Addendum to the Environmental Assessment of Chevron's Offshore Labrador Seismic Program, 2010-2017

Prepared by

LGL LIMITED
environmental research associates

for

Chevron

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Project No. SA1031

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Preface

This addendum contains Chevron's response to review comments on the "Environmental Assessment of Chevron's Offshore Labrador Seismic Program, 2010-2017." Reviewer comments are in italic font followed by Chevron's response in normal font.

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General Comment 1 – Biological and Socio-economic Environments

(a) *This section provides a generally comprehensive overview of the species that may be impacted by seismic activity in the Study Area, but there appears to be a general lack of supporting references for this information. Typically, all scientific statements should be properly cited and referenced.*

(b) *It should also be noted that at least two fish species under moratoria (2+3K American Plaice and Witch Flounder) and possibly other sensitive species are found in this area, so even a small event may have a large impact for some of these species.*

(c) *There also seems to be a lack of recent studies on the life history of some species. For example, there are more recent DFO reports for Greenland Halibut than the studies referenced in this report, which should be considered during this assessment. Please refer to the NAFO Scientific Council Studies for annual studies and updates on Greenland Halibut. Also, if additional information is required on specific species please contact respective DFO Scientists.*

(d) *It should be noted that there are no studies that support the following statement: "Planktonic organisms are so ubiquitous and abundant and many have such rapid generation times that there will be essentially no effect on plankton communities from the seismic program". And even if this statement was true, this does not necessarily mean that there is no potential for influence on other organisms which depend on these planktonic organisms for food. For example, it is possible that timing of the survey may significantly affect feeding for certain species.*

Response to General Comment 1(a)

Chevron feels that the scientific statements in the 'Biological and Socio-economic Environments' section are cited and referenced properly. However, if identified, any exceptions to this can be corrected.

Response to General Comment 1(b)

It is noted that particular fish stocks that occur in the Study Area (e.g., American plaice, witch flounder) are currently under moratoria, and thus their populations may be more sensitive to perturbation.

Response to General Comment 1(c)

The life history information provided for various species in this section, regardless of the date of the source, is correct. As for Greenland halibut, the most recent publication pertaining to fish in the Study Area was used, in combination with other references that provide correct information for this species. Most of the recent DFO and NAFO documents relating to Greenland halibut are specific to other areas (e.g., Gulf of St. Lawrence, Baffin Island waters). If there are other

references for Greenland halibut in offshore Labrador waters that were overlooked for this EA, their identifications are welcome.

Response to General Comment 1(d)

Based on what is known about the potential effects of exposure to seismic sound on ichthyoplankton and invertebrate eggs and larvae, it is likely that the effect of seismic surveying on phytoplankton and zooplankton would be negligible. The plankton occurring immediately next to the airguns might be affected but they represent a miniscule proportion of all plankton in the area. Any negligible effects on plankton would translate to negligible effects on their grazers and predators.

General Comment 2 – Effects of the Project on the Environment – Marine Fish

The unknown long term effects of seismic activities continue to concern harvesters. There have been reports from harvesters that fish behaviour has been affected following seismic blasts and shellfish have disappeared from areas following seismic work being undertaken. There have also been reports from vessel captains that groundfish catches have been impacted when oil and gas activities have been ongoing. While the research has not determined any direct mortality of fish or shellfish attributable to seismic activity it needs to be recognized that there may be behavioural changes that could affect migration and/or reproductive and spawning activities as well as movement of the exploitable biomass in an area. While Atlantic cod is not a significant commercial species in the project area, some stocks do migrate off the Labrador coast during the time that Chevron proposes to conduct its activities. There is a possibility that seismic work may induce some behavioural changes in the stock(s).

Response to General Comment 2

Section 5.7.4.2 refers to anecdotal information provided by Newfoundland and Labrador fishers that suggests behavioural effects of exposure to seismic sound on some commercial species. In addition, references cited in Section 5.7.4.2 have suggested effects of seismic sound on groundfish catches in other areas of the world. Scientists currently investigating the potential effects of seismic sound on invertebrates and fish are in agreement that behavioural effects warrant most of the focus of study, particularly as to how they relate to what 'normal' behaviour an animal is exhibiting at the time of exposure to seismic sound. Section 5.7.4.2 discusses the various types of behavioural effects on marine invertebrates and fishes observed to date.

General Comment 3 – Effects Assessment

(a) *The effects assessment section contains a comprehensive review and interpretation of known risks of sound and seismic on marine organisms. Expertise has been applied to evaluating risks to fish, shellfish and other aquatic organisms in the survey area and conclusions are consistent with what is known to date about the risks of seismic and the present guidelines for evaluating risk. The report also correctly notes in several places that*

this data is very limited. It is still important to note that the few studies which have been carried out for this type of assessment have considered different species and even fewer have replicate studies for any particular species. It should also be noted that extrapolating results of individual studies to population scale effects may be difficult, especially since it may require a large response for an effect to become obvious in any one study or survey. Population scale effects may therefore not become obvious until some time has passed. Furthermore, to date studies have involved different species, environments, sound levels as well as field and lab conditions, making comparisons difficult.

(b) *Considering the broader question regarding the potential risks of seismic, the assessment notes a somewhat dated paper in which a variety of effects were recorded in brown shrimp chronically exposed to a relatively low level of sound. Included were effects on growth and reproduction. This dated paper reinforces the question of acute versus chronic effects, which is a major knowledge gap for aquatic organisms in general. Given that shrimp is a major fishery in the Study Area, and that 2D and 3D surveys may be carried out along the Labrador coast for a number of years (by Chevron as well as others), regulators should address the question on whether chronic exposure of shrimp to low levels of sound poses any risk to these species during surveys of 3 weeks duration or more. Addressing this question would provide a basis for providing an informed opinion on whether a risk might exist or not. Any such studies on shrimp would also be of value for application to other crustaceans.*

(c) *Overall, this section provides little discussion regarding the impacts on less mobile invertebrates. Mobile organisms may be able to avoid impacts of seismic sound, but those with less mobility may have increased susceptibility to repeated exposures to high levels of sound. Effects on organisms such as invertebrates may have an added effect on the food web as a whole. This may lead to problems such as reduced prey availability for important species such as Atlantic Cod.*

(d) *It is indicated that "spatial and temporal avoidance of critical life history times" would mitigate airgun sound. This statement is very general and it is not clear how this strategy would be implemented. Would there be monitoring for large aggregations of fish? It is possible that the July to November time period may overlap with the spawning period of some species.*

(e) *Although a general outline of the project area was indicated, information on specific proposed seismic survey lines would be beneficial to more accurately evaluate project footprint and seismic survey impacts.*

Response to General Comment 3(a)

It is recognized that scientific data related to the effects of exposure to seismic sound on marine organisms have several limitations, besides their limited availability. For example, interspecific differences exist for marine fishes in terms of sound detection mechanisms, hearing sensitivity and impact from exposure to sound. However, assessment of the effects on the VECs at a

population level still requires careful extrapolation from existing defensible studies as well as sound professional judgement. The EA does indicate that the available database has limitations and requires ongoing addition of data.

Response to General Comment 3(b)

We agree that further study of the effects of exposure to seismic sound on invertebrates (and fishes for that matter) would decrease the level of uncertainty. It should be noted that the study involving brown shrimp used captive animals unable to escape exposure. Anecdotal information from Newfoundland and Labrador fishers suggests that northern shrimp move away from a seismic source, thereby decreasing exposure levels (see Section 5.7.4.2, behavioural effects on invertebrates).

Response to General Comment 3(c)

Section 5.7.4.2 does discuss the effects of exposure to seismic sound on marine invertebrates, based on all available scientific literature. In general, the sessile marine invertebrates occur on bottom further from the seismic source than more mobile invertebrates that can occur throughout the water column.

Response to General Comment 3(d)

The phrase "spatial and temporal avoidance of critical life history times" in Section 5.7.4.3 should have been qualified. This mitigation would only be used if a particular location has been identified as being unique for a key behaviour of a species at a particular time. Obviously various life history behaviours (e.g., reproduction) of numerous species are occurring in the Study Area at different times. However, the areas where these behaviours occur tend to be widespread and not localized in the Study Area, and therefore the mitigation of spatial and temporal avoidance would not be necessary.

Response to General Comment 3(e)

The exact location and orientation of seismic lines is not known at this time. As a result, the Study Area selected as the spatial boundary of the environmental assessment encompasses any potential areas of seismic activity.

General Comment 4 – Effects of the Project on the Environment-Marine Mammals and Sea Turtles

A discussion of factors such as visibility, which may impact timing of the survey as well as the effectiveness of mitigation measures, such as the ability of marine mammal observers (MMOs) to detect marine mammals should be included in the assessment.

This section mentions that surveys will not likely affect the prey of sea turtles, including jellyfish. Given the fragile nature of jellyfish, it would be useful to have more information to examine this

likelihood more closely. As for other species, the possible interruption of prey availability due to seismic activity should be noted as a potential negative effect.

Response to General Comment 4

Visibility does not usually have an affect the timing of seismic surveys and typically does not affect day-to-day seismic operations. Streamer repair operations from the source vessel's workboat may be limited by poor visibility or poor weather because visual contact between the seismic source vessel and the workboat are usually required. This situation occurs infrequently. Sea state conditions have the most affect on seismic operations. Typically operations are not possible in Beaufort wind force conditions higher than 6.

The reviewer is referred to Moulton et al. (2009) which provides an assessment of factors which affect the efficacy of mitigation measures outlined in the "Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment". Factors reviewed include those that affect visual monitoring such as environmental conditions (darkness, sea state/swell, water turbidity, glare, and fog/rain/snow), logistical factors (vessel obstructions, height above sea level, MMOs, and equipment), and marine mammals and their behaviour. Fog and darkness are the two environmental factors which have greatest influence on the ability of MMOs to visually detect marine mammals (and sea turtles). Moulton et al. (2009) noted that the 500-m safety zone could be fully monitored only ~39% of the time, on average (minimum 25%) in months during which seismic exploration commonly occurs in the NW Atlantic (based on MMO data collected offshore Newfoundland and Nova Scotia). However, based on observations collected during periods with good visibility, few marine mammals are observed within 500 m of the seismic vessel during periods with and without airgun activity. As discussed in the EA, it is unlikely that marine mammals would incur injury as a result of exposure to seismic survey sound.

Jellyfish are not fragile with respect to exposure to seismic sound. In fact, the body density of these animals is more similar to the density of seawater than most other marine organisms. Therefore, a pressure wave produced by a seismic airgun discharge is less likely to impact a jellyfish. Supposing that seismic sound can negatively impact a jellyfish, it would likely only occur if the animal was immediately next to an airgun. That being said, the proportion of the jellyfish population that would be affected is negligible. Pilot studies that have been conducted at Fisheries and Oceans Canada, St. John's, NL included exposing ctenophores (comb jellies) to airgun discharges. The unpublished results indicated that the ctenophores were not acutely affected. See Section 5.7.4 that discusses fish and fish habitat, and the potential effects of exposure to seismic sound on this VEC.

General Comment 5 – Mitigations and Follow-up

In Table 5.19 (p. 220) it was noted that delayed start-up will be used for marine mammals and sea turtles within 500 m, but that shutdown will occur only for endangered/threatened species. However, harming or disturbing any marine mammal is prohibited under s. 32 of the Fisheries Act and all mitigation measures identified in Appendix 2 of the "Geophysical, Geological,

Environmental and Geotechnical Program Guidelines (C-NLOPB 2008), as well as those identified in Table 5.19, should be considered. Also in this regard, it is suggested that multiple MMOs be utilized to ensure sufficient rest during the course of the survey. While it is emphasized that MMOs will be utilized during daylight hours, it is not clear whether these mitigation measures will exist for nighttime survey activity.

To mitigate potential conflicts with fishing vessels and fishing gear it is recommended that Chevron utilize a Fisheries Liaison Officer (FLO) during the various seismic activities proposed. FLOs have experience with vessel traffic and gear deployment and can provide a communication platform for the fishing industry. They are also trained as MMOs.

Response to General Comment 5

Chevron is committed to following the mitigations outlined in the "Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment". Section 8 of the Statement reads as follows:

8. "The air source array(s) must be shut down immediately if any of the following is observed by the Marine Mammal Observer in the safety zone:
    a. a marine mammal or sea turtle listed as endangered or threatened on Schedule 1 of the *Species at Risk Act*; or
    b. based on the considerations set out in sub-section 4(b), any other marine mammal or sea turtle that has been identified in an environmental assessment process as a species for which there could be significant adverse effects."

A review of available literature and assessment of potential impacts taking into consideration application of mitigation measures in the EA demonstrated that no significant adverse effects were predicted for marine mammals and sea turtles. Physical harm and significant disturbance are not predicted to occur. Chevron will have at least one MMO aboard the seismic source vessel throughout the proposed seismic survey to implement mitigation measures. Additionally, Chevron is currently reviewing the applicability and effectiveness of Passive Acoustic Monitoring for the Labrador Shelf Program. During periods of darkness, ramp up procedures will continue. However, it is not possible to effectively visually monitor the safety zone during darkness. If the ship's crew detects a marine mammal or sea turtle during periods of darkness, the typical procedure is for a MMO to report to the bridge and implement mitigation measures as appropriate.

As stated in Section 5.9 *Mitigations and Follow-up,* Chevron will utilize a Fisheries Liaison Officer during proposed seismic activities. The FLO typically assists MMOs with marine mammal watch duties.

General Comment 6 – Cumulative Effects

Cumulative effects should also include other seismic studies which are expected to occur near the Study Area within the same time frame (2010 to 2017). It is likely that other seismic surveys

will be conducted in adjacent areas of the Labrador Shelf during this time period, and it is suggested that this should be carefully considered when timing the present study in order to avoid concurrent surveys, which may lead to greater stress and displacement of organisms.

With the recognition that there may be three concurrent seismic programs in the project area, more quantitative analyses, with respect to the potential cumulative effects of these operations, would be helpful. With this in mind, a follow-up and monitoring program for fish and shellfish within the area is recommended by the Nunatsiavut Government.

As there is the possibility of concurrent seismic programs in the area, the potential conflicts with fishing vessels and gear and the potential influence of seismic activity on important fish and shellfish resources are increased.

Response to General Comment 6.

To date, concurrent seismic surveys have been rare in Newfoundland and Labrador waters. This is at least partly due to the fact that different operators tend to use the same vessel for logistic efficiency. In 2010, there were two seismic surveys off Labrador with two clients utilizing the same vessel. Chevron and Co-venturers conducted two concurrent surveys in Orphan Basin and the survey patterns were designed so that the sound emanating from one vessel would not interfere with the data quality of the other. As a general rule, vessels kept a distance of at least 40 km apart. Given the state of knowledge concerning the potential effects of seismic sound on marine animals and the potential levels of received sound, it was predicted that there would be little or no cumulative effects on marine animals from overlapping sounds.

Potential effects of seismic surveys on marine fish and invertebrates are reviewed in detail in the EA. It was concluded that physical or physiological effects are unlikely. There are a few anecdotal and published reports that have reported effects (both positive and negative) on fish catches but such effects are not expected to last more than a few days. For this reason and because the *Canadian Environmental Assessment Act* does not specify follow-up monitoring unless there is a possibility of significant effects, follow-up monitoring is not warranted.

Conflicts with fishing vessels will be minimized and operational monitoring will be conducted through the use of a FLO and should there be any concurrent seismic programs, the Chevron FLO would also be in contact with other operator FLOs nearby. Other key mitigations include a Single Point of Contact (SPOC) and a communications program.

General Comment 7 – SARA

For the purposes of this assessment, it is sufficient to simply include species listed under Schedule 1 of SARA and omit the COSEWIC designations, since this is the official list (federally) of species at risk.

Please note all species designated under Schedule 2 of SARA have been reassessed and 13 out of 103 species designated under Schedule 3 have been reassessed. Please refer to the links below for more information:

http://www.sararegistry.gc.ca/species/schedules_e.cfm?id=2;
http://www.sararegistry.gc.ca/species/schedules_e.cfm?id=3.

Response to General Comment 7

Table 4.14 in Section 4.6 currently contains both *SARA* and COSEWIC designations for species at risk which may occur within the study area, including potential candidate species for COSEWIC listing. However, in light of the fact that COSEWIC has recently reassessed all 39 species listed under Schedule 2 of *SARA*, and 90 (not 13) of 103 species listed under Schedule 3, this environmental assessment will focus exclusively on those species listed under the federally official Schedule 1 of *SARA*. As such, Table 4.14 should appear as follows. The harbour porpoise has been classified *special concern* on *SARA* Schedule 1 since the environmental assessment was originally submitted.

Table 4.14 *SARA* Schedule 1-listed marine species that potentially occur in the Study Area.

Species		***SARA* Schedule 1**		
Common Name	**Scientific Name**	***Endangered***	***Threatened***	***Special Concern***
Blue whale (Atlantic population)	*Balaenoptera musculus*	X		
Northern bottlenose whale	*Hyperoodon ampullatus*	X		
Leatherback sea turtle	*Dermochelys coriacea*	X		
Ivory gull	*Pagophila eburnea*	X		
Northern wolffish	*Anarhichas denticulatus*		X	
Spotted wolffish	*Anarhichas minor*		X	
Atlantic wolffish	*Anarhichas lupus*			X
Fin whale (Atlantic population)	*Balaenoptera pyhysalus*			X
Harbour porpoise	*Phocoena phocoena*			X

General Comment 8 – Potentially Sensitive Areas

The study and project areas are both located in Canada's NL-Labrador Shelves Marine Ecoregion. This is important to note, as two primary uses of this biogeographic classification system are i) assessing and reporting on ecosystem status and trends, and ii) spatial planning for the conservation of ecosystem properties and management of human activities. In addition, these areas (and information) will be useful towards guiding the selection of future representative marine protected areas.

Response to General Comment 8

Chevron recognizes the importance of indicating that the Study Area occurs within the Canadian NL-Labrador Shelves Marine Ecoregion, one of the selected biogeographic units based on those identified by the Canadian Council of Resource Ministers (CCRM) (DFO 2009). This is

important to note, as two primary uses of this biogeographic classification system are (1) assessing and reporting on ecosystem status and trends, and (2) spatial planning for the conservation of ecosystem properties and management of human activities.

General Comment 9 – Commercial Fisheries

(a) *The commercial fishery is very important to many communities on the south coast of Labrador. While the membership of the Fish, Food and Allied Workers' Union (FFAWU) live in communities as far north as Fish Cove Point (north of Nain), members fish in NAFO divisions 2J, 2H and 2G for crab, shrimp, turbot, cod and other species. Harvesters in 4R (northern Newfoundland) have rights to fish in 2J, and members on the northeast coast still have fishing rights off the coast of Labrador. FFAWU members fish quotas for the Natuashish Government in NAFO zone 2H.*

(b) *Communication between the proponent and the FFAWU during a multi-year seismic program is essential as harvesters are spread out over a wide geographic area and communication is essential to the safety of all involved. There is a need for good planning and further consultation with the fishing industry several months prior to the start of the various components of the seismic program to avoid potential conflicts at sea.*

(c) *Fishing activity can change from year to year and during season as well. As an example, turbot is becoming more of an important commercial species and many harvesters have geared up to fish turbot in 2010. The fishery uses fixed gear that may introduce more potential interactions between the fishing and oil and gas sectors in the coming years. The fishery is also being actively prosecuted at the time that Chevron is proposing to conduct its program. The peak month for shrimp landings within the project area is June, the peak time for harvesting snow crab is July and August and turbot fishing peaks in August and September. It is therefore important that Chevron maintain regular communication with the FFAWU to keep apprised of ongoing developments in the fishing industry.*

Response to General Comment 9(a)

The importance of the commercial fishery off the coast of Labrador to communities and people of Labrador and parts of Newfoundland is understood by Chevron. Mitigation measures intended to minimize disturbance to the commercial fishery (discussed in Sections 5.7.4, 5.7.5 and 5.9) will be implemented.

Response to General Comment 9(b)

Chevron is committed to ongoing stakeholder relations. The timing of planned seismic activities will be communicated to those involved in the fishing industry, and subsequent feedback to Chevron will be considered during the planning process.

Response to General Comment 9(c)

Chevron is committed to maintaining regular communication with the FFAWU to keep apprised of ongoing developments and changes in the fishing industry as they relate to the Study Area, including peak fishing times for various species and the gear types that will be used during the various fisheries. Specifics of the various fisheries (e.g., timing, gear types) can change on a year-to-year basis or even within a season. Therefore, regular communication is essential.

General Comment 10 – Aboriginal Fisheries

It is extremely important to the Nunatsiavut Government that the aboriginal fishery (offshore and nearshore) is not disturbed or negatively affected by the proposed seismic program. The area proposed for seismic activity is extremely important to the Nunatsiavut fishery and will probably become more important in the future. As a mitigating factor, it is recommended that the Torngat Joint Fisheries Board have input into the EA process and the seismic program during its implementation.

A follow-up and monitoring program regarding catch rates (fishing success) for the aboriginal fishery in and near the study area to ensure that catch rates are not decreasing is recommended. If there are effects being detected, then mitigative measures will have to be put in place over the duration of the seismic program.

Response to General Comment 10

Please refer to Section 5.2 for a description of consultations held for this Project. Chevron met with representatives of the Torngat Wildlife, Plants and Fisheries Secretariat during project consultations. Chevron is committed to ongoing stakeholder relations, and will include the Torngat Joint Fisheries Board (TJFB) on the distribution list for any program notifications, and in future consultation meetings.

The EA predicted there would be no significant effects of the Chevron seismic program on fisheries in and near the Project Area. The chief means of mitigating potential effects on fisheries activities is to avoid active fishing areas, particularly fixed gear zones when they are occupied by harvesters. For these reasons, a follow-up and monitoring program of fishing success is not seen to be warranted. However, the TJFB will be contacted after the seismic survey to discuss any concerns.

General Comment 11 – Traditional Ecological Knowledge

It has been demonstrated within the scientific literature that Inuit Knowledge (or Traditional Ecological Knowledge, more broadly) is a valuable source of knowledge that can complement and augment knowledge and information from a western scientific standpoint. In most studies of Arctic ecosystems, such as those that are completed within Environmental Assessments, it is recognized that the absence of Traditional Ecological Knowledge is a gap. After reviewing the

EA, nowhere is Inuit Knowledge integrated into the environmental assessment in a meaningful way in terms of potential issues associated with the physical environment or marine resources. The incorporation of Inuit Knowledge should be required within the environmental assessment. In this way, Inuit Knowledge and western science can come together to form a combined, and much more holistic and accurate understanding of the potential effects of the proposed seismic program on the project and affected areas, through collaborative inquiry and analysis.

Response to General Comment 11

Chevron recognizes the value of Traditional Ecological Knowledge (TEK), and the important role TEK plays in both the project planning and environmental assessment process. While preparing the project environmental assessment, representatives of Chevron held consultation meetings with representatives of the Nunatsiavut Government, Innu Nation, Torngat Wildlife, Plants and Fisheries Secretariat, Torngat Fish Producers Co-operative Society Limited, available Town Councils and the public (see Section 5.2 and Appendix 1 of the EA). Participants were invited to share their knowledge of the area, and applicable information gained was incorporated into the environmental assessment as appropriate.

General Comment 12. Guide Vessels

It is recommended by the Nunatsiavut Government that the Proponent use a local fishing guide vessel to reduce conflicts with fishing vessels and gear. This would result in local employment opportunities while providing more effective communications with fishing vessels due to intimate knowledge of the local area and fishery.

Response to General Comment 12.

Chevron has not yet contracted guide vessels or FLOs for the program, but will consider local vessels if they are appropriate and competitive for offshore survey work.

Specific Comment 13 - § 2.2.5 Personnel, Page 7

The report states that the seismic vessel "may have a FLO and a MMO(s) on board". The wording should be "the seismic vessel will have a FLO and a MMO(s) on board". The commitment has been made by Chevron in other sections of the EA to include a FLO and qualified MMO as mitigation. Moreover, the Nunatsiavut Government would like to see Aboriginal Labradorians, especially Inuit, employed as FLOs and MMOs for the purposes of this work. Inuit are keen observers of the ocean and many have previously been employed as observers onboard marine vessels in these sorts of capacities.

Response to Specific Comment 13

Chevron commits to having personnel in the role of MMO and FLO whenever appropriate, although due to space limitations aboard the vessel, there will be constraints on the total number.

While Chevron will consult further with the Nunatsiavut Government regarding their recommendations, contracting of qualified FLOs and MMOs will likely be an open employment opportunity.

Specific Comment 14 - § 2.2.5 Personnel, Page 7

Appendix 2 of the "Geophysical, Geological, Environmental and Geotechnical Program Guidelines" (C-NLOPB 2008) states that Operators are expected to implement a seabird and marine mammal observation program throughout survey activities. Such a program should involve a designated observer trained in marine mammal and seabird observations. A report on the monitoring program and its results should be submitted to the C-NLOPB.

Response to Specific Comment 14

As stated in Section 5.9 *Mitigations and Follow-up,* marine mammal and seabird observations will be made during ramp-ups and during data acquisition periods, and at other times on an opportunistic basis. Protocols will be consistent with those developed by LGL in conjunction with DFO and Environment Canada. A monitoring program will be designed in consultation with DFO and CWS as per the C-NLOPB *Guidelines*. Data will be collected by a qualified environmental observer(s) (MMO) and FLO. A monitoring report will be submitted to the C-NLOPB within one year after completion of the surveys.

Specific Comment 15 - § 3.0 Physical Environment, Page 12 – 1st Para

Within this section Oceans (2009) is summarized and refers the reader to Sikumiut (2008). While this may be appropriate in some circumstances, it appears that some information, which is important to the timing of the survey and assessing the effectiveness of certain mitigation measures, such as MMOs has been overlooked in this section.

Response to Specific Comment 15

It is not clear which information the reviewer is referencing. The physical environment factors which mostly affect the timing of seismic surveys offshore Labrador are wind/waves and ice. These factors were reviewed in Section 3 of the EA and provided in detail in Oceans (2009) which was referenced in the EA.

As noted in response to Comment No. 4, many factors (physical environment and otherwise) influence the ability of an MMO to effectively monitor and implement mitigation measures for marine mammals and sea turtles. The reviewer is referred to the response to Comment No. 4 as well as Section "Factors Affecting Efficacy of Mitigation Measures, Visual Monitoring" in Moulton et al. (2009), as well as the response to Comment No. 16 below.

Specific Comment 16 - § 3.3 Climatology, Page 12 –1st para

It mentions that "…maritime climate tends to be fairly humid, resulting in reduced visibilities, low cloud heights, and significant amounts of precipitation". These factors should be discussed in more detail as they relate to the timing of the proposed surveys and the implementation of various mitigation measures. This would include data on wind, waves and especially visibility.

Response to Specific Comment 16

As noted in response to Comment Nos. 4 and 15, reduced visibility does not affect the timing of seismic operations. Low cloud cover and precipitation would also not typically be a factor, except in extreme instances when freezing spray or heavy snowfall influence seismic operations. The key physical environmental factors affecting the timing of seismic surveys offshore Labrador would be wind/waves and ice conditions. These factors were reviewed in Section 3 of the EA and provided in detail in Oceans (2009) which was referenced in the EA.

Regarding the effects of wind, waves, and visibility and their effect on the implementation of various mitigation measures, the reviewer is referred to Moulton et al. (2009) for a detailed review. The following text on the effects of sea state and visibility was extracted from that report.

> "**Sea State/Swell.—**An increase in the sea state/swell can result in variable negative effects on the ability of a MMO to visually detect a marine mammal within a safety zone, depending on the Beaufort wind force, and the size and behaviour of the species (Table 3). For instance, beaked whale sighting rate decreases by more than an order of magnitude when Beaufort wind force conditions deteriorate from 1 to 5 (Barlow et al. 2006).
>
> As a general rule, the impact of increased sea state is greater for smaller species and solitary species, and for animals at longer distances from the observer. Thus, the effects of elevated sea state are greater when attempting to monitor a large than a small safety zone, especially beyond Beaufort Wind Force 3. The studies described in Table 3 do not take into account what the sighting rates would be if observations were only limited to a safety distance of 500 m. In such a case, it would be expected that the proportion of cetaceans detected would be lower with increasing sea state, but this decline might not be as dramatic as it is when considering the entire visual range of the observers. The deleterious effect of high sea state might also be less noticeable when attempting to monitor large cetaceans (e.g., a blue or bowhead whale) or large groups of smaller species (e.g., large groups of dolphins) than when searching for sea turtles, pinnipeds, and isolated small odontocetes (e.g., harbour porpoise)."
>
> **"Fog/Rain/Snow.—**Fog and precipitation can have a large negative impact on the ability of MMOs to detect marine mammals within a safety zone. A review of seismic monitoring programs off the Atlantic coast of Canada during 2003–2007 revealed that, on average, visibility was <500 m during ~25% of daylight monitoring effort from June to

October (Fig. 3; LGL Ltd., unpubl. data). In June and July, when fog was most prevalent, visibility was <500 m during ~40% of the MMO effort when airguns were active, on average, with a maximum of 62% during June on the Scotian Slope. Considering that daylight hours account for ~65% of the day during June and July in the NW Atlantic (see Figure 2) and assuming that airguns were active throughout the day and night, the 500-m safety zone could be fully monitored only ~39% of the time, on average (minimum 25%) in months during which seismic exploration commonly occurs."

Specific Comment 17 – Section 3.3 – Climatology – Page 13 - 3rd Para

The discussion of storm occurrence is informative, but is not likely to have much of an effect on seismic activities as they would not likely occur under these conditions.

Response to Specific Comment 17

This comment on the need for inclusion in the EA of the discussion of storm occurrence in the Study Area during December to February period is noted.

Specific Comment 18 – Section 3.4 – Physical Oceanography – Page 14

Captions for tables and figures in Section 3.4 should include information on the source of the data. This is particularly important for comparisons purposes. This generalization also applies to other tables and figures throughout the report.

Response to Specific Comment 18

Although the sources of information included in tables and figures in Section 3.4 are indicated in the accompanying text, Chevron agrees that sources should also be indicated in each table/figure itself. The following data sources should be added as a note below each table/figure in Section 3.4 as indicated.

- Table 3.1: Data report submitted to Petro-Canada Exploration by Nordco Ltd. (1981); Data report submitted to Chevron Standard Ltd by Nordco Ltd. (1981)
- Table 3.2: Data report submitted to Petro-Canada Exploration by Nordco Ltd. (1981)
- Table 3.3: Data collected by Oceans Ltd. in (1983)
- Tables 3.4 to 3.8: BIO Archive
- Figures 3.1 and 3.2: Data report submitted to Petro-Canada Exploration by Nordco Ltd. (1981); Data report submitted to Chevron Standard Ltd by Nordco Ltd. (1981)
- Figures 3.3 and 3.4: Data collected by Oceans Ltd. in 1983
- Figure 3.5: Colbourne (2002)

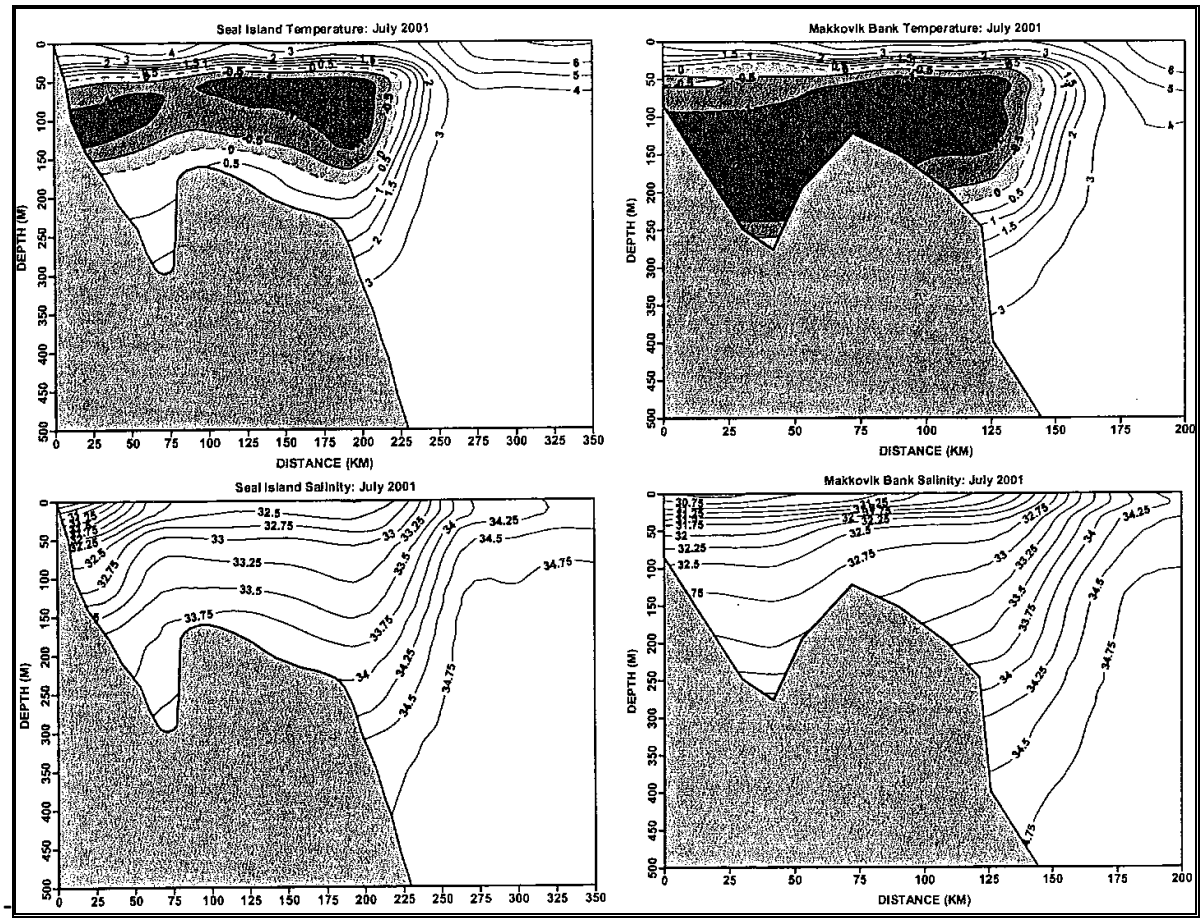
Specific Comment 19 – Section 3.4.2 – Water Properties in the Project Area – Page 20

Figure 3.5- The resolution in this figure is poor, particularly the numbers associated with the contours. It appears the data in this figure is for July only. This should be clarified.

Response to Specific Comment 19

Chevron agrees that the resolution of Figure 3.5 is poor and compromises one's ability to interpret the figure. The data presented in Figure 3.5 is for July only. Figure 3.5 is provided below.

Seal Island Makkovik Bank



Source: Colbourne (2002).

Figure 3.5. Hydrographic contours of the Makkovik Bank and Seal Island transects.

Specific Comment 20 – Section 3.4.2 – Water Properties in the Project Area – Page 20 - 2nd Para

It is noted that differences in salinity and temperature may be related to geographic variability, but the statement that this is "more related" to geographical rather than seasonal variation is not likely, particularly for surface waters.

Response to Specific Comment 20

We suggest replacing the last sentence in the second paragraph on page 20 with "Since the Project Area spans different bathymetry, the variations in salinity are due to geographical location of the data sampling and to seasonal variations."

Specific Comment 21 – Section 3.5 – Ice and Icebergs – Page 25

There should be a discussion in this section as to whether more icebergs have been observed recently due to increased effort. Is there any way to know the "error rate" for observing icebergs? It seems likely that monthly sightings would be more relevant to the proposed study.

Response to Specific Comment 21

The increase in the number of icebergs sighted during recent years is related to increased effort and more flight paths over the Project Area.

Specific Comment 22 – Section 3.5 – Ice and Icebergs – Pages 26-27

Figures 3.6 and 3.7, it is unclear what the colours are referring to when the y-axis represents percent coverage. Should the axis be percent observations while the bar colours refer to percent coverage? Simple monthly median values would likely be sufficient to convey the necessary information.

Response to Specific Comment 22

Chevron agrees that the y-axes in Figures 3.6 and 3.7 are ambiguous. Figure 3.6 y-axis should be labelled "% of observations." Figure 3.7 y-axis should be labelled "% of Study Area with Median Ice Concentration."

Specific Comment 23 - §5.7.1 Generic Activities – Air Quality, pg 127 & §5.7.3 Generic Activities – Waste Handling, pg 128

"Vessel Incinerators" and "Solid combustibles will be incinerated". It has been identified in potential interactions tables (e.g. Tables 5.2, 5.5, 5.8, 5.11, 5.16) that "garbage will be brought to shore" and assessed accordingly. What is being proposed?

Response to Specific Comment 23

As stated in Section 5.7.3 *Generic Activities – Waste Handling*, Solid combustibles will be incinerated. Non-combustibles will be containerized and transported to shore.

Specific Comment 24 - §5.7.2 Generic Activities – Marine Use, pg 127

Will streamers be deployed outside the Project Area (e.g. transit routes) and if so, has this activity been adequately assessed within the EA.

Response to Specific Comment 24

There is no current plan to have streamers deployed outside the Project Area. However, an unforeseen event (eg. hurricane) might have the vessel seeking calmer waters. In such a scenario, or under another unlikely scenario, streamers might remain deployed outside the Project Area. It should be noted that even if streamers were deployed outside the project area, under no circumstances would the source arrays be operating.

Specific Comment 25 – 5.7.4.2 – Effects of Exposure to Airgun Sound – Page 133 - 2nd Para

Although it states that "design problems" may have impacted the results from DFO (2004b), it does not define these problems or how they would impact the findings.

Response to Specific Comment 25

The design problems associated with the DFO experiment that studied the potential impacts of seismic energy on female snow crab off the western coast of Cape Breton, Nova Scotia include the following (DFO 2004).

1. The test and control sites were quite different in terms of bottom temperature, substrate character and food availability; and
2. The animals used at the control site were slightly larger than those used at the test site.

These design problems made it difficult to conclusively interpret the study results.

Specific Comment 26 – 5.7.4.2 – Effects of Exposure to Airgun Sound – Page 135 - 1st Para

Further explanation should be provided regarding the following: Saetre and Ona (1996) determined the mortality rates for eggs and larvae by employing a "worst-case scenario" computer model. How is this defined? It also appears that few of the variables used here are understood well enough to make this type of model useful.

Response to Specific Comment 26

Saetre and Ona (1996) has been cited before in the literature relating to potential effects of exposure to seismic sound on eggs and larvae of marine invertebrates and fishes (e.g., Christian et al. 2003; Hassel et al. 2004). Their results support what has been observed in exposure studies; that is only some of the eggs and larvae immediately next to an airgun appear to be affected. It would likely be difficult to differentiate between such a small proportion of eggs and larvae in exposure studies being affected by exposure to seismic sound from those being affected by other factors in nature (e.g., predation, natural mortality). At the same time, Chevron agrees that discussion of results from this modeling exercise should probably include certain *caveats.*

Specific Comment 27 – 5.7.4.2 – Effects of Exposure to Airgun Sound – Page 137 - 3rd Para

It states that, "...even if masking does occur in some invertebrates, the intermittent nature of airgun sound is expected to result in less masking effect than would occur with continuous sound." However, there seems to be little data to support this assertion. While it was mentioned in the assessment that fish may produce sounds in various behavioral contexts such as mating, the potential effect of masking in this context is not discussed within the report. Atlantic Cod have been shown to produce sounds during spawning and therefore this may be a potential impact in this area.

Response to Specific Comment 27

Chevron contends that the speculative statement that intermittent airgun sound would likely have less masking effect than continuous sound is a logical interpretation. The intention of the statement is to point out how differences in sound type can affect the level of potential impact. Section 5.7.4.1 briefly discusses the potential masking effect as it pertains to fishes.

Specific Comment 28 – 5.7.4.3 – Effects of Exposure to Marine Vessel Sound – Page 143

(a) *4th para- Reference to "…Subsection 5.7.5.2…." is incorrect and should be Subsection 5.7.4.2*

(b) *Also in this section, Snow Crab and Atlantic Cod were chosen as representative species that have been studied in the context of exposure to airgun sound. However, it is not clear how specifying Atlantic Cod guides the assessment of these effects, especially when there is generally little information available about the effect of seismic sound for this species. While it appears there have been a number of studies on Snow Crab, there appeared to be only two studies referenced for cod at different life stages (Wardle et al 2001 - juvenile cod; Thomsen 2002 - cod catch data).*

Response to Specific Comment 28(a)

The reference to Subsection 5.7.5.2 in the indicated paragraph should be to Subsection 5.7.4.2.

Response to Specific Comment 28(b)

The selection of snow crab and Atlantic cod as representative species for the assessment of the effects of exposure to seismic sound on marine invertebrates and fishes was based not only on available scientific data on effects of exposure to seismic sound but also on available information on the life histories of the animals. It is difficult to discuss the potential effects of exposure to seismic sound without a relatively good understanding of life history details. In addition, there are also unpublished results of pilot studies of the effect of exposure to seismic sound on Atlantic cod. Therefore, these two species are deemed the best choices as representative invertebrate and fish biota in the Study Area.

Specific Comment 29 – 5.7.4.4 – Other Project Activities Not Related to Sound – Page 145

Table 5.3 indicates that there is evidence of existing negative impacts in the assessment of effects on fish and fish habitat, yet the basis for this assessment does not appear to have been described in the text.

Response to Specific Comment 29

Table 5.3 indicates that there is potential of negative environmental effect on fish and fish habitat by particular non-sound related activities, specifically sanitary/domestic waste, air emissions and accidental events. For the most part, such effects would be no different than those from a similar-size vessel and crew. Sanitary/domestic waste and air emissions could potentially affect fish and fish habitat, although this is very unlikely given the relatively small scale of effluents and emissions. Further detail is not warranted in this EA as the focus is on the effects of seismic sound. More detail is provided for accidental events since these could result in the release of substantially more chemicals that could be toxic to fish and fish habitat.

Specific Comment 30 – 5.7.4.4 – Other Project Activities Not Related to Sound, Accidental Events – Page 145

Many of the references pertaining to the effects of accidental spills on eggs and larvae appear to be rather dated. It is uncertain as to whether or not these studies are reflective of the present level of knowledge.

Response to Specific Comment 30

The references used in the discussion of potential effects of hydrocarbons on invertebrate and fish eggs and larvae are appropriate and relevant, regardless of their years of publication. Most are review papers that present information still considered accurate and current today.

Specific Comment 31 - §5.7.6.1 Vessel Lights, line 6, pg 159

Is more recent information regarding Storm-petrels on drill rigs available from Suncor. U. Williams, pers. comm. appears to be a dated reference.

Response to Specific Comment 31

Chevron is not aware of any more recent information in regard to drill rigs. In recent years, all seismic vessels operating in Newfoundland and Labrador waters have instituted a stranded bird rescue program as specified by CWS. Some programs have reported very few strandings whereas a few have reported tens of Storm-petrels stranded. Storm-petrels, by far, are the main species involved and most are released alive (LGL, unpubl. data; B. Mactavish, LGL, pers. comm.).

Specific Comment 32 - §5.7.7.2 Categories of Noise Effects- (B) Masking Effects of Airgun Sounds, Pages 167-169

The assessment of masking suggests repeatedly that the "intermittent nature" of airgun pulses would reduce any masking impact. However, this statement is somewhat speculative. While whales may continue to call during seismic activity, it is not clear whether they can still hear under these conditions. Whale calls may actually be longer than the time between pulses and therefore important information may be lost to them. The data required to truly assess the importance of masking in this context is still rather sparse, making an accurate assessment of effects difficult. Similarly, based on the data available, it appears that little is known about how turtles detect sound. Therefore it is also speculative to assume that sea turtles will be able to receive important sound information between airgun pulses.

Response to Specific Comment 32

The comment that "Whale calls may actually be longer than the time between pulses…" is not well founded in that cetaceans (and seals) which occur offshore Labrador during the proposed period of seismic operations typically produce sounds with durations much less than the time between airgun pulses (see Chapter 7 in Richardson et al (1995)). Relative to some marine mammal species, it is accurate to say that little is known about the hearing capabilities of sea turtles. Several studies have shown that they are particularly sensitive to frequencies below 1000 Hz (see page 167 of the EA and Dow Piniak et al. (2010)). As noted in the EA, an airgun array might cause appreciable masking for marine mammals (and sea turtles) in only one situation: When propagation conditions are such that sound from each airgun pulse reverberates strongly

and persists for much or the entire interval up to the next airgun pulse (e.g., Simard et al. 2005; Clark and Gagnon 2006). Situations with prolonged strong reverberation are infrequent, in our experience.

Specific Comment 33 - §5.7.7.2 Categories of Noise Effects-(C) Disturbance by Seismic and Geohazard Vessels, Page 173, 2nd Para

Regarding the ramp-up procedure, there seems to be some indication that certain species of pinnipeds may move towards an array, and it was also noted in the report that some male whales had approached an array. This questions the assumption that mammals will necessarily move away from airgun sound and avoid injury. Therefore, data indicating that the ramp-up procedure is effective for these species should be included if available or the appropriate uncertainties should be described.

Response to Specific Comment No. 33

As the reviewer noted, use of the ramp-up procedure is based on the assumption that some marine mammals will move away from the airgun(s) sounds before levels are high enough to potentially cause harm. The following text is extracted from Moulton et al. (2009) which examined the efficacy of ramp up, including a discussion of uncertainties associated with the procedure.

> "There is evidence that, in some species of marine mammals, some individuals do show avoidance reactions to the onset of sound from a single airgun. In those species, ramp up seems likely to be an effective tool for minimizing the risk of hearing impairment (and other physical effects). Experiments with a single airgun showed that bowhead (Richardson et al. 1986; Ljungblad et al. 1988), humpback (Malme et al. 1985; McCauley et al. 1998, 2000a, b), and gray whales (Malme et al. 1984, 1986, 1988) all showed localized avoidance of a single airgun of 20–100 in^3. As start up of a single airgun is equivalent to the start of a ramp up, this strongly suggests that many baleen whales will begin to move away during the initial stages of a ramp up. It seems likely that species known to show strong avoidance responses to various sources of anthropogenic sound, such as most beaked whales, harbour porpoises, and belugas in certain situations, would also show avoidance during ramp up, but insofar as we know this has not been documented empirically.
>
> There is considerably less evidence for the effectiveness of ramp up in the case of most odontocetes and pinnipeds than in mysticetes. For example, Stone and Tasker (2006) found that long-finned pilot whales were more frequently observed swimming towards vs. away from the seismic vessel during ramp up whereas the opposite was true for mysticetes (and odontocetes and mysticetes combined). However, the small sample size prevented statistical comparisons of orientation (Stone and Tasker 2006). During the Stone and Tasker (2006) study, the closest point of approach (CPA) of cetaceans during ramp up did not differ significantly from CPAs observed during periods when the array was silent or operating at full volume (Stone and Tasker 2006). Many seals seem to show little avoidance during the approach of an operating full-scale airgun array (e.g.,

Harris et al. 2001; Moulton and Lawson 2002), so it is doubtful that they would show much response to a ramp up. Weir (2008) did provide some limited evidence suggesting a small avoidance effect in a group of short-finned pilot whales observed during ramp up.

Some authors (Pierson et al. 1998; Weilgart 2007) suggested that ramping up a high-energy source could actually be harmful if animals habituate to the gradual ramp up and remain in the area during the initial phases of ramp up until harmful levels are reached. That very likely would not occur in the case of baleen whales and other species that tend to avoid industrial sounds. However, ramp-up effectiveness no doubt varies with species and circumstances, and may be largely ineffective for some pinnipeds and odontocetes. Sperm whales exhibited no obvious changes in foraging dives or movement direction during ramp up at ranges of 7–13 km (Jochens et al. 2006)."

Specific Comment 34 – 5.7.8 – Effects of the Project on Species at Risk, last line, 1st paragraph – Page 211

This is the first time salmon has appeared.

Response to Specific Comment 34

Salmon should not be included in Species at Risk for this EA. Only wolffish should be considered in the paragraph in question.

Specific Comment 35 - §5.8 Cumulative Effects, 4th Para., Line 3, pg 219

"It should be noted…mitigate them". This statement is not appropriate in the context of this EA.

Response to Specific Comment 35

Chevron agrees with the reviewer that the statement is not appropriate in terms of an assessment of Chevron's activities in isolation but does believe that the statement is appropriate within a discussion of cumulative effects which by its nature concerns effects of other human activities.

Specific Comment 36 - §5.8 Mitigations and Follow-up, pg 219

As per Appendix 2 of the Geophysical, Geological, Environmental and Geotechnical Program Guidelines" (C-NLOPB 2008), "Where more than one survey operation is active in a region, the operator(s) should arrange for a :Single Point of Contact: for marine users that may be used to facilitate communication". This should be included in Table 5.19.

Response to Specific Comment 36

So noted. Please include the Single Point of Contact (SPOC) in Table 5.19.

Specific Comment 37 – 5.10 – Residual Effects of the Project – Page 222

(a) *Table 5.20 indicates a high level of confidence for the effect of the airgun array. A medium level of confidence seems more warranted based on the limited data available.*

(b) *Other surveys have maintained small airgun pulses during line changes. Will this be done in the present study or will this involve ramp-ups? Is this considered necessary?*

Response to Specific Comment 37(a)

Table 5.20 considers all VECs combined, therefore, the level of confidence assigned to physical and behavioural effects from airgun array sound should be "2-3" versus the 3 currently shown in the table.

Response to Specific Comment 37(b)

There is debate as to whether operating a single airgun between survey lines (particularly during periods of reduced visibility) versus shutting down all airguns minimizes potential effects on marine fauna, notably marine mammals and sea turtles. Either technique (ramp up or single airgun) could be employed and the choice will depend on the situation.

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