

# **Addendum to the Environmental Assessment of Petro-Canada's Jeanne d'Arc Basin 3-D Seismic Program**



**Prepared by**



**for**



**May 2007  
Project No. SA940-2**



**Addendum to the Environmental Assessment  
of Petro-Canada's Jeanne d'Arc Basin  
3-D Seismic Program**

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# 1.0 Introduction

This document is an addendum to the screening level Environmental Assessment (EA) of Petro-Canada's Jeanne d'Arc Basin 3-D Seismic Program (LGL Limited 2007) and it assesses the potential environmental effects of a wellsite geohazard survey program (the Project) proposed for the Jeanne d'Arc Basin by Petro-Canada (the Proponent). Petro-Canada proposes to undertake a wellsite geohazard survey in the Jeanne d'Arc Basin over the North Mara K-36 and Wild Cove B-27 wellsites, northwest of the Terra Nova development and within the Project Area defined in LGL Limited (2007; Figure 1.1). Petro-Canada anticipates that geohazard survey may begin as early as July 2007, and is expected to last 9-11 days. Further wellsite geohazard surveys may follow, within the Project Area, in 2008, 2009, or 2010.

## 1.1. Relevant Legislation and Regulatory Approvals

The Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB or the Board) requires that drilling operations are conducted in a safe manner and that an "application for Authority to Drill a Well (ADW) must be preceded or accompanied by documentation to show that the operator has investigated the immediate area of the proposed location to identify any possible hazards to drilling on the seafloor and during the drilling of the well prior to setting surface casing" (C-NOPB 2004). Legislation relevant to this EA addendum was summarized in Section 1.1 of LGL Limited (2007).

## 1.2. Contacts

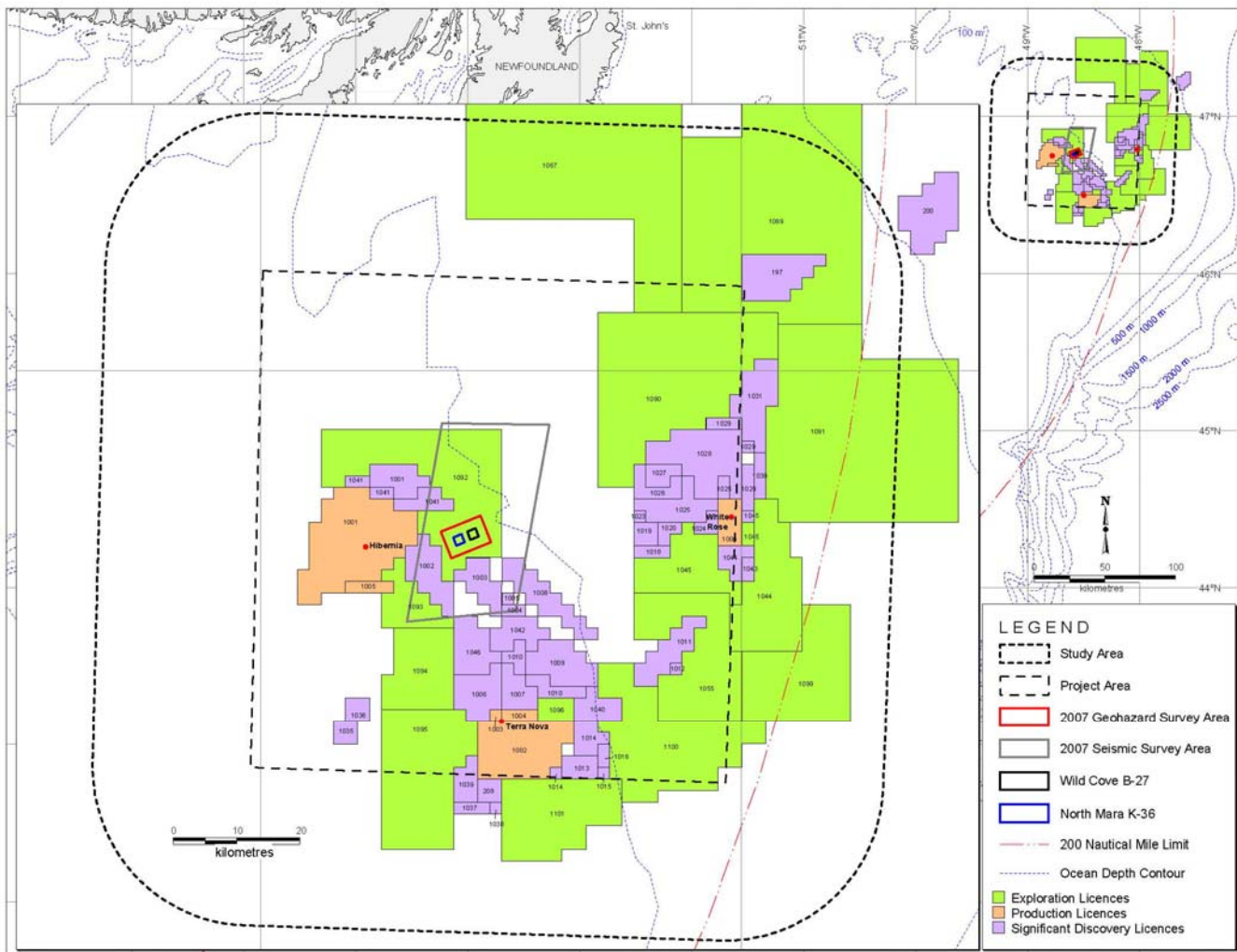
Relevant contacts at Petro-Canada for the wellsite geohazard program are the same as provided in Section 1.4 of the EA of Petro-Canada's Jeanne d'Arc Basin 3-D Seismic Program (LGL Limited 2007).

# 2.0 Project Description

## 2.1. Spatial and Temporal Boundaries

The *spatial boundaries* of the wellsite geohazard application covers the proposed North Mara K-36 and Wild Cove B-27 wellsites and is considered the same as the Project Area defined in LGL Limited (2007; see Figure 1.1). At present, the defined Project Area includes space to accommodate a geohazard (and seismic) vessel turning radius. The Study Area encompasses the Project Area and includes a 25 km buffer around that area.

The *temporal boundaries* of the proposed geohazard program are between 1 July and 31 December of 2007, and between 1 May and 31 December of 2008, 2009, or 2010. In 2007, it is estimated that the survey duration will be 9-11 days. It is possible that additional geohazard surveys may occur in 2008, 2009, or 2010.



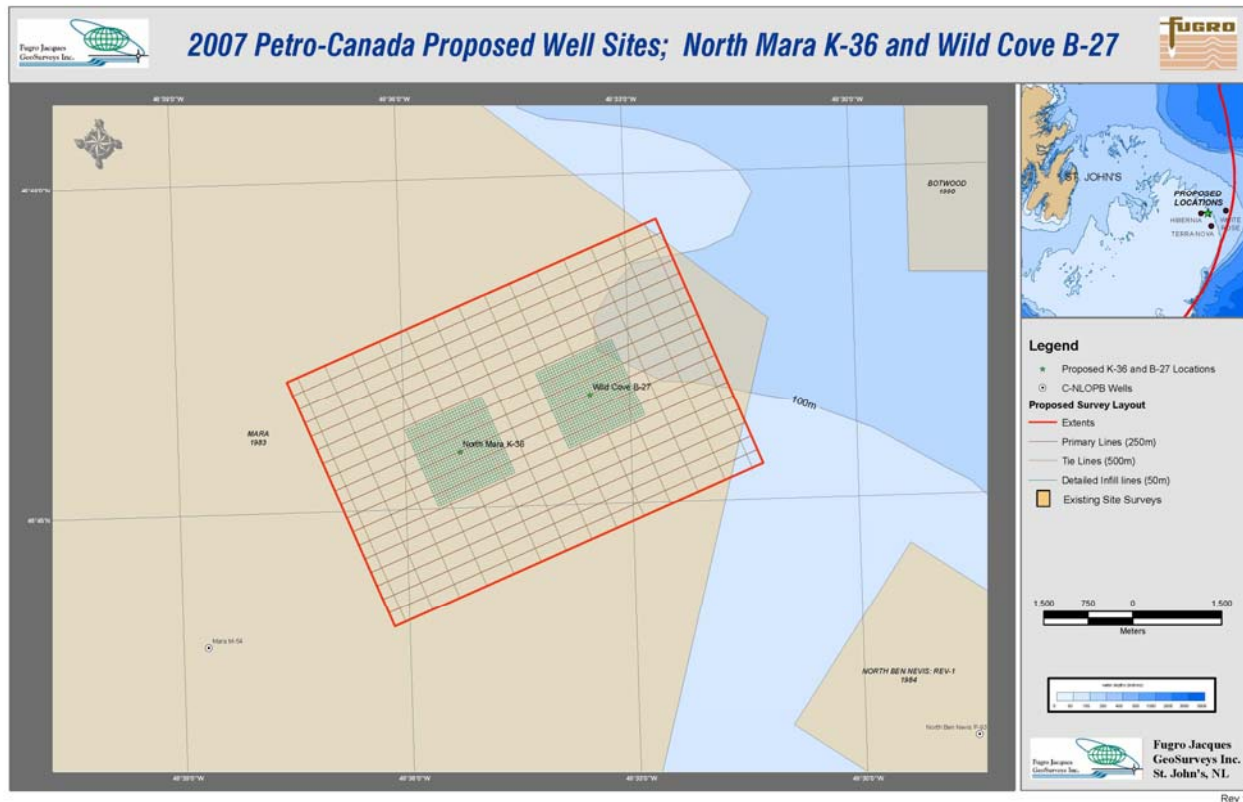
**Figure 2.1. Location of proposed wellsite geohazard survey for Petro-Canada’s 2007 program and the Seismic Survey, Project, and Study areas as defined in LGL Limited (2007).**

## 2.2. Project Overview

As shown in Figure 2.1, Petro-Canada’s approach for its proposed 2007 geohazard survey has been to define a single geohazard survey area which encompasses the two potential drilling locations, using a survey grid compatible with a geohazard survey for a semi-submersible drill rig (as per C-NLOPB Guidelines; C-NOPB 2004). The offset distance between the two wells (approximately 2.4 kilometres) permits maximum efficiency using this approach. In addition, the resultant primary survey line orientation (WSW-ENE) approximates the regional stratigraphic dip direction, which is an advantage for the interpretation of the seismic data.

In addition to the 250 m (primary) x 500 m (tieline) survey grid, two smaller infill surveys have been included around each of the two proposed wellsite locations. These infill surveys have been designed to permit potential drilling with a jack-up rig, should that drilling approach be selected. The line density shown in Figure 2.1 (50 m line spacing within at least 200 m of the well location) is in keeping with the





**Figure 2.2. Proposed geohazard survey area, including 250 m (primary) x 500 m (tieline) survey grid and detailed infill survey.**

C-NLOPB Guidelines. The size of these infill surveys has been increased from the specified minimum, as requested, to permit some degree of flexibility in final well location (up to +/-500 m at either location). During interpretation of the geohazard data, data from the infill surveys will be integrated into the larger suite of data, to permit a more regional assessment.

The proposed 2007 geohazard survey area has overall dimensions of approximately 4.4 x 6.8 km. The proposed line densities and lengths will equate with approximately 425 line km of survey (including infill surveys, and also including 500 metres of run-out on all lines). Petro-Canada anticipates that this program will take approximately 5.5 days to complete (including groundtruthing work) and that a total of 2.5 days will be required for transit and deployment / testing time. Depending on weather, the total duration of the 2007 field program will likely last from 9 to 11 days.

The proposed work would comprise a full suite geohazards investigation (used in several recent geohazards programs on the Grand Banks) intended to provide assurances of safe drilling conditions. Data will be acquired with a 96 channel multichannel seismic system, a Hunttec DTS sub-bottom profiler, digital side scan sonar system, multibeam echo sounder, magnetometer, and ground-truthing systems (seabed video and grab sample). It is anticipated that geohazard surveys potentially conducted in 2008-2010 would be similar in scope to the proposed 2007 program.

### **2.2.1. Objectives and Rationale**

Geohazard surveys are required to meet C-NLOPB and operator safety requirements (C-NOPB 2004). The objectives of the survey(s) are to identify any possible hazards to drilling on the seafloor and during the drilling of the well prior to setting surface casing.

### **2.2.2. Alternatives to the Project, Alternatives within the Project**

As the geohazard surveys are a regulatory requirement by the Board and a safety requirement for drilling operations, there is no alternative to them *per se*. Another alternative would be to not drill the well and thus forgo the energy and economic benefits that would accrue to Petro-Canada and partners, the province, and Canada. However, there are alternatives within the Project in the form of different types of survey equipment as described below. Viable alternatives within the Project are essentially the choices between different contractors' ships and survey equipment which are presently being evaluated through the bid evaluation process.

### **2.2.3. Project Scheduling**

The proposed survey may occur between 1 July and 31 December 2007. The duration of the survey is estimated at 9-11 days. Additional geohazard survey(s) may also occur in 2008-2010 (from 1 May to 31 December). It is unlikely that a geohazard program would occur in the same area and time as 3-D seismic surveys, given the potential for physical and acoustic interference between the two programs.

### **2.2.4. Site Plans**

Figure 1.1 shows the Project and Study areas and Figure 2.1 provides details of the site survey plans proposed for 2007. In 2007, it is anticipated that geohazard data will be acquired in a 30.5 km<sup>2</sup> area in EL 1092. There will be 17 primary survey lines oriented WSW-ENE and 14 tie lines oriented in the opposite direction. In addition to the (primary) 250 m x 500 m (tieline) survey grid, two smaller infill surveys have been included around each of the two proposed wellsite locations. The line density (50 m line spacing within at least 200 m of the well location) for the infill surveys is in keeping with the C-NLOPB Guidelines for potential use of jack-up rigs. The size of these infill surveys has been increased from the specified minimum, as requested, to permit some degree of flexibility in final well location (up to +/-500 m at either location).

### **2.2.5. Geohazard Vessel**

The survey work will be conducted from the MV *Anticosti* or *Maersk Placentia* or similar vessel. The *Anticosti* is a 54 m long offshore research vessel/tug owned by Cape Harrison Marine of St. John's. The survey vessel will employ the equipment utilized by Fugro-Jacques Geosciences (FJG) within eastern Canada over the past few years, and for recent Petro-Canada (2004), Hibernia (2005), and Husky (2005) geohazard programs. Total crew on board will likely be 12 (vessel), and 12 (technical), and one

environmental observer (EO)<sup>1</sup> for a total of 24-26 individuals. Vessels presently approved and operating on the East Coast on other offshore programs will be utilized. Vessel specifics will be provided once the contractors are selected. Most, if not all likely survey vessels have diesel-electric propulsion systems (main and thrusters) and operate on marine diesel.

## **2.2.6. Geohazard Survey**

The wellsite geohazard program will acquire high resolution seismic, side-scan sonar, sub-bottom profiler and bathymetric data over the proposed area. Survey speed will be on the order of four to five knots. The geohazard equipment is identical to those used in recent years for site survey work offshore Newfoundland for various operators (e.g., LGL Limited 2004; 2005a,b). From an operational perspective, the following text summarizes the acoustic sources to be used during surveying.

### **2.2.6.1. Seismic Data**

High-resolution multi-channel seismic data will be acquired with an airgun array with a total volume of 160 in<sup>3</sup>, a 96-channel streamer (6.25 m group and shot interval, 600 m active length), and a TTS 2+ digital recording system. Data will be acquired to two seconds depth, sampled at one millisecond.

The seismic source will be comprised of four airguns, each of 40 in<sup>3</sup> capacity. They will be deployed within a ladder array, approximately 30 m off the stern of the vessel, and at a depth of 3 m. The compressed air is provided by a diesel-powered compressor on deck. The maximum output from this array has a peak to peak value of 17.0 Bar metres. This equates to a source level (at 1 m) of 244.6 dB re 1µPa (peak to peak), or 238 dB re 1µPa (zero to peak). The *CEAA* identifies an output level of 275.79 kPa at a distance of one metre from the seismic energy source, as a criterion for inclusion in the list of activities requiring an EA. This is equivalent to a value of 228.69 dB//1µPa at 1 m. As such, the present acoustic source exceeds the defined threshold level (if considering instantaneous levels).

The streamer will be towed from the port quarter of the vessel. A tail buoy will be used, equipped with a radar reflector and strobe light. Total streamer length will be approximately 650 m.

### **2.2.6.2. Surficial Data**

***Huntec Deep Tow System.***—A Huntec Deep Tow System (DTS) will be deployed from the stern of the survey vessel, through an “A” Frame. This system has been proven to be the most effective at providing high resolution sub-bottom profiles from the Grand Banks. The system is towed within the water column, at a distance of between 20 and 40 m off the seabed. The system will be approximately 150 m behind the survey vessel (dependent on cable deployed, water depth and vessel speed).

The Huntec DTS uses a “broadband” boomer acoustic source, with frequency bandwidth from 500 Hz to 6 kHz. Power output is typically 500 Joules, but may be increased to 1 kJ if necessary. Rise time of the

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<sup>1</sup> If space availability aboard the geohazard vessel is limited, one of the ship’s crew trained in marine mammal and seabird identification and data collection protocols will perform the duties of an EO.

pulse is less than 0.1 millisecond. The boomer derived pulse is primarily restricted to a 60° cone. Maximum peak to peak amplitude is 221 dB re 1 µPa at 1 m.

**Side-scan Sonar.**—Seabed imagery, for the clearance survey, will be acquired with a digital, dual frequency (105 kHz and 390 kHz) side-scan sonar system. The sonar source level for 390 kHz is 216 dB re 1 µPa at 1 m (zero to peak) and for 105 kHz is 221 dB re 1 µPa at 1 m (zero to peak). The activation rate of the side-scan sonar is 3.3 times per second at 200 m range. The beamwidth is: horizontal, 1.2° and 0.5° for the 105 kHz and 390 kHz frequencies, respectively. A 50° arc is swept perpendicular to the survey transect. Data will be logged to tape and printed in hard copy for on-board assessment. Geo-referenced data will be utilized to create a digital side scan sonar mosaic for inclusion in survey reports.

**Echosounders.**—A Reson 8101 multi-beam echo sounder will be operated to acquire bathymetric data. Power output levels are similar to a typical echo sounder commonly used on the Grand Banks. The system operates at a frequency of 240 kHz and the source level is 207 dB re 1 uPa at 1 m (zero to peak) and its sounding rate may be ~4-6 times per second. The multibeam echo sounder covers 1.5° per beam and 101 beams cover a 150° arc perpendicular to the survey transect.

A single-beam echosounder will be operated to provide quality control of the data acquired from the multi-beam echosounder. The single-beam echosounder operates at 24 kHz and 200 kHz (dual frequency capable) and the source levels are 213 dB re 1 uPa at 1 m (zero to peak) and 209 dB re 1 uPa at 1 m (zero to peak) for 24 kHz and 200 kHz frequencies, respectively. The sounding rate of this source will be typically two times per second. The single-beam echosounder derived pulse is primarily restricted to a 9° (200 Hz) and a 24° (24 kHz) conical beam.

**Magnetometer.**—In the event that potential debris is identified by the side scan or multi-beam systems, a proton magnetometer will be utilized. This system is towed behind the vessel, 5-10 m above the seabed, and emits a low power electromagnetic field.

**Camera and Sediment Sampler.**—A camera system and sediment sampler will be deployed at a number of locations across the site, for the purposes of groundtruthing the geophysical data. Surficial sediment samples (of approximately 0.7 L in size) will be described on board by a geologist, and stored in sample bags for subsequent processing. The camera will be lowered to an elevation of 1 m or more above the seabed as the vessel drifts across the intended sites. A deployment arm will be mounted on the side of the vessel, as far forward (on the back deck) as possible.

## **2.2.7. Logistics and Support**

Petro-Canada and contractors maintain offices and shore facilities in St. John's. No new shore base facilities will be established as part of geohazard surveys.

## **2.2.8. Waste Management**

Waste management aboard the geohazard survey vessel will be managed in accordance with MARPOL and with Petro-Canada's East Coast Waste Management Plan. The contracted vessel policies and procedures that will be reviewed against the Petro-Canada Plan. Petro-Canada's East Coast Waste Management Plan is currently on file with the C-NLOPB. A licensed waste contractor will be used for any waste returned to shore.

## **2.2.9. Air Emissions**

Air emissions will be those associated with standard operations of the geohazard vessel. There are no anticipated implications for the health and safety of workers on these vessels.

## **2.2.10. Accidental Events**

In the unlikely event of the accidental release of hydrocarbons during the geohazard program, Petro-Canada and its geohazard contractor will implement the measures outlined in its Oil Spill Response Plan (TN-IM-EV03-X00-004) which is registered with the C-NLOPB. In addition, Petro-Canada has emergency response plans in place which will be bridged with the geohazard contractor's response plans prior to commencement of the geohazard program.

## **2.3. Mitigation**

Mitigation measures are detailed throughout the EA Addendum. The measures are reviewed and summarized in Section 5.8.

## **3.0 Physical Environment**

The physical environment of the Jeanne d'Arc Basin, which includes the Study Area, is described in Section 3 of the EA of Petro-Canada's Jeanne d'Arc Basin 3-D Seismic Program (LGL Limited 2007).

## **4.0 Biological Environment**

The biological environment of the Jeanne d'Arc Basin, which includes the Study Area, is described in Section 4 of the EA of Petro-Canada's Jeanne d'Arc Basin 3-D Seismic Program (LGL Limited 2007).

## **5.0 Effects Assessment Methodology**

Two general types of effects are considered in this document:

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

Details of the effects assessment methodology are described in Section 5 of the EA of Petro-Canada's Jeanne d'Arc Basin 3-D Seismic Program (LGL Limited 2007).

## **5.1. Scoping**

### **5.1.1. Consultations**

In preparation for Petro-Canada's proposed 2007 geohazard survey, Canning and Pitt Associates, Inc. consulted with relevant government agencies, representatives of the fishing industry and other interest groups. The purpose of these consultations was to describe the planned geohazard program, to identify any issues and concerns and to gather additional information relevant to the EA addendum report.

A short overview of the proposed program (see Appendix A) and a survey location map were sent to all agencies and groups via email in April 2007. The consultants asked each agency/group to review this information and to respond with any comments or concerns they might have about planned activities.

Consultations were undertaken with the following agencies and interest groups:

- Fisheries and Oceans
- Environment Canada
- Natural History Society
- One Ocean
- Fish, Food and Allied Workers Union (FFAW)
- Association of Seafood Producers
- Fishery Products International
- Groundfish Enterprise Allocation Council (Ottawa)
- Clearwater Seafoods
- Icewater Harvesting

Appendix B provides a list of agency and industry officials consulted.

#### **5.1.1.1. Issues and Concerns**

None of the fisheries industry firms and representatives (FPI, ASP, Icewater Harvesting) contacted raised any concerns or issues about the survey, nor did they feel it necessary to meet with Petro-Canada and its consultants. Icewater's representative stated that the proposed survey would not interfere with its 2007 offshore harvesting operations, and FPI managers noted that they would like to be kept informed about when the survey would be taking place. Representatives of One Ocean, the FFAW, GEAC and the Natural History Society did not provide any written or verbal response.

Environment Canada indicated that they would be reviewing further details and discussion of the planned survey when the department receives the EA Addendum.

DFO noted that Petro-Canada submitted an EA report last October for VSP work, but not for any geohazard work in the Terra Nova oilfield, and thus asked if this type of exploration work had been screened previously under CEAA prior to 2006. Managers said they would like to refer to previous EA documents dealing with these kinds of surveys in order to review any previous concerns raised by DFO. They also asked if the 2007 work would be taking place within the Terra Nova exclusion zone and, if not, to be assured that it would not be overlapping into fishing or research survey zones. The consultants subsequently responded to these questions and comments in a follow-up email.

## 5.2. Valued Ecosystem Components

The Valued Ecosystem Component (VEC) approach was used to focus the assessment on those biological resources of most potential concern and value to society. VECs are detailed in Section 5.2 of the EA of Petro-Canada's Jeanne d'Arc Basin 3-D Seismic Program (LGL Limited 2007).

## 5.3. Boundaries

For the purposes of this EA Addendum, the following boundaries are defined.

**Temporal**—the temporal boundaries of the Project are 1 July to 31 December in 2007 and 1 May to 31 December in subsequent years (2008 to 2010).

**Project Area**—the 'Project Area' is defined as the area where wellsite geohazard surveys (and 3-D seismic surveys) will occur plus an additional area around the outer perimeter of the data acquisition area to accommodate the ships' turning radii (see Figure 1.1). The '2007 Geohazard Survey Area' is the area where geohazard data will be acquired in 2007.

**Affected Area**—the 'Affected Area' varies according to the specific vertical and horizontal distributions and sensitivities of the VECs of interest and is defined as that area within which effects (physical or important behavioural ones) have been reported to occur. It is likely that in the present case virtually all potential effects will be confined within the Project Area.

**Study Area**—an area around the Project Area large enough to encompass effects reported in the literature.

**Regional Area**—the regional boundary is the boundary as defined in previous EAs such as Hibernia, Terra Nova and White Rose and is retained here for consistency.

## 5.4. Effects Assessment Procedures

The systematic assessment procedures of the potential effects of the proposed geohazard program are described in the EA of Petro-Canada's Jeanne d'Arc Basin 3-D Seismic Program (LGL Limited 2007).

## **5.5. Effects of the Environment on the Project**

The physical environment is described in Section 3 of the EA of Petro-Canada's Jeanne d'Arc Basin 3-D Seismic Program (LGL Limited 2007) and the reader is referred to this report to assist in determining the effects on the Project. Furthermore, safety issues are assessed in some detail during the permitting and program application processes. Potential effects of the environment on the proposed geohazard survey are similar in scope to the effects described for Petro-Canada's proposed 3-D seismic surveys (see Section 5.5 of LGL Limited 2007).

## **5.6. Effects of the Project on the Environment**

### **5.6.1. Ecosystem**

There will likely be *no significant effect (negligible at most)* of the Project on fish habitat components including water quality, plankton and benthos. Therefore, they are not discussed directly in this section. Plankton and benthos are discussed indirectly in relation to the fish VEC (e.g., ichthyoplankton and benthic fish and macroinvertebrates).

### **5.6.2. Fish and Invertebrates**

#### *Effects of Seismic on Fish and Invertebrates*

An overview of available information pertaining to the effects of exposure to seismic sound on fish and invertebrates, including the results of scientific studies of varying degrees of scientific rigor and anecdotal information is provided in Section 5.6.2 of the EA of Petro-Canada's Jeanne d'Arc Basin 3-D Seismic Program (LGL Limited 2007).

#### *Effects of Sonar on Fish and Invertebrates*

As indicated in Section 5.6.2 of the EA (LGL Limited 2007), most fish detect sounds with frequencies up to about 2 kHz (i.e., hearing generalists). However, some species, particularly clupeiform fish such as herring and shad, appear to detect sounds of much higher frequencies (up to 180 kHz in the case of American shad). These fish are referred to as hearing specialists. With respect to invertebrates, crustaceans appear to be most sensitive to frequencies below 1 kHz. Little information is available on the effects of ultrasound on fish and invertebrates. Available information pertains to behavioural effects only, not pathological or physiological effects.

Behavioural studies of responses of American shad (*Alosa sapidissima*) to ultrasound demonstrated that these fish show a graded series of responses depending on the received sound pressure level (SPL), and to a lesser degree, the frequency of the source sound (Plachta and Popper 2002 *in* Popper et al. 2004). The American shad exhibited negligible response to sounds below 160 dB re 1  $\mu$ Pa at any frequency. Received SPLs of 175 dB re 1  $\mu$ Pa at 30 to 120 kHz with stimuli of at least one second duration, the



shad showed mild reactions to the onset of the sound. Between 175 and 184 dB re 1  $\mu$ Pa at stimulus frequencies ranging between 70 and 110 kHz, the fish showed rapid and directional responses directly away from the sound source. At received SPLs above 185 dB re 1  $\mu$ Pa, the shad exhibited very rapid and random patterns of behaviours that resulted in some animals attempting to jump from the experimental tank. A field study by Wilson and Dill (2002) showed that Pacific herring (*Clupea pallasii*) reacted in a manner similar to that of the shad in the tank experiment. There is speculation that these responses to ultrasound evolved to help these fish, particularly shallow-water species, detect and avoid echolating cetacean predators.

Based on the frequency specifics of the ultrasound sources during the proposed geohazard survey, hearing generalist fish and crustaceans could potentially detect the sounds emitted by the Hunttec DTS. The lower frequency sounds emitted by the side scan sonar (i.e., ~100 kHz) could potentially be detected by hearing specialist fish.

### **5.6.3. Effects Assessment for Fish VEC**

The best approach when assessing the effects of the proposed geohazard program on the fish VEC is to use species that best represent the variability associated with crucial criteria considered during the assessment. It would also be most effective to assess the effects of geohazard on species that have been studied after exposure to sound sources used in geohazard programs. Snow crab and Atlantic cod are two species that appropriately serve just that purpose.

The criteria worth consideration in the assessment include (1) distance between the geohazard source and animal under normal conditions (post-larval snow crabs remain on bottom, post-larval cod occur in the water column, and larvae of both snow crab and cod are planktonic in upper water column), (2) motility of the animal (post-larval snow crabs much less motile than post-larval cod, and larvae of both are essentially passive drifters), (3) absence or presence of a swim bladder (i.e., auditory sensitivity) (snow crabs without swimbladder and cod with swimbladder), (4) reproductive strategy (snow crabs carry fertilized eggs at the bottom until larval hatch and cod eggs are planktonic), and (5) residency in the Project Area (i.e., year-round vs. seasonal) (snow crab are essentially permanent residents and cod are more temporary residents).

Potential impacts on other marine invertebrate and fish species may be inferred from the assessment using snow crab and Atlantic cod.

Potential interactions between the proposed geohazard survey program and the fish VEC are shown in Table 5.1.

#### **5.6.3.1. Physical Effects (Pathological and Physiological)**

As indicated in Section 5.6.2, there is a relative lack of knowledge of the physical effects of seismic sound, like would be emitted by the 160 in<sup>3</sup> array in the proposed geohazard program, on marine fish

**Table 5.1. Potential interactions between the proposed geohazard program and Fish VEC.**

VALUED ECOSYSTEM COMPONENT: FISH						
PROJECT ACTIVITIES	Feeding		Reproduction		Adult Stage	
	Plankton	Benthos	Eggs/Larvae	Juveniles <sup>a</sup>	Pelagic Fish	Groundfish
Vessel Lights	x		x		x	
Sanitary/Domestic Waste	x		x		x	
Air Emissions	x		x		x	
Garbage <sup>b</sup>						
Noise						
Geohazard Vessel					x	
Echo Sounder	x	x	x	x	x	x
Side Scan Sonar	x	x	x	x	x	x
Seismic Array	x	x	x	x	x	x
Boomer	x	x	x	x	x	x
Towfish	x	x	x	x	x	x
Presence of Geohazard Vessel					x	
Shore Facilities <sup>c</sup>						
Accidental Spills	x		x		x	
<b>OTHER PROJECTS AND ACTIVITIES</b>						
Hibernia	x	x	x	x	x	x
Terra Nova	x	x	x	x	x	x
White Rose	x	x	x	x	x	x
Exploration	x	x	x	x	x	x
Fisheries	x	x	x	x	x	x
Marine Transportation	x		x		x	x
<sup>a</sup> Juveniles are young fish that have left the plankton and are often found closely associated with substrates. <sup>b</sup> Not applicable as garbage will be brought ashore. <sup>c</sup> There will not be any new onshore facilities. Existing infrastructure will be used.						

and invertebrates. Available experimental data suggest that there may be physical impacts on the fertilized eggs of snow crab and on the egg, larval, juvenile and adult stages of cod, but only at very close range. Considering the typical source levels associated with commercial seismic arrays, close proximity to the source would result in exposure to very high sound pressure levels. While egg and larval stages are not able to actively escape such an exposure scenario, juvenile and adult cod would most likely avoid it. Juvenile and adult snow crab are benthic and generally far enough from the source so that the received sound pressure levels are well below the levels that may have had impact during experimentation. In the case of eggs and larvae, it is likely that the numbers negatively affected by exposure to seismic sound would be similar to those succumbing to natural mortality.

Limited data regarding physiological impacts on fish and invertebrates indicate that these impacts are both short-term and most obvious after exposure at close range. Table 5.2 provides the details of the

**Table 5.2. Effects assessment on Fish VEC.**

VALUED ECOSYSTEM COMPONENT: FISH								
Project Activity	Potential Positive (P) or Negative (N) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/Socio-Cultural and Economic Context
Vessel Lights	Attraction (N)	-	0	1	2	1	R	1
Sanitary/Domestic Waste	Increased Food (N/P)	-	0	1	1	1	R	1
Air Emissions	Surface Contaminants (N)	-	0	1	1	1	R	1
<b>Noise</b>								
Geohazard Vessel	Disturbance (N)	-	0-1	1	1	1	R	1
Echo Sounder	Disturbance (N)	-	0-1	1	1	1	R	1
Side Scan Sonar	Disturbance (N)	-	0-1	3	1	1	R	1
Seismic Array	Physical Effects (N)	Ramp-up Delay Start	0-1	1	1	1	R	1
Seismic Array	Disturbance (N)	Ramp-up Delay Start	0-1	3-4	1	1	R	1
Boomer	Disturbance (N) Physical Effects (N)		0-1	3-4	1	1	R	1
Towfish	Disturbance (N)	-	0-1	1	1	1	R	1
Presence of Geohazard Vessel		-	0-1	1	1	1	R	1
Accidental Spills	Injury/Mortality (N)	Spill Response	1	2	1	1	R	1
<p><b>Key</b></p> <p><b>Magnitude:</b>                      0 = Negligible, (essentially no effect)                      1 = Low                      2 = Medium                      3 = High</p> <p><b>Frequency:</b>                      1 = &lt; 11 events/yr                      2 = 11-50 events/yr                      3 = 51-100 events/yr                      4 = 101-200 events/yr                      5 = &gt; 200 events/yr                      6 = continuous</p> <p><b>Reversibility:</b>                      R = Reversible                      I = Irreversible (refers to population)</p> <p><b>Duration:</b>                      1 = &lt;1 month                      2 = 1-12 months                      3 = 13-36 months                      4 = 37-72 months                      5 = &gt;72 months</p> <p><b>Geographic Extent:</b>                      1 = &lt;1 km<sup>2</sup>                      2 = 1-10 km<sup>2</sup>                      3 = 11-100 km<sup>2</sup>                      4 = 101-1,000 km<sup>2</sup>                      5 = 1,001-10,000 km<sup>2</sup>                      6 = &gt;10,000 km<sup>2</sup></p> <p><b>Ecological/Socio-cultural and Economic Context:</b>                      1 = Relatively pristine area or area not affected by human activity                      2 = Evidence of existing effects</p>								

physical effects assessment of the geohazard. The 160 in<sup>3</sup> array proposed for use in the geohazard program will be ramped up over at least a 20 min period. This mitigation measure may reduce the likelihood of fish and invertebrates experiencing physical effects.

The proposed geohazard survey program is predicted to have *negligible to low* physical effects on the various life stages of the fish VEC over a duration of < 1 month in an area <1 km<sup>2</sup>. Therefore, physical effects of the proposed program on the fish VEC would be *not significant* (Table 5.3).

**Table 5.3. Significance of potential residual environmental effects of the proposed geohazard program on the Fish VEC.**

VALUED ECOSYSTEM COMPONENT: FISH				
Project Activity	Significance Rating	Level of Confidence	Likelihood (Significant Effect Only)	
	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Vessel Lights	NS	3	-	-
Sanitary/Domestic Wastes	NS	3	-	-
Air Emissions	NS	3	-	-
<b>Noise</b>				
Geohazard Vessel	NS	3	-	-
Seismic Array – physical effects	NS	3	-	-
Seismic Array – behavioural effects	NS	3	-	-
Echo-Sounder	NS	3	-	-
Side Scan Sonar	NS	3	-	-
Boomer	NS	3	-	-
Towfish	NS	3	-	-
Presence of Geohazard Vessel	NS	3	-	-
Accidental Spills	NS	2	-	-
<p>Key:</p> <p>Residual environmental Effect Rating:            S = Significant Negative Environmental Effect            NS = Not-significant Negative Environmental Effect            P = Positive Environmental Effect            Significance is defined as a medium or high magnitude (2 or 3 rating) and duration greater than 1 year (3 or greater rating) and geographic extent &gt;100 km<sup>2</sup> (4 or greater rating).</p> <p>Level of Confidence: based on professional judgment:            1 = Low Level of Confidence            2 = Medium Level of Confidence            3 = High Level of Confidence</p> <p>Probability of Occurrence: based on professional judgment:            1 = Low Probability of Occurrence            2 = Medium Probability of Occurrence            3 = High Probability of Occurrence</p> <p>Scientific Certainty: based on scientific information and statistical analysis or professional judgment:            1 = Low Level of Confidence            2 = Medium Level of Confidence            3 = High Level of Confidence</p>				

### 5.6.3.2. Disturbance Effects (Behavioural)

Based on the review of the behavioural effects of seismic on fish and invertebrates in Section 5.6.2.3 of LGL Limited (2007), there are limited data to support any conclusive statements regarding the behavioural effects of exposure to seismic sound (like would be emitted by the 160 in<sup>3</sup> array in the proposed geohazard program) on these animals. Available information indicates that behavioural changes in response to sound are short-term. However, there is no available information on what constitutes critical durations of change to the various behaviours. There appears to be a great deal of inter- and intra-specific variability. In the case of finfish, three general types of behavioural responses have been identified: (1) startle, (2) alarm, and (3) avoidance. The type of behavioural reaction appears to depend on many factors, including the type of normal behaviour being exhibited at time of exposure, proximity of the sound source, and the pressure/energy level of the sound source. The behaviours of most concern would include those associated with reproduction and migration. Behavioural effects on fish and invertebrates appear to occur at greater distances from the seismic sound source than physical effects. As discussed earlier, certain clupeid fish also exhibit avoidance behaviours when exposed to ultrasound of sufficient amplitude and within a specific frequency range. These responses appear to be temporary. Table 5.2 provides the details of the disturbance effects assessment of the proposed

geohazard program. The 160 in<sup>3</sup> array proposed for use in the geohazard program will be ramped up over at least a 20 min period. This mitigation measure may reduce the likelihood of fish and invertebrates experiencing disturbance effects.

The proposed geohazard survey program is predicted to have *negligible to low* behavioural effects on the various life stages of the fish VEC over a duration of <1 month in an area 11-100 or 101-1,000 km<sup>2</sup>. Therefore, disturbance effects of the Project on the fish VEC would be *not significant* (Table 5.3).

#### **5.6.4. Effects on Commercial Fisheries VEC**

Impacts of the proposed wellsite geohazard survey on the commercial fisheries may be related to (1) changes in catch rates resulting from noise-induced behavioural changes (scaring) of fish, (2) interference with fishing activities - particularly fixed gear - owing to gear or vessel conflicts, or (3) as a result of effects on stock assessments / DFO research activities, which are used, among other purposes, for setting fishing quotas or exploring new fisheries.

The chief means of mitigating any such potential impacts on the commercial fisheries surveys is to avoid active fishing areas, particularly fixed gear zones, when they are occupied by harvesters. Impacts on DFO assessment/research surveys would occur either as a result of behavioural responses or fishing interference (i.e., through the same pathways as impacts on commercial fishing) and avoidance is also an appropriate mitigation for these potential effects. For the commercial fisheries, gear damage compensation, in case a conflict does occur with fishing gear (i.e., contact with the survey streamers), provides a means of final mitigation of impacts.

As described in the Commercial Fisheries section of the EA of Petro-Canada's Jeanne d'Arc Basin 3-D Seismic Program (Section 4.5; LGL Limited 2007), the proposed 2007 Geohazard Survey Area has had no recorded harvesting activity over the past three years, and there has been very little fishing in the Project Area (an average of 36 tonnes of snow crab annually). Within the larger Study Area, the fishing (almost entirely for snow crab) is concentrated well north of the Survey Area and to the east, beyond 200 nmi. Thus, the location of the proposed geohazard activities away from fishing will greatly reduce the likelihood of any impacts on commercial harvesting.

Mitigation measures employed during the geohazard program will be similar to those proposed for the 3-D seismic survey (see Section 5.6.4 in LGL Limited 2007). Fishers who may be operating in the area will be notified of the timing and location of planned activities by means of a CCG "Notice to Mariners" and a "Notice to Fishers" on the CBC Radio Fisheries Broadcast. In addition, if necessary, individual fixed gear fishers will be contacted to arrange mutual avoidance. Any contacts with fishing gear, with any identifiable markings, will be reported to the C-NLOPB within 24 h of the contact. Any floating debris resulting from contact with fish gear will be retrieved and retained if it is safe to do so in the opinion of the vessel's master. Petro-Canada will advise the C-NLOPB prior to compensating and settling all valid lost gear/income claims promptly and satisfactorily. Petro-Canada will also coordinate with Fisheries and Oceans, St. John's, and the FFAW to avoid any potential conflicts with survey vessels that may be operating in the area.

Specific mitigations to minimize potential conflicts and any negative effects with other vessels; these include:

- Excellent communications (VHF, HF, Satellite, etc.)
- Posting of advisories with the Canadian Coast Guard and the CBC Fisheries Broadcast
- Compensation program in the event any Project vessels damage fishing gear
- Single Point of Contact (SPOC)

The potential interactions between the proposed geohazard survey program and the conduct of commercial fisheries activities (including fisheries research) are shown in Table 5.4 of the current document. The effects assessments are shown in Tables 5.5 and 5.6. Given the short duration of the geohazard program (9-11 days), its limited geographic scope, and the mitigation measures that will be employed, it is predicted that the geohazard program will have negligible impact on commercial fisheries activities (including fisheries research) and will be not significant (Table 5.7).

**Table 5.4. Potential interactions between the proposed geohazard program and Commercial Fisheries VEC.**

<b>VALUED ECOSYSTEM COMPONENT: COMMERCIAL FISHERIES</b>			
<b>PROJECT ACTIVITIES</b>	<b>For Finfish and Mobile Invertebrates (using fixed gear or mobile trawls)</b>	<b>For Sedentary Benthic Invertebrates (using fixed crab pots)</b>	<b>Research Surveys</b>
Vessel Lights			
Sanitary/Domestic Waste			
Air Emissions			
Garbage <sup>a</sup>			
Noise			
Geohazard Vessel			
Echo Sounder			
Side Scan Sonar			
Seismic Array	x	x	x
Boomer	x	x	x
Towfish			
Presence of Geohazard Vessel/Streamer	x	x	x
Shore Facilities <sup>b</sup>			
Accidental Spills			
<b>OTHER PROJECTS AND ACTIVITIES</b>			
Exploration	x	x	x
Marine Transportation	x	x	x
<sup>a</sup> Not applicable as garbage will be brought ashore.			
<sup>b</sup> There will not be any new onshore facilities. Existing infrastructure will be used.			

**Table 5.5. Effects assessment on Commercial Fisheries VEC.**

VALUED ECOSYSTEM COMPONENT: COMMERCIAL FISHERIES								
Project Activity	Potential Positive (P) or Negative (N) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/Socio-Cultural and Economic Context
Noise								
Seismic Array	Behavioural Response (N/P)	Avoidance, FLO, Communications	0	2-3	1	1	R	1
Boomer	Behavioural Response (N/P)	Avoidance, Communications	0	2-3	1	1	R	1
Presence of Geohazard Vessel/Streamer	Gear conflict and damage (N)	Avoidance, SPOC, Compensation plan	0 <sup>a</sup>	1-2	1	1	R	1
<p><b>Key:</b></p> <p><b>Magnitude:</b>            0 = Negligible, essentially no effect            1 = Low            2 = Medium            3 = High</p> <p><b>Frequency:</b>            1 = &lt; 11 events/yr            2 = 11-50 events/yr            3 = 51-100 events/yr            4 = 101-200 events/yr            5 = &gt; 200 events/yr            6 = continuous</p> <p><b>Reversibility:</b>            R = Reversible            I = Irreversible            (refers to population)</p> <p><b>Duration:</b>            1 = &lt; 1 month            2 = 1-12 months            3 = 13-36 months            4 = 37-72 months            5 = &gt; 72 months</p> <p><b>Geographic Extent:</b>            1 = &lt; 1-km<sup>2</sup>            2 = 1-10-km<sup>2</sup>            3 = 11-100-km<sup>2</sup>            4 = 101-1000-km<sup>2</sup>            5 = 1001-10,000-km<sup>2</sup>            6 = &gt; 10,000-km<sup>2</sup></p> <p><b>Ecological/Socio-cultural and Economic Context:</b>            1 = Relatively pristine area or area not affected by human activity            2 = Evidence of existing effects</p> <p><sup>a</sup>This is considered negligible since, if a conflict occurs, compensation will eliminate any economic impact.</p>								

**Table 5.6. Effects assessment on Research Surveys.**

VALUED ENVIRONMENTAL COMPONENT: RESEARCH SURVEYS								
Project Activity	Potential Positive (P) or Negative (N) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/Socio-Cultural and Economic Context
Noise								
Seismic Array	Behavioural Response (N/P)	Separation plan, Avoidance, Communications	0	2-3	1	1	R	1
Boomer	Behavioural Response (N/P)	Separation plan, Avoidance, Communications	0	2-3	1	1	R	1
Presence of Geohazard Vessel/Streamer	Gear conflict and damage (N)	Avoidance, SPOC	0	1-2	1	1	R	1
<p><b>Key:</b></p> <p><b>Magnitude:</b>            0 = Negligible, essentially no effect            1 = Low            2 = Medium            3 = High</p> <p><b>Frequency:</b>            1 = &lt; 11 events/yr            2 = 11-50 events/yr            3 = 51-100 events/yr            4 = 101-200 events/yr            5 = &gt; 200 events/yr            6 = continuous</p> <p><b>Reversibility:</b>            R = Reversible            I = Irreversible (refers to population)</p> <p><b>Duration:</b>            1 = &lt; 1 month            2 = 1-12 months            3 = 13-36 months            4 = 37-72 months            5 = &gt; 72 months</p> <p><b>Geographic Extent:</b>            1 = &lt; 1-km<sup>2</sup>            2 = 1-10-km<sup>2</sup>            3 = 11-100-km<sup>2</sup>            4 = 101-1000-km<sup>2</sup>            5 = 1001-10,000-km<sup>2</sup>            6 = &gt; 10,000-km<sup>2</sup></p> <p><b>Ecological/Socio-cultural and Economic Context:</b>            1 = Relatively pristine area or area not negatively affected by human activity            2 = Evidence of existing negative effects</p>								



**Table 5.7. Significance of potential residual environmental effects of the proposed geohazard program on the Commercial Fisheries VEC.**

VALUED ECOSYSTEM COMPONENT: COMMERCIAL FISHERIES (INCLUDING RESEARCH SURVEYS)				
Project Activity	Significance Rating	Level of Confidence	Likelihood (Significant Effect Only)	
	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Vessel Lights	NS	3	-	-
Sanitary/Domestic Wastes	NS	3	-	-
Air Emissions	NS	3	-	-
<b>Noise</b>				
Geohazard Vessel	NS	3	-	-
Echo Sounder	NS	3	-	-
Side Scan Sonar	NS	3	-	-
Seismic Array – physical effects	NS	3	-	-
Seismic Array – behavioural effects	NS	3	-	-
Boomer	NS	3	-	-
Towfish	NS	3	-	-
<b>Presence of Geohazard Vessel and Streamer</b>	NS	3	-	-
<b>Accidental Spills</b>	NS	2	-	-
<p>Key:</p> <p>Residual environmental Effect Rating:</p> <p>S = Significant Negative Environmental Effect</p> <p>NS = Not-significant Negative Environmental Effect</p> <p>P = Positive Environmental Effect</p> <p>Significance is defined as a medium or high magnitude (2 or 3 rating) and duration greater than 1 year (3 or greater rating) and geographic extent &gt;100 km<sup>2</sup> (4 or greater rating).</p> <p>Level of Confidence: based on professional judgment:</p> <p>1 = Low Level of Confidence</p> <p>2 = Medium Level of Confidence</p> <p>3 = High Level of Confidence</p> <p>Probability of Occurrence: based on professional judgment:</p> <p>1 = Low Probability of Occurrence</p> <p>2 = Medium Probability of Occurrence</p> <p>3 = High Probability of Occurrence</p> <p>Scientific Certainty: based on scientific information and statistical analysis or professional judgment:</p> <p>1 = Low Level of Confidence</p> <p>2 = Medium Level of Confidence</p> <p>3 = High Level of Confidence</p>				

### 5.6.5. Seabirds

The potential impacts of offshore seismic exploration to seabirds, including underwater sound exposure from airgun arrays, leakage of petroleum product from streamer(s), and attraction to ship lights at night are reviewed in Section 5.6.5 of the EA of Petro-Canada’s Jeanne d’Arc Basin 3-D Seismic Program (LGL Limited 2007). No additional literature is available or potential impacts are predicted from a wellsite geohazard survey. Potential interactions between the proposed geohazard program and seabirds are shown in Table 5.8. The effects assessment is summarized in Table 5.9.

Most effects of the geohazard program on seabirds will be *negligible* because for the most part birds are not particularly sensitive to underwater sound (see Section 5.6.5.1 in LGL Limited 2007). There is some potential to affect seabirds if some flotation fluid from the geohazard streamer were accidentally released and formed a surface slick. The geohazard streamer will be inspected before deployment.

**Table 5.8. Potential interactions between the proposed geohazard program and Seabird VEC.**

<b>PROJECT ACTIVITIES</b>	<b>VALUED ECOSYSTEM COMPONENT: SEABIRDS</b>
<b>Vessel Lights</b>	x
<b>Sanitary/Domestic Waste</b>	x
<b>Air Emissions</b>	x
<b>Garbage <sup>a</sup></b>	
<b>Noise</b>	
Geohazard Vessel	x
Echo Sounder	x
Side Scan Sonar	x
Seismic Array	x
Boomer	x
Towfish	x
<b>Presence of Geohazard Vessel</b>	x
<b>Shore Facilities <sup>b</sup></b>	
<b>Accidental Spills</b>	x
<b>OTHER PROJECTS AND ACTIVITIES</b>	
<b>Hibernia</b>	x
<b>Terra Nova</b>	x
<b>White Rose</b>	x
<b>Exploration</b>	x
<b>Fisheries</b>	x
<b>Marine Transportation</b>	x
<sup>a</sup> Not applicable as garbage will be brought ashore.	
<sup>b</sup> There will not be any new onshore facilities. Existing infrastructure will be used.	

**Table 5.9. Effects assessment on Seabird VEC.**

VALUED ECOSYSTEM COMPONENT: SEABIRDS								
Project Activity	Potential Positive (P) or Negative (N) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/Socio-Cultural and Economic Context
Vessel Lights	Attraction, mortality (N)	Turn off non-essential lighting; release protocols	1	2	1	1	R	2
Sanitary/Domestic Waste	Increased Food (N/P)	-	1	1	1	1	R	1
Air Emissions	Surface Contaminants (N)	-	0	1	1	1	R	1
<b>Noise</b>								
Geohazard Vessel	Disturbance (N)	-	0-1	1	1	1	R	1
Echo Sounder	Disturbance (N)	-	0-1	1	1	1	R	1
Side Scan Sonar	Disturbance (N)	-	0-1	1	1	1	R	1
Seismic Array	Physical Effects (N)	Ramp-up	1	1	1	1	R	1
Seismic Array	Disturbance (N)	Ramp-up	1	1	1	1	R	1
Boomer	Disturbance (N)		0-1	1	1	1	R	1
Towfish	Disturbance (N)	-	0-1	1	1	1	R	1
Presence of Geohazard Vessel	Disturbance (N)	-	0	1	1	1	R	1
Accidental Spills	Injury/Mortality (N)	Spill Response	2	1-2	1	1-2	R	1
Key: <b>Magnitude:</b> 0 = Negligible, (essentially no effect) 1 = Low 2 = Medium 3 = High  <b>Frequency:</b> 1 = <11 events/yr 2 = 11-50 events/yr 3 = 51-100 events/yr 4 = 101-200 events/yr 5 = >200 events/yr 6 = continuous  <b>Reversibility:</b> R = Reversible I = Irreversible (refers to population)  <b>Duration:</b> 1 = <1 month 2 = 1-12 months 3 = 13-36 months 4 = 37-72 months 5 = >72 months  <b>Geographic Extent:</b> 1 = < 1 km <sup>2</sup> 2 = 1-10 km <sup>2</sup> 3 = 11-100 km <sup>2</sup> 4 = 101-1,000 km <sup>2</sup> 5 = 1,001-10,000 km <sup>2</sup> 6 = >10,000 km <sup>2</sup>  <b>Ecological/Socio-cultural and Economic Context:</b> 1 = Relatively pristine area or area not affected by human activity 2 = Evidence of existing effects								

Some petrels could be affected if they become attracted to and then stranded on the ship but mitigation/handling methods (see Williams and Chardine, n.d.) should reduce or eliminate any mortalities. In addition, lighting on the geohazard ship at night and in poor weather conditions will be reduced as much as possible. Thus, the number of birds affected by the geohazard program should be quite low and thus any effects will be *not significant* (Table 5.10).

**Table 5.10. Significance of potential residual environmental effects of the proposed geohazard program on the Seabird VEC.**

VALUED ECOSYSTEM COMPONENT: SEABIRDS				
Project Activity	Significance Rating	Level of Confidence	Likelihood (Significant Effect Only)	
	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Vessel Lights	NS	3	-	-
Sanitary/Domestic Wastes	NS	3	-	-
Air Emissions	NS	3	-	-
<b>Noise</b>				
Geohazard Vessel	NS	3	-	-
Echo Sounder	NS	3	-	-
Side Scan Sonar	NS	3	-	-
Seismic Array – physical effects	NS	3	-	-
Seismic Array – behavioural effects	NS	3	-	-
Boomer	NS	3	-	-
Towfish	NS	3	-	-
Presence of Geohazard Vessel	NS	3	-	-
Accidental Spills	NS	2	-	-
<p>Key:</p> <p>Residual environmental Effect Rating:</p> <p>S = Significant Negative Environmental Effect</p> <p>NS = Not-significant Negative Environmental Effect</p> <p>P = Positive Environmental Effect</p> <p>Significance is defined as a medium or high magnitude (2 or 3 rating) and duration greater than 1 year (3 or greater rating) and geographic extent &gt;100 km<sup>2</sup> (4 or greater rating).</p> <p>Level of Confidence: based on professional judgment:</p> <p>1 = Low Level of Confidence</p> <p>2 = Medium Level of Confidence</p> <p>3 = High Level of Confidence</p> <p>Probability of Occurrence: based on professional judgment:</p> <p>1 = Low Probability of Occurrence</p> <p>2 = Medium Probability of Occurrence</p> <p>3 = High Probability of Occurrence</p> <p>Scientific Certainty: based on scientific information and statistical analysis or professional judgment:</p> <p>1 = Low Level of Confidence</p> <p>2 = Medium Level of Confidence</p> <p>3 = High Level of Confidence</p>				

## 5.6.6. Marine Mammals and Sea Turtles

### 5.6.6.1. Review of Effects of Geohazard Activity

Airguns used during marine seismic and geohazard operations introduce strong sound impulses into the water (see Appendix C in the EA of Petro-Canada’s Jeanne d’Arc Basin 3-D Seismic Program (LGL Limited 2007) for a review of the characteristics of airgun pulses). The seismic pulses produced by the airguns are directed downward toward the seafloor, insofar as possible; however, energy will propagate outward from the source through the water. The airguns could have several types of effects on marine mammals and sea turtles and are the principal concern associated with the proposed geohazard survey.

This section complements the EA of Petro-Canada’s Jeanne d’Arc Basin 3-D Seismic Program (LGL Limited 2007) and reviews literature pertaining to geohazard surveys that was not covered in the EA. To assess the potential effects of the proposed geohazard survey on the marine mammals and sea turtles of the Jeanne d’Arc Basin, this section provides the following: (A) a description of the hearing abilities of marine mammals and sea turtles, (B) a discussion of the potential for masking by geohazard surveys, and (C) disturbance effects of geohazard surveys. A summary of the types of noise effects on marine

mammals, the possibility of hearing impairment, the possibility of strandings and mortality, and non-auditory physiological effects is provided in Section 5.6.6 of the EA of Petro-Canada's Jeanne d'Arc Basin 3-D Seismic Program (LGL Limited 2007).

### **(A) Hearing Abilities of Marine Mammals and Sea Turtles**

The hearing abilities of marine mammals and sea turtles were reviewed in Section 5.6.6.1 of LGL Limited (2007).

**Toothed Whales.**—The Huntec boomer emits pulsed sounds with frequency bandwidth from 500 Hz to 6 kHz. That frequency is within the hearing range of many odontocetes. The side-scan sonar emits pulsed sounds at dual frequencies of 105 kHz and 390 kHz. The 105 kHz channel can likely be heard by some odontocetes. The single-beam echosounder operates at dual frequencies of 24 kHz and 200 kHz and the towfish tracking system operates at frequencies ranging from 5 kHz to 30 kHz. Thus, sound pulses from the boomer, sidescan sonar, towfish, and single-beam echosounder will be readily audible to these animals when they are within the narrow angular extent of the transmitted sound beam. However, the multibeam echosounder operates at frequencies (240 kHz) that are likely too high to be detected by odontocetes.

**Baleen Whales.**—Sound pulses from the airgun array and Huntec boomer will likely be readily audible to baleen whales. The lower operating frequency of the towfish tracking system is likely audible to baleen whales as might the lower operating frequencies of the single-beam echosounder. However, the multibeam echosounder and side-scan sonar operate at frequencies that are likely too high to be detected by baleen whales.

**Pinnipeds.**—Sound pulses from the airgun array and Huntec boomer will likely be readily audible to phocids. The operating frequencies of the towfish tracking system are likely audible to seals as might the lower operating frequencies of the single-beam echosounder. However, the multibeam echosounder and side-scan sonar operate at frequencies that are likely too high to be detected by phocids.

**Sea Turtles.**—Sea turtles can likely hear sound emitted from the seismic array and Huntec boomer given that available information (albeit limited—see Section 5.6.6.1 of LGL Limited 2007) indicates that the frequency range of best hearing overlaps with that of these two sound sources. It is unlikely that sea turtles can hear the side-scan sonar and echosounders.

### **(B) Masking Effects of Geohazard Surveys**

Masking effects on marine mammal calls and other natural sounds are expected to be limited. Seismic sounds are short pulses occurring for less than 1-sec every 20 or thereabouts. Sounds from the sonars are very short pulses, 1-4 times every sec, depending on water depth and are emitted in a very narrow beam. Furthermore, in the case of baleen whales, the side-scan sonar signals do not overlap with the predominant frequencies in the calls, which would avoid significant masking.

An industrial sound source will reduce the effective communication or echolocation distance only if its frequency is close to that of the cetacean signal. If little or no overlap occurs between the industrial noise and the frequencies used, communication and echolocation are not expected to be disrupted. Furthermore, the discontinuous nature of sonar pulses makes significant masking effects unlikely.

Thus, masking is unlikely to be a significant issue for either marine mammals or sea turtles exposed to the sonar pulses from geohazard surveys.

### **(C) Disturbance by Geohazard Surveys**

Very little information exists about marine mammal responses to sonar pulses, especially the types of sonar that will be employed during the proposed geohazard survey.

**Toothed Whales.**—Toothed whale behavioural reactions to military and other sonars appear to vary by species and circumstance. While there may be a link between naval sonar use (note that navy sonars are generally more powerful, have a longer pulse duration and shorter rise time, and are directed close to horizontal in wide area) and changes in cetacean vocalization rates and movements, it is unclear what impact these behavioural changes might have on the animals (Watkins et al. 1985; Rendell and Gordon 1999; Schlundt 2000; Finneran 2000, 2002).

There are increasing indications that some beaked whales tend to strand when naval exercises, including sonar operations, are ongoing nearby. The sound sources that have been coincident with beaked whale strandings are predominantly military, mid-frequency sonar (2-10 kHz) (Barlow and Gisiner 2006). These strandings are apparently at least in part a disturbance response, although auditory or other injuries may also be a factor. Whether beaked whales would ever react similarly to geohazard surveys is unknown. However, geohazard sonar sources are much less powerful, have a shorter pulse duration, and are emitted in a narrow beam, mostly directed downwards.

**Baleen Whales.**— Most studies on the potential disturbance of baleen whales have focused on the effects of sound from seismic airguns and have not been designed to address effects of sound from simultaneously operating sonar systems. Baleen whales tend to avoid operating airguns, but avoidance radii are quite variable (see Section 5.6.6.1 in LGL Limited 2007). Some whales show no overt reactions to airgun pulses at distances beyond a few kilometers, even though the airgun pulses remain well above ambient sound levels out to much farther distances.

In 1998 during the SURTASS LFA sonar playback experiment, minor course changes were recorded in migrating gray whales within their migration corridor in response to signals with source levels of 170 to 178 dB. The whales resumed their course after tens of minutes once the signal ceased (Clark et al. 2001 in USN 2005). Frankel (2005) reported that migrating gray whales apparently reacted to a 21–25 kHz “whale-finding” sonar with a source level of 215 dB re 1  $\mu$ Pa · m by orienting away from the source and being deflected from their course by about 200 m. These responses were not obvious in the field and were only determined later during data analysis. Calambokidis (1998) and Frankel and Clark (2002)

reported increased distances of humpback whales from the low-frequency Acoustic Thermometry of Ocean Climate (ATOC) source (75 Hz at a source level of 195 dB re 1  $\mu$ Pa) during operation. Frankel and Clark (1998, 2000) also showed slight changes in behavior of humpback whales (increase in time and distance between surfacings) during ATOC operation. In contrast, Mobley (2005) noted no differences in sighting rates or distributional changes in humpback whales near Kauai, Hawaii, during two years of transmissions of low-frequency sounds (same as for ATOC) from the North Pacific Acoustics Laboratory source (formerly ATOC). However, Mobley (2005) gave several interpretations for this discrepancy: 1) his study could have lacked statistical power, 2) the humpback whales had habituated to the sounds, or 3) the effects were too short-term to detect statistically. Mobley (2005) concluded that the whales continue to visit the wintering grounds off Kauai with little or no changes in their distribution. During a 1998-2000 study in the Eastern Tropical Pacific (ETP) assessed the reactions of marine mammals to an echosounder and an Acoustic Doppler Current Profiler (ADCP). Results indicated that baleen whales showed no significant responses when the echosounder and ADCP were on (Gerrodette and Pettis 2005).

Most of these observations are of limited relevance to the proposed geohazard program. This is because pulse durations from the sonars used in the reported studies were much longer than those of the geohazard sources. A given mysticete would not receive many of the sonar's narrow-beam, downward-directed pulses as the vessel passes by. Any disturbance of baleen whales from use of the geohazard sonar sources would be expected to be small and of short duration.

***Pinnipeds.***— Data on the reactions of pinnipeds to sonar sounds are lacking, but the few reports available on their reactions to other pulsed sounds suggest that they would exhibit either no, or short-term, behavioural responses (Mate 1993; Richardson et al. 1995).

***Sea Turtles.***—There does not appear to be any available data on reactions of sea turtles to sonars. Their frequency range of optimal hearing is at considerably lower frequencies. Thus, it is highly unlikely that brief exposure of sea turtles to a small number of signals from the geohazard sonars would cause strong or prolonged behavioural effects.

#### **5.6.6.2. Effects of Presence of Vessels**

During the proposed geohazard program, there will be one geohazard ship on site at all times during the 9 to 11-day program in 2007. Marine mammal responses to ships are presumably responses to noise, but visual or other cues are also likely involved. Marine mammal response (or lack thereof) to ships and boats (pre-1995 studies) are summarized in Richardson et al. (1995), p. 252-274. More recent studies are summarized in the EA of Petro-Canada's Jeanne d'Arc Basin 3-D Seismic Program (LGL Limited 2007).

#### **5.6.6.3. Effects of Accidental Spills**

All petroleum hydrocarbon handling and reporting procedures on board will be consistent with Petro-Canada's policy, and handling and reporting procedures. In 2007, a fluid-filled streamer is planned for

use in the geohazard program. It is possible that small amounts of Isopar could leak from the streamer; or a fuel spill could occur from the survey ship. Any spills would likely be small and quickly dispersed by wind, wave, and ship's propellor action. The effects of hydrocarbon spills on marine mammals and sea turtles were overviewed in Husky (2000) in Section 5.9.1.3 and 5.9.2.3, respectively and are not repeated here. Based on studies, whales and seals do not exhibit large behavioural or physiological responses to limited surface oiling, incidental exposure to contaminated food, or ingestion of oil (St. Aubin 1990; Williams et al. 1994). Sea turtles are thought to be more susceptible to the effects of oiling than marine mammals but any effects are believed to be sublethal (Husky 2000). Effects of an Isopar spill on marine mammals and sea turtles would be *negligible*.

#### **5.6.6.4. Effects of Other Project Activities**

There is potential for marine mammals and sea turtles to interact with the lights, domestic and sanitary wastes, and air emissions from the geohazard ship. Any effects from these interactions are predicted to be *negligible*.

#### **5.6.6.5. Application of Effects Assessment**

Based on the above review and the review provided in the EA of Petro-Canada's Jeanne d'Arc Basin 3-D Seismic Program (LGL Limited 2007), marine mammals and sea turtles will likely exhibit certain behavioural reactions, including displacement from an area around a geohazard survey and the sound sources it employs. The size of this displacement area will likely vary amongst species, during different times of the year, and even amongst individuals within a given species. There is also a risk that marine mammals (and perhaps sea turtles) that are very close to the seismic array may incur temporary hearing impairment. The assessment of impacts presented here is based upon the best available information; however, there are data gaps that limit the certainty of these impact predictions. Note that we have discussed potential impacts separately for toothed whales, baleen whales, and seals given their different hearing abilities and sensitivities to sound. Potential interactions between Petro-Canada's proposed geohazard program and marine mammals and sea turtles are shown in Table 5.11.

#### **5.6.6.6. Assessment of Effects of Geohazard Activities on Marine Mammal VEC**

Marine mammal effects assessment from Petro-Canada's proposed geohazard program is summarized in Table 5.12 and discussed in further detail in the EA of Petro-Canada's Jeanne d'Arc Basin 3-D Seismic Program (LGL Limited 2007).

Similar mitigation measures will be used during the geohazard program (as they pertain to the 160 in<sup>3</sup> airgun array) as were outlined for the 3-D seismic survey in LGL Limited (2007). Mitigation measures (see Section 5.8 for more details) will include:

- ramp-ups,
- no initiation of airgun array if a marine mammal or sea turtle is sighted 30 min prior to ramp-up within 500-m safety zone of the energy source, and



**Table 5.11. Potential interactions between the proposed geohazard program and (1) Marine Mammal and (2) Sea Turtle VECs.**

<b>VALUED ECOSYSTEM COMPONENTS: (1) MARINE MAMMALS (2) SEA TURTLES</b>				
<b>PROJECT ACTIVITIES</b>	<b>Toothed Whales</b>	<b>Baleen Whales</b>	<b>Seals</b>	<b>Sea Turtles</b>
<b>Vessel Lights</b>				
<b>Sanitary/Domestic Waste</b>	x	x	x	x
<b>Air Emissions</b>	x	x	x	x
<b>Garbage <sup>a</sup></b>				
<b>Noise</b>				
Geohazard Vessel	x	x	x	x
Echo Sounder	x	x	x	x
Side Scan Sonar	x	x	x	x
Seismic Array	x	x	x	x
Boomer	x	x	x	x
Towfish	x	x	x	x
<b>Presence of Geohazard Vessel</b>	x	x	x	x
<b>Shore Facilities <sup>b</sup></b>				
<b>Accidental Spills</b>	x	x	x	x
<b>OTHER PROJECTS AND ACTIVITIES</b>				
<b>Hibernia</b>	x	x	x	x
<b>Terra Nova</b>	x	x	x	x
<b>White Rose</b>	x	x	x	x
<b>Exploration</b>	x	x	x	x
<b>Fisheries</b>	x	x	x	x
<b>Marine Transportation</b>	x	x	x	x
<sup>a</sup> Not applicable as garbage will be brought ashore.				
<sup>b</sup> There will not be any new onshore facilities. Existing infrastructure will be used.				

**Table 5.12. Effects assessment on marine mammal VEC.**

VALUED ECOSYSTEM COMPONENTS: MARINE MAMMALS								
Project Activity	Potential Positive (P) or Negative (N) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/Socio-Cultural and Economic Context
Sanitary/Domestic Waste	Increased Food (N/P)	-	0-1	1	1	1	R	1
Air Emissions	Surface Contaminants (N)	-	0	1	1	1	R	1
Noise								
Geohazard Vessel	Disturbance (N)	-	0-1	1-2	1	1	R	1
Echo Sounder	Disturbance (N)	-	0-1	1-2	1	1	R	1
Side Scan Sonar	Disturbance (N)	-	0-1	1-2	1	1	R	1
Seismic Array	Physical Effects (N)	Ramp-up; Delay Start; Shutdown <sup>a</sup>	0-1	1	1	1	R	1
Seismic Array	Disturbance (N)	Ramp-up; Delay Start; Shutdown <sup>a</sup>	1	3-4	1	1	R	1
Boomer	Disturbance (N) Physical Effects (N)		0-1	1-2	1	1	R	1
Towfish	Disturbance (N)	-	0-1	1-2	1	1	R	1
Presence of Geohazard Vessel	Disturbance (N)	-	0-1	1	1	1	R	1
Accidental Spills	Injury/Mortality (N)	Spill Response	1	1-2	1	1	R	1
<p>Key:</p> <p>Magnitude:            0 = Negligible, essentially no effect            1 = Low            2 = Medium            3 = High</p> <p>Frequency:            1 = &lt;11 events/yr            2 = 11-50 events/yr            3 = 51-100 events/yr            4 = 101-200 events/yr            5 = &gt;200 events/yr            6 = continuous</p> <p>Reversibility:            R = Reversible            I = Irreversible            (refers to population)</p> <p>Duration:            1 = &lt;1 month            2 = 1-12 months            3 = 13-36 months            4 = 37-72 months            5 = &gt;72 months</p> <p>Geographic Extent:            1 = &lt;1 km<sup>2</sup>            2 = 1-10 km<sup>2</sup>            3 = 11-100 km<sup>2</sup>            4 = 101-1,000 km<sup>2</sup>            5 = 1,001-10,000 km<sup>2</sup>            6 = &gt;10,000 km<sup>2</sup></p> <p>Ecological/Socio-cultural and Economic Context:            1 = Relatively pristine area or area not negatively affected by human activity            2 = Evidence of existing negative effects</p> <p><sup>a</sup> The airgun array will be shutdown if an endangered (or threatened) marine mammal or sea turtle is sighted within 500 m of the array.</p>								

- shutdown of the energy source if an endangered (or threatened) whale or sea turtle is observed within the 500-m safety zone.

The planned monitoring and mitigation measures, including ramp-ups, visual monitoring, and shutdown of the airguns when endangered or threatened whales or turtles are seen within the “safety radii”, will minimize the already-low probability of exposure of marine mammals (and sea turtles) to sounds strong enough to induce hearing impairment.

### ***Toothed Whales.***

***Hearing Impairment and Physical Effects:*** With mitigation measures in place, the Proponent's proposed geohazard program is predicted to have *negligible to low* physical impacts on toothed whales, over a duration of *<1 month* in an area *<1 km<sup>2</sup>* (Table 5.12). Therefore, auditory and physical impacts on toothed whales would be *not significant* (Table 5.13).

***Disturbance Effects:*** Disturbance effects from the geohazard program on toothed whales would likely be *low*, over a duration of *<1 month* in an area of *11-100* or *101-1,000 km<sup>2</sup>* (Table 5.12). Therefore, impacts related to disturbance, are judged to be *not significant* for toothed whales (Table 5.13).

***Prey Species:*** Potential impacts of reduced prey availability on toothed whales are predicted to be *negligible*.

### ***Baleen Whales.***

***Hearing Impairment and Physical Effects:*** With mitigation measures in place, the Proponent's proposed geohazard program is predicted to have *negligible to low* physical impacts on baleen whales, over a duration of *<1 month* in an area *<1 km<sup>2</sup>* (Table 5.12). Therefore, auditory and physical impacts on baleen whales would be *not significant* (Table 5.13).

***Disturbance Effects:*** Disturbance effects on species of baleen whales would likely be *low*, over a duration of *<1 month* in an area of *11-100* or *101-1,000-km<sup>2</sup>* (Table 5.12). Therefore, impacts related to disturbance, are judged to be *not significant* for baleen whales (Table 5.13).

***Prey Species:*** Potential impacts of reduced prey availability on baleen whales, including those species considered at risk by COSEWIC, are predicted to be *negligible*.

### ***Seals.***

***Hearing Impairment and Physical Effects:*** With mitigation measures in place, the Proponent's proposed geohazard program is predicted to have *negligible to low* physical impacts on seals, over a duration of *<1 month* in an area *<1 km<sup>2</sup>* (Table 5.12). Therefore, auditory and physical impacts on seals would be *not significant* (Table 5.13).

***Disturbance Effects:*** Disturbance effects from the proposed geohazard program on seals is predicted to be *low*, over a *<1 month* in an area of *11-100* or *101-1,000 km<sup>2</sup>* (Table 5.12). Therefore, impacts related to disturbance, are judged to be *not significant* for seals (Table 5.13).

***Prey Species:*** Potential impacts of reduced prey availability are predicted to be *negligible*.

**Table 5.13. Significance of potential residual environmental effects of the proposed geohazard program on the Marine Mammal VEC.**

VALUED ECOSYSTEM COMPONENT: MARINE MAMMALS				
Project Activity	Significance Rating	Level of Confidence	Likelihood (Significant Effect Only)	
	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Vessel Lights	NS	3	-	-
Sanitary/Domestic Wastes	NS	3	-	-
Air Emissions	NS	3	-	-
<b>Noise</b>				
Geohazard Vessel	NS	3	-	-
Echo Sounder	NS	3	-	-
Side Scan Sonar	NS	3	-	-
Seismic Array – physical effects	NS	3	-	-
Seismic Array – behavioural effects	NS	3	-	-
Boomer	NS	3	-	-
Towfish	NS	3	-	-
Presence of Geohazard Vessel	NS	3	-	-
Accidental Spills	NS	3	-	-
<p>Key:</p> <p>Residual environmental Effect Rating:            S = Significant Negative Environmental Effect            NS = Not-significant Negative Environmental Effect            P = Positive Environmental Effect            Significance is defined as a medium or high magnitude (2 or 3 rating) and duration greater than 1 year (3 or greater rating) and geographic extent &gt;100 km<sup>2</sup> (4 or greater rating).</p> <p>Level of Confidence: based on professional judgment:            1 = Low Level of Confidence            2 = Medium Level of Confidence            3 = High Level of Confidence</p> <p>Probability of Occurrence: based on professional judgment:            1 = Low Probability of Occurrence            2 = Medium Probability of Occurrence            3 = High Probability of Occurrence</p> <p>Scientific Certainty: based on scientific information and statistical analysis or professional judgment:            1 = Low Level of Confidence            2 = Medium Level of Confidence            3 = High Level of Confidence</p>				

**5.6.6.7. Assessment of Effects of Geohazard Activities on Sea Turtle VEC**

Effects assessment for sea turtles is summarized in Table 5.14.

*Hearing Impairment and Physical Effects:* With mitigation measures in place, the Proponent’s proposed geohazard program is predicted to have *negligible to low* physical impacts on sea turtles, over a duration of <1 month in an area <1 km<sup>2</sup> (Table 5.14). Therefore, auditory and physical impacts on sea turtles would be *not significant* (Table 5.15).

*Disturbance Effects:* The Proponent’s proposed geohazard program is predicted to have *low* disturbance effects on sea turtles, over a duration of <1 month in an area 11-100 km<sup>2</sup> (Table 5.14). Therefore, impacts related to disturbance, are judged to be *not significant* for sea turtles (Table 5.15).

*Prey Species:* Potential impacts of reduced prey availability are predicted to be *negligible*.

**Table 5.14. Effects assessment on sea turtle VEC.**

VALUED ECOSYSTEM COMPONENTS: SEA TURTLES								
Project Activity	Potential Positive (P) or Negative (N) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/Socio-Cultural and Economic Context
Sanitary/Domestic Waste	Increased Food (N/P)	-	0-1	1	1	1	R	1
Air Emissions	Surface Contaminants (N)	-	0	1	1	1	R	1
Noise								
Geohazard Vessel	Disturbance (N)	-	0-1	1-2	1	1	R	1
Echo Sounder	Disturbance (N)	-	0-1	1-2	1	1	R	1
Side Scan Sonar	Disturbance (N)	-	0-1	1-2	1	1	R	1
Seismic Array	Physical Effects (N)	Ramp-up; Delay Start; Shutdown <sup>a</sup>	0-1	1	1	1	R	1
Seismic Array	Disturbance (N)	Ramp-up; Delay Start; Shutdown <sup>a</sup>	1	3	1	1	R	1
Boomer	Disturbance (N) Physical Effects (N)		0-1	1-2	1	1	R	1
Towfish	Disturbance (N)	-	0-1	1-2	1	1	R	1
Presence of Geohazard Vessel	Disturbance (N)	-	0-1	1	1	1	R	1
Accidental Spills	Injury/Mortality (N)	Spill Response	1	1-2	1	1	R	1
<p>Key:</p> <p><b>Magnitude:</b>            0 = Negligible, essentially no effect            1 = Low            2 = Medium            3 = High</p> <p><b>Frequency:</b>            1 = &lt;11 events/yr            2 = 11-50 events/yr            3 = 51-100 events/yr            4 = 101-200 events/yr            5 = &gt;200 events/yr            6 = continuous</p> <p><b>Reversibility:</b>            R = Reversible            I = Irreversible (refers to population)</p> <p><b>Duration:</b>            1 = &lt;1 month            2 = 1-12 months            3 = 13-36 months            4 = 37-72 months            5 = &gt;72 months</p> <p><b>Geographic Extent:</b>            1 = &lt;1 km<sup>2</sup>            2 = 1-10 km<sup>2</sup>            3 = 11-100 km<sup>2</sup>            4 = 101-1,000 km<sup>2</sup>            5 = 1,001-10,000 km<sup>2</sup>            6 = &gt;10,000 km<sup>2</sup></p> <p><b>Ecological/Socio-cultural and Economic Context:</b>            1 = Relatively pristine area or area not negatively affected by human activity            2 = Evidence of existing negative effects</p> <p><sup>a</sup> The airgun array will be shutdown if an endangered (or threatened) marine mammal or sea turtle is sighted within 500 m of the array.</p>								

**Table 5.15. Significance of potential residual environmental effects of the proposed geohazard program on the Sea Turtle VEC.**

VALUED ECOSYSTEM COMPONENT: SEA TURTLES				
Project Activity	Significance Rating	Level of Confidence	Likelihood (Significant Effect Only)	
	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Vessel Lights	NS	3	-	-
Sanitary/Domestic Wastes	NS	3	-	-
Air Emissions	NS	3	-	-
<b>Noise</b>				
Geohazard Vessel	NS	3	-	-
Echo Sounder	NS	3	-	-
Side Scan Sonar	NS	3	-	-
Seismic Array – physical effects	NS	3	-	-
Seismic Array – behavioural effects	NS	3	-	-
Boomer	NS	3	-	-
Towfish	NS	3	-	-
Presence of Geohazard Vessel	NS	3	-	-
Accidental Spills	NS	2	-	-
<p>Key:</p> <p>Residual environmental Effect Rating:            S = Significant Negative Environmental Effect            NS = Not-significant Negative Environmental Effect            P = Positive Environmental Effect            Significance is defined as a medium or high magnitude (2 or 3 rating) and duration greater than 1 year (3 or greater rating) and geographic extent &gt;100 km<sup>2</sup> (4 or greater rating).</p> <p>Level of Confidence: based on professional judgment:            1 = Low Level of Confidence            2 = Medium Level of Confidence            3 = High Level of Confidence</p> <p>Probability of Occurrence: based on professional judgment:            1 = Low Probability of Occurrence            2 = Medium Probability of Occurrence            3 = High Probability of Occurrence</p> <p>Scientific Certainty: based on scientific information and statistical analysis or professional judgment:            1 = Low Level of Confidence            2 = Medium Level of Confidence            3 = High Level of Confidence</p>				

### 5.6.7. Effects of the Project on Species at Risk

A biological overview of all species considered at risk under *SARA* and/or by COSEWIC that are likely or may occur in the Study Area was provided in Section 4.8 of the EA of Petro-Canada’s Jeanne d’Arc Basin 3-D Seismic Program (LGL Limited 2007). No critical habitat has been defined for the Study Area. As discussed in previous sections and presented in Table 4.22 of the EA of Petro-Canada’s Jeanne d’Arc Basin 3-D Seismic Program (LGL Limited 2007), *SARA*/COSEWIC species of relevance to the Study Area and their listing on Schedule 1 of *SARA* include:

- Wolffish (Atlantic wolffish: Special Concern; spotted and northern wolffish: Threatened)
- Ivory Gull (Special Concern)
- Blue whale (Endangered), fin whale (Special Concern)
- Leatherback sea turtle (Endangered)

Species not currently listed (see Table 4.22 of the EA of Petro-Canada's Jeanne d'Arc Basin 3-D Seismic Program (LGL Limited 2007) on Schedule 1 of SARA but listed on Schedule 2 or 3 or being considered for addition to Schedule 1 (as per their current COSEWIC listing of Endangered, Threatened or Special Concern), are not included in the SAR VEC here but have been assessed in the appropriate VEC in sections 5.6.3 (Fish) and 5.6.6 (Marine Mammals and Sea Turtles) of this EA Addendum. If species not currently listed on Schedule 1 of SARA do become listed on this legal list during the remainder of the life of the Project (2008-2010), the Proponent will re-assess these species considering the prohibitions of SARA and any recovery strategies or action plans that may be in place. Possible mitigation measures as they relate to Species at Risk will be reviewed with DFO and Environment Canada.

As per the detailed effects assessment contained in Section 5.6.3 and shown again in Tables 5.16-5.18, physical effects of the proposed geohazard program on the various life stages of wolffish will range from *negligible* to *low* over a duration of <1 month, within an area of <1 km<sup>2</sup>. Behavioural effects may extend out to a larger area but are still predicted to be *not significant*. The mitigation measure of ramping-up the airgun array is expected to minimize the potential for impacts on wolffish. The water depths in the Study Area are shallower than the known preferred water depths that wolffish typically inhabit.

As per the detailed effects assessment in Section 5.6.5, the predicted effect of the proposed geohazard program on Ivory Gulls is *not significant* as this species foraging behaviour would not likely expose it to underwater sound and this species is unlikely to occur in the Study Area, particularly during the summer when geohazard surveys are likely to be conducted. Furthermore, Ivory Gulls are not known to be sensitive to stranding on vessels. The mitigation measure of monitoring the geohazard vessel and releasing stranded birds (in the unlikely event that an Ivory Gull will strand on the vessel) and ramping-up the airgun array will minimize the potential for impacts on this species.

Based on available information, blue whales and sea turtles are not expected to occur regularly in the Study Area. [It is extremely unlikely that a North Atlantic right whale will occur in the Study Area.] No confirmed sightings of blue whales have been made in the Study Area and there have been two reported sightings of leatherback sea turtles (see Section 4.8 of the EA of Petro-Canada's Jeanne d'Arc Basin 3-D Seismic Program (LGL Limited 2007)). Fin whales, listed as Special Concern, are expected to occur regularly in the Study Area, particularly during summer months. There are no available recovery strategies or action plans in place for marine mammals that occur regularly in Newfoundland. A recovery strategy for leatherback sea turtles is available (ALTRT 2006). Mitigation and monitoring designed to minimize potential effects of airgun array noise on SARA-listed marine mammals and sea turtles will include:

- ramp-up of the airgun array;
- monitoring by a dedicated EO during daylight hours that the airgun array is active;
- shutdown of the airgun array when an endangered or threatened marine mammal or sea turtle is sighted within the 500 m safety zone; and
- delay of ramp-up if any marine mammal or sea turtle is sighted within the 500 m safety zone.

**Table 5.16. Potential interactions between the proposed geohazard program and Species At Risk VEC.**

<b>VALUED ECOSYSTEM COMPONENTS: SPECIES AT RISK</b>				
<b>PROJECT ACTIVITIES</b>	<b>Wolffish</b>	<b>Ivory Gull</b>	<b>Blue, Fin Whales</b>	<b>Leatherback Turtle</b>
Vessel Lights	x	x		
Sanitary/Domestic Waste	x	x	x	x
Air Emissions	x	x	x	x
Garbage <sup>a</sup>				
Noise				
Geohazard Vessel	x	x	x	x
Echo Sounder	x	x	x	x
Side Scan Sonar	x	x	x	x
Seismic Array	x	x	x	x
Boomer	x	x	x	x
Towfish	x	x	x	x
Presence of Geohazard Vessel	x	x	x	x
Shore Facilities <sup>b</sup>				
Accidental Spills	x	x	x	x
<b>OTHER PROJECTS AND ACTIVITIES</b>				
Hibernia	x	x	x	x
Terra Nova	x	x	x	x
White Rose	x	x	x	x
Exploration	x	x	x	x
Fisheries	x	x	x	x
Marine Transportation	x	x	x	x
<sup>a</sup> Not applicable as garbage will be brought ashore.				
<sup>b</sup> There will not be any new onshore facilities. Existing infrastructure will be used.				



**Table 5.17. Effects assessment on Species At Risk VEC.**

VALUED ECOSYSTEM COMPONENTS: SPECIES AT RISK								
Project Activity	Potential Positive (P) or Negative (N) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/Socio-Cultural and Economic Context
Vessel Lights	Attraction (N); mortality (N)	Turn off non-essential lighting; release protocols for Ivory Gull	0-1	1-2	1	1	R	1-2
Sanitary/Domestic Waste	Increased Food (N/P)	-	0-1	1	1	1	R	1
Air Emissions	Surface Contaminants (N)	-	0	1	1	1	R	1
Noise								
Geohazard Vessel	Disturbance (N)	-	0-1	1-2	1	1	R	1
Echo Sounder	Disturbance (N)	-	0-1	1-2	1	1	R	1
Side Scan Sonar	Disturbance (N)	-	0-1	1-3	1	1	R	1
Seismic Array	Physical Effects (N)	Ramp-up; Delay Start <sup>a</sup> ; Shutdown <sup>b</sup>	0-1	1	1	1	R	1
Seismic Array	Disturbance (N)	Ramp-up; Delay Start <sup>a</sup> ; Shutdown <sup>b</sup>	0-1	3-4	1	1	R	1
Boomer	Disturbance (N) Physical Effects (N)		0-1	1-4	1	1	R	1
Towfish	Disturbance (N)	-	0-1	1-2	1	1	R	1
Presence of Geohazard Vessel	Disturbance (N)	-	0-1	1	1	1	R	1
Accidental Spills	Injury/Mortality (N)	Spill Response	1-2	1-2	1	1-2	R	1
<p>Key:</p> <p><b>Magnitude:</b>            0 = Negligible, essentially no effect            1 = Low            2 = Medium            3 = High</p> <p><b>Frequency:</b>            1 = &lt;11 events/yr            2 = 11-50 events/yr            3 = 51-100 events/yr            4 = 101-200 events/yr            5 = &gt;200 events/yr            6 = continuous</p> <p><b>Reversibility:</b>            R = Reversible            I = Irreversible (refers to population)</p> <p><b>Duration:</b>            1 = &lt;1 month            2 = 1-12 months            3 = 13-36 months            4 = 37-72 months            5 = &gt;72 months</p> <p><b>Geographic Extent:</b>            1 = &lt;1 km<sup>2</sup>            2 = 1-10 km<sup>2</sup>            3 = 11-100 km<sup>2</sup>            4 = 101-1,000 km<sup>2</sup>            5 = 1,001-10,000 km<sup>2</sup>            6 = &gt;10,000 km<sup>2</sup></p> <p><b>Ecological/Socio-cultural and Economic Context:</b>            1 = Relatively pristine area or area not negatively affected by human activity            2 = Evidence of existing negative effects</p> <p><sup>a</sup> Ramp-up will be delayed if any marine mammal or sea turtle is sighted within the 500 m safety zone.  <sup>b</sup> The airgun array will be shutdown if an endangered (or threatened) marine mammal or sea turtle is sighted within 500 m of the array.</p>								

**Table 5.18. Significance of potential residual environmental effects of the proposed geohazard program on the Species At Risk VEC.**

VALUED ECOSYSTEM COMPONENT: SPECIES AT RISK				
Project Activity	Significance Rating	Level of Confidence	Likelihood (Significant Effect Only)	
	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Vessel Lights	NS	3	-	-
Sanitary/Domestic Wastes	NS	3	-	-
Air Emissions	NS	3	-	-
<b>Noise</b>				
Geohazard Vessel	NS	3	-	-
Echo Sounder	NS	3	-	-
Side Scan Sonar	NS	3	-	-
Seismic Array – physical effects	NS	3	-	-
Seismic Array – behavioural effects	NS	3	-	-
Boomer	NS	3	-	-
Towfish	NS	3	-	-
Presence of Geohazard Vessel	NS	3	-	-
Accidental Spills	NS	2-3	-	-
<p>Key:</p> <p>Residual environmental Effect Rating:            S = Significant Negative Environmental Effect            NS = Not-significant Negative Environmental Effect            P = Positive Environmental Effect            Significance is defined as a medium or high magnitude (2 or 3 rating) and duration greater than 1 year (3 or greater rating) and geographic extent &gt;100 km<sup>2</sup> (4 or greater rating).</p> <p>Level of Confidence: based on professional judgment:            1 = Low Level of Confidence            2 = Medium Level of Confidence            3 = High Level of Confidence</p> <p>Probability of Occurrence: based on professional judgment:            1 = Low Probability of Occurrence            2 = Medium Probability of Occurrence            3 = High Probability of Occurrence</p> <p>Scientific Certainty: based on scientific information and statistical analysis or professional judgment:            1 = Low Level of Confidence            2 = Medium Level of Confidence            3 = High Level of Confidence</p>				

With these mitigation measures in place and as per the detailed effects assessment in Section 5.6.6, the proposed geohazard program is predicted to have *no significant effect* (physical or behavioural) on blue whales, fin whales, or leatherback sea turtles.

In summary, potential effects of the proposed geohazard program is not expected to contravene the prohibitions of SARA (Sections 32(1), 33, 58(1)).

## 5.7. Cumulative Effects

This document has assessed cumulative effects within the Project and thus the residual effects described in preceding sections include any potential cumulative effects from the Petro-Canada geohazard survey activities in the Project Area. As already noted, it is unlikely that a geohazard program would occur in the same area and time as 3-D seismic surveys, given the potential for physical and acoustic interference between the two programs.

It is also necessary to assess cumulative effects from other activities outside the Project that are planned for the area. These activities may include:

- Commercial fishing [Note that there are no recreational or aboriginal fisheries in Jeanne d'Arc Basin.]
- Vessel traffic (e.g., transportation, defense, yachts)
- Hunting (e.g., seabirds, seals)
- Offshore oil and gas industry

Commercial fishing has been assessed in Section 5.6.4 and discussed in detail in Section 4.5 of LGL Limited (2007). Commercial fishing activities, by their nature, cause mortality and disturbance to fish populations and may cause incidental mortalities or disturbance to seabirds, marine mammals, and sea turtles. It is predicted that the geohazard surveys will not cause any mortality to these VECs (with the potential exception of small numbers of petrels) and thus, there will be *no* or *negligible* cumulative effect from mortalities. There is some potential for cumulative effect from disturbance (e.g., fishing vessel noise) but there will be directed attempts by both industries to mitigate effects and to avoid each other's active areas and times. Any gear damage attributable to the Project will be compensated and thus any effects will be *not significant*.

In the summer, the main North Atlantic shipping lanes between Europe and North America lie to the north of the Grand Banks into the Strait of Belle Isle. In the winter, that traffic shifts to the main shipping lanes along the southern Grand Banks into the Gulf of St. Lawrence. Thus, potential for cumulative effects with other shipping is predicted to be *negligible to low*.

The vast majority of hunting of seabirds (mostly murre) in Newfoundland and Labrador waters occurs near shore from small boats and thus, there is little or no potential for cumulative effects on this VEC. Similarly, most, if not all, seal hunting would occur inshore of the Project Area.

Offshore oil and gas industry 2007 projects listed on the C-NLOPB public registry ([www.cnlopb.nl.ca](http://www.cnlopb.nl.ca) as viewed 2 May 2007) include:

- Canada/Greenland 2006 2-D Marine Seismic Survey (TGS-NOPEC)
- Jeanne d'Arc Basin 3-D Seismic Program (Husky Energy)
- Orphan Basin controlled source electromagnetic (CSEM) Program (ExxonMobil Canada Ltd.)
- White Rose New Drill Centre Construction and Operations Program (Husky Energy)
- Terra Nova Vertical Seismic Profiling (Petro-Canada)

In addition, there are three existing offshore production developments (Hibernia, Terra Nova, and White Rose) on the northeastern part of the Grand Banks. While the existing developments are all included within the borders of the proposed Project Area., they are within the range of activities that have occurred on the Grand Banks over the last 10 years. Any cumulative effects (i.e., disturbance), if they occur, will be additive (not multiplicative or synergistic) and predicted to be *not significant*.

There is potential for cumulative effects with the Husky Energy Jeanne d’Arc Basin 3-D Seismic Program and ExxonMobil Canada Orphan Basin CSEM Program, which have the potential to overlap in time and, potentially in space, if animals in both areas receive sound from more than one program at a time. Nonetheless, the two surveys will have to be far enough apart at any given time so as not to interfere with each other’s data quality. As discussed in LGL Limited (2007) and reviewed in this document, significant negative effects on key sensitive VECs such as marine mammals appear unlikely beyond a localized area from the sound source (it is this zone upon which the mitigation measures are based). In addition, all programs will use mitigation measures such as ramp-ups, delayed start ups, and shutdowns of the airgun array. Thus, it seems likely that while some animals may receive sound from one or more seismic programs in 2007, the current scientific prediction is it that *no significant residual effects* will result.

## 5.8. Summary of Mitigations and Follow-up

Project mitigations pertaining to the geohazard program have been detailed in the various individual sections of this document and are summarized in the text provided below and in Table 5.19. [The reader is referred to Section 5.8 of LGL Limited 2007 for mitigation measures specific to the 3-D seismic program.] Petro-Canada and contractors will adhere to mitigations detailed in Appendix 2 of the C-NOPB *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (April 2004).

**Table 5.19.** Summary of mitigation measures for the proposed geohazard program.

Potential Effects	Primary Mitigations
Interference with fishing vessels	Upfront planning to avoid high concentrations of fishing vessels; SPOC; advisories and communications
Fishing gear damage	Upfront planning to avoid high concentrations of fishing gear; SPOC; advisories and communications; compensation program
Interference with shipping	SPOC; advisories and communications
Interference with DFO/FFAW research vessels	Communications and scheduling
Temporary or permanent hearing damage/disturbance to marine animals	Delay start-up if marine mammals or sea turtles are within 500 m; ramp-up of airguns; shutdown of airgun arrays for endangered or threatened marine mammals and sea turtles. Use of an EO to monitor for marine mammals and sea turtles during daylight seismic operations.
Temporary or permanent hearing damage/ disturbance to Species at Risk or other key habitats	Delay start-up if marine mammals or sea turtles are within 500 m; ramp-up of airguns; shutdown of airgun arrays for endangered or threatened marine mammals and sea turtles. Use of an EO to monitor for marine mammals and sea turtles during daylight seismic operations. [No critical habitat has been identified in or near the Study Area.]
Injury (mortality) to stranded seabirds	Daily monitoring of vessel; handling and release protocols, minimize lighting if safe
Seabird oiling	Adherence to MARPOL; spill contingency plans

Fishers who may be operating in the area will be notified of the timing and location of planned activities by means of a CCG “Notice to Mariners” and a “Notice to Fishers” on the CBC Radio Fisheries

Broadcast. In addition, if necessary, individual fixed gear fishers will be contacted to arrange mutual avoidance. Any contacts with fishing gear, with any identifiable markings, will be reported to the C-NLOPB within 24 h of the contact. Any floating debris resulting from contact with fish gear will be retrieved and retained if it is safe to do so in the opinion of the vessel's master. Petro-Canada will advise the C-NLOPB prior to compensating and settling all valid lost gear/income claims promptly and satisfactorily.

Specific mitigations to minimize potential conflicts and any negative effects with other vessels from the geohazard program include:

- Excellent communications (VHF, HF, Satellite, etc.)
- Posting of advisories with the Canadian Coast Guard and the CBC Fisheries Broadcast
- Compensation program in the event any project vessels damage fishing gear
- Single Point of Contact (SPOC)

Petro-Canada will also coordinate with Fisheries and Oceans, St. John's, and the FFAW to avoid any potential conflicts with survey vessels that may be operating in the area.

Mitigation measures designed to reduce the likelihood of impacts on marine mammals and sea turtles will include ramp-ups, no initiation of airgun array if a marine mammal or sea turtle is sighted 30 min prior to ramp-up within 500-m safety zone of the energy source, shutdown of the energy source if an endangered (or threatened) whale or sea turtle is observed within the 500-m safety zone. Prior to the onset of the seismic survey, the airgun array will be gradually ramped up. One airgun will be fired first and then the volume of the array will be increased gradually over a 20-40 minute period<sup>2</sup>. An observer aboard the survey vessel will watch for marine mammals and sea turtles 30 min prior to ramp-up. If a marine mammal or sea turtle is sighted within 500 m of the array, then ramp-up will not commence until the animal has moved beyond the 500-m zone or 20 min have elapsed since the last sighting. The observers will watch for marine mammals and sea turtles when the airgun array is active (during daylight periods) and note the location and behaviour of these animals. The seismic array will be shutdown if an endangered (or threatened) whale or sea turtle is sighted within the safety zone. Any dead or distressed marine mammals or sea turtles will be reported immediately to the C-NLOPB.

Any seabirds (most likely Leach's Storm-Petrel) that become stranded on the vessel will be released using the mitigation methods consistent with *The Leach's Storm-Petrel: General Information and Handling Instructions* by U. Williams (Petro-Canada) and J. Chardine (CWS) (n.d.). It is understood

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<sup>2</sup> Given the short length of the geohazard survey lines and that airguns may have to be repaired between survey lines, it will not always be possible to conduct a 20-40 min ramp up between each survey line. As such, activating a single airgun during line changes as a mitigation measure was considered. However, during turns between survey lines maintaining one or more active airguns poses a concern for streamer damage (E. Cummings, Furgro-Jacques, pers. comm.). Thus, the Huntec system will remain active during turns to provide sound input to the water during that time; in addition, as the turn is completed and risk to the streamer is reduced, the array will be started up sequentially (i.e., one airgun at a time) for as long a period as possible; the EO will maintain a watch during this period and if marine mammals or sea turtles are observed within 500 meters then shutdown will be required followed by full ramp up procedures.

by Petro-Canada that a CWS *Migratory Bird Handling Permit* will likely be required. In the unlikely event that marine mammals, sea turtles or birds are injured or killed by Project equipment or accidental spills of fuel or streamer flotation fluid, a report will immediately be filed with C-NLOPB and the need for follow-up monitoring assessed.

Marine mammal observations will be made during ramp-ups and during data acquisition periods, and at other times on an opportunistic basis. A monitoring program will be designed in consultation with DFO and CWS as per the C-NLOPB *Guidelines*. Data will be collected by an EO. A monitoring report will be submitted to the C-NLOPB within one year after completion of the surveys.

## 5.9. Summary of Residual Effects

A summary of the Project’s residual effects on the environment, in other words those effects that remain after mitigations have been instituted, are shown in Table 5.20. Geohazard activities in the Project Area should not result in any significant effects on VECs, including the Species at Risk VEC (Table 5.20). Petro-Canada will implement mitigation and monitoring during survey activities. A dedicated EO will monitor for seabirds, marine mammals and turtles. This will also assist in minimizing any potential effects on VECs. No significant effects are predicted for VECs from survey activities as magnitude of impacts will be negligible to low, geographic extent of negative effects in most cases will be well less than 100 km<sup>2</sup>, duration will be <1 month, and any effects will be reversible, at least at the population level.

**Table 5.20. Significance of potential residual environmental effects of the proposed geohazard program on VECs in the Study Area.**

Valued Ecosystem Component: Fish, Fisheries, Birds, Turtles, Mammals, Species at Risk				
Project Activity	Significance Rating	Level of Confidence	Likelihood (Significant Effect Only)	
	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Vessel Lights	NS	3	-	-
Sanitary/Domestic Wastes	NS	3	-	-
Air Emissions	NS	3	-	-
<b>Noise</b>				
Geohazard Vessel	NS	3	-	-
Echo Sounder	NS	3	-	-
Side Scan Sonar	NS	3	-	-
Seismic Array – physical effects	NS	3	-	-
Seismic Array – behavioural effects	NS	3	-	-
Boomer	NS	3	-	-
Towfish	NS	3	-	-
<b>Vessels</b>				
Seismic Vessel and Streamer	NS	3	-	-
<b>Presence of Geohazard Vessel/Streamer</b>	NS	3	-	-
<b>Accidental Spills</b>	NS	2-3	-	-

**Table 5.20 (Continued).**

Key:	
Residual environmental Effect Rating:	Probability of Occurrence: based on professional judgment:
S = Significant Negative Environmental Effect	1 = Low Probability of Occurrence
NS = Not-significant Negative Environmental Effect	2 = Medium Probability of Occurrence
P = Positive Environmental Effect	3 = High Probability of Occurrence
Significance is defined as a medium or high magnitude (2 or 3 rating) and duration greater than 1 year (3 or greater rating) and geographic extent >100 km <sup>2</sup> (4 or greater rating).	Scientific Certainty: based on scientific information and statistical analysis or professional judgment:
	1 = Low Level of Confidence
	2 = Medium Level of Confidence
	3 = High Level of Confidence
Level of Confidence: based on professional judgment:	1 = Low Level of Confidence    3 = High Level of Confidence
	2 = Medium Level of Confidence

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## **Appendix A. Short Overview of the Proposed 2007 Petro-Canada Geohazard Survey (Email Text Cover Letter)**

Dear \*

Petro-Canada is proposing to conduct a geohazard survey over the proposed North Mara K-36 and Wild Cove B-27 wellsites located northwest of the Terra Nova development (see attached map). This work is scheduled for the summer of 2007, though it could be extended into the fall months. These proposed survey activities will be conducted within a relatively small (4.4 km x 6.8 km) area (approximately 30 km<sup>2</sup>).

The C-NOPB requires that drilling operations are conducted in a safe manner and that an “application for Authority to Drill a Well (ADW) must be preceded or accompanied by documentation to show that the operator has investigated the immediate area of the proposed location to identify any possible hazards to drilling on the seafloor and during the drilling of the well prior to setting surface casing” (C-NOPB 2004).

Petro-Canada’s proposed 2007 wellsite survey activities are similar to other geohazard surveys undertaken in previous years, e.g. in 2004 and 2005.

The survey vessel remains to be determined but will likely be the MV Anticosti. The geohazard survey will likely take about 8 days to complete, including approximately 2.5 days of vessel transit and deployment/testing time. However, if weather conditions are not ideal, the work might take up to 9-11 days to complete.

The proposed work would comprise a full-suite geohazards investigation intended to provide assurances of safe drilling conditions. Data will be acquired with a 96 channel multichannel seismic system, a Hunttec DTS sub-bottom profiler, digital side scan sonar system, multibeam echo sounder, magnetometer, and groundtruthing systems (seabed video and grab sample).

Further information about these proposed survey activities may also be obtained from Mr. Greg Janes, Petro-Canada’s Senior Advisor (Environment), at 778-3710 (or email address [gjanes@petro-canada.ca](mailto:gjanes@petro-canada.ca)).

If you have any concerns or questions about these planned survey activities, or if you would like to receive additional information about them, would you please let me know.

I look forward to hearing from you.

Yours truly,  
Strat Canning

## **Appendix B. Persons Consulted**

### **Environment Canada (Environmental Protection Branch)**

Glenn Troke, EA Co-ordinator

### **Fisheries and Oceans**

Randy Power, Senior Regional Habitat Biologist

### **Natural History Society**

Dr. Len Zedel, MUN

### **One Ocean**

Maureen Murphy, Research Director

### **Fish, Food and Allied Workers Union (FFAWU)**

Jamie Coady, Fisheries Liaison Officer

### **Association of Seafood Producers**

E. Derek Butler, Executive Director

### **Fishery Products International**

Derek Fudge, Manager, Fleet Administration and Scheduling

Russ Carrigan, Corporate Communications (Industry and Government Relations)

### **Icewater Harvesting**

Michael O'Connor, Fish Harvesting Consultant

Tom Osbourne, Asst. Plant Manager (Arnold's Cove)

### **Nova Scotia**

Christine Penney, Director of Corporate Affairs, Clearwater Seafood's Limited Partnership

### **Groundfish Enterprise Allocation Council (Ottawa)**

Bruce Chapman, Executive Director