments for Offshore Application

Stability Category	Frequency of Occurrence, Land-based Typing Scheme	Frequency of Occurrence as Adjusted for Offshore Application
A – very unstable	0.24%	0%
B – unstable	2.5%	0%
C – mildly unstable	7.12%	7.12%
D – neutral	78.7%	78.7%
E – stable	7.0%	9.5%
F – very stable	4.56%	4.80%

1.1.2 Receptor Grid and Terrain Data

The receptor grid is the set of points at which predictions of ground-level concentrations is performed. For this study a polar grid centered on Deep Panuke was created. The receptors were located at 5 degree azimuth spacing, and at variable radii from 100 m near the Project to 35,000 m.

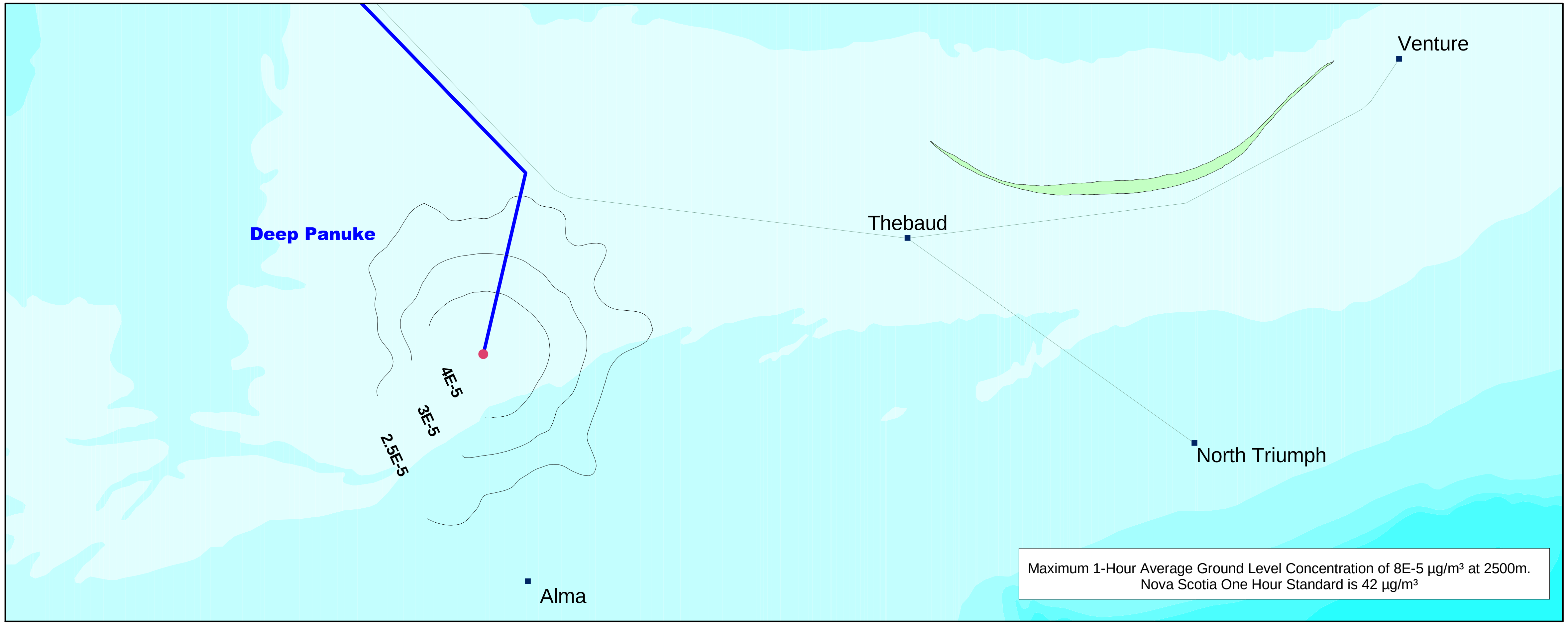
ISC-PRIME provides the capability of using terrain height information in the calculation of ground-level concentrations.

SCREEN3 uses a range of receptor distances supplied by the user, and calculates the distance of greatest concentration within that range.

Both models are of the Gaussian type. The concentration of emissions from a point source disperse in the atmosphere in the horizontal and vertical in a pattern similar to the Gaussian statistical distribution. The spread of the pollutants is proportional to the turbulence of the atmosphere and is reflected by a parameter analogous to the standard deviation of the normal distribution. The Gaussian model is widely accepted but has certain limitations. A particular weakness is the occurrence of very calm conditions. In practice, the dispersion of thermally buoyant or lighter than air gases that occurs in very calm conditions is often dominated by vertical rise. The models use a lower limit of 1 m/s on wind speed.

1.2 Atmospheric Modeling Results

Figures 1 to 6 present the modeling results for normal and upset operating conditions, which have formed the basis for the discussion in Section 6.3.1 of the CSR.



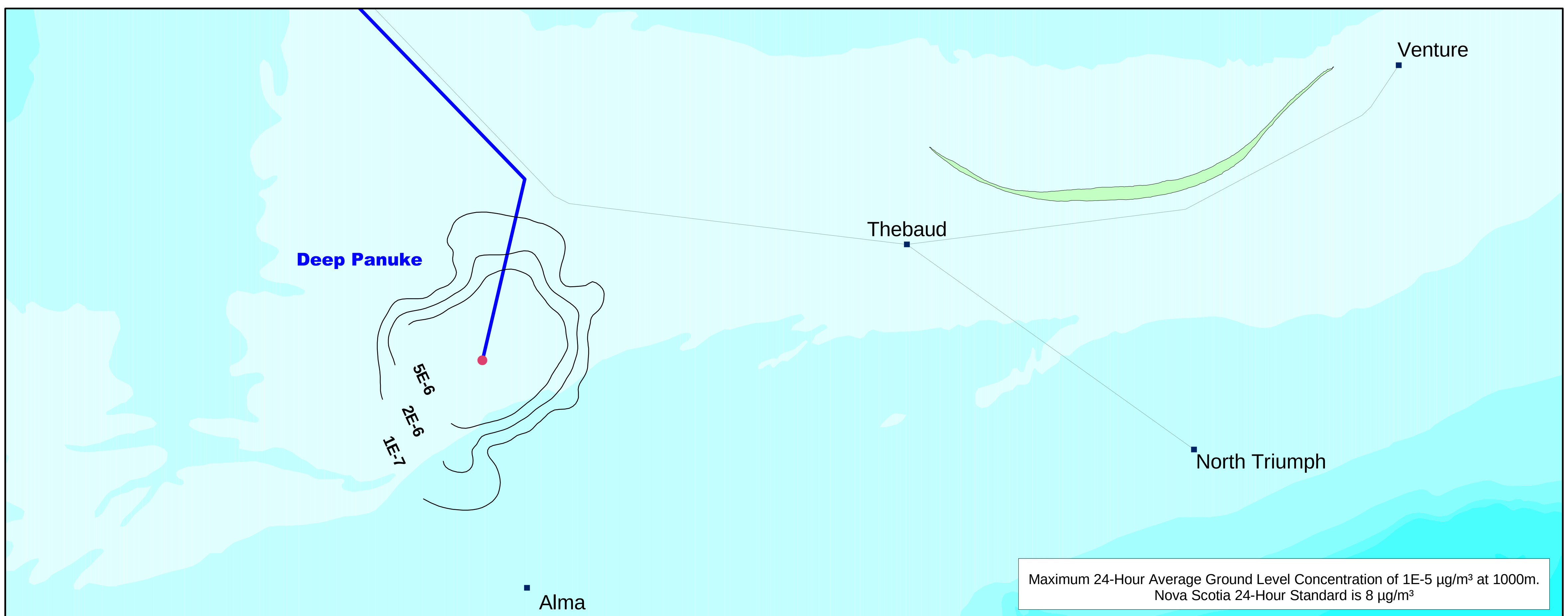


Figure 1

Deep Panuke Project

Normal Production - H_2S Maximum Average Ground Level Concentrations (µg/m³)

EnCana Proposed Pipeline Route

SOEI Pipeline

N

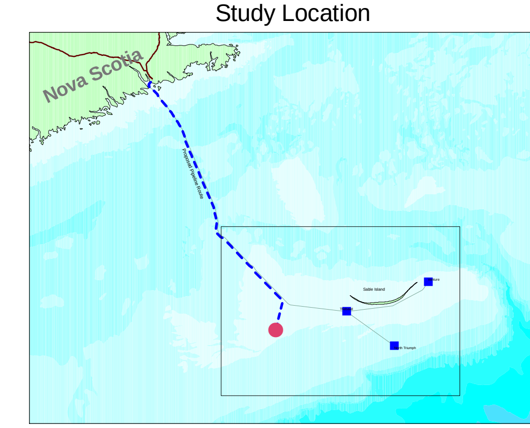
0 5 10 15 20 25

Kilometres

Map Parameters
Projection: Universal Transverse Mercator
Zone: 20
Datum: NAD 83
Scale: 1:500,000
Grid: Lat/Long 1°

Model Date: September 13, 2002
Print Date: September 17, 2002

Study Location



0 25 50 75 100

Kilometres

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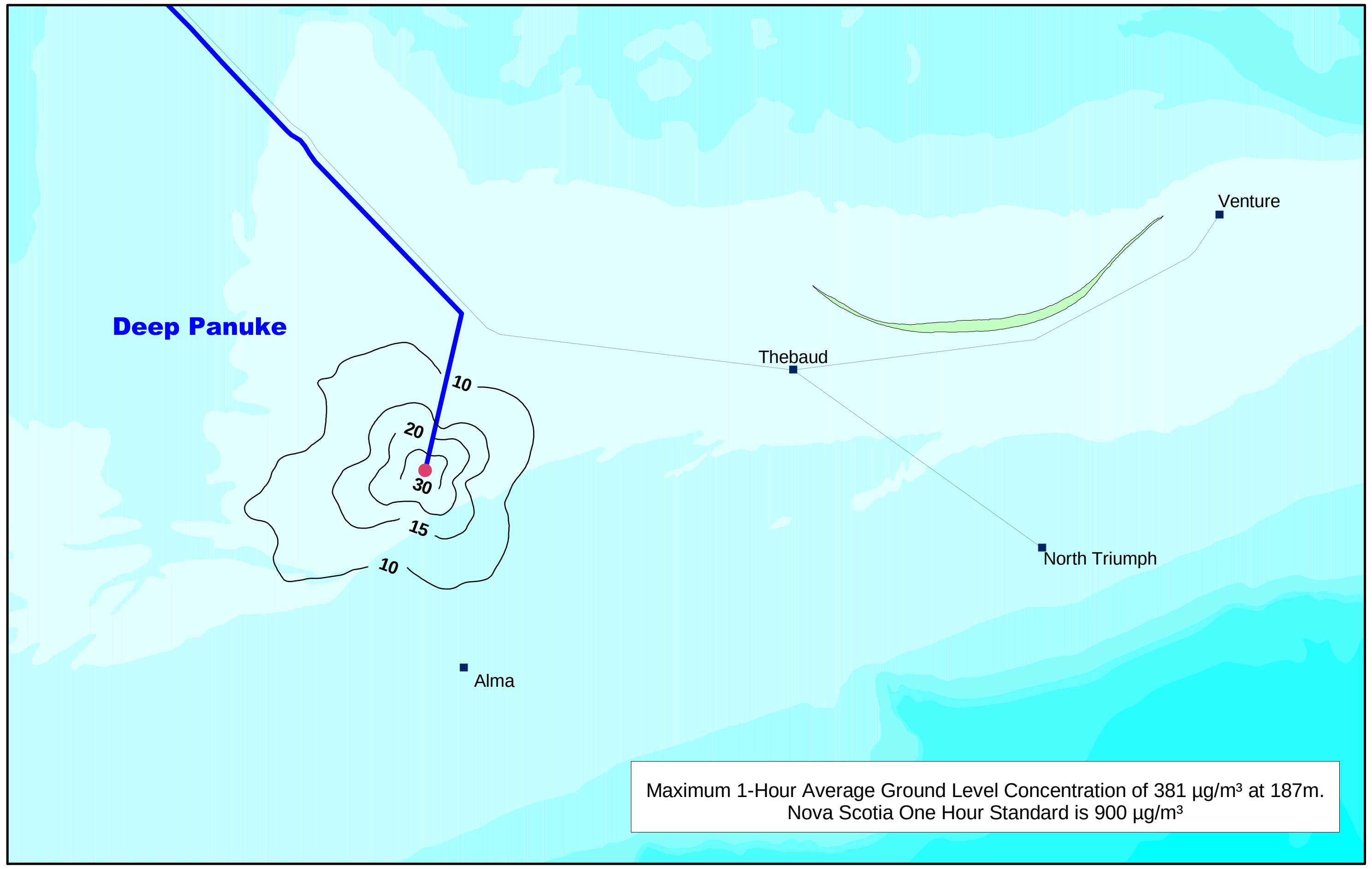
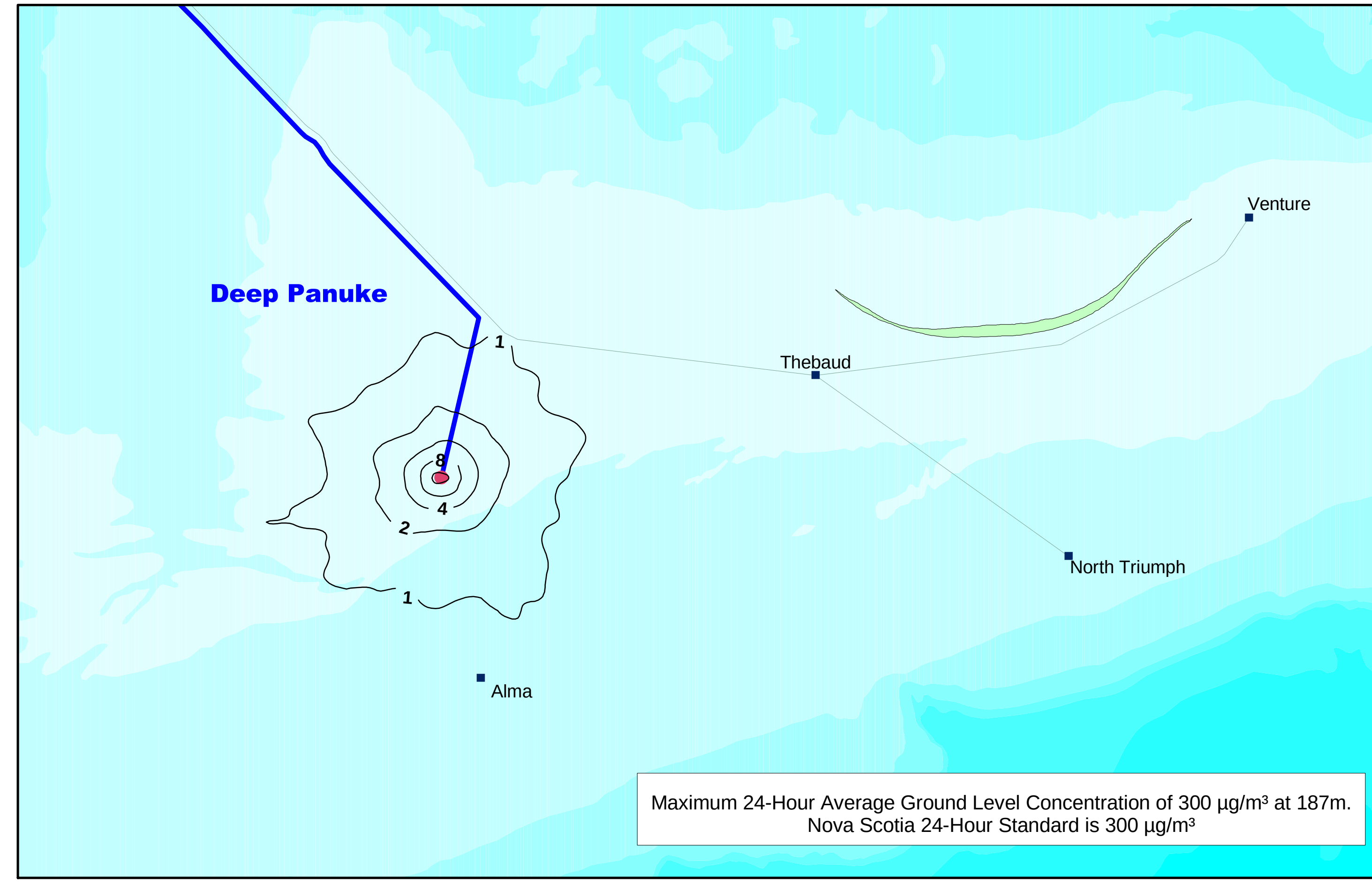




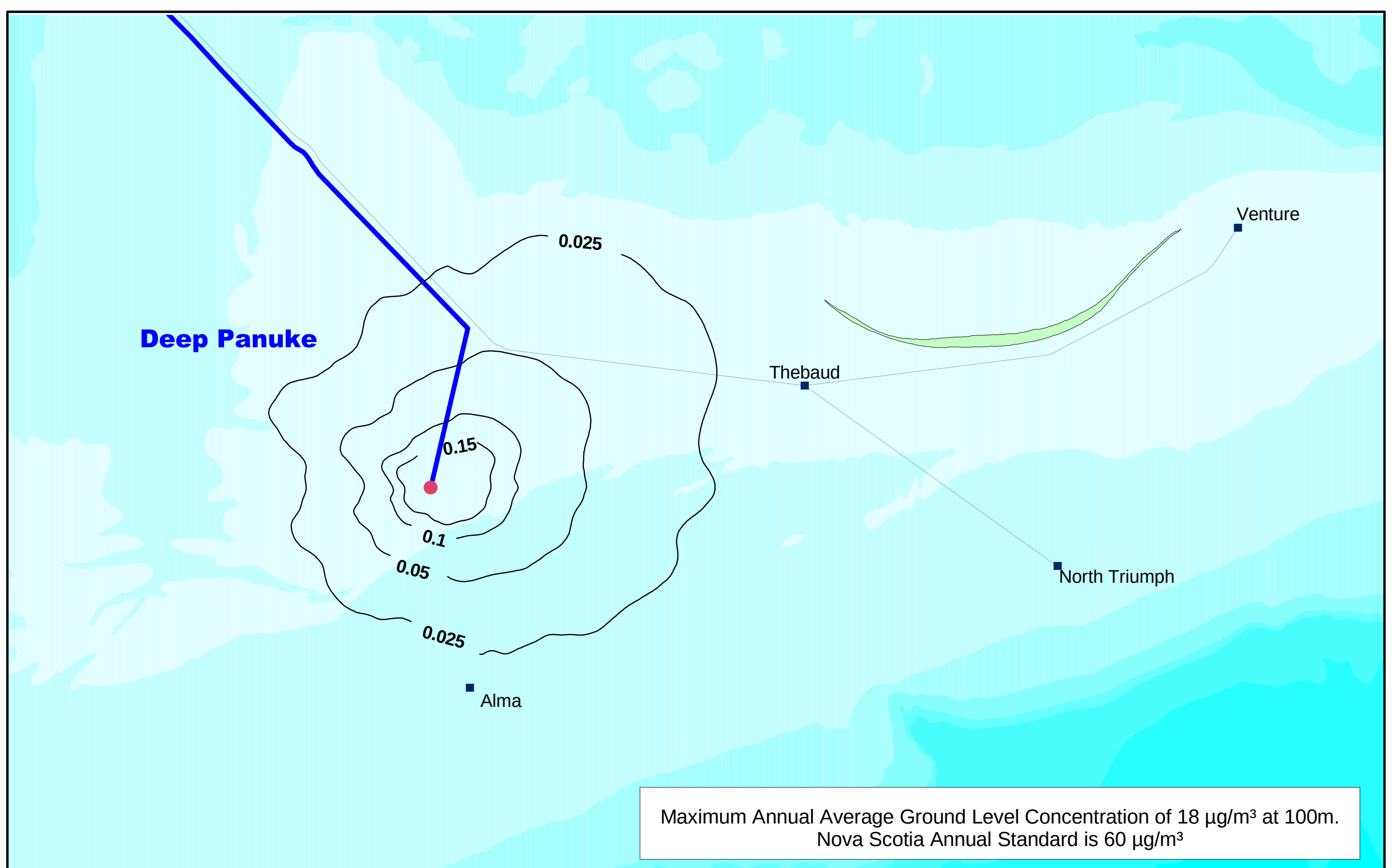


Figure 2

Deep Panuke Project

Normal Production SO2
Maximum Average Ground Level
Concentrations (µg/m³)

EnCana Proposed Pipeline Route

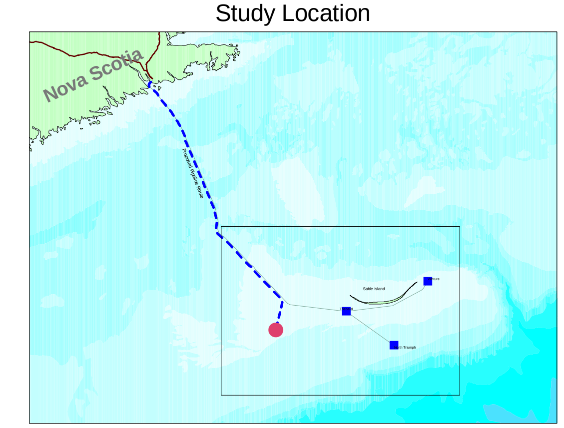
SOEI Pipeline

N

0 25 50

Kilometres

Study Location



0 25 50 75 100

Kilometres

Model Date: September 13, 2002
Print Date: September 17, 2002

Map Parameters
Projection: Universal Transverse Mercator
Zone: 20
Datum: NAD 83
Scale: 1:800,000
Grid: Lat/Long 1°

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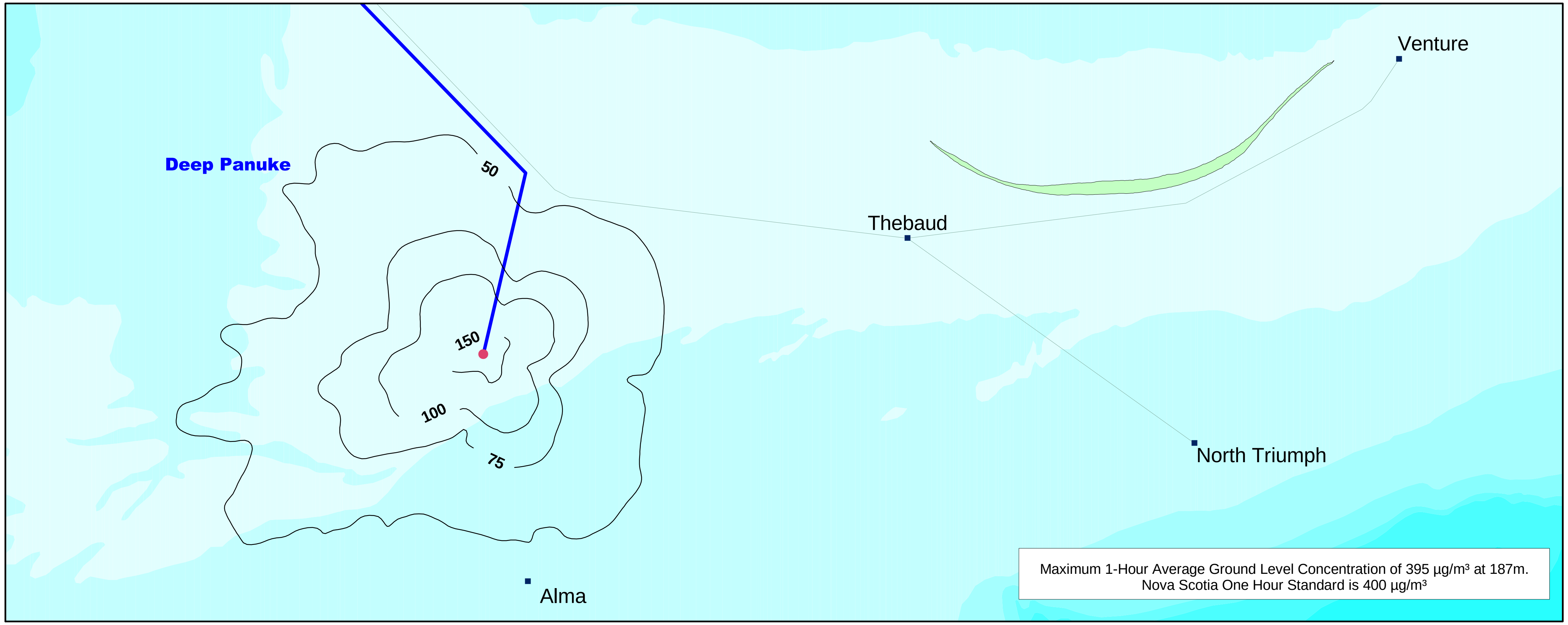
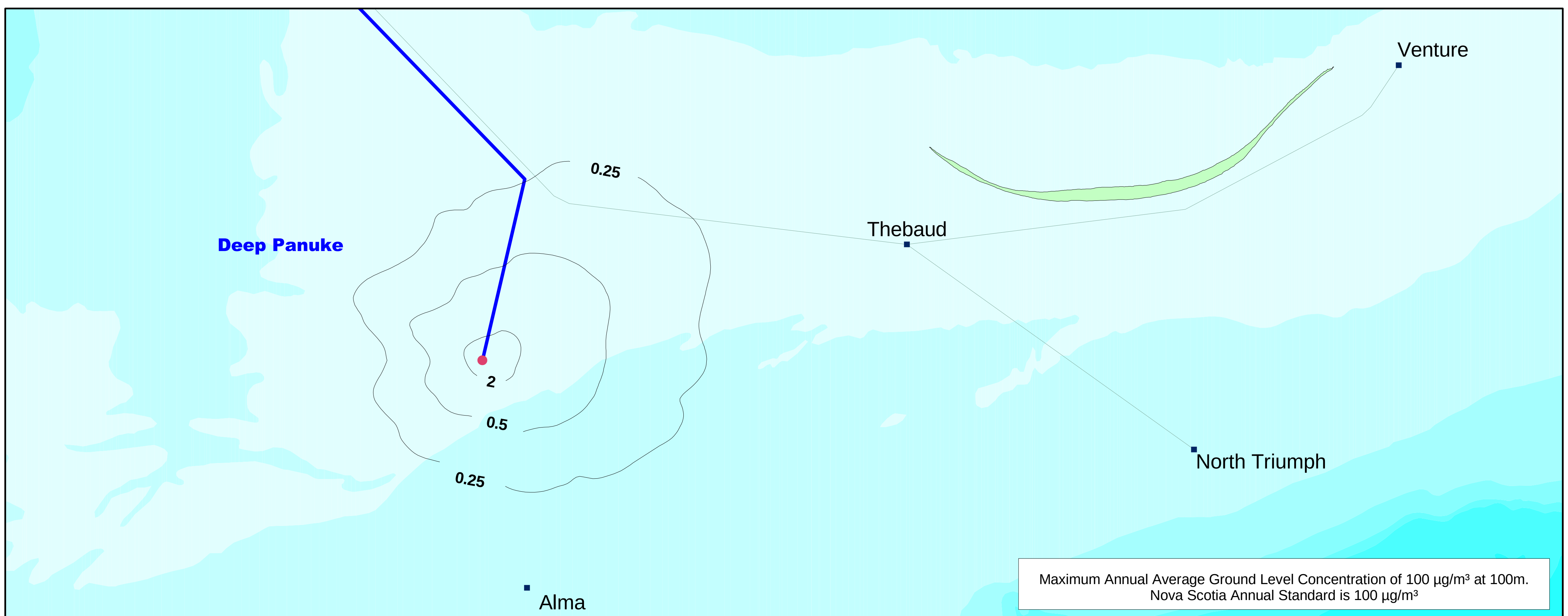
Figure 3

Deep Panuke Project

Normal Production - NOx Maximum Average Ground Level Concentrations (µg/m³)





EnCana Proposed Pipeline Route

SOEI Pipeline

N

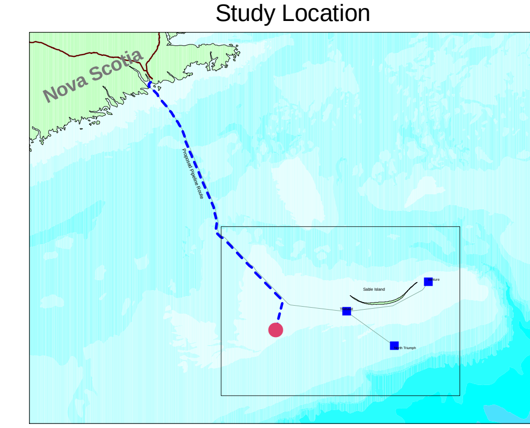
0 5 10 15 20 25

Kilometres

Map Parameters
Projection: Universal Transverse Mercator
Zone: 20
Datum: NAD 83
Scale: 1:500,000
Grid: Lat/Long 1°

Model Date: September 13, 2002
Print Date: September 17, 2002

Study Location



0 25 50 75 100

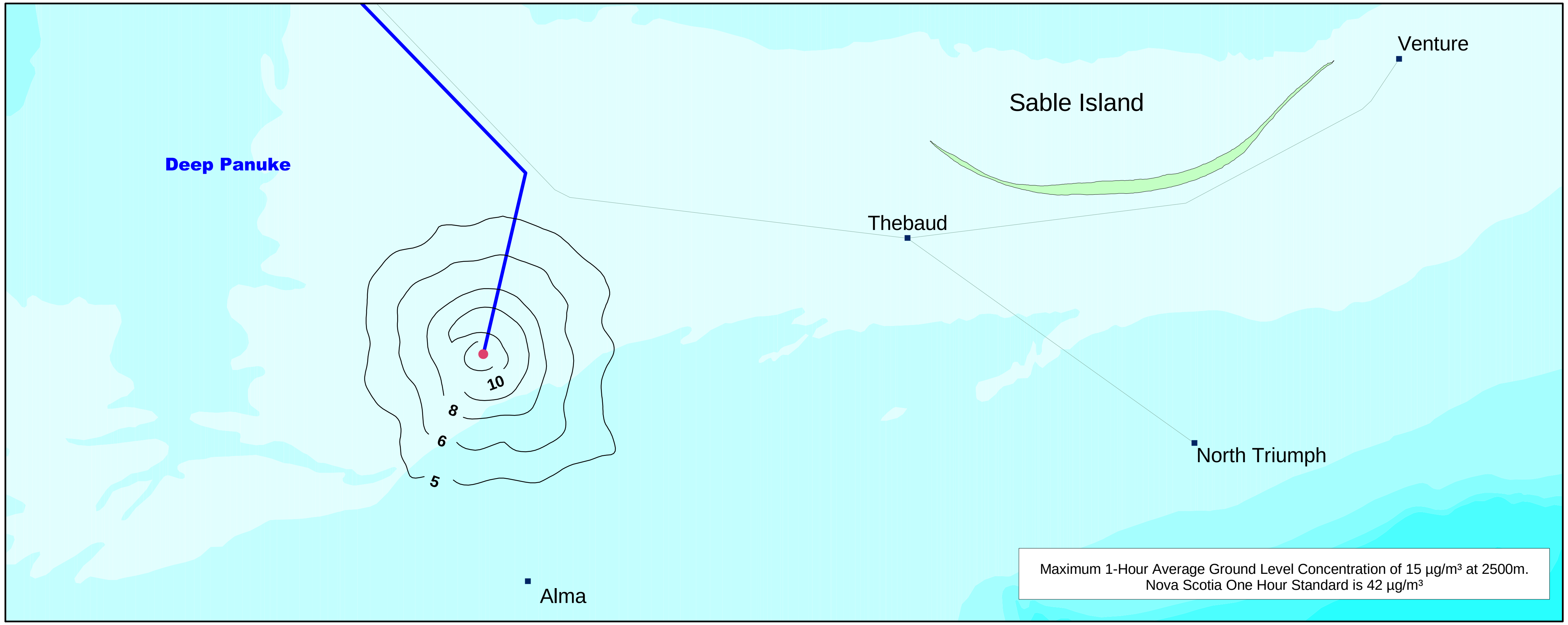
Kilometres

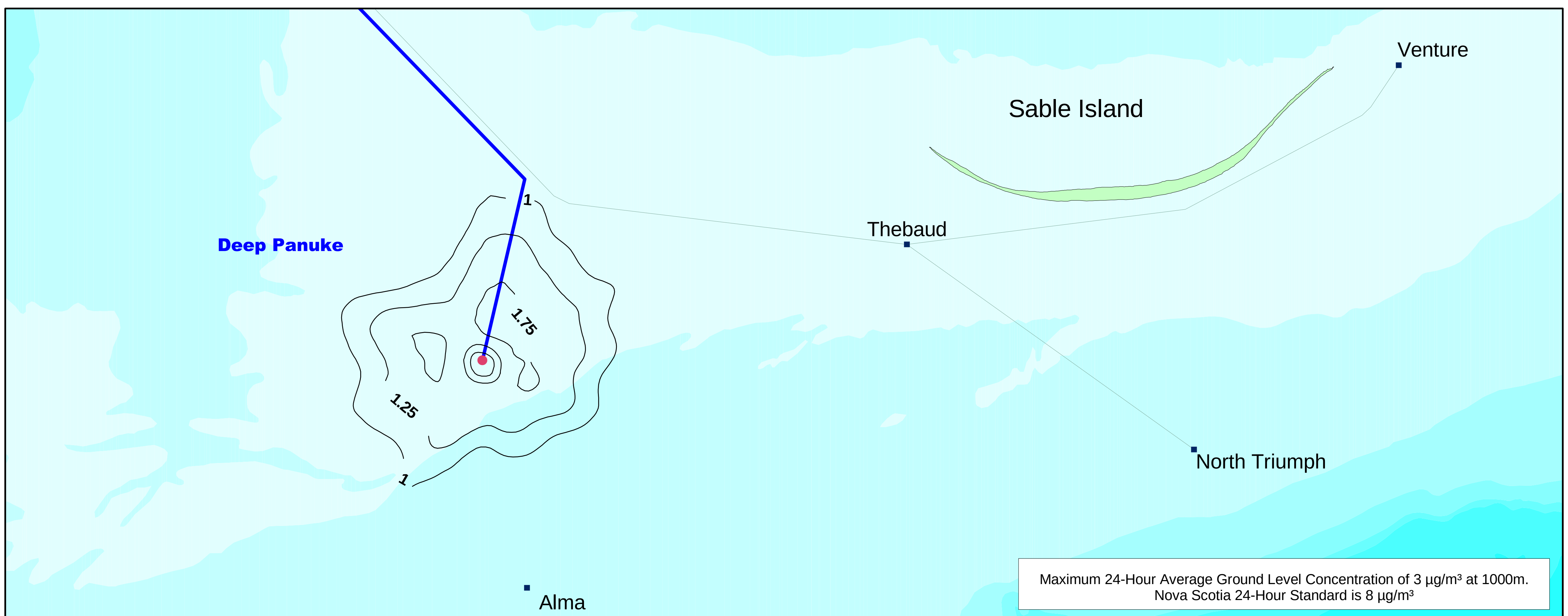
X:\Projects\NovaScotia\NSD15999\AV_Projects\AirQuality\Airquality_08_26_02.apr

Figure 4

Deep Panuke Project

Equipment Maintenance & Upset of Acid Gas System H2S Maximum Average Ground Level Concentrations (μg/m³)





EnCana Proposed Pipeline Route

SOEI Pipeline

N

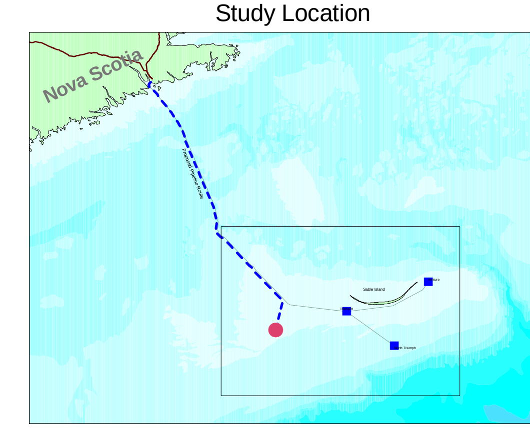
0 5 10 15 20 25

Kilometres

Map Parameters
Projection: Universal Transverse Mercator
Zone: 20
Datum: NAD 83
Scale: 1:500,000
Grid: Lat/Long 1°

Model Date: September 13, 2002
Print Date: September 17, 2002

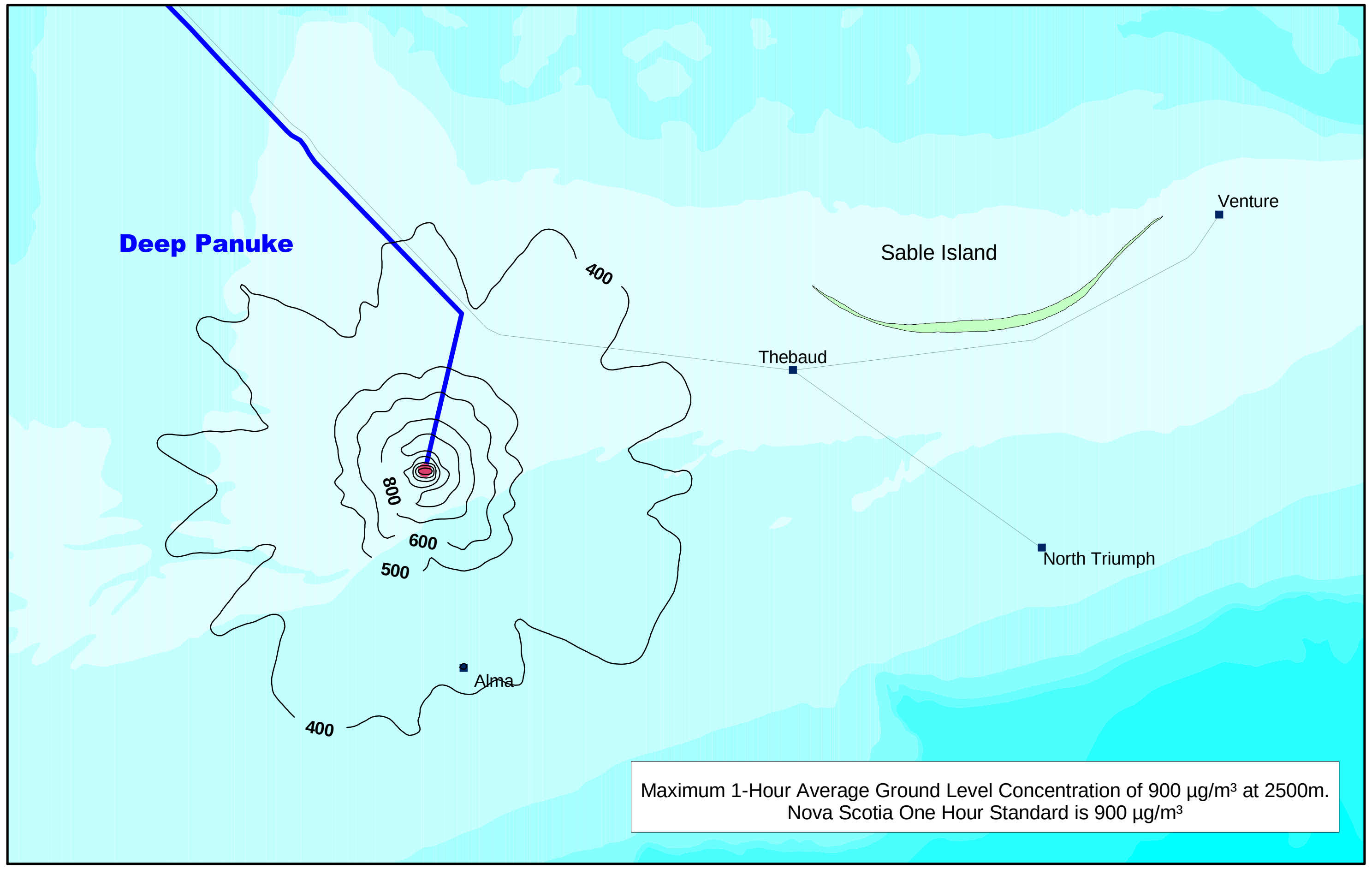
Study Location

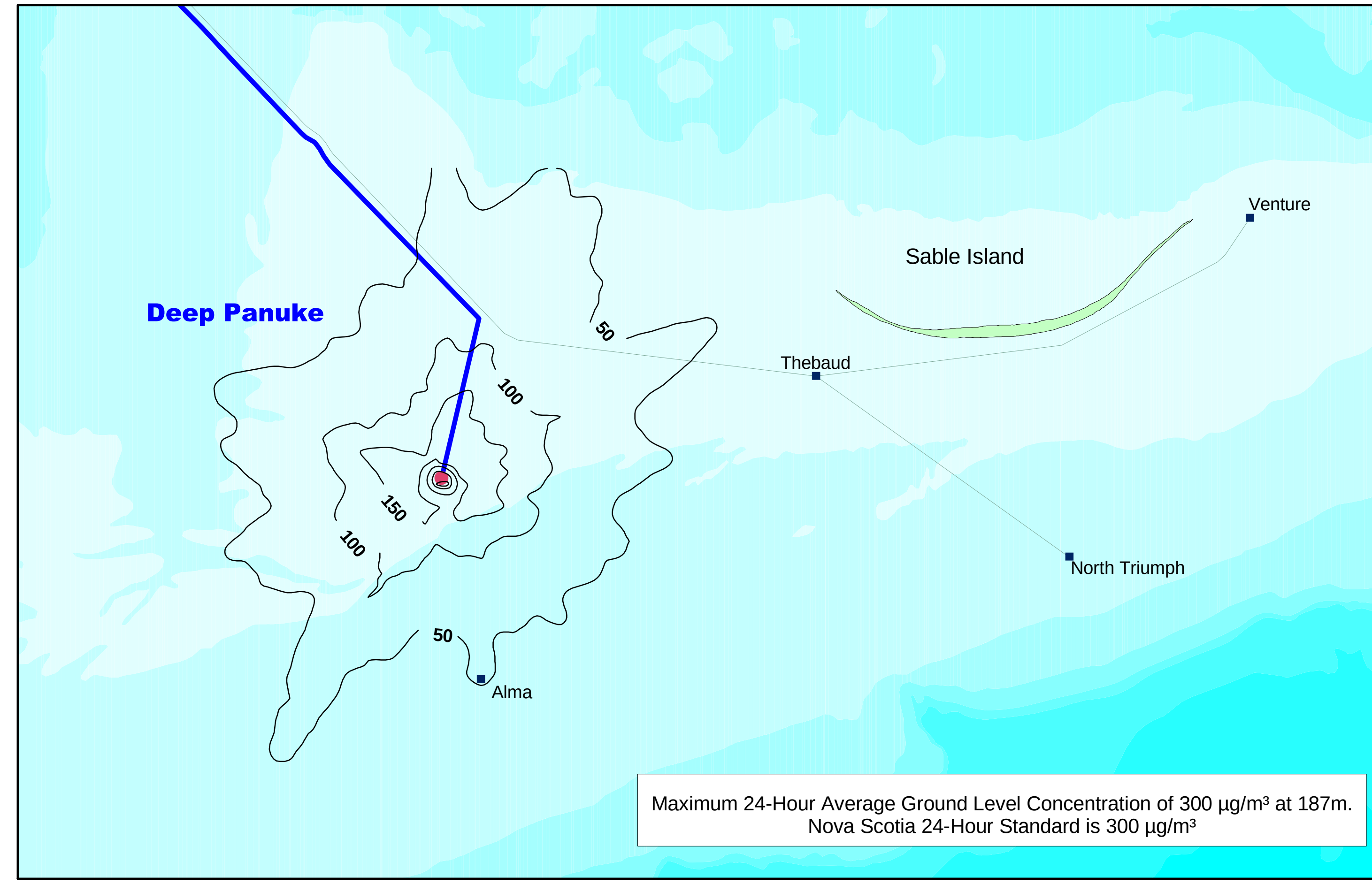


0 25 50 75 100

Kilometres

X:\Projects\NovaScotia\NSD15999\AV_Projects\AirQuality\Airquality_08_26_02.apr





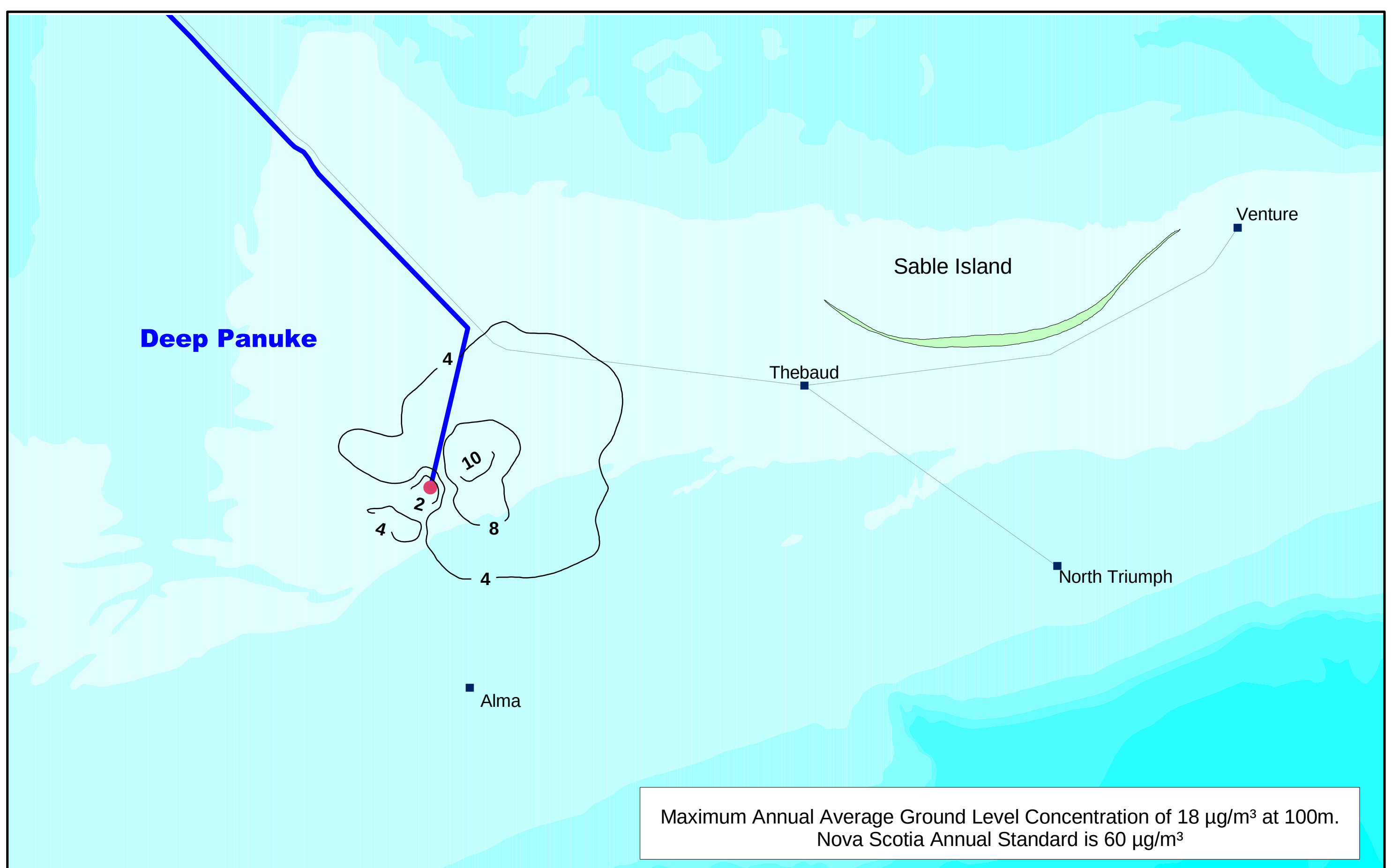


Figure 5

Deep Panuke Project

Equipment Maintenance &
Upset of Acid Gas System SO2
Maximum Average Ground Level
Concentrations (µg/m³)

EnCana Proposed Pipeline Route

SOEI Pipeline

N

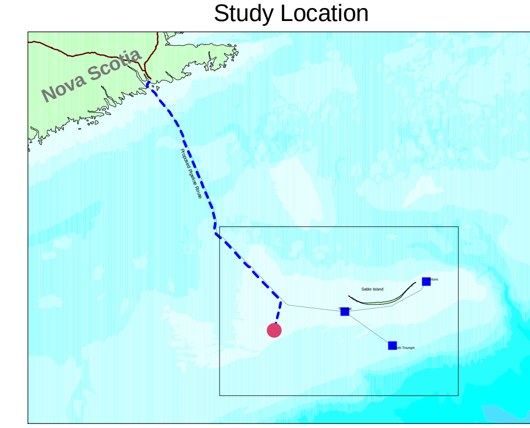
0 25 50

Kilometres

Map Parameters
Projection: Universal Transverse Mercator
Zone: 20
Datum: NAD 83
Scale: 1:800,000
Grid: Lat/Long 1°

X:\Projects\NovaScotia\NSD15999\AV_Projects\AirQuality\Ariquality_08_26_02.apr

Study Location



0 25 50 75 100

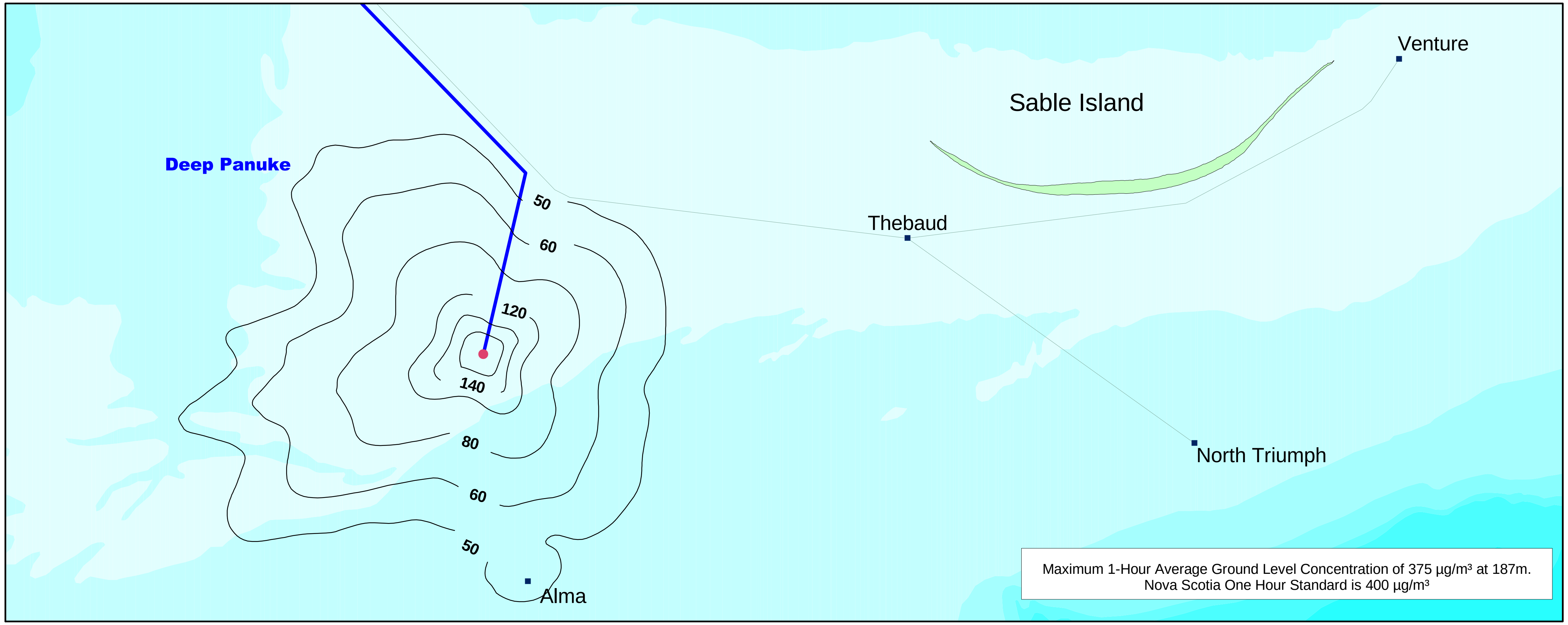
Kilometres

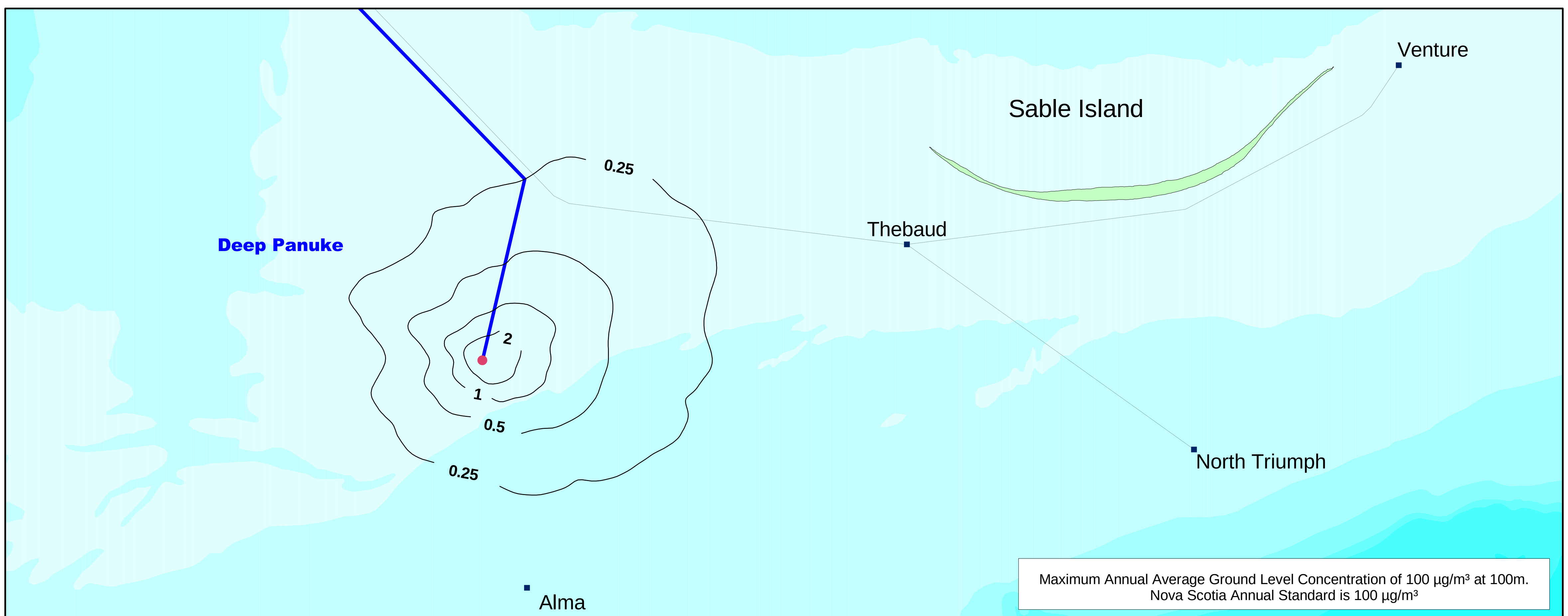
Model Date: September 13, 2002
Print Date: September 17, 2002

Figure 6

Deep Panuke Project

Equipment Maintenance & Upset of Acid Gas System NOx Maximum Average Ground Level Concentrations (µg/m³)





EnCana Proposed Pipeline Route

SOEI Pipeline

N

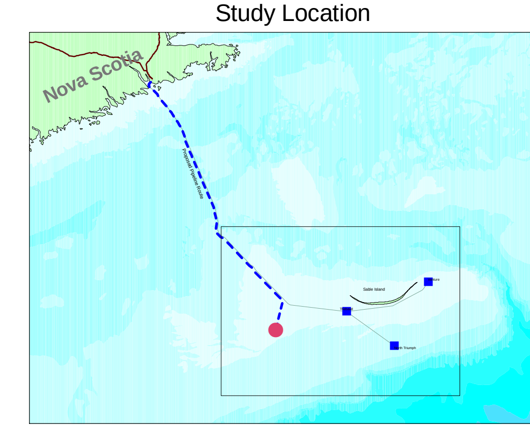
0 5 10 15 20 25

Kilometres

Map Parameters
Projection: Universal Transverse Mercator
Zone: 20
Datum: NAD 83
Scale: 1:500,000
Grid: Lat/Long 1°

Model Date: September 13, 2002
Print Date: September 17, 2002

Study Location



0 25 50 75 100

Kilometres

X:\Projects\NovaScotia\NSD15999\AV_Projects\AirQuality\Airquality_08_26_02.apr

2 PRODUCED WATER DISPERSION MODELLING

This Section describes the methodology and results for the produced water discharge modeling. Section 2.4.1.7 of the CSR describes the estminated produced water production rates and describes the treatment and discharge process for the Project.

The present estimate for dilution rate of cooling water to produced water is 68:1. The dispersion model (discussed below) used a more conservative dilution rate of approximately 48:1 which was based on projected quantities of produced water that were available in early design phase of the Deep Panuke program. More recent information from the reservoir model reduced the projected maximum quantity of produced water from 65 m^3/hr to 45 m^3/hr. Given this reduction in the maximum discharge rate, it is reasonable to assume that the conclusions of the dispersion model are conservative and therefore the findings remain valid.

The following text has been provided to provide clarification and correction, and to address omissions in the produced water dispersion modeling originally presented in Appendix A of the EIS. The EIS predicted that dilutions of the produced water of from 500:1 to 1,000:1 would occur within the vicinity of the discharge. Far-field modeling was conducted for a month-long representative tidal current time series using a slab model with a horizontal resolution of 20 m and a thickness of 10 m. The following clarification, omission and correction are presented in detail below:

1. Dilution factors are clarified in terms of their application to “produced” water from the well. The “total” discharge also includes cooling water from the sea. The ratio of cooling water to produced water in the discharge is 48:1. The stated dilutions of 500:1 to 1,000:1 in the EIS referred to the produced water component only.
2. Assumptions and results of near-field plume modeling were omitted in the EIS. The near-field analysis is presented below.
3. Hydrocarbon concentrations presented in the EIS were incorrect. Original results presented in the EIS were based on the incorrect assumption that the total discharge could contain as much as 40 mg/L hydrocarbon. In fact, only the (treated) produced water component would contain hydrocarbon at that concentration. The modeled hydrocarbon concentrations presented in the EIS were therefore overestimated. A procedure for calculation of the marine concentration of any constituent based on the dilution of total discharge is provided below. (Note: Modeling is conservative since EnCana is striving to meet a target oil in water concentration of 25 mg/L; the Offshore Waste Treatment Guidelines specify a 30 mg/L limit (30 day average)).

2.1 Initial Dilution

The Project design is proposed to provide dilution of produced water (65 m^3/h) by cooling water (3,000 m^3/h) prior to discharge. This causes a 48:1 dilution of the produced water component prior to discharge. Discharge of the total flow will be from a vertical caisson of diameter 122 cm (48") extending 10 m below the sea surface. The discharge will be buoyant due to the heat of the cooling water and will undergo additional dilution as it rises to the surface in a turbulent plume. This results in an additional dilution from 10:1 to 20:1 in the near-field (see near-field analysis below) so that the average total dilution of the produced water component in the near-field is from 500:1 to 1,000:1.

2.2 Near-Field Analysis

The cross-sectional area of the discharge caisson is 1.17 m^2. The total rate of discharge is 0.87 m^3/s, corresponding to an initial jet velocity of 0.81 m/s. The discharge is 20 degrees above ambient and will be positively buoyant. Hence, the vertical descent of the jet will be limited by buoyancy forces. Based on seasonal background temperatures and densities it is estimated that the vertical deceleration of the downward discharged plume will be complete in 25 seconds in winter and 12 seconds in summer. Average tidal current is 25 cm/s. The cooling water intake will be situated at a depth of approximately 15 m. Modeling is used to verify that:

a) the plume does not reach the intake depth;
b) the initial dilution during the buoyant rise phase is of the order 10:1 to 20:1;
c) once surfaced, the plume is characterized by horizontal dimensions on the order of the far-field model resolution (20 m x 20 m x 10 m cells); and
d) the ambient flow is strong enough to sustain continued dilution. Given this initial behaviour, it is reasonable to proceed with far-field modeling based on a horizontal resolution of 20 m in a slab model 10 m thick.

2.2.1 Near-Field Plume Modeling

The investigation of the near-field behaviour of the plume was conducted using the EPA model UPLUMES. Initial runs with no ambient current showed that the plume would descend approximately 5 m from the end of the caisson before rising to the surface. The dilution during the vertical rise of a downward discharge of buoyant discharge is not described by the model (the near-field results are provided only for the descent phase), however, a conservative approach has been taken, to model the case of a horizontal discharge. The model was run for winter unstratified conditions and for summer stratification, assuming a 1 ppt difference between surface and bottom salinity. Summer runs were conducted assuming that the intake was taken from the surface (lower salinity) and from the bottom (higher salinity) in order to assess the sensitivity to intake salinity. The UPLUMES inputs and summary outputs are presented below.

Winter Case - Unstratified

Model Input

```
  tot flow   # ports port flow   spacing  effl sal effl temp   far inc   far dis
      0.87         1    0.8700       100        32        21        20     10000
  port dep  port dia plume dia total vel horiz vel vertl vel asp coeff print frq
        10      1.17      1.17    0.8092    0.8092     0.000       0.1         1
 port elev ver angle cont coef  effl den poll conc     decay  Froude # Roberts F
        25         0     1.000   22.2399         1         0     4.129     54.70
 hor angle red space p amb den p current   far dif   far vel K:vel/cur Stratif #
        90    100.00   25.6623    0.2500    0.0005      0.25     3.237     0.000
     depth   current   density  salinity      temp  amb conc  N (freq) red grav.
         0      0.25   25.6623        32         1         0     0.000   0.03283
        35      0.25   25.6623        32         1         0 buoy flux puff-ther
                                                             0.0002856     4.110
                                                             jet-plume jet-cross
                                                                 4.547     3.356
                                                             plu-cross jet-strat
                                                                 1.828
```

Model Output

```
 plume dep plume dia poll conc  dilution   hor dis
        m         m                              m
     10.00     1.170     1.000     1.000     0.000
        …         …         …         …         …
     4.469     9.153   0.04672     21.34     27.51 -> surface hit
```

Summer Case – Low salinity at intake

Model Input

```
tot flow   # ports port flow   spacing  effl sal effl temp   far inc   far dis
      0.87         1    0.8700       100        31        35        20     10000
  port dep  port dia plume dia total vel horiz vel vertl vel asp coeff print frq
        10      1.17      1.17    0.8092    0.8092     0.000       0.1         1
 port elev ver angle cont coef  effl den poll conc     decay  Froude # Roberts F
        25         0     1.000   16.9653         1         0     3.016     29.18
 hor angle red space p amb den p current   far dif   far vel K:vel/cur Stratif #
        90    100.00   23.3468    0.2500    0.0005      0.25     3.237  0.004031
     depth   current   density  salinity      temp  amb conc  N (freq) red grav.
         0      0.25   23.1270        31        14         0   0.01452   0.06154
        35      0.25   23.8965        32        14         0 buoy flux puff-ther
                                                             0.0005354     3.333
                                                             jet-plume jet-cross
                                                                 3.322     3.356
                                                             plu-cross jet-strat
                                                                 3.427     7.603
```

Model Output

```
plume dep plume dia poll conc  dilution   hor dis
        m         m                               m
    10.00     1.170     1.000     1.000     0.000
      …         …         …         …         …
    3.852     8.265   0.05366     18.52     17.03 -> surface hit
```

Summer Case – High salinity at intake

Model Input

```
tot flow   # ports port flow   spacing  effl sal effl temp   far inc   far dis
     0.87         1    0.8700       100        32        35        20     10000
  port dep  port dia plume dia total vel horiz vel vertl vel asp coeff print frq
       10      1.17      1.17    0.8092    0.8092     0.000       0.1         1
 port elev ver angle cont coef  effl den poll conc     decay  Froude # Roberts F
       25         0     1.000   17.7087         1         0     3.210     33.06
 hor angle red space p amb den p current   far dif   far vel K:vel/cur Stratif #
       90    100.00   23.3468    0.2500    0.0005      0.25     3.237  0.004563
     depth   current   density  salinity      temp  amb conc  N (freq) red grav.
        0      0.25   23.1270        31        14         0   0.01452   0.05433
       35      0.25   23.8965        32        14         0 buoy flux puff-ther
                                                           0.0004727     3.474
                                                           jet-plume jet-cross
                                                               3.535     3.356
                                                           plu-cross jet-strat
                                                               3.025     7.603
```

Model Output

```
plume dep plume dia poll conc  dilution   hor dis
        m         m                               m
    10.00     1.170     1.000     1.000     0.000
      …         …         …         …         …
    3.982     8.456   0.05219     19.06     18.47 -> surface hit
```

The results show that winter dilution of 21:1 occurs within a distance of 28 m from the caisson. At this point, the centre of the plume is 4.5 m below the surface and its uppermost part has reached the surface. Hence, it is approximately 9 m thick. The (Gaussian) diameter of the plume is also 9 m. The results for the summer runs present a similar picture, indicating that the important dynamical influence is the buoyancy and the ambient current, not ambient temperature or statification. Initial dilutions are 19:1, with the plume surfacing at between 17 m and 19 m from the caisson. The (Gaussian) diameter of the plume is 8 m and it is approximately 8 m in thickness as it reaches the surface.

These results suggest that dilutions of 10:1 to 20:1 are reasonable to assume for conditions of average current. As stated in the EIS, the currents at the site are rotary and therefore, rarely go to zero. However, in the limiting case of zero ambient current, the model shows that a dilution of approximately 5:1 occurs as the plume rises to the surface. Modeled dilutions are greater than 20:1 when the current exceeds the average value.

Based on the average current, the total oceanic flux through the side of the 20 m x 20 m x 10 m far-field model cell is 50 m^3/s (or more, depending on the direction of the current). This is approximately 57 times larger than the total discharge rate of 0.87 m^3/s and suggests that, on average, the discharge will tend to be swept away from the source cell without build up of concentrations.

2.3 Total Discharge, Hydrocarbon and H_2S Concentrations – Far-Field Model Results

2.3.1 Total Discharge

Selection of resolution and modeling scenarios for the far-field inevitably involve compromise. The model used assumed a slab thickness similar to the plume diameter from the near-field model results. The horizontal resolution was set to 20 m. This resolution, which is a factor of 2 larger than the initial horizontal (Gaussian) diameter of the plume in the near-field, gives reasonable results given the averaging and filtering used in processing the far-field model results. The results presented are the highest levels that occurred in each cell over the month-long simulation after one-hour averaging. The dilution of the total discharge ranges from approximately 5:1 (20 % total discharge concentration) at the source cell, to levels of approximately 50:1 (2 % total discharge concentration) at a distance of 500 m from the source cell as shown in Figure 7.

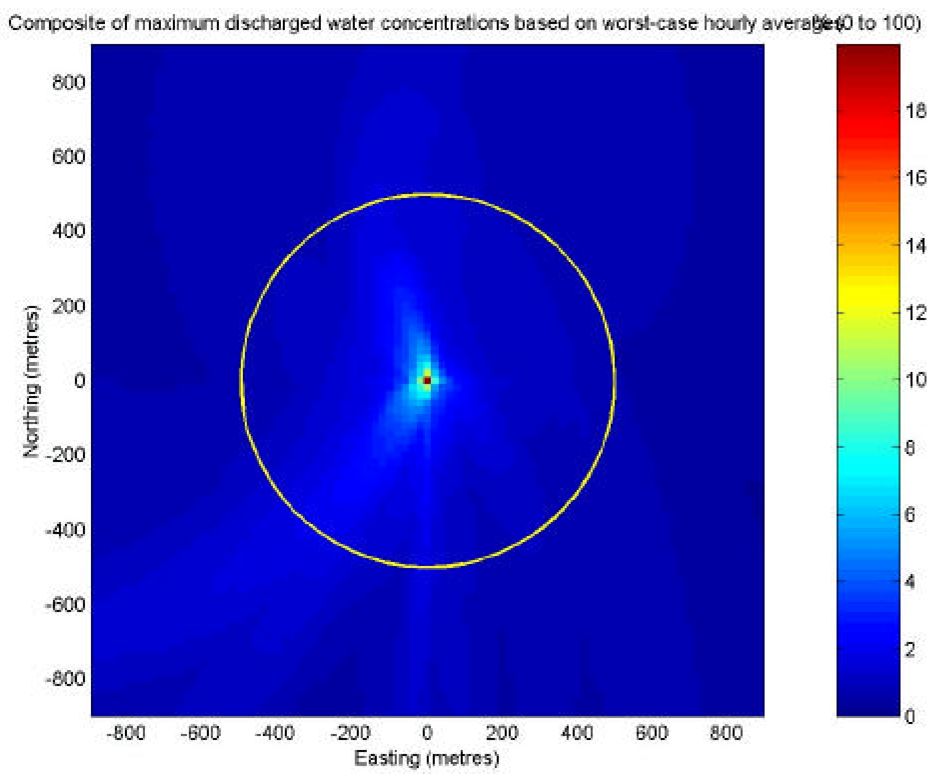


Figure 7 Maximum Discharged Water Concentrations Based on Worst Case Hourly Average

This worst case concentration over the source cell is consistent with the near-field result with zero ambient current. Notably, the high concentrations near the source cell are due to infrequent periods during which the current is low and the discharge concentration builds up near the caisson. For most of the simulation, the concentrations are much smaller.

2.3.2 Hydrocarbon Concentrations

The produced water is processed to bring the concentration of oil below 40 mg/L over a 30-day weighted average and the H_2S content between 1 and 2 ppm (Note: Modeling is conservative since EnCana is striving to meet a target oil in water concentration of 25 mg/L; the Offshore Waste Treatment Guidelines specify a 30 mg/L limit (30 day average)). The produced water (flow approximately 65 m^3/h) is then mixed with the cooling water (flow approximately 3,000 m^3/h), providing a 48:1 dilution of the produced water.

The composite maximum worst case hourly averaged model results are presented in Figures 8 and 9. Figure 2 shows that the highest oil concentrations are 0.0035 mg/L near the discharge pipe. Maximum hourly averaged concentrations drop to below 0.001 mg/L at a distance of 200 m from the discharge pipe. Figure 3 shows that, in the event that all the produced water oil in the water column rises to the surface, a layer of hydrocarbon of approximately 50 Fm would result near the discharge pipe. The thickness of this layer would drop to less than 10 Fm at a distance of 200 m from the discharge pipe.

2.3.3 Other Produced Water Contaminants

The concentration of other produced water contaminants may be estimated from the total discharge dilution by appropriate scaling after allowing for the dilution of produced water in the total discharge. For example, H_2S in produced water at levels of 1 ppm correspond to marine concentrations of 0.004 ppm (1 ppm x 20 % / 100 / 48) at the source cell to 0.0004 ppm (1 ppm x 2% / 100 / 48) at a distance of 500 m from the caisson.

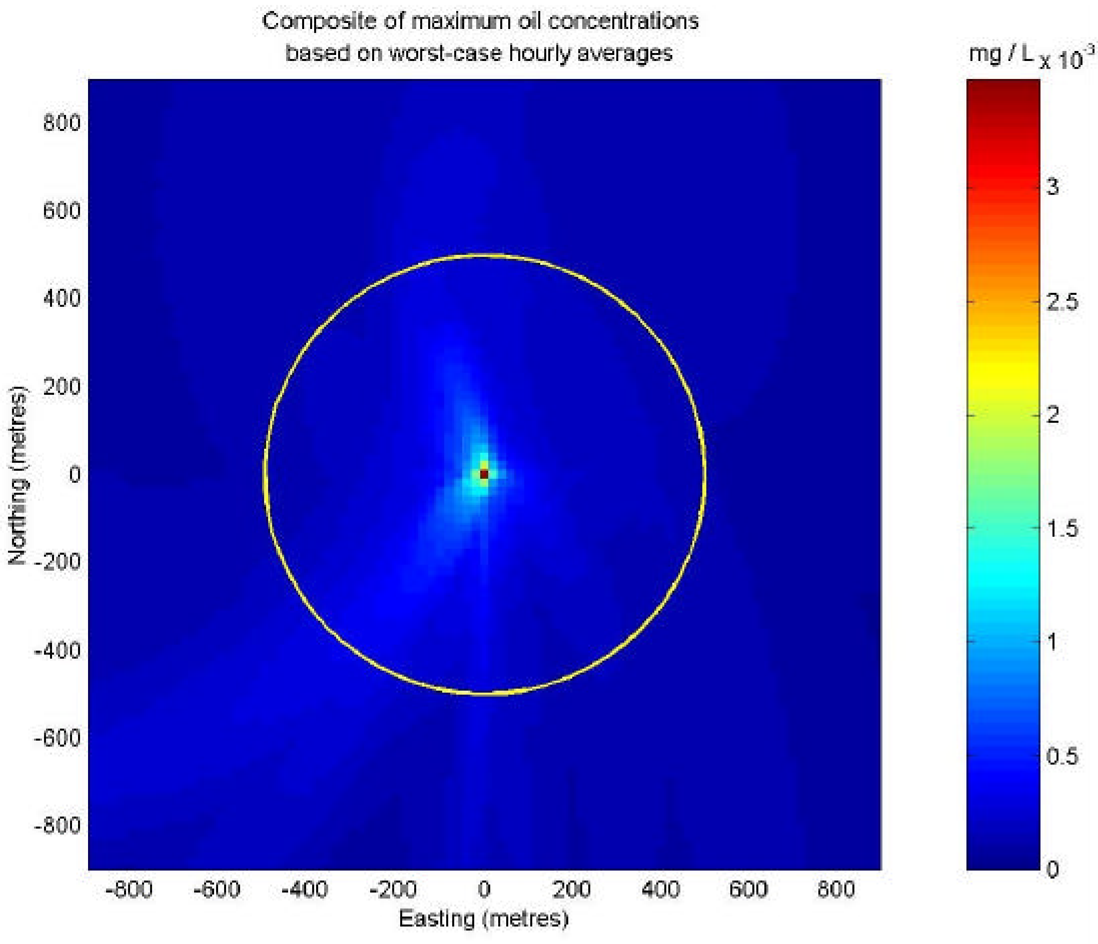


Figure 8 Produced Water Dispersion Modeling Results (assuming no plume surfacing or oil evaporation)

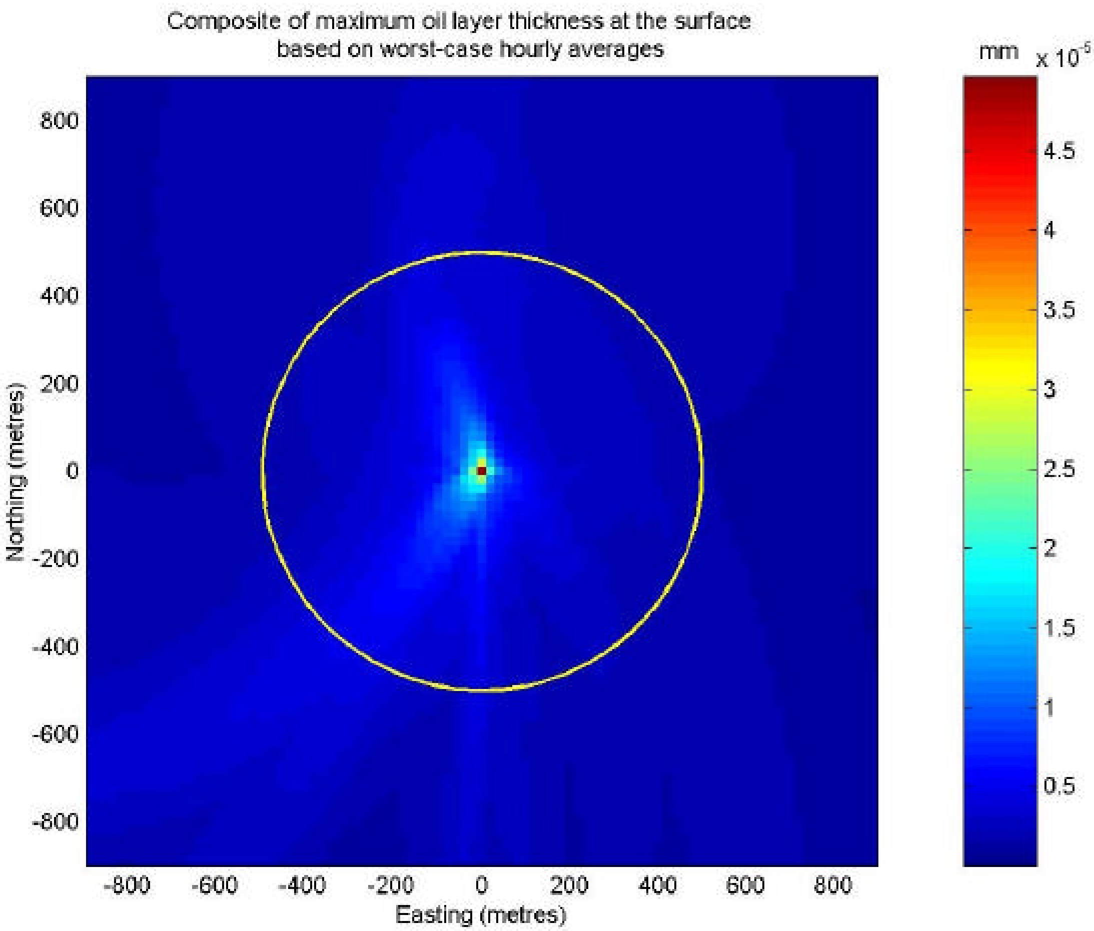


Figure 9 Produced Water Surface Layer Modeling Results (assuming worst case complete surfacing and no evaporation)

APPENDIX D

INFORMATION ON ENCANA'S PROPOSED ENVIRONMENTAL MANAGEMENT DOCUMENTS

TABLE OF CONTENTS

1 ENVIRONMENTAL MANAGEMENT PLAN

The Environmental Management Plan (EMP) for EnCana's Deep Panuke Project will be developed during the detailed engineering phase of the Project. The following information provides an overview of the EMP and a sample table of contents for reference purposes.

Purpose

The purpose of this document is to provide guidance for and document the approach to the implementation of environmental protection in accordance with the HSEMS. EnCana accepts its responsibility to protect the environment and to ensure that its operations are conducted with proper regard for environmental issues, and it recognizes that environmental impacts and risks must be properly identified and managed. EnCana is committed to the continual improvement of environmental performance in all of its operations. The EMP will document the identification of environmental issues and procedures in place to manage or mitigate these concerns, including responsibilities, training, legislative requirements, communication, and measuring and evaluating performance.

Scope

This document is applicable to all EnCana ECR operations, both offshore and onshore. All Company and third party personnel working within ECR will be required to adhere to the requirements of the EMP. The EMP addresses all potential environmental issues related to the Deep Panuke Project. It is a corporate umbrella document under which all other environmental protection and monitoring plans will be documented, evaluated and communicated.

Objectives

The primary objective of the EMP is to ensure that environmental risk is properly identified and managed and that any effects on the environment are mitigated, minimized and monitored.

HSE Management System

This document supports the implementation of Aims and Objectives detailed within each of the elements of EnCana's Operations Risk Management System, as applicable to environmental issues.

EMP Requirements

As part of the HSEMS, EnCana ECR has established procedures and processes to ensure that all operational activities are carried out in accordance with the following environmental management requirements:

- adherence to a defined environmental policy;
- compliance with legislation;
- identification of potential environmental issues and impacts, and establishment of environmental objectives;
- establishment of an EMP; and
- monitoring to achieve continual improvement in environmental performance.

Responsibilities

All EnCana personnel, whether a direct employee or a contractor, are responsible for environmental protection and for complying with the requirements of this document. The level of these responsibilities and the degree of involvement will differ depending on job function.

The Vice President of ECR is accountable for all EnCana activities and has overall responsibility for environmental issues. This responsibility is delegated throughout management and detailed responsibilities are assigned to appropriate Managers and Supervisors.

The Loss Management Coordinator is responsible for ensuring that the HSEMS is effectively communicated and implemented through ECR and their Contractors. Accordingly, the Loss Management Coordinator is responsible for ensuring that these procedures are maintained in line with appropriate legislation and HSEMS requirements.

Sample Table of Contents

1.0	INTRODUCTION
2.0	IDENTIFICATION, EXAMINATION AND EVALUATION OF ENVIRONMENTAL ASPECTS
3.0	SETTING OF ENVIRONMENTAL OBJECTIVES AND TARGETS
4.0	PREPARING ENVIRONMENTAL IMPACT ASSESSMENTS
5.0	PREPARING ENVIRONMENTAL PROTECTION PLANS
6.0	ENVIRONMENTAL PROTECTION AND MONITORING PLANS
7.0	COMMUNICATION AND COMPLAINTS PROCEDURE
8.0	MONITORING AND AUDITING
9.0	MANAGEMENT RECORDS AND REVIEW

2 ENVIRONMENTAL PROTECTION PLAN

The Environmental Protection Plan (EPP) for EnCana's Deep Panuke Project will be developed during the detailed engineering phase of the Project in consultation with regulators and key stakeholders. It will be developed to ensure the implementation of the many environmental commitments made by EnCana throughout the environmental assessment and permitting process. The following information provides an overview of the EPP and a sample table of contents for reference purposes.

Purpose

EnCana is ultimately responsible and accountable for all activities associated with the Deep Panuke Project. EnCana will implement environmental protection measures, which will be documented in an EPP, to mitigate potential impacts from its activities. The EPP will be updated over the life of the Project and will be consistent with the requirements of the CNSOPB's regulations and guidelines.

The EPP will include environmental protection procedures for general activities common to all phases in the Project lifecycle. The EPP will cover the following activities or phases: construction (offshore and onshore), drilling, production, and decommissioning. For some activities, such as construction (offshore and onshore), separate EPPs will be developed to provide clear and specific instruction and guidance to employees and contractors during these short term, but critical phases of project development. The EPP for decommissioning will be developed at a later date to ensure that protection measures comply with industry standards and best practices at that time.

Objectives

The EPP will be developed to provide detailed guidance, in particular for Project personnel (including contractors), on methods of eliminating or minimizing and mitigating adverse environmental effects from the Project. Specific objectives will be to:

- ensure that EnCana's commitments to minimize environmental impacts are met;
- document environmental concerns, applicable legislative requirements and appropriate protection measures;
- provide clear and specific guidance to employees and contractors regarding procedures for protecting the environment and minimizing environmental impact;
- provide a field-usable, reference document for personnel when planning and/or conducting specific activities;
- provide for appropriate training of employees/contractors;
- communicate changes in procedures through the specified revision process; and
- provide procedures for monitoring compliance with applicable regulations.

Scope

This document is applicable to all EnCana ECR operations, both offshore and onshore. All Company and third party personnel working within ECR will be advised to adhere to the requirements of the EPP. The EPP will be reviewed at least annually during the life of the Project to ensure its effectiveness.

HSE Management System

The EPP will be a practical document containing environmental protection requirements and will serve as an important tool in staff orientation and training, and an integral component of environmental inspection under EnCana's HSEMS.

Environmental performance will be reviewed throughout the life of the Project. The EPP will reflect the commitments that EnCana has made in the CSR and other DPA documentation, regulatory conditions of approval, and other regulatory requirements of the Project, and will be a critical tool in understanding and evaluating these commitments.

EPP Requirements

An important aspect of the EPP is Environmental Compliance Monitoring (ECM), which ensures compliance with all regulatory requirements and self-imposed environmental commitments. EnCana will use ECM to monitor performance standards developed for the Project. ECM will primarily involve monitoring for conformance with the discharge limits identified in the Offshore Waste Treatment Guidelines (OWTG) and targets set by EnCana.

ECM procedures will be clearly defined in the EPP including sampling protocols, responsibilities, requirements for training, and reporting. The plan will address routine and abnormal conditions and emergencies that can reasonably be anticipated. Specifically, the CNSOPB's *Nova Scotia Offshore Area Petroleum Production and Conservation Regulations* stipulate the development of a program to monitor the effects on the natural environment of routine operations of a production installation, and identification of the measures adopted to minimize or mitigate these effects. Compliance monitoring programs ensure that the composition of operational discharges is in accordance with the limits specified in the EPP.

The EPP is a comprehensive document that will also refer to several key distinct plans: Waste Management Plan, Chemical Management Plan, Spill Response Plan, Environmental Effects Monitoring Plan and the Fisheries Compensation Plan.

For the purposes of administration, two important aspects will be broken out into separate documents from the main EPP. The Onshore Constuction EPP and the Offshore Construction EPP will be employed during the construction phases of the Project and will be contractor specific documents to outline environmental protection measures required during installation. Once this construction phase is complete, these documents will no longer be required for ongoing operations.

The EPP will include EnCana's Codes of Practice for recognized special areas. These areas include Sable Island, the Sable Gully and Country Island. The intent is to provide a guide for the development and implementation of the Deep Panuke Project so that sensitive and valued local environments are protected. All EnCana personnel and its contractors must comply with this Code. For further detail on these Codes, refer to Appendix E of this CSR.

Responsibilities

To ensure the successful implementation of environmental protection procedures, the EPP will include a clear description of the roles and responsibilities of all employees having environmental responsibilities. This description will provide clear direction related to accountability, lines of communication and reporting relationships.

Sample Table of Contents

3 OFFSHORE CONSTRUCTION EPP

The Offshore Construction EPP for EnCana's Deep Panuke Project will be developed during the detailed engineering phase of the Project in consultation with regulators and key stakeholders. The following information provides an overview and sample table of contents for reference purposes.

Purpose

The Offshore Construction EPP is required to support the installation of the offshore section of the export pipeline and the facilities associated with wellhead platform (WHP), the production platform (PP), and the utilities and quarters platform (UQP).

This Plan is part of the overall Deep Panuke EPP, however it has been separated out for the purposes of administration. This is because this Construction Plan is activity- and contractor-specific and will not be required once the construction phase of the Project is complete.

Scope

The EPP will provide a strategy to mitigate any impacts on environmental resources through a planned approach and procedures to be carried out during the installation of the offshore platform and the pipeline. This plan will cover installations from the low tide mark in Bettys Cove to the offshore production facility: a distance of approximately 175 kilometres.

Objectives

The Offshore Construction EPP will be developed to provided detailed guidance, in particular for Project personnel (including contractors) on mitigating adverse environmental effects during the various operations required to install the offshore pipeline and associated facilities.

HSE Management System

The Offshore Construction EPP will be developed as per guidelines outlined in Section 5 "Preparing Environmental Protection Plans" of the EnCana Health, Safety and Environmental (HSE) Management Plan. The Offshore EPP is an integral component of the main EnCana EPP.

Offshore Construction EPP Requirements

The Offshore Construction EPP will be a practical, field-usable document, which will:

- outline EnCana's commitments, as described in the CSR, to minimize potential offshore environmental effects;
- summarize environmental issues and legislative requirements applicable to offshore project activities;
- provide concise and clear instructions to Project personnel (including Contractors) regarding measures for protecting the offshore environment and minimizing potential adverse effects to the offshore environment during the construction phase of the project;
- outline steps for compliance monitoring with applicable regulations; and
- provide a basis for environmental orientation and training programs for EnCana and Contractor personnel.

Responsibilities

To ensure the successful implementation of environmental protection procedures, the EPP will include a clear description of the roles and responsibilities of all employees having environmental responsibilities. This description will provide clear direction related to accountability, lines of communication and reporting relationships.

Sample Table of Contents

4 ONSHORE CONSTRUCTION EPP

The Onshore Construction EPP for EnCana's Deep Panuke Project will be developed during the detailed engineering phase of the Project in consultation with regulators and key stakeholders. The following information provides an overview of the Onshore Construction EPP and a sample table of contents for reference purposes.

Purpose

The Onshore Construction EPP is required to support the installation of the onshore section of the export pipeline and associated facilities. It is part of the overall Deep Panuke Environmental Protection Plan, however it has been separated out for the purposes of administration. This is because this Onshore Construction EPP is activity- and contractor-specific and will not be required once the construction phase of the Project is complete.

Note: Environmental surveys indicate that the pipeline can be routed to avoid stream crossings, wetlands, and species of concern. Preliminary observations indicate that abandoned gold mine shafts (from mining activities of the early-twentieth and late-nineteenth centuries) are debris- and water-filled and therefore not likely utilized as hibernicula for small brown bats. These findings will be confirmed after completion of a topographic survey and a detailed environmental survey of the pipeline ROW. There are no residential wells within 900 m of the ROW and there is a low risk of encountering acid-generating rock in the pipeline corridor. The EPP will reference the Erosion and Sedimentation Control Manual for Construction Sites and the *Sulphide Bearing Materials Disposal Regulations* and will include specific measures as determined by the features to be encountered over the pipeline route.

Scope

The Onshore Construction EPP will provide a planned strategy to mitigate any impacts on environmental resources through a planned approach and procedures to be carried out during the pipeline installation. The pipeline ROW is from the low tide mark in Bettys Cove to the hook up point with Maritime and Northeast Pipeline (M&NP): a distance of approximately 3.5 kilometres.

Objectives

The Onshore EPP will be developed to provided detailed guidance, in particular for Project personnel and contractors, on methods of mitigating adverse environmental effects during the installation of the onshore pipeline and associated facilities.

HSE Management System

The Onshore Construction EPP will be developed as per guidelines outlined in Section 5 "Preparing Environmental Protection Plans" of the EnCana HSE Management Plan. The Onshore Construction EPP is an integral component of the main EnCana EPP.

Onshore Construction EPP Requirements

The Onshore EPP will be a practical document, which will:

- outline EnCana's commitments, as developed through the environmental assessment and permitting process, to minimize potential onshore environmental impacts;
- summarize environmental issues and legislative requirements applicable to onshore project activities;
- provide concise and clear instructions to Project personnel (including Contractors) regarding measures for protecting the onshore environment and minimizing potential adverse effects;
- outline steps for compliance monitoring with applicable regulations; and
- provide a basis for environmental orientation and training programs for EnCana and Contractor personnel.

Responsibilities

To ensure the successful implementation of environmental protection procedures, the EPP will include a clear description of the roles and responsibilities of all employees having key environmental responsibilities. This description will provide clear direction related to accountability, lines of communication and reporting relationships.

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5 ENVIRONMENTAL EFFECTS MONITORING PLAN

The Environmental Effects Monitoring Plan (EEMP) for EnCana's Deep Panuke Project will be developed during the detailed engineering phase of the Project. The following information provides an overview of the EEMP. As detailed engineering and the regulatory process (and conditions of approval) have not yet been completed, it is premature to propose a complete EEMP to address potential impacts from the Deep Panuke Project. However, a sample table of contents has been provided to assist in the regulatory review process.

Purpose

EEM is conducted to test hypotheses built on effects predictions in the Environmental Impact Statement (EIS) and CSR and to verify the models used. EEM is also used to:

- assess the effectiveness of implemented mitigative measures;
- provide an early warning of changes in the environment;
- improve understanding of environmental cause and effect relationships; and
- prompt corrective action.

Through adaptive management, the EEM will detect and assess Project-induced changes in the environment, providing essential feedback to operational managers who can effect any necessary modifications to Project activities.

Scope

The EEMP will overview methods to effectively measure potential environmental effects between selected Project activities and valued ecosystem components. EnCana will develop these EEM methods in consultation with all appropriate stakeholders and regulatory authorities. The EEMP will cover all activities or phases of the Project, including construction (offshore and onshore), drilling, production, and decommissioning.

Objectives

The primary objective of the EEMP is to provide management and regulatory authorities the appropriate information to determine if the effects predictions set forward in the EIS are correct, or if further mitigative strategies are required.

HSE Management System

EnCana is committed to EEM for the Deep Panuke Project and believes that an effective EEMP is a critical component of the EnCana HSEMS. An effective EEMP will provide management with an early warning mechanism for any unforeseen environmental effects and provide direction for operational change or modification. An EEMP can also provide assurance to interested stakeholders of the extent of the predicted environmental effects and fulfil regulatory commitments for follow-up programs under *CEAA* and the CNSOPB.

The EEMP and the results will be continually reviewed over the life of the Project and will be publicly available to interested parties. The EEMP will also be an important aspect of EnCana and contractor staff orientation and training and performance review for the company.

EEMP Requirements

The first step in the development of an EEMP will be confirmation, through detailed engineering, of the Project activities that may interact with the environment. A literature review would then be conducted to determine potential methods for EEM that will best measure Project activities and their potential effects on the environment. Next, consultation with all appropriate stakeholders and regulatory authorities will be undertaken to determine key indicator species and technically and economically feasible methods to monitor them. It is important that all EEM designs are rigorously reviewed to ensure they are statistically sound and will provide results that can be used in the decision-making process.

Many of the EEM programs initiated by operators on the East Coast employ similar methods and have shown similar results. Part of the review of appropriate EEM methods would be to determine if these similar methods should be employed, or if new methods, providing a different focus, may add more value to the overall knowledge of EEM on the East Coast.

The EnCana EEM program will be designed to measure acute and chronic effects of discharges and emissions on key monitoring organisms over all phases of the Project (both short-term and long-term).

EnCana supports the establishment of a regional EEM mechanism and will endeavour to explore this when engaging in consultation with appropriate stakeholders and regulatory authorities. EnCana believes that a regional EEM mechanism is the best strategy to better understand the cumulative effects of oil and gas activities on the Scotian Shelf. EnCana also believes that by releasing environmental effects information into the public forum, advances in cumulative effects assessment will be greater than if individual operators work in isolation.

One example of this type of regional program is the oiled bird surveys conducted by resident independent zoologist (Z. Lucas) on Sable Island. EnCana has supported this program since 1993 and intends to continue supporting it throughout the Deep Panuke Project. EnCana has also committed to implementing a marine birds and mammal monitoring program to be undertaken by independent fisheries observers on Project facilities and vessels to ensure representative coverage of Project activities.

Responsibilities

To ensure the successful implementation, the EEMP will include a clear description of the roles and responsibilities for the development, implementation and reporting of EEM. This description will provide clear direction related to accountability, lines of communication and reporting relationships

Sample Table of Contents

6 PHYSICAL ENVIRONMENTAL MONITORING PLAN

Meteorological and oceanographic conditions will be monitored throughout the operational life of the project. Plans for this monitoring program will be described in the Physical Environmental Monitoring Plan (PEMP). This summary document gives a brief overview of the requirements of the PEMP and provides a sample table of contents. EnCana will consult with appropriate stakeholders and regulatory authorities for review and approval of the Deep Panuke PEMP prior to Project operations.

Purpose

The Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) *Guidelines Respecting Physical Environmental Programs during Petroleum Drilling and Production Activities on Frontier Lands,* April 1994 (Physical Environmental Guidelines) provide detailed descriptions of the measurement instrument specifications, calibration and reporting content and format requirements. These requirements will be followed for the Deep Panuke Project. The purpose of the PEMP is to provide the specifications for compliance with the Physical Environment Guidelines and to provide operational and design information to EnCana.

Objectives

The primary objective of the PEMP is to ensure that operational and design meteorological data is obtained, reported and archived from all of EnCana's offshore facilities.

Scope

This document is applicable to all EnCana East Coast operations, both offshore and onshore. All Company and third party personnel and facilities working within the East Coast Business Unit will be advised to adhere to the requirements of the PEMP.

PEMP Requirements

Meteorological and oceanographic sensors and instrumentation will be deployed or installed on the Deep Panuke facilities and interfaced to suitable terminals and signal processors, such that the data can be viewed and recorded to meet the reporting requirements. The instrument package will include the sensors to measure the following parameters:

- wind speed and direction;
- barometric pressure;
- air temperature (dry and wet bulb);
- dew point;
- relative humidity;
- sea surface temperature;
- wave height and period; and
- current direction and speed.

Meteorological data consisting of synoptic measurements and meteorological observations will be recorded and transmitted by platform personnel who are qualified in conducting these observations. The format for the observations is provided under the Manual of Marine Weather Observations (MANMAR), the Manual of Surface Weather Observations (MANOBS), and the Aviation Routine Weather Report (METAR – acronym is translated). Observations will be transmitted to shore in the formats specified for these observations.

These data will be transmitted to qualified weather forecasting services. In addition to the provision of site specific weather forecasts, the contract weather forecaster will compile the meteorological data and prepare the annual Meteorological Summary Report. These services must meet the specifications laid out in the Physical Environment Guidelines.

Responsibilities

To ensure successful implementation, the PEMP will include a clear description of the roles and responsibilities of all employees having key environmental responsibilities. This description will provide clear direction related to accountability, lines of communication and reporting relationships.

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7 WASTE MANAGEMENT PLAN

The Waste Management Plan (WMP) for EnCana's Deep Panuke Project will be developed during the detailed engineering phase of the Project. This plan will outline the various sources of waste that is generated during the Project phases and establish policies and procedures for the handling and reduction of waste. This plan will be consistent with the East Coast EHS Management System and with all applicable regulatory requirements, including Workplace Hazardous Materials Information System regulations and the *Transportation of Dangerous Goods Act*, and the Nova Scotia *Solid Waste Resource Management Regulations*. The following information provides an overview of the WMP and a sample table of contents for reference purposes.

Purpose

The purpose of the WMP is to describe the requirements for the control and management of waste by EnCana Corporation ECR and its third party contractors. Wastes include all waste streams leaving a facility as well as all identified waste products.

EnCana ECR has based it principles of waste management on continually striving to reduce the volume of wastes being generated and controlling concentrations of contaminants. The plan not only addresses applicable regulatory requirements but is also based on the Environmental Management System which EnCana ECR has developed to continually improve environmental performance based on best practices.

Objectives

The primary objective of this plan is to clearly identify all of the requirements for the control and management of waste throughout EnCana ECR operations. Wastes are controlled and managed in accordance with regulatory requirements and best practice.

The WMP will establish a performance management and control structure for waste management, comprising specific targets/objectives against which success of the program will be measured. Annual reports will be produced that clearly outline areas in which EnCana has met or exceeded its specified objectives and also identifying opportunities for continuous improvement. This plan, as well as subsequent annual reports, will be submitted to regulators for review prior to project start-up.

The overall aim is to reduce the volume of residual waste requiring disposal at each stage of the waste cycle, which is expressed as:

- **Reduction** Generate less waste through more efficient practices,
- **Reuse** Re-use waste materials in their original form,
- **Recycle** Convert waste back into a reusable material,
- **Recover** Extract material or energy from waste for other uses,
- **Treatment** Destruction, detoxification and/or neutralisation,
- **Residue** Efficient disposal of the remaining residues.

Scope

This document is applicable to all EnCana ECR operations, both offshore and onshore. All Company and third party personnel working within ECR will be advised to adhere to the requirements of the WMP.

HSE Management System

This document will be developed to support Element 4 (Operations and Maintenance) of EnCana's Operations Risk Management System. This Element states that a system shall be in place to track emissions and wastes to ensure regulatory requirements are met.

Waste Management Plan Requirements

EnCana ECR has adopted the policy of managing waste from cradle to grave. This means that EnCana ECR has adopted a "Duty of Care" by planning waste management activities in order to minimize risk to the environment and to the health and safety of individuals at all stages of the waste management process.

To comply with this policy, each Department/Site/Facility is required to set out its arrangements in a WMP to demonstrate how waste is managed (and tracked) at each stage of its life from generation to final disposal.

Responsibilities

All EnCana personnel, whether a direct employee or a contractor, are responsible for waste management and for complying with the requirements. The level of these responsibilities and the degree of involvement will differ depending on job function. For example, the VP Operations of ECR has overall responsibility for ensuring that all EnCana ECR personnel and nominated contractors adhere to the WMP for managing waste in line with current regulations.

The Loss Management Coordinator provides guidance and support to all EnCana ECR departments and operational facilities on the development of the plan. The Coordinator also initiates reviews and updates of waste management strategies to assist in ensuring compliance or adherence to EnCana ECR waste management standards and legal requirements, and ensures availability of suitable training programs for staff and third party contractors.

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- 1.1 Overview
- 1.2 Scope
- 1.3 Relevant Legislation and Guidelines
- 1.4 Waste Management Structure and Responsibility

2.0 WASTE MANAGEMENT PRINCIPLES AND OBJECTIVES
- 2.1 Waste Management Policy
- 2.2 Waste Management Objectives and Targets

3.0 WASTE CLASSIFICATION AND TRACKING
- 3.1 Waste Classification
- 3.2 Waste Tracking

4.0 STORAGE AND TRANSPORTATION
- 4.1 Predisposal Planning
- 4.2 Waste Segregation
- 4.3 Waste Transportation

5.0 TREATMENT AND DISPOSAL
- 5.1 Pretreatment
- 5.2 Treatment/Disposal Methods

6.0 PERFORMANCE MANAGEMENT AND CONTROLS
- 6.1 Communications
- 6.2 Document Data and Change Controls
- 6.3 Compliance Monitoring
- 6.4 Performance Management
- 6.5 Management Review

7.0 LITERATURE CITED

8 CHEMICAL MANAGEMENT PLAN

The Chemical Management Plan (CMP) for EnCana's Deep Panuke Project will be developed during the detailed engineering phase of the Project. The following information provides an overview of the CMP and a sample table of contents for reference purposes.

Purpose

The purpose of the CMP is to provide the policy and procedures for the safe and efficient management of chemical substances throughout EnCana Corporation ECR operations and to ensure compliance with legislation and regulatory guidelines (*e.g.*, Offshore Chemical Selection Guidelines (1999)).

The Offshore Chemical Selection Guidelines (OCSG) are intended to provide a consistent framework for chemical selection as part of the environmentally responsible management of chemicals used in offshore drilling and production activities. The OCSG are under the jurisdiction of the National Energy Board (NEB), the Canada-Newfoundland Offshore Petroleum Board (C-NOPB) and the CNSOPB. These Guidelines are applied in making decisions related to the selection of chemicals to be used in offshore drilling and production activities, and to the treatment and disposal of the chemicals selected.

EnCana ECR is committed to minimizing adverse environmental impact from the use and discharge of chemical substances throughout its operations. Where practicable and commercially viable, "environmentally friendly" chemical products will be used.

Scope

This document is applicable to all EnCana ECR operations, both offshore and onshore. All Company and third party personnel working within ECR will be advised to adhere to the requirements of the CMP.

Objectives

The objectives of the CMP are to establish and implement a Chemical Management System in support of all EnCana ECR operations. The specific objectives include the:

- identification of chemicals needed;
- selection process for chemicals to be used;
- establishment of WHMIS and TDG requirements for operations; and
- establishment of a Chemical Management Database to include:
    - chemical purchasing requirements;
    - transportation requirements;
    - chemical stock management;
    - chemical use/recycle;
    - safety considerations; and
    - chemical disposal.

HSE Management System

This document will be developed to support Element 4 (Operations and Maintenance) and Element 9 (Documentation) of EnCana's Operations Risk Management System (ORMS). Element 9 states that a system shall be in place to ensure that information on the potential hazards of materials involved in operations is in place and kept current.

CMP Requirements

EnCana ECR has adopted the policy of managing its selection and use of chemicals throughout its operations. This means that EnCana ECR has adopted a "Duty of Care" by planning all chemical-related work activities in order to minimize risk to the environment and to the health and safety of individuals at all stages of the chemical management process.

To comply with this policy, each Department/Site/Facility is required to implement the requirements of this Chemical Management Procedure to demonstrate that the use of chemicals is managed (and tracked) throughout their operation.

The chemical management process has been designed to ensure:

- the purchase, use, storage, transport and eventual disposal of chemicals, is carried out in a manner which prevents harm to people and the environment;

- Material Safety Data Sheets are provided to employees and contractor chemical users;
- risk assessments are carried out on chemicals prior to use and as part of the Task Risk Assessment process for work activities; these risk assessments are communicated to chemical user; and
- the training of chemical users is implemented for EnCana ECR employees and is assured for contractors working on EnCana ECR sites.

Responsibilities

To ensure the successful implementation of chemical management procedures, the CMP will include a clear description of the roles and responsibilities of all Project personnel (including contractors) who purchase, use, store, transport and disposal of chemicals. This description will provide clear direction related to accountability, lines of communication and reporting relationships.

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4.0	LEGISLATIVE REQUIREMENTS
5.0	CHEMICAL MANAGEMENT POLICY AND PROCEDURES
6.0	ROLES AND RESPONSIBILITIES
7.0	DEFINITIONS AND TERMINOLOGY
8.0	CHEMICAL MANAGEMENT DATABASE
9.0	REFERENCES

9 SPILL RESPONSE PLAN

EnCana is currently in the process of updating its Spill Response Plan for its exploration activities offshore Nova Scotia. This document will soon be forwarded to the CNSOPB and other applicable regulatory authorities for review and approval. EnCana intends to update this Spill Response Plan to ensure alignment with the Deep Panuke Project. The following information is an excerpt from this draft exploration Spill Response Plan.

Purpose

This plan provides guidelines to respond to spills that may result from oil and gas operations offshore Nova Scotia. Given the history of oil and gas activities offshore Nova Scotia, the most likely hydrocarbon products to be encountered are gas and condensate. However, this plan also makes provisions for Tier 1, 2 and 3 responses for crude oil spills. Spills that may occur from seismic programs in advance of drilling, as well as from development construction activities, are also covered by this plan. Spills of chemicals other than oil could also occur, however, this framework will still apply.

The spills that are most likely to occur are small operational spills of fuel and drilling fluids. Despite the small likelihood of a blowout involving gas and oil, provisions have been made in the Plan for response to such spills. This Plan presents a framework for spill response; it does not cover the environmental impact of potential spills. For each project, environment impact is covered in the project-specific Environmental Impact Assessment. This Plan will be continually updated as EnCana's operations evolve in Nova Scotia.

Scope

This document is applicable to all EnCana ECR operations, both offshore and onshore. All Company and third party personnel working within ECR should adhere to the requirements of the Spill Response Plan. The Plan will also outline EnCana's philosophy and strategies for spill response. The primary focus of the Plan will be on prevention; however it will also include initial response, contact information, training and exercises and regulatory reporting. The Plan will be compliant with EnCana's AERCP, and will also outline specific aspects of spill environmental effects monitoring.

Objectives

This contingency plan is designed to provide information that will:

- aid response team personnel in planning and conducting a safe, efficient, and effective response to a spill;

- describe the equipment and techniques that can be used to respond to the spill in the prevailing conditions; and
- describe the equipment and techniques that can be used to quantify the environmental effects of the spill.

HSE Management System

This document will be developed to support Element 10 (Emergency Preparedness) of EnCana's Operations Risk Management System.

Spill Response Plan Requirements

The plan comprises four main elements:

- background information on the potential spills and strategies for response;
- the response plan, which describes actions for mitigating the effects of a spill;
- an environmental monitoring plan, which describes actions for quantifying damage to the environment; and
- appendices containing supporting information, including reporting forms, contact lists, and available equipment.

The requirement to have a spill contingency plan for drilling programs in the waters off Nova Scotia is specified in the Nova Scotia Offshore Petroleum Drilling Regulations made under the Canada-Nova Scotia Atlantic Accord Implementation Act. The regulations require that the operator prepare a contingency plan to cope with any reasonably foreseeable emergency situation during a drilling program, including, among other possible events, spills of oil or other pollutants. Any such plans are to be readily accessible on each drilling installation and any accommodation installation.

In areas outside the drilling location, the *Canada Shipping Act* (CSA) governs the control of pollution from ships that support the drilling operation. All vessels of more than 400 GT must have in place a shipboard oil pollution emergency plan to operate in Canadian waters. The Canadian Coast Guard (CCG) (Rescue Safety and Environmental Response Directorate), a part of the Department of Fisheries and Oceans, is responsible for overseeing the preparation of plans for responding to oil spills from vessels.

The polluter is required to enact measures to respond to the incident and is expected to appoint an On-Scene Commander (OSC), who is responsible for directing the response according to a government-approved plan. Both the CNSOPB and the CCG have the responsibility of overseeing the response to ensure that it is implemented according to the plan and that it is as effective as possible. The CNSOPB is responsible for prevention and control of pollution from offshore exploration and production facilities, while the CCG is responsible for prevention and control of pollution from ships, in general.

Depending on the location and circumstances of the spill, a number of federal, provincial or local agencies may provide input into the response and deal with the effects of the spill. These agencies provide input to the spill response through the Regional Environmental Emergency Team (REET). The Regional Environmental Emergencies Coordinator (REEC), who is a representative of Environment Canada, coordinates the REET. The use of non-conventional oil spill response techniques, such as chemical dispersants or in-situ burning, requires prior approval from Environment Canada. Requests for approval are made through the REET and are considered on a case-by-case basis.

Responsibilities

To ensure the successful implementation of environmental protection procedures, the Spill Response Plan will include a clear description of the roles and responsibilities of all employees having responsibilities in this regard. This description will provide clear direction related to accountability, lines of communication and reporting relationships.

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10 ALERT/EMERGENCY RESPONSE CONTINGENCY PLAN

EnCana is currently in the process of updating its Alert/Emergency Response Contingency Plan (AERCP) for its activities offshore Nova Scotia. EnCana intends to update the AERCP to ensure alignment with the Deep Panuke Project. The following information is an excerpt from the AERCP.

Purpose

This AERCP has been developed to provide a suitable and consistent response to Emergency situations which may arise during the course of EnCana's operations. The AERCP provides consistency with the parent organization of EnCana by maintaining conformity with the Corporate Crisis Management Plan. The primary objective of contingency planning is to ensure the safety of Project personnel, of the public, and of the environment in which the Project operates. Contingency planning provides a system for quick communication of essential details in an emergency situation.

Scope

This document is applicable to all EnCana ECR operations, both offshore and onshore. All Company and third party personnel working within ECR should adhere to the requirements of the AERCP.

The AERCP provides emergency response command and control functions and makes provision for liaison with federal, provincial and municipal emergency response resources, should they be required. For specific construction activities, the contractor emergency response plans will be bridged to the AERCP to ensure consistency and effectiveness of response. The AERCP provides information on Levels of Alert, notification structure, key response team duties, Emergency Control Room (ECR) support teams, emergency telephone lists, and various forms and checklists. A current copy of the AERCP is on file with the CNSOPB.

The AERCP will be updated for the Deep Panuke Project in compliance with the CAPP "Guidelines for the Preparation of Emergency Response Plans" and CAN/CSA-Z731-95 "Emergency Planning for Industry". The contractor bridging documents will be a logical extension of the present plan and will evolve as the Project progresses through its lifecycle.

Offshore emergency considerations for the AERCP include:

- loss of well control;
- subsea pipeline breaks;
- platform incidents;

- hydrogen sulphide release;
- collision;
- marine incidents;
- aviation incidents;
- force majeure;
- fire/explosion;
- serious injury/fatality; and
- spills.

Onshore emergency considerations for the AERCP include:

- gas leak;
- fire/explosion;
- structural failure/damage;
- onshore flowline failure/damage; and
- evacuation (personnel and residents).

EnCana will also address site specific hazards and emergency situations during the life of the Project and develop Plans as required. One example of these Plans is EnCana's Spill Response Plan, which will be reviewed and updated for the Deep Panuke Project.

Objectives

The AERCP has been structured so as to provide a graduated, or staged, response when dealing with Emergencies - some of which provide limited warning of the impending situation and others which provide no warning at all. If some notice is given, the period between warning and the event's occurrence is referred to as the Alert stage. This Alert stage allows management and operations personnel alike to prepare for the impending state of danger and thus mitigate the potential negative impact. If the situation can be dealt with and resolved, then the Alert is cancelled and operations resume as normal.

HSE Management System

This document will be developed to support Element 10 (Emergency Preparedness) of EnCana's Operations Risk Management System.

AERCP Requirements

The AERCP outlines a plan to initiate and organize what must be done and by whom in order to reduce the adverse effects of the Emergency situation. An Alert may be declared in sufficient time to permit gathering of additional information and assessing alternative courses of action. This manual also provides for a smooth transition of actions and notification from an Alert response to an Emergency response in the event the situation develops into an Emergency. The response to an Emergency situation is therefore an extension and continuation of that for the Alert phase.

Responsibilities

To ensure the successful implementation of the AERCP, a clear description of the roles and responsibilities of all employees are outlined. This description will provide clear direction related to accountability, lines of communication and reporting relationships.

The manager's and supervisor's role is to co-ordinate and manage resources to obtain the maximum result for any time and effort expended. To this end, the AERCP provides guidance on when to declare an alert or emergency and a form of checklist for those personnel who must co-ordinate a response to an emergency situation during periods which may be highly stressful.

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11 FISHERIES COMPENSATION PLAN

The Fisheries Compensation Plan for EnCana's Deep Panuke Project will be developed during the detailed engineering phase of the Project and in consultation with the fishing industry. The following information provides an overview of the Plan and a sample table of contents for reference purposes.

Purpose

The purpose of this program will be to compensate fishing interests, fully and fairly, for any actual economic loss or damage as a result of EnCana Corporation's operations. The aim is to develop a program which will be fair, rapid and voluntary, enabling fishers to resume work as soon as possible, no worse and no better off than before the damage occurred.

EnCana's strategy is to prevent incidents by following a well-devised EPP that prevents or mitigates such occurrences. EnCana is also currently negotiating a Memorandum of Understanding (MOU) with Fishing Interests that makes reference to the Fisheries Compensation Plan.

The EnCana voluntary fisheries compensation program will be consistent with the provisions of "Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity" published jointly by the Canada-Newfoundland Offshore Petroleum Board and the CNSOPB, dated March, 2002.

Objectives

This program will be developed as an alternative to making a claim through the CNSOPB or the courts or other legal process and will be designed to allow potential claimants to have their claims evaluated expeditiously. Compensation will be a means of "last resort", only when other means of conflict resolution fail.

HSE Management System

This plan will be referenced in EnCana's EPP and EMP and underlies commitments that EnCana has made in the CSR and other DPA documentation.

Fisheries Compensation Plan Requirements

The Plan will outline the process that fishing interests will undertake when making a claim for compensation. An overview will be provided for the eligible claims and timelines associated with the process. Also, the Plan will overview an appeals process if the initial claim is rejected. Details of the Plan will be developed through consultation with fishing interests.

Responsibilities

The Fisheries Compensation Plan will include a clear description of the roles and responsibilities of all employees having key environmental responsibilities. This description will provide clear direction related to accountability, lines of communication and reporting relationships.

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12 DECOMMISSIONING PLAN

The Decommissioning Plan for EnCana's Deep Panuke Project will be developed prior to the decommissioning phase of the Project. The Plan will be based on review of relavant research, drawing strongly from North Sea experience, and existing regulatory requirements at the time of decommissioning. The Plan will be developed in conjunction with regulatory authorities and key stakeholders. The following information provides an overview of the Plan and a sample table of contents for reference purposes.

Purpose

The purpose of the Decommissioning Plan is to ensure that the decommissioning of the Deep Panuke Project is properly engineered, adequately risked and complies with all applicable regulatory requirements. Extensive engineering and documentation needs to be generated to ensure that the process flows smoothly and that the facilities removal takes place in a safe and environmental responsible manner. Although it is premature to create a complete Decommissioning Plan for the Deep Panuke Project, a sample table of contents is given to provide an overview of the document.

Objectives

The primary objective of the Decommissioning Plan is to outline the successful deconstruction of the Project in a safe and environmentally acceptable manner.

Scope

Decommissioning can be defined as the process which the operator of an offshore oil and gas installation goes through to plan, gain approval for and implement the removal, disposal or re-use of an installation when it is no longer needed for its current purpose. Decommissioning has been described as having four distinct stages:

- options are developed, assessed and selected and put through a detailed planning process that includes engineering, operational, health, safety and environmental reviews and risk screenings;
- production ceases, wells are safely abandoned and platforms are made safe for the start of deconstruction activities; and
- installations and associated equipment are removed, including restoration of the seabed.

Typically in a project the size of Deep Panuke, the decommissioning process is broken down into more manageable Phases (a two-phase example is shown below):

- Phase I consists of purging of residual hydrocarbons from the production platform, flushing and suspension of wells, capping of the pipeline, removal of stored chemicals and hazardous materials, installation of navigational aids and partial removal of non-critical equipment. The goal of Phase I is to turn the installation into a stand-alone, unmanned platform until Phase II can be implemented.

- Phase II consists of abandonment of production and injection wells, removal of the platforms via a heavy lift vessel, and post removal inspections of the seabed. A critical component of Phase II is waste management, with the goal being to minimize waste generated by reusing or recycling platforms, equipment, etc.

HSE Management System

This document will be developed to support Element 4 (Operations and Maintenance) of EnCana's Operations Risk Management System.

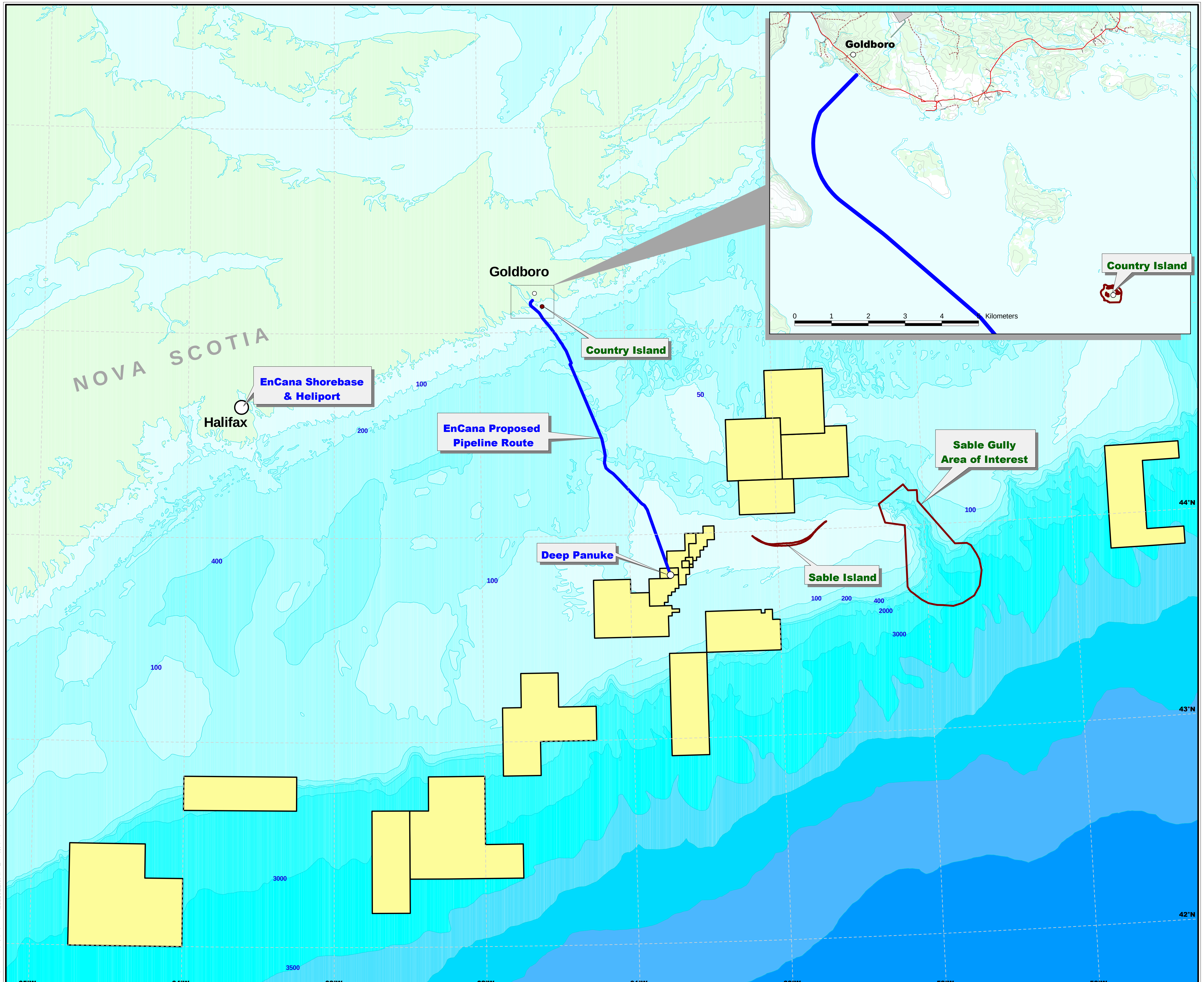
Responsibilities

The Decommissioning Plan will include a clear description of the roles and responsibilities of all employees having key environmental responsibilities. This description will provide clear direction related to accountability, lines of communication and reporting relationships.

Sample Table of Contents

APPENDIX E

ENCANA CODES OF PRACTICE FOR SABLE GULLY, SABLE ISLAND, and COUNTRY ISLAND



Codes of Practice Reference Map

EnCana-Operated Leases

N

0 25 50 75 100

Kilometres

Map Parameters
Projection: Universal Transverse Mercator (UTM)
Zone: 20
Datum: NAD 83
Scale: 1:2,000,000
Grid: Lat/Long 1°
Project No: NSD15999

ENCANA™

September 1st, 2002

EnCana Code of Practice for the Sable Gully

A. OVERVIEW

EnCana has developed, as part of its environmental protection planning, a Code of Practice to protect the uniqueness and integrity of the Sable Gully (see attached map). This Code is not a regulatory requirement and is indicative of EnCana's environmental stewardship philosophy and corporate policies. This Code of Practice applies to all EnCana-operated activities.

The Sable Gully is a large submarine canyon approximately 40km east of Sable Island on the edge of the Scotian Shelf. It is unique among canyons of the Eastern Canadian margin because of its depth, steep slopes and extension back into the continental shelf. It is thought to be an area of high productivity and important marine mammal habitat. Fifteen species of whales and dolphins have been identified in the area and eight of them are commonly found there. The Sable Gully also supports a resident population of approximately 280 Northern Bottlenose Whales.

The Federal Department of Fisheries and Oceans (DFO) has designated the core area of the Sable Gully as a Whale Sanctuary. DFO is also considering Marine Protected Area (MPA) status for a portion of this area, and the Canadian Parks Service has also identified the Gully as an area of future interest. The potential Sable Gully MPA is shown as the Sable Gully Area of Interest (AOI) on the map below.

B. DETAILS

As part of its environmental stewardship with respect to the Sable Gully:

EnCana will not conduct drilling or seismic operations inside the Sable Gully AOI. In addition, no vessels are permitted within the Sable Gully AOI and aircraft in regular transit to and from any vessels, drilling units, or facilities are restricted to flying at a height of at least 500m. These restrictions apply unless it is required for purposes of safety or safe operation of a vessel/aircraft or as part of an approved Environmental Monitoring Program.

EnCana will include discussion of this Code of Practice in its environmental awareness training program for employees and contractors. EnCana intends that this Code is a 'living document' and will review and update it as required. The Code of Practice will also be publicly available on the EnCana Corporation web site (www.encana.com).

Original signed by

Larry LeBlanc

Senior Vice-President, East Coast Region

September 1st, 2002

EnCana Code of Practice for Sable Island

A. OVERVIEW

EnCana has developed, as part of its environmental protection planning, a Code of Practice to protect the uniqueness and integrity of Sable Island (see attached map). This Code of Practice is intended to protect the sensitive environment of Sable Island and its Valued Ecosystem Components. This Code is not a regulatory requirement and is indicative of EnCana's environmental stewardship philosophy and corporate policies. This Code of Practice applies to all EnCana-operated activities.

Sable Island is approximately 41km in length and is located 290km southeast of Halifax. The Island is composed of sand and is the only emergent portion of the Sable Island Bank. It supports a fragile ecosystem consisting of diverse flora and fauna; the best known components being the feral horses, seal population and the rare Ipswich Sparrow.

Access to Sable Island is regulated under the legislative mandate of Department of Fisheries and Oceans through the Canada Shipping Act. It is also protected under Environment Canada regulations, specifically the Migratory Birds Convention Act. Recently, the Sable Island Preservation Trust assumed responsibility to maintain the existing infrastructure and operations on Sable Island, ensure a human presence on the island and ensure long-term conservation of the Island's ecosystem. The Trust is a non-profit, charitable organization, which has been supported financially by EnCana since inception.

EnCana recognizes the importance of Sable Island in its emergency response preparedness for its offshore operations. Due to the proximity of the Island to its operations, EnCana has established emergency facilities and a helicopter refueling station to support an emergency response. EnCana will maintain these facilities to ensure compliance with all applicable standards and will request periodic audits of the facilities by Sable Island Trust personnel.

B. DETAILS

As part of its environmental stewardship with respect to Sable Island:

EnCana will not conduct drilling or seismic operations within 2km (1 nautical mile) of Sable Island. All EnCana activities on Sable Island must receive approval from EnCana senior management and the Sable Island Station Manager and will comply with all applicable guidelines, including the 1992 Canadian Coast Guard Visitors Guidelines.

EnCana vessels and aircraft are not permitted within 2km (1 nautical mile) of the Island. However, this restriction does not apply for purposes of safety or safe operation of a vessel or aircraft, for access required as part of an approved Environmental Monitoring Program, for maintenance of EnCana's emergency facilities on the Island or for special trips approved by the Station Manager.

EnCana will include discussion of this Code of Practice in its environmental awareness training program for its personnel and provide orientation for its visitors to the Island. EnCana intends that this Code is a 'living document' and will review and update it as required. The Code of Practice will also be publicly available on the EnCana Corporation web site (www.encana.com).

Original signed by

Larry LeBlanc

Senior Vice-President, East Coast Region

September 1st, 2002

EnCana Code of Practice for Country Island

A. OVERVIEW

EnCana has developed, as part of its environmental protection planning, a Code of Practice to protect the uniqueness and integrity of the Roseate tern colony of Country Island (see attached map). While the focus is on Country Island, the Code will also serve to protect nearby seabird colonies. This Code is not a regulatory requirement and is indicative of EnCana's environmental stewardship philosophy and corporate policies. This Code of Practice applies to all EnCana-operated activities.

Country Island is a 19 ha island, located approximately 8km offshore from Drum Head, Nova Scotia (45º06'N, 61º32'W). The Island hosts a sizeable breeding colony of Common and Arctic Terns and has provided a nesting opportunity for the threatened Roseate Tern (*Sterna dougallii*) for many years. The Roseate is the tern species most at risk in northeastern North America, with only 87-137 pairs breeding annually in Canada. The Island has been one of the few remaining Canadian breeding sites for this species.

There are currently no formal restrictions on travel to Country Island, although the Canadian Wildlife Service (CWS) is considering a Migratory Bird Sanctuary designation for it. CWS is managing the Country Island Tern Restoration Program, in association with the Nova Scotia Department of Natural Resources. Dalhousie University researchers have also played a key role in conducting research at the colony and advising on strategies for the Restoration Program.

B. DETAILS

As part of its environmental stewardship with respect to Country Island:

EnCana will not fly over, disembark or approach within 2km of Country Island unless it is required for purposes of safety or safe operation of a vessel or aircraft or as part of an approved Environmental Monitoring Program. EnCana aircraft will follow the established pipeline corridor when transiting in the vicinity of Country Island.

EnCana will not conduct construction activities during the installation of the Deep Panuke pipeline in the vicinity of Country Island from May 1 to June 20 when roseate terns typically prospect for nests and lays eggs. EnCana will consult with CWS personnel to determine appropriate mitigation strategies and effects monitoring for activities occurring near the Island.

EnCana Corporation will include discussion of this Code of Practice in its environmental awareness training program for employees and contractors. EnCana intends that this Code is a 'living document' and will review and update it as required. The Code of Practice will also be publicly available on the EnCana Corporation web site (www.encana.com).

Original signed by

Larry LeBlanc

Senior Vice-President, East Coast Region

APPENDIX F

WATER QUALITY DATA

Table 1 Water Quality Parameters in Region of Project

Latitude	Longitude	Date	Sounding (meters)	Start Depth (meters)	End Depth (meters	Salinity no units	Temperature °C	O_2 uM	Silicate uM	Phosphate uM	Nitrate uM
43.725	-59.575	3-Dec-60	76	0	0	30.91	7	302			
43.725	-59.575	3-Dec-60	76	75	75	32.39	2.94	297			
44.7	-59.7	9-Jul-62	130	10	10	31.06	10.81			0.44	
44.7	-59.7	9-Jul-62	130	30	30	31.832	4.1	359		0.56	
44.7	-59.7	9-Jul-62	130	50	50	32.288	2.67	333		0.82	
44.7	-59.7	9-Jul-62	130	100	100	32.71	2.03	295		1.1	
44.22	-59.55	4-Oct-98		20	20				0.53	0.241	0.1
44.22	-59.55	4-Oct-98		6	6				0.47	0.226	0.05
44.15	-60.8833	27-Jul-70	40	0	0	31.529	17.91	252			
44.15	-60.8833	27-Jul-70	40	20	20	31.709	8.85	308			
44.15	-60.8833	27-Jul-70	40	30	30	31.837	7.85	299			
44.15	-60.8833	27-Jul-70	40	35	35	31.847	7.83	297			
44.55	-61.1	27-Jul-70	103	10	10	31.033	17.56	255			
44.55	-61.1	27-Jul-70	103	20	20	31.499	12.5	299			
44.55	-61.1	27-Jul-70	103	50	50	32.345	4.24	304			
44.55	-61.1	27-Jul-70	103	100	100	33.134	4.69	234			
44.1	-61.05	29-Aug-70	57	0	0	31.18	18.4	250			0.8
44.1	-61.05	29-Aug-70	57	10	10	31.22	18.39	274			1
44.1	-61.05	29-Aug-70	57	20	20	31.27	17.84	251			0.8
44.23283	-59.54816	27-Oct-99		150	150				12.94	1.182	14.46
44.23283	-59.54816	27-Oct-99		100	100				12.47	1.151	11.92
44.23283	-59.54816	27-Oct-99		70	70				10.9	1.084	10.63
44.23283	-59.54816	27-Oct-99		50	50				7.74	0.935	8.21
44.23283	-59.54816	27-Oct-99		40	40				4.63	0.712	4.77
44.23283	-59.54816	27-Oct-99		35	35		11.3				
44.23283	-59.54816	27-Oct-99		30	30				2.01	0.336	0.31
44.23283	-59.54816	27-Oct-99		20	20		12.3				
44.23283	-59.54816	27-Oct-99		10	10				1.98	0.322	0.34
44.23283	-59.54816	27-Oct-99		10	10		12.3				
44.23283	-59.54816	27-Oct-99		1	1				1.84	0.312	0.28
44.18	-60.73333	16-Jun-76	50	0	0	31.437		331	6.3	0.34	0.24
44.46667	-61.01667	16-Jun-76	90	3	3	31.314		331	3.75	0.46	0.04
44.46667	-61.01667	16-Jun-76	90	11	11	31.305		330		0.26	0.08
44.46667	-61.01667	16-Jun-76	90	19.5	19.5	31.317		331	0.83	0.28	0.18
44.46667	-61.01667	16-Jun-76	90	36	36	31.601		356	3.45	0.37	0.68
44.46667	-61.01667	16-Jun-76	90	51	51	32.097		332	3.6	0.72	4.2
44.225	-60.075	18-Jun-76	172	0	0			317	0.7	0.31	0.09

Table 1 Water Quality Parameters in Region of Project

Latitude	Longitude	Date	Sounding (meters)	Start Depth (meters)	End Depth (meters	Salinity no units	Temperature °C	O_2 uM	Silicate uM	Phosphate uM	Nitrate uM
44.225	-60.075	18-Jun-76	172	10	10			317	1.5	0.29	0.05
44.225	-60.075	18-Jun-76	172	75	75			317	3.3	0.58	2.4
44.225	-60.075	18-Jun-76	172	150	150			247	10.24	1.1	12.6
43.8833	-61.2333	20-Jul-76	52	0	0	31.683	16.23	362			
43.8833	-61.2333	20-Jul-76	52	10	10	31.677	16	380			
43.8833	-61.2333	20-Jul-76	52	30	30	32.03	6.91	415			
43.8833	-61.2333	20-Jul-76	52	49	49	32.391	5.68	420			
44.76667	-59.96667	26-Apr-73	228	12	12	31.371		367.1			
44.76667	-59.96667	26-Apr-73	228	44	44	31.644		370.7			
44.76667	-59.96667	26-Apr-73	228	196	196	32.789		378.3			
43.916	-59.916	30-Nov-78		0	0	30.644	10.3				
43.916	-59.916	30-Nov-78		0	0	30.526	10				
43.916	-59.916	30-Nov-78		0	0	30.549	9.6				
44.7	-59.83333	10-Jun-79	82	1	1	31.803					
44.7	-59.83333	10-Jun-79	82	10	10	31.808					
44.7	-59.83333	10-Jun-79	82	20	20	32.121					
44.7	-59.83333	10-Jun-79	82	30	30	32.251					
44.7	-59.83333	10-Jun-79	82	50	50	32.469					
44.7	-59.83333	10-Jun-79	82	75	75	32.785					
44.77667	-59.92	2-Jul-85	250	0	0	31.516			0.35	0.385	0.02
44.77667	-59.92	2-Jul-85	250	25	25	31.826	6.253		0.7	0.395	0.06
44.77667	-59.92	2-Jul-85	250	50	50	32.198	2.086		2.27	0.615	2.28
44.77667	-59.92	2-Jul-85	250	100	100	33.164	3.494		6.3	0.97	9.25
44.77667	-59.92	2-Jul-85	250	200	200	33.572	4.809		8	1.045	11.06
44.77667	-59.92	2-Jul-85	250	239	239	33.814	5.344		7.31	1	10.26
44.12667	-60.305	2-Jul-85	105	0	0	31.663			0.34	0.4	0.22
44.12667	-60.305	2-Jul-85	105	10	10	31.667	8.808		0.3	0.38	0.21
44.12667	-60.305	2-Jul-85	105	25	25	31.76	7.091		0.56	0.395	0.48
44.50167	-60.64167	3-Jul-85	44	25	25	31.807	5.169		1.84	0.485	1.35
44.50167	-60.64167	3-Jul-85	44	40	40	31.821	5.04		1.89	0.52	1.51
44.83167	-60.94833	3-Jul-85	222	0	0	31.188			0.31	0.35	0.04
44.83167	-60.94833	3-Jul-85	222	214	214	33.477	5.216				
44.83167	-60.94833	3-Jul-85	222	50	50	32.017	1.271				
44.83167	-60.94833	3-Jul-85	222	10	10	31.196	8.604				
44.83167	-60.94833	3-Jul-85	222	10	10	31.424	8.604		0.4	0.37	0.03
44.83167	-60.94833	3-Jul-85	222	25	25	31.67	7.189		1.29	0.5	0.84
44.49833	-60.25167	19-Apr-88	137	1	1	31.225	1.437	371.1	2.09	0.505	2.47

Table 1 Water Quality Parameters in Region of Project

Latitude	Longitude	Date	Sounding (meters)	Start Depth (meters)	End Depth (meters	Salinity no units	Temperature ^{o}C	O_2 uM	Silicate uM	Phosphate uM	Nitrate uM
44.49833	-60.25167	19-Apr-88	137	25	25	32.212	1.137	355.5	2.12	0.495	2.86
44.49833	-60.25167	19-Apr-88	137	50	50	32.335	1.413	361.3	1.55	0.435	2.43
44.49833	-60.25167	19-Apr-88	137	125	125	32.811	1.618	308.6	7.19	0.86	8.97
44.49833	-60.25167	19-Apr-88	137	125	125	32.28	1.618				
44.49833	-60.25167	19-Apr-88	137	125	125	32.28	1.618				
44.635	-60.33167	19-Apr-88	185	30	30	31.916	0.471	383.6	1.61	0.46	1.83
44.635	-60.33167	19-Apr-88	185	70	70	32.133	0.67	356.4	3.38	0.53	3.56
44.635	-60.33167	19-Apr-88	185	140	140	32.64	1.337	305.5	6.75	0.76	7.15
44.635	-60.33167	19-Apr-88	185	160	160	32.662	1.469	302.3	9.62	0.995	10.1
43.85	-60.8767	27-Oct-94	44	38	38	31.13	9.092		2.9	0.602	2.06
43.85	-60.8767	27-Oct-94	44	1	1	30.566	11.191		1.23	0.379	
43.8502	-60.6603	27-Oct-94	39	32	32	30.649	10.456		1.36	0.382	0.22
43.872	-60.6278	27-Oct-94	30	30	30	30.809	10.053		1.84	0.436	0.68
43.895	-60.6283	28-Oct-94	41	35	35	30.773	10.108		1.8	0.457	0.7
43.895	-60.6283	28-Oct-94	41	20	20	30.573	10.795		1.46	0.399	0.26
43.895	-60.6283	28-Oct-94	41	1	1	30.437	10.777		1.29	0.385	0.09
43.9417	-60.6283	28-Oct-94	27	1	1	30.39	10.817		1.52	0.348	0.04
43.85	-61.1367	28-Oct-94	51	2	2	30.666	11.119		1.24	0.331	
43.8483	-60.6333	26-Oct-94	44	32	32	30.936	10.105		1.87	0.426	0.72
43.8483	-60.6333	26-Oct-94	44	20	20	30.782	10.356		1.52	0.376	0.36
43.8483	-60.6333	26-Oct-94	44	1	1	30.609			1.23	0.322	
43.8483	-60.64	27-Oct-94	40	20	20	30.783	10.361		1.67	0.405	0.45
43.8483	-60.64	27-Oct-94	40	1	1	30.586	10.946		1.33	0.365	
43.85	-60.6583	27-Oct-94	35	32	32	30.739	10.349		1.77	0.4	0.49
43.85	-60.7533	27-Oct-94		32	32	30.772	10.375		2	0.445	0.79
43.85	-60.7533	27-Oct-94		21	21	30.541	10.811				
44.4442	-59.5402	3-Jun-99		3	3				0.51	0.388	0.12
44.4745	-59.5685	3-Jun-99		3	3				0.56	0.37	0.1
44.4872	-59.5803	3-Jun-99	58	55	55				2.84	0.605	1.04
44.4872	-59.5803	3-Jun-99	58	30	30				2.63	0.568	1
44.4872	-59.5803	3-Jun-99	58	20	20				2.91	0.631	1
44.4872	-59.5803	3-Jun-99	58	10	10				1.8	0.473	0.56
44.436	-59.58	3-Jun-99		3	3				0.43	0.316	0.08
44.4195	-59.5798	3-Jun-99		3	3				0.48	0.367	0.1
44.4195	-59.5798	3-Jun-99	80	76	76				4.61	0.793	3.62
44.4195	-59.5798	3-Jun-99	80	31	31				3.09	0.631	1.39
44.4195	-59.5798	3-Jun-99	80	20	20				1.21	0.412	0.5

Table 1 Water Quality Parameters in Region of Project

Latitude	Longitude	Date	Sounding (meters)	Start Depth (meters)	End Depth (meters	Salinity no units	Temperature °C	O_2 uM	Silicate uM	Phosphate uM	Nitrate uM
44.4195	-59.5798	3-Jun-99	80	6	6				0.6	0.345	0.16
44.4077	-59.5802	3-Jun-99		3	3				0.44	0.309	0.1
44.3608	-59.5797	3-Jun-99		3	3				0.6	0.343	0.08
44.3608	-59.5797	3-Jun-99	176	179	179				15.26	1.156	14.86
44.3608	-59.5797	3-Jun-99	176	99	99				8.5	0.828	9.32
44.3608	-59.5797	3-Jun-99	176	50	50				3.79	0.677	3.3
44.3608	-59.5797	3-Jun-99	176	20	20				0.74	0.342	0.37
44.3608	-59.5797	3-Jun-99	176	11	11				0.77	0.379	0.24
44.3198	-59.5715	3-Jun-99		3	3				0.44	0.311	0.08
44.3198	-59.5715	3-Jun-99	133	130	130				11.8	1.119	13.11
44.3198	-59.5715	3-Jun-99	133	101	101				9.49	1.035	10.64
44.3198	-59.5715	3-Jun-99	133	51	51				2.41	0.533	2.63
44.3198	-59.5715	3-Jun-99	133	21	21				0.58	0.335	0.23
44.3198	-59.5715	3-Jun-99	133	5	5				0.65	0.355	0.22
44.3047	-59.5793	3-Jun-99		3	3				0.43	0.295	0.1
44.2835	-59.5798	3-Jun-99	146	141	141				10.9	1.044	12.17
44.2835	-59.5798	3-Jun-99	146	50	50				2.26	0.669	2.73
44.2835	-59.5798	3-Jun-99	146	20	20				0.75	0.344	0.23
44.2835	-59.5798	3-Jun-99	146	6	6				0.75	0.282	0.19
44.2835	-59.5798	3-Jun-99	146	3	3				0.49	0.335	0.22
44.2618	-59.5793	3-Jun-99		3	3				0.42	0.268	0.11
44.2433	-59.5785	3-Jun-99		3	3				0.44	0.274	0.09
44.2243	-59.578	3-Jun-99		3	3				1.78	0.41	0.24
44.204	-59.5793	3-Jun-99	194	191	191				15.98	1.252	15.79
44.204	-59.5793	3-Jun-99	194	20	20				0.41	0.167	0.29
44.204	-59.5793	3-Jun-99	194	10	10				0.48	0.226	0.21
44.204	-59.5793	3-Jun-99	194	5	5				0.68	0.297	0.22
44.187	-59.579	3-Jun-99		3	3				0.56	0.317	0.11
44.1547	-59.5803	3-Jun-99	105	95	95				8.14	0.868	8.13
44.1547	-59.5803	3-Jun-99	105	50	50				5.22	0.838	5.33
44.1547	-59.5803	3-Jun-99	105	31	31				0.81	0.414	0.54
44.1547	-59.5803	3-Jun-99	105	10	10				0.61	0.299	0.32
44.1537	-59.5415	3-Jun-99		3	3				1.71	0.309	0.22
44.0358	-59.5487	3-Jun-99		3	3				0.49	0.386	0.24
44.0327	-59.5747	3-Jun-99		3	3				0.45	0.366	0.26
44.0327	-59.5785	3-Jun-99		3	3				0.47	0.397	0.36
44.3	-60.46	3-Oct-98		95	95				10.36	1.138	9.46

Table 1 Water Quality Parameters in Region of Project

Latitude	Longitude	Date	Sounding (meters)	Start Depth (meters)	End Depth (meters	Salinity no units	Temperature °C	O_2 uM	Silicate uM	Phosphate uM	Nitrate uM
44.3	-60.46	3-Oct-98		74	74				9.7	1.127	8.99
44.3	-60.46	3-Oct-98		51	51				7.99	1.064	7.92
44.3	-60.46	3-Oct-98		23	23				0.56	0.261	0.06
44.3	-60.46	3-Oct-98		2	2				0.47	0.225	0.04
44.22	-59.55	4-Oct-98		214	214				12.92	1.242	15.99
44.22	-59.55	4-Oct-98		105	105				10.22	1.129	11.03
44.22	-59.55	4-Oct-98		84	84				8.49	1.068	9.18
44.22	-59.55	4-Oct-98		56	56				5.31	0.908	5.51
44.22	-59.55	4-Oct-98		35	35				1.91	0.529	0.24
44.31	-60.46	18-Apr-98		130	130				10.71	1.059	9.86
44.31	-60.46	18-Apr-98		100	100				9.36	0.999	8.8
44.31	-60.46	18-Apr-98		81	81				9.3	1.068	8.82
44.31	-60.46	18-Apr-98		61	61				6.46	0.901	6.72
44.31	-60.46	18-Apr-98		41	41				6.33	0.995	7.03
44.31	-60.46	18-Apr-98		20	20				0.27	0.418	0.07
44.31	-60.46	18-Apr-98		10	10				0.38	0.454	0.05
44.31	-60.46	18-Apr-98		6	6				0.27	0.428	0.15
44.23	-59.56	19-Apr-98		205	205				9.56	1.021	12.28
44.23	-59.56	19-Apr-98		150	150				9.68	1.065	12.91
44.23	-59.56	19-Apr-98		101	101				7.41	0.896	9.85
44.23	-59.56	19-Apr-98		62	62				6.11	0.832	7.02
44.23	-59.56	19-Apr-98		41	41				1	0.592	1.23
44.23	-59.56	19-Apr-98		21	21				0.37	0.361	0.06
44.23	-59.56	19-Apr-98		11	11				0.26	0.336	
44.23	-59.56	19-Apr-98		6	6				0.24	0.328	
44.83399	-60.27149	24-Jun-98		90	90				9.86	1.1	10.23
44.83399	-60.27149	24-Jun-98		80	80				6.56	0.98	7.96
44.83399	-60.27149	24-Jun-98		70	70				5.63	1.01	7.61
44.83399	-60.27149	24-Jun-98		60	60				2.61	0.88	5.03
44.83399	-60.27149	24-Jun-98		50	50				0.66	0.77	2.85
44.83399	-60.27149	24-Jun-98		40	40				0.28	0.53	0.64
44.83399	-60.27149	24-Jun-98		30	30				0.27	0.43	0.34
44.83399	-60.27149	24-Jun-98		1	1				0.23	0.31	0.35
43.916	-59.916	30-Nov-78		0	0	30.533	7.7				
43.872	-60.6278	27-Oct-94	30	15	15	30.757	10.41		1.69	0.416	0.48
43.9417	-60.6283	28-Oct-94	27	25	25	30.396	10.83		1.23	0.354	0.04
43.85	-61.1367	28-Oct-94	51	27	27	31.09	9.6		2.16	0.485	1.29

Table 1 Water Quality Parameters in Region of Project

Latitude	Longitude	Date	Sounding (meters)	Start Depth (meters)	End Depth (meters	Salinity no units	Temperature °C	O_2 uM	Silicate uM	Phosphate uM	Nitrate uM
43.8495	-60.63	26-Oct-94	41	40	40	31.019	9.603		1.94	0.45	0.84
43.85	-60.6583	27-Oct-94	35	17	17	30.689	10.516		1.55	0.402	0.31
43.85	-60.69	27-Oct-94	32	1	1	30.563	10.97		1.45	0.373	0.15
44.7	-59.7	9-Jul-62	130	20	20	31.518	7.3	343		0.46	
44.15	-60.8833	27-Jul-70	40	10	10	31.38	14.64	272			
44.55	-61.1	27-Jul-70	103	30	30	31.971	7.27	324			
44.1	-61.05	29-Aug-70	57	30	30	31.62	10.18	294			1.7
43.8833	-61.2333	20-Jul-76	52	20	20	31.749	10.94	415			
43.916	-59.916	30-Nov-78		0	0	30.588	7.7				
44.83167	-60.94833	3-Jul-85	222	100	100	32.763	2.157				
44.49833	-60.25167	19-Apr-88	137	75	75	32.389	1.332	351.9	2.48	0.515	3.38
44.635	-60.33167	19-Apr-88	185	1	1	31.875	0.854	395.7	1.15	0.425	0.92
44.635	-60.33167	19-Apr-88	185	175	175	32.708	1.548	300.6	7.81	0.9	8.09
43.8502	-60.6603	27-Oct-94	39	1	1	30.536	10.912		1.4	0.361	
43.8495	-60.63	26-Oct-94	41	20	20	30.991	9.717		1.79	0.407	0.69
43.85	-60.6583	27-Oct-94	35	1	1	30.591	10.949		1.3	0.361	0.03
44.7	-59.7	9-Jul-62	130	125	125	32.799	2.22	295		1.1	
44.55	-61.1	27-Jul-70	103	75	75	32.837	4.06	263			
44.18	-60.73333	16-Jun-76	50	45	45	31.684		330	1.65	0.43	1.07
44.46667	-61.01667	16-Jun-76	90	75	75	32.669		284	9.83	1.09	10.5
44.225	-60.075	18-Jun-76	172	100	100			280	6.75	0.86	7.84
44.76667	-59.96667	26-Apr-73	228	1	1	31.359		383.6			
44.49833	-60.25167	19-Apr-88	137	100	100	32.42	1.369	352.4	3.1	0.595	4.25
44.22	-59.55	4-Oct-98		25	25				0.54	0.26	0.05
44.23283	-59.54816	27-Oct-99		80	80				10.57	1.042	10
44.23283	-59.54816	27-Oct-99		20	20				2.16	0.36	0.36
44.18	-60.73333	16-Jun-76	50	25	25	31.507		328	1.35	0.37	0.4
44.225	-60.075	18-Jun-76	172	50	50			329	2.93	0.58	2.43
44.50167	-60.64167	3-Jul-85	44	10	10	31.582	6.787		1.02	0.415	0.37
44.83167	-60.94833	3-Jul-85	222	200	200	33.401	4.904		14.71	1.365	14.16
44.635	-60.33167	19-Apr-88	185	100	100	32.278	0.61	336.7	5.71	0.73	6.05
43.872	-60.6278	27-Oct-94	30	1	1	30.624	10.892		1.49	0.423	0.2
43.8495	-60.63	26-Oct-94	41	1	1	30.57	10.753		1.49	0.344	0.03
43.85	-60.69	27-Oct-94	32	30	30	30.736	10.41		1.93	0.437	0.73
44.4872	-59.5803	3-Jun-99		3	3				0.61	0.363	0.08
44.4872	-59.5803	3-Jun-99	58	5	5				0.88	0.342	0.22
44.204	-59.5793	3-Jun-99	194	50	50				2.36	0.641	2.76

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Table 1 Water Quality Parameters in Region of Project

Latitude	Longitude	Date	Sounding (meters)	Start Depth (meters)	End Depth (meters	Salinity no units	Temperature °C	O_2 uM	Silicate uM	Phosphate uM	Nitrate uM
44.1712	-59.5792	3-Jun-99		3	3				0.59	0.228	0.09
44.1547	-59.5803	3-Jun-99	105	21	21				0.52	0.327	0.25
44.036	-59.5362	3-Jun-99		3	3				0.5	0.283	0.12
44.3	-60.46	3-Oct-98		131	131				11.71	1.148	9.97
44.3	-60.46	3-Oct-98		34	34				3.23	0.712	2.57
44.22	-59.55	4-Oct-98		156	156				11.91	1.184	12.9
44.22	-59.55	4-Oct-98		45	45				2.19	0.665	1.59
44.83167	-60.94833	3-Jul-85	222	100	100	32.804	2.157		7.46	1.125	10.21
43.85	-60.7533	27-Oct-94		1	1	30.417	11.074		1.36	0.372	
44.7	-59.7	9-Jul-62	130	75	75	32.574	2.11	304		1.04	
44.23283	-59.54816	27-Oct-99		60	60				9.08	0.994	8.9
44.46667	-61.01667	16-Jun-76	90	0	0	31.306		310	0.83	0.47	0.06
44.225	-60.075	18-Jun-76	172	25	25			345	2.1	0.51	1.45
44.77667	-59.92	2-Jul-85	250	10	10	31.528	7.623		0.3	0.365	0.04
44.12667	-60.305	2-Jul-85	105	50	50	32.797	2.648		4.53	0.845	6.54
44.50167	-60.64167	3-Jul-85	44	0	0	31.357			0.3	0.37	0.06
44.49833	-60.25167	19-Apr-88	137	10	10	32.175	1.435	368.4	2.43	0.58	3.22
43.85	-60.8767	27-Oct-94	44	19	19	30.615	11.052		1.36	0.361	0.15
43.85	-61.1367	28-Oct-94	51	51	51	31.613	7.341		4	0.671	3.3
43.85	-60.69	27-Oct-94	32	16	16	30.64	10.79		1.56	0.386	0.36
44.4623	-59.5805	3-Jun-99		3	3				0.46	0.33	0.08
44.3843	-59.5807	3-Jun-99		3	3				0.29	0.217	0.1
44.3608	-59.5797	3-Jun-99	176	5	5				0.53	0.304	0.18
44.3198	-59.5715	3-Jun-99	133	10	10				0.68	0.331	0.32
44.2835	-59.5798	3-Jun-99	146	11	11				0.6	0.238	0.18
44.204	-59.5793	3-Jun-99		3	3				0.49	0.264	0.09
44.1547	-59.5803	3-Jun-99		3	3				0.27	0.162	0.07
44.034	-59.5688	3-Jun-99		3	3				0.4	0.333	0.32
44.3	-60.46	3-Oct-98		44	44				5.83	0.939	6.18
44.22	-59.55	4-Oct-98		66	66				6.38	0.977	6.9
44.23	-59.56	19-Apr-98		82	82				7.16	0.891	9.11
44.83399	-60.27149	24-Jun-98		100	100				10.09	1.13	10.45
44.83399	-60.27149	24-Jun-98		20	20				0.22	0.35	0.34
43.8483	-60.64	27-Oct-94	40	35	35	30.927	9.943		1.94	0.437	0.78
43.9417	-60.6283	28-Oct-94	27	12	12	30.391	10.828		1.21	0.353	0.05
44.23283	-59.54816	27-Oct-99		200	200				15.02	1.236	17.12
44.18	-60.73333	16-Jun-76	50	10	10	31.438		332	1.09	0.36	0.2

Table 1 Water Quality Parameters in Region of Project

Latitude	Longitude	Date	Sounding (meters)	Start Depth (meters)	End Depth (meters	Salinity no units	Temperature °C	O_2 uM	Silicate uM	Phosphate uM	Nitrate uM
44.83167	-60.94833	3-Jul-85	222	50	50	32.33	1.271		4.06	0.895	5.84
43.8502	-60.6603	27-Oct-94	39	20	20	30.639	10.698		1.55	0.372	0.16
43.85	-60.7533	27-Oct-94		16	16	30.556	11.096		1.8	0.38	0.24
44.4195	-59.5798	3-Jun-99	80	11	11				0.72	0.376	0.21
44.1757	-59.5803	3-Jun-99		3	3				0.53	0.353	0.08
44.2835	-59.5798	3-Jun-99	146	101	101				8.97	0.999	10.3
44.204	-59.5793	3-Jun-99	194	100	100				6.46	0.66	7.41
44.1547	-59.5803	3-Jun-99	105	6	6				0.64	0.315	0.23
44.3	-60.46	3-Oct-98		4	4				0.62	0.234	0.04
44.31	-60.46	18-Apr-98		51	51				7.54	1.036	7.94
44.23	-59.56	19-Apr-98		52	52				4.38	0.833	5.86
44.83399	-60.27149	24-Jun-98		10	10				0.24	0.32	0.36
44.12667	-60.305	2-Jul-85	105	90	90	33.531	4.6		7.63	1.14	10.81
44.4195	-59.5798	3-Jun-99	80	51	51				3.04	0.544	2.28
44.31	-60.46	18-Apr-98		31	31				1.97	0.792	3.8

Source: BIO Biochem Database 2002

Table 2 Concentrations of Major Ions in Seawater

Major Ion	Concentration (g/kg of water of 35.0 salinity)
Chloride	19.353
Sodium	10.76
Sulfate	2.712
Magnesium	1.294
Calcium	0.413
Potassium	0.378
Bicarbonate	0.142
Bromide	0.067
Strontium	0.008
Boron	0.004
Fluoride	0.001
Sources: Culkin 1965; Wilson 1975	

Table 3 Predicted Trace Metal Seawater Concentrations in the Deep Panuke Area

Trace Metal	Concentration (ug/l)
Arsenic	2
Barium	25
Cadmium	0.04
Chromium	0.4
Copper	0.3
Iron (total)	1.5
Lead	0.02
Manganese	0.3
Mercury	0.002
Molybdenum	1.1
Nickel	0.2
Vanadium	2
Zinc	1
Source: SOEP 1996a	

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Additions and Errata for the Deep Panuke Offshore Gas Development Comprehensive Study Report October 2002

These additions and errata form part of the Comprehensive Study Report, dated October 2002, for the Deep Panuke Offshore Gas Development.

Additions

Section 9 – Summary and Conclusions

Add the following to Table 9.1, Onshore Pipeline Routing and Construction, and RoW Management, Page 9-6:

- In selecting appropriate dust suppression techniques EnCana will comply with all applicable legislation.

Add the following to Table 9.1, Subsea Pipeline Routing and Construction, Page 9-6:

- In high energy areas characterized by fine sand, options for returning trenched material will be implemented if follow-up program results indicate that the material has not naturally backfilled the trench.
- For any material which is side cast during blasting to construct a trench, provision will be made to return the material to the trench.
- If horizontal directional drilling (HDD) is carried out, drill muds and cuttings will be collected on site. The drill mud will be recycled and cuttings will be disposed of onshore as required.
- A follow-up program that will allow verification of backfilling of material to trenches will be designed in consultation with Environment Canada.
- As the Project is further refined, and before construction, EnCana will provide details regarding subsea pipeline installation (including trenching, backfilling, HDD and blasting) to Environment Canada and verify provisions for management of sidecast material (if applicable) in order for Environment Canada to verify any disposal at sea requirements (if applicable).

Add the following to Table 9.1, Engineering Design, Page 9-8:

- No flame-retardant chemicals will be used in the firewater deluge system.
- Details on fire suppression systems (water-based or gaseous) and a review of impacts associated with the selected firewater deluge system will be included in the EPP.

Add the following to Table 9.1, Environmental Protection Planning and Environmental Performance, Page 9-10:

- Clearing will be undertaken, where feasible, outside of the March-to-August breeding season for most bird species.
- Results of the baseline terrestrial surveys carried out to date will be provided to Environment Canada by November 2002. EnCana will undertake a detailed habitat survey along the onshore pipeline route when the final routing has been determined. The survey will be designed in consultation with

Environment Canada and the results provided for review. Based on the results of these surveys, the Onshore EPP will be refined to incorporate applicable mitigation measures to reduce impacts on species of special conservation concern (species of special status).

- Flaring mitigation procedures will be included in the Offshore EPP. EnCana will review the Offshore EPP with Environment Canada.
- As part of its EPP, EnCana will implement environmental protection measures to mitigate potential impacts from Project activities, including the use of chlorine for the treatment of biological growth in cooling water.
- EnCana will limit activities undertaken within 22 km of Country Island between May 1st and June 20th to onshore pipelaying construction activities (including winch set-up) and nearshore small-diving and environmental-support vessel activities, subject to consultation with the Canadian Wildlife Service of Environment Canada (CWS).

Add the following to Table 9.1, Emission and Waste Management, Page 9-10:

- Activities undertaken at existing wharf and temporary construction facilities will be covered in the EPP, which will consider local and regional environmental issues. EnCana will ensure, through environmental site inspections, that the operation of existing wharf and temporary construction facilities meets the standards and requirements of EnCana's Environmental Management System.

Add the following to Table 9.1, Atmosphere Emissions, Page 9-11:

- The emissions from stationary combustion turbines will meet the CEPA Ambient Air Quality Guidelines and the Provincial Regulations for Ground Level Emissions.
- EnCana will discuss the final configuration of turbines with Environment Canada.
- EnCana will provide Environment Canada with an annual report of the greenhouse gas (GHG) emissions associated with the Deep Panuke Project and other EnCana operations in Nova Scotia and its offshore. Prior to construction of Deep Panuke, an appropriate reporting framework will be negotiated with Environment Canada taking into account the requirements that are then included in the National Pollutant Release Inventory. Information on how GHG emissions were calculated, including the assumptions and emission factors used, will be provided. The annual GHG report will include a review of changes in GHG emissions from previous years. Additionally, EnCana will prepare an annual corporate GHG action plan, including reduction targets and measures to achieve those targets. EnCana's GHG action plan will include all its Canadian operations, including Deep Panuke once in operation, and other operations in Nova Scotia and its offshore. EnCana will provide a copy of its corporate GHG action plan to Environment Canada on an annual basis. Measures to reduce GHG emissions from the Project will be included in the Environmental Protection Plan (EPP), as per the Offshore Waste Treatment Guidelines. EnCana will consult with Environment Canada during the development and implementation of the EPP, which will be updated as necessary to reflect reporting results and best management practices.

Add the following to Table 9.1, Monitoring and Follow-up Studies, Page 9-12:

- Independent observers have been contracted to provide observations of seabirds and marine mammals on EnCana's facilities and vessels. EnCana will consult with the CWS in regard to an appropriate follow-up program for identification and verification of predicted impacts on marine birds including provision of appropriate mitigation measures. EnCana's commitments to conduct marine bird surveys, and to develop and implement mitigation and follow-up programs (e.g., interactions of birds with lights, flares, and spills), will include consultation with the CWS in regard to the specific design elements set out in Environment Canada's October 9, 2002 review of the Addendum (Volume 1).

- The EnCana Spill Response Plan has been submitted to Environment Canada and DFO for review and comment. EnCana will put measures in place to manage small and large spills and resulting slicks. EnCana will ensure that the plan is acceptable to Regional Environmental Emergencies Team (REET) before construction commences. Based on consultations with Environment Canada, EnCana will ensure the spill response plan and other related management plans includes provisions for minimizing the potential for birds to be impacted by accidental releases and any resulting sheens or slicks.
- EnCana is committed to consulting with CWS on emergency response for dealing with oiled birds. EnCana employees and contractors will adhere to a CWS-approved protocol for handling injured or stranded birds on vessels and offshore platforms. EnCana acknowledges the Williams and Chardine (1999) protocol and potential permitting requirements.
- EnCana will continue to support oiled bird surveys on Sable Island.
- The follow-up monitoring program developed in consultation with the CWS will include identification and verification of potential effects of lighting and flaring activity and provision of appropriate mitigation measures.
- EnCana will consult with the CWS in regard to an appropriate follow-up program for identification and verification of predicted impacts on Roseate Terns; such consultation will include a consideration of the design elements set out in Environment Canada's October 9, 2002 review of the Addendum (Volume 1).
- EnCana will adhere to the provisions of the National Pollution Release Inventory (NPRI) for the project. In conjunction with the CNSOPB Offshore Chemical Selection Guidelines and its Waste and Chemical Management Plans, EnCana will strive to reduce or eliminate wastes and transfers of NPRI substances throughout the life of the Project.
- EnCana commits to consult with appropriate regulatory authorities with respect to EEM program design.
- Follow-up monitoring will include potential toxicity, fate and environmental effects of WBM and associated cuttings.
- Follow-up monitoring will include potential toxicity, fate and environmental effects of produced water. EnCana will conduct toxicity testing of organisms satisfactory to the CNSOPB Chief Conservation Officer as required under the OWTG with respect to produced water and in consultation with Environment Canada.
- Follow-up monitoring will include consideration of contaminant transport and resident organisms.

Errata

General

The Offshore Waste Treatment Guidelines (OWTG) citation throughout the CSR should be revised as (NEB *et al.* 2002).

Section 2 – Project Description

Section 2.2.4, Figure 2.7 should be revised to reverse the symbol for the PIPING ABOVE GROUND with the symbol for the PIPING BELOW GROUND.

Section 2.2.4, Figure 2.7. The dimensions of the onshore facilities should be revised to "50 m" in an east-west direction and "40 m" in a north-south direction.

Section 6 - Biophysical Assessment

Section 6.1.1.3, Page 6-2: Reference to "EnCana (2001b)" should be revised as "PanCanadian (2001c)". See Reference section for addition of this reference.

Section 6.1.2.5, Species at Risk, Page 6-26: Add the following text: "Based on CWS expert opinion, EnCana recognizes that the Ivory Gull, a migratory bird species of special concern (COSEWIC 2002), may also occur within the area influenced by the Project. The need to protect this species will be considered in all environmental management plans for the Project as applicable."

Table 6.7, Marine Related Birds, Page 6-34: Add the following text: "Ivory Gull".

Table 6.15, Page 6-67: The predicted maximum for the 24-hour SO_2 criterion should be revised as 300*. The associated percentage of criterion should be revised as 100*.

Section 6.3.8.8, Page 6-167: The first sentence should be revised as follows: "The environmental assessment investigated a pipeline corridor within which the pipeline, access road, and associated onshore facilities would be situated."

Section 7 – Socio-Economic Assessment

Section 7.2.4.1, Page 7-16: The last bullet on the page should be revised as follows: "the potential for Black Loyalist resources in and around Webbs Cove".

Section 9 – Summary and Conclusions

Page 9-2: The last sentence in the first paragraph should be revised as follows: "Regional and local economic benefits are presented in Section 7.3."

Table 9-1, Page 9-6: The second sentence on the page should be revised as follows: "The results will be forwarded to NSDEL (along with an application for Water Approval) and to the NEB.

Table 9-1, Page 9-12: Revise the 10th bullet as follows: "Prior to construction of the offshore pipeline, a seabed survey will be performed along the pipeline route and at the platform site to provide further data to mitigate effects on marine communities near Project facilities."

Section 10 – References Cited

Page 10-13: The reference for the Offshore Waste Treatment Guidelines (OWTG) should be revised as follows:

"National Energy Board (NEB), Canada-Newfoundland Offshore Petroleum Board (C-NOPB), and Canada-Nova Scotia Offshore Petroleum Board (CNSOPB). 2002. Offshore Waste Treatment Guidelines."

Add New Reference:

"PanCanadian. 2001c. Deep Panuke Project - Environmental Design Criteria, Design Data Book. Prepared by Seimac Ltd. and Coastal Ocean Associates Inc. November 2001."

Appendix D

Page D-3. Second paragraph, last sentence should be revised as follows: "The EPP will be updated over the life of the Project and will be consistent with the requirements of the CNSOPB's and NEB's regulations and guidelines."

Appendix E

Legend label on the Codes of Practice Reference Map should be revised as follows: "EnCana Operated Licences".