ENVIRONMENTAL OFFSHORE SERVICES LIMITED

OMV New Zealand Limited

Mohua 2D Marine Seismic Survey

Marine Mammal Impact Assessment

26 March 2014

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Date	26 March 2014
Project no	OMV02
Report status	FINAL

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List of Acronyms

ACE	Annual Catch Entitlement
AEI	Areas of Ecological Importance
ALARP	As Low as Reasonably Practicable
AOI	Area of Interest
BPA	Benthic Protected Area
CMA	Coastal Marine Area
Code of Conduct	2013 Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations
COLREGS	International Regulations for the Prevention of Collisions at Sea 1972
dB	Decibels
DC	D'Urville Current
DOC	Department of Conservation
ECC	East Cape Currents
EEZ	Exclusive Economic Zone
EEZ Act	Exclusive Economic Zone and Continental Shelf Act 2012
EMP	Environmental Management Plan
EOS Ltd	Environmental Offshore Services Limited
EPA	Environmental Protection Authority
FMA	Fisheries Management Area
HSE	Health and Safety in Employment
IAPPC	International Air Pollution Prevention Certificate
IOPPC	International Oil Pollution Prevention Certificate
ISPPC	International Sewage Pollution Prevention Certificate
IUCN	International Union of Conservation of Nature
Km	Kilometre
MARPOL	International Convention for the Prevention of Pollution from Ships
MBIE	Ministry of Business, Innovation and Employment
MEC	Marine Environment Classification
MfE	Ministry for the Environment
MMIA	Marine Mammal Impact Assessment
MMMP	Marine Mammal Mitigation Plan
MMO	Marine Mammal Observer
MMS	Marine Mammal Sanctuary
MPI	Ministry for Primary Industry
MSL	MetOcean Solutions Limited
MSS	Marine Seismic Survey

NABIS	National Aquatic Biodiversity Information System
NIWA	National Institute of Water and Atmospheric Research
Nm	Nautical Mile
NZ	New Zealand
NZOG	New Zealand Oil & Gas Limited
NZP&M	New Zealand Petroleum & Minerals
OMV	OMV New Zealand Limited
PAM	Passive Acoustic Monitoring
PEP	Petroleum Exploration Permit
PEPANZ	Petroleum Exploration & Production Association New Zealand
PNA	Protected Natural Area
QMS	Quota Management System
RMA	Resource Management Act 1991
SC	Southland Current
SEL	Sound Exposure Level
SLIMPA	Sugar Loaf Island Marine Protected Area
SOPEP	Shipboard Oil Pollution Emergency Plan
SRD	Self-Recovery Devices
STLM	Sound Transmission Loss Modelling
TACC	Total Allowable Commercial Catch
TRC	Taranaki Regional Council
WAUC	West Auckland Current
WC	Westland Current

1 Introduction

1.1 Background

Environmental Offshore Services Limited (EOS Ltd) have been engaged by OMV New Zealand Limited (OMV) to prepare a Marine Mammal Impact Assessment (MMIA) for an approximate 200 line km 2D Marine Seismic Survey (MSS) in the Taranaki Basin, scheduled to commence in March 2014. The Mohua Survey Area will be largely located within Petroleum Exploration Permit (PEP) 53537 with the exception of three tie lines. One tie line is planned to go through the West Cape-1 well and the other two lines will go through the Matuku-1 well and into the Kahurangi trough.

The Mohua Survey Area will be bound by the Mohua Operational Area; allowing for the operation of line turns, acoustic source testing and soft start initiation (Figure 1). It is anticipated that the Mohua 2D MSS will take approximately 3 days to complete, depending on weather constraints and marine mammal encounters. The actual commencement date of the Mohua 2D MSS is dependent on the seismic vessel *Aquila Explorer's* prior work commitments, however, with the current schedule is anticipated to commence at the start of April 2014.

Under Section 23 of the Crown Minerals Act 1991, the purpose of a PEP is to identify petroleum deposits and evaluate the feasibility of mining any discoveries that are made, and is exclusive to the permit holder. PEP 53537 allows OMV to undertake geological or geophysical surveying, exploration and appraisal drilling and testing of petroleum discoveries, however this MMIA is only in relation to the acquisition of a 2D MSS.

The Mohua 2D MSS will acquire approximately 200 km of 2D seismic data to provide a general understanding of the geological structure within PEP 53537 and to identify more prospective areas for further investigation utilising a 3D MSS to enhance structural interpretation and allow these areas to be more comprehensively examined. Further details of a 2D and 3D MSS is provided in Section 3.1.

The Exclusive Economic Zone (EEZ) and Continental Shelf (Environmental Effects – Permitted Activities) Act (EEZ Act) came into effect on 28 June 2013 and manages the previously unregulated potential for adverse environmental effects of activities in the EEZ and continental shelf. MSS's are classified as permitted activities within the EEZ Act as long as the operator undertaking the MSS complies with the '2013 Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations' (Code of Conduct) (DOC, 2013). Further details of the Code of Conduct are provided in Section 2.

The Mohua 2D MMIA has been prepared in accordance with the Code of Conduct (Appendix 1: Marine Mammal Impact Assessment) to assess the potential environmental effects from the Mohua 2D MSS, the sensitive environments and marine species in the surrounding areas and mitigation measures to avoid or minimise any potential effects to as low as reasonably practicable (ALARP).

Figure 1: Location Map of the Mohua 2D MSS and Operational Area. Approximate survey lines are shown, exact locations of 2D lines are still under review

1.2 General Approach

As part of the preparation for the Mohua 2D MSS, the MMIA is an integral component to receive regulatory approval for OMV to undertake the Mohua 2D MSS in adherence to the Code of Conduct. As well as the Code of Conduct, OMV will operate in accordance to relevant NZ laws and regulations, international guidelines and procedures and their own internal environmental standards.

Within the Code of Conduct, the Mohua 2D MSS is classified as a 'Level 1 Survey' and OMV will comply with these requirements and mitigation measures while carrying out the MSS. The requirements of a Level 1 survey under the Code of Conduct and mitigation measures that OMV will implement is outlined in Section 2.2.1 and Section 5.3.1.

During the preparation of the Mohua 2D MMIA an extensive review of literature and existing data was used from both national and international sources. This information forms a considerable amount of the background information and descriptions of the existing environments surrounding the Mohua Operational Area. A full list of references can be found in Section 8.

1.3 Consultation

OMV has undertaken extensive consultation over the last several years with iwi, key local stakeholders and interested parties throughout the Taranaki and surrounding regions. This has been in regards to the Maari well head platform, the Matuku and KAKA 3D MSS within PEP 51906, the exploration and appraisal drilling programme utilising the semi-submersible drilling rig Kan Tan IV and the upcoming development drilling programme with the Ensco 107 that will be cantilevered over the Maari well head platform.

For the purpose of the Mohua 2D MSS key interested parties and stakeholders were identified in relation to the seismic activities within the Mohua Operational Area and were consulted either in person, through an information sheet or contacted over the phone to describe the proposed Mohua MSS operations and the Mohua Operational Area. This opportunity was also used to provide a follow-up on the KAKA 3D MSS that OMV acquired in January 2014, which was located directly east of the proposed Mohua 2D MSS. A copy of the information sheet sent out for the consultation process is attached in Appendix 1. The groups that were consulted with are defined below:

- Department of Conservation – National Office;
- Department of Conservation – Taranaki Office;
- Department of Conservation – Golden Bay Office;
- Environmental Protection Authority;
- New Zealand Petroleum & Minerals;
- Ministry for Primary Industries;
- Petroleum Exploration & Production Associated New Zealand (PEPANZ);
- Deepwater Group;
- Sealord;
- Maruha NZ Ltd;
- Independent Fisheries;
- Talley's Group;
- Sanford Limited;
- Southern Inshore Fisheries Management Company Limited;
- Challenger Finfisheries;
- Egmont Seafoods;

- Taranaki Commercial Fishing Federation;
- Port Taranaki;
- Port Taranaki Harbourmaster;
- Taranaki Regional Council;
- Maritime New Zealand;
- Venture Taranaki;
- Land Information New Zealand;
- Taranaki Iwi Trust;
- Nga Hapu o Nga Ruahine Iwi Inc;
- Te Runanga o Ngati Ruanui;
- University of Auckland;
- University of Otago; and
- National Institute of Water & Atmosphere (NIWA).

A consultation register of OMV's engagements is included in Appendix 2.

1.4 Research

Throughout the world where MSS's are undertaken, research is being undertaken to assess any potential effects from MSS operations on marine species and habitats. Within the Code of Conduct it is identified that research should be undertaken that is relevant to the local species, habitats and conditions (DOC, 2013), while not duplicating international efforts.

OMV have contributed to a desktop study that is nearing completion on the effects of seismic operations on NZ fur seals which is being funded by the petroleum industry. Over the last few years Marine Mammal Observers (MMO) have recorded the behaviour of NZ fur seals when they are in close proximity to a seismic vessel, streamers or the acoustic source. This information has formed part of the data set for the desktop study.

The Code of Conduct states that within 60 days following the completion of the Mohua 2D MSS, a MMO report is to be submitted to DOC providing all marine mammal observational data, where shut downs occurred due to marine mammals within the mitigation zones and GPS coordinates of each marine mammal sighting. This information will be included in the DOC marine mammal sighting database and can be used for research purposes by DOC, Universities or other institutions to keep developing the knowledge of marine mammals in regards to distribution and behaviour around an operating seismic vessel.

As an additional mitigation measure while conducting the Mohua 2D MSS; OMV will have Massey University perform a necropsy on any marine mammals found dead inshore of the Mohua Operational Area, along the Taranaki, Wanganui, Manawatu, Kapiti/Wellington and top of the South Island coastline during the Mohua 2D MSS and for a period two weeks after the Mohua 2D MSS is completed. If a necropsy is performed it will be to assess if the cause of death was from any auditory pressure related injuries. The two week time frame after the MSS is to demonstrate that auditory pressure related injuries may indirectly result in death, which may be some time after exposure to the acoustic source. DOC will be responsible for all aspects of undertaking the necropsy and coordination with pathologists at Massey University; however OMV will cover the associated costs.

OMV have sponsored the DOC Cook Strait whale monitoring project since 2008 to observe humpback whale migrations and to assess whale recovery since the end of commercial whaling in NZ in 1964. Each year the survey is undertaken in June – July to coincide with the humpbacks northern migration from Antarctic waters to the South Pacific breeding grounds.

NIWA conducted a research voyage in the South Taranaki Bight in late January 2014 as part of a current research project on blue whales in the South Taranaki Bight. Sampling methodology involved photo-id, tissue sampling for genetics and stable isotopes, conductivity, temperature and depth (CTD) casts and plankton tows. It is hoped that the data collected will help address population and ecological gaps in the knowledge on blue whales. As part of the KAKA 3D MSS, OMV provided sighting information of potential blue whales to NIWA. The same provision for notifying NIWA of any blue whale sightings will be made for the Mohua 2D MSS.

2 Legislative Framework

The NZ Government's oil, gas, mineral and coal resources are administered by New Zealand Petroleum & Minerals (NZP&M) and are often regarded as the Crown Mineral Estate. NZP&M has the role of maximising the gains to NZ from the development of mineral resources, in line with the Government's objectives for energy and economic growth. NZP&M is a branch of the Ministry of Business, Innovation and Employment (MBIE) and they report to the Minister of Energy and Resources.

There is a wide range of legislation applicable to the offshore petroleum industry which regulates maritime activities, environmental protection, biosecurity and industrial safety. For the Mohua 2D MSS, OMV are required to comply with the EEZ Act – Permitted Activities and the Code of Conduct.

2.1 Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act

The purpose of the EEZ Act is to promote the sustainable management of the natural resources of the EEZ and Continental Shelf. Sustainable management involves managing the use, development and protection of natural resources in a way, or at a rate, that enables people to provide for their economic well-being while:

- Sustaining the potential of natural resources to meet the reasonably foreseeable needs of future generations; and
- Safeguarding the life-supporting capacity of the environment; and
- Avoiding, remedying, or mitigating any adverse effects of activities on the environment.

The Minister for the Environment can classify activities within the EEZ and Continental Shelf as:

- **Permitted** – the activity can be undertaken provided the operator meets the conditions specified within the regulations. Marine seismic surveys are a permitted activity as long as the operator complies with the Code of Conduct;
- **Non-notified discretionary** – activities can be undertaken if applicants obtain a marine consent from the EPA, who may grant or decline consent and place conditions on the consent. The consent application is not publically notified and has statutory timeframes adding up to 60 working days in which the Environmental Protection Authority (EPA) must assess the marine consent application. (Note: this classification is not yet in effect, it will come into effect when activities are first classified under it);
- **Discretionary** – activities can be undertaken if applicants obtain a marine consent from the EPA. The consent application will be publicly notified, submissions will be invited and hearings will be held if requested by any party, including submitters. The process has a statutory timeframe of 140 working days in which the EPA must assess the marine consent application; and

- **Prohibited** – the activity may not be undertaken.

The classification for each activity depends on a number of considerations outlined in section 33 of the EEZ Act. These considerations include; the environmental effects of the activity, the importance of protecting rare and vulnerable ecosystems, and the economic benefit to NZ of an activity taking place.

2.2 2013 Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations

The Code of Conduct has been developed by DOC in consultation with a broad range of stakeholders involved with marine seismic survey operations in NZ and on 29 November 2013 replaced the 2012 Code of Conduct. The 2012 Code of Conduct was initially developed as a voluntary regime to manage the potential effects of seismic survey activities while teething issues were ironed out, of which the petroleum industry adopted while carrying out MSS operations in NZ waters. It was believed the initial 2012 Code of Conduct achieved world-leading environment protection, while providing for the sustainable economic development that is vital to NZs future prosperity. However, when the EEZ Act came into effect on 28 June 2013, seismic surveys were classified as permitted activities (Section 2.1), requiring operators undertaking a MSS in the EEZ or Continental Shelf to operate in compliance with the Code of Conduct. This resulted in a review of the 2012 Code of Conduct to take into account a few operational difficulties that were found through the first seismic season operating with the 2012 Code of Conduct and to make the Code of Conduct enforceable from a regulatory perspective.

The update to the 2013 Code of Conduct incorporated a number of amendments; including a reduced period of time that the NZ fur seal has to be beyond the 200 mitigation zone before the pre-start observations can commence, operational procedures to implement if the PAM system malfunctions and a slight change to pre-start observations. The full mitigation requirements within the updated 2013 Code of Conduct are provided in Section 2.2.1.

The Mohua 2D MSS is classified as a Level 1 survey within the Code of Conduct; where the acoustic source has a total combined operational capacity that exceeds 427 cubic inches (in^3). Most MSS for oil and gas exploration activities are classified as Level 1, which feature the most stringent requirements for marine mammal protection and is the main focus of the Code of Conduct.

Any operator undertaking a MSS (except those classified as Level 3) has to provide notification to the Director-General of DOC at the earliest opportunity but not less than three months prior to commencement.

The Code of Conduct requires a MMIA to be developed and submitted to the Director-General to ensure that all potential environmental effects and sensitivities have been identified and measures to reduce those potential environmental effects are in place.

When MSS are conducted in Areas of Ecological Importance (AEI) as detailed in Schedule 1 of the Code of Conduct, and it is necessary and unavoidable; additional mitigation measures are to be put in place. The Mohua Operational Area is located within an AEI; the additional measures that OMV will implement, following discussions with DOC are identified in Section 5.3.2.

As well as visual MMO's onboard the Survey Vessel, Passive Acoustic Monitoring (PAM) is required as a mitigation measure under a Level 1 MSS. Technical details of the PAM system to be used in the Mohua 2D MSS are included in Appendix 3. The Code of Conduct states that where additional mitigation measures are required a Marine Mammal Mitigation Plan (MMMP) is to be developed and circulated amongst the observers and crew to guide the offshore operations. The MMMP has been compiled by the MMO and PAM system provider Blue Planet Marine and is attached in Appendix 4.

In November 2013, the Ministers of Conservation and Primary Industries announced a number of decisions relating to measures to mitigate human-related threats to Maui's dolphins under the Threat Management Plan. Within the Threat Management Plan review process it was highlighted that oil and gas exploration, vessel strikes, and disease are the highest non-fishing related threats to Maui's dolphins. In relation to MSS's it is proposed to make the Code of Conduct a mandatory standard by reference under section 28 of the Marine Mammals Protection Act 1978. This would apply in Territorial waters, EEZ and within the Marine Mammal Sanctuaries (i.e. in all NZ fisheries waters).

2.2.1 Level 1 Marine Seismic Survey

For compliance with the Code of Conduct, OMV must submit a MMIA to the Director-General at least one month prior to commencement of the Mohua 2D MSS. The observer and operational requirements which OMV will adhere to for the Level 1 MSS are listed in the following sections.

2.2.1.1 Observer Requirements

To undertake the Mohua 2D MSS in compliance with the Code of Conduct, the minimum qualified observer requirements are:

- At all times there will be at least two qualified MMOs onboard;
- At all times there will be at least two qualified PAM operators onboard;
- The observer's role on the vessel during the Mohua 2D MSS is strictly for the detection and data collection of marine mammal sightings, and instructing crew on the Code of Conduct and crew requirements when a marine mammal is detected within the relevant mitigation zone (including pre-start, soft start and operating at full acquisition capacity requirements);
- At all times when the acoustic source is in the water, at least one qualified MMO (during daylight hours) and at least one qualified PAM operator will maintain watch for marine mammals; and
- The maximum on-duty shift for an observer must not exceed 12 hours per day.

DOC also encourage observations at all times where practical and possible to help build on the knowledge and distribution of marine mammals around the NZ coastline.

If during the Mohua 2D MSS the MMOs onboard the *Aquila Explorer* consider that there are higher numbers of marine mammals encountered than what is believed through the formation of this MMIA, the Director-General will be notified immediately. A decision on what adaptive management procedures will be implemented if this scenario arises will depend on the marine mammal species observed and the situation which is occurring at that time; this management decision will be made from discussions between DOC and OMV, who shall then advise the MMO/PAM team of the correct approach.

If the PAM system onboard the *Aquila Explorer* malfunctions or becomes damaged, MSS operations may continue for 20 minutes without PAM while the PAM operator diagnoses the problem. If it is found that the PAM system needs to be repaired, MSS operations may continue for an additional two hours without PAM as long as the following conditions are met:

- It is during daylight hours and the sea state is less than or equal to Beaufort 4;
- No marine mammals were detected solely by PAM in the relevant mitigation zones in the previous two hours;
- Two MMOs maintain watch at all times during MSS operations when PAM is not operational;
- DOC is notified via email as soon as practicable, stating time and location in which MSS operations began without an active PAM system; and

- MSS operations with an active source, but without an active PAM system, do not exceed a cumulative total of four hours in any 24 hour period.

2.2.1.2 Operational and Reporting Requirements

Both visual MMOs and PAM operators are required to record and report all marine mammal sightings during MSS's conducted in adherence to the Code of Conduct.

MMO requirements include:

- Provide effective briefings to crew members, and establish clear lines of communication and procedures for onboard operations;
- Continually scan the water surface in all directions around the acoustic source for presence of marine mammals, using a combination of naked eye, and high-quality binoculars from optimum vantage points for unimpaired visual observations;
- Use GPS, sextant, reticle binoculars, compass, measuring sticks, angle boards or any other appropriate tools to accurately determine distances/bearings and plot positions of marine mammals whenever possible during sightings;
- Record and report all marine mammal sightings, including species, group size, behaviour/activity, presence of calves, distance and direction of travel (if discernible);
- Record sighting conditions (Beaufort sea state, swell height, visibility, fog/rain and glare) at the beginning and end of the observation period, and whenever the weather conditions change significantly;
- Record acoustic source power output while in operation, and any mitigation measures taken;
- Communicate with DOC to clarify any uncertainty or ambiguity in application of the Code of Conduct; and
- Record and report to DOC any instances of non-compliance with the Code of Conduct.

While PAM operator requirements include:

- Give effective briefings to crew member to establish clear lines of communication and procedures for onboard operations;
- Deploy, retrieve, test and optimise hydrophone arrays;
- When on duty, concentrate on continually listening to received signals and/or monitor PAM display screens in order to detect vocalising cetaceans, except for when required to attend to PAM equipment;
- Use appropriate sample analysis and filtering techniques;
- Record and report all cetacean detections, including, if discernable, identification of species or cetacean group, position, distance and bearing from vessel and acoustic source;
- Record type and nature of sound, time and duration heard;
- Record general environmental conditions;
- Record acoustic source power output while in operation, and any mitigation measures taken;
- Communicate with DOC to clarify any uncertainty or ambiguity in application of the Code of Conduct; and

Record and report to DOC any instances of non-compliance with the Code of Conduct.

2.2.1.3 Pre-start Observations

Normal Requirements

The Mohua 2D MSS acoustic source can only be activated if it is within the Mohua Operational Area (Figure 1) and no marine mammals have been observed or detected in the relevant mitigation zones (Section 2.2.1.4).

During daylight hours the Mohua 2D MSS acoustic source cannot be activated unless:

- At least one qualified MMO has made continuous visual observations around the source for the presence of marine mammals, from the bridge (or preferably even higher vantage point) using both binoculars and the naked eye, and no marine mammals have been observed in the respective mitigation zones for at least 30 minutes; and
- Passive acoustic monitoring for the presence of marine mammals has been carried out by a qualified PAM operator for at least 30 minutes before activation and no vocalising cetaceans have been detected in the respective mitigation zones.

During night-time hours or poor sighting conditions (daylight visibility of <1.5 km or a sea state greater than or equal to Beaufort 4), the acoustic source cannot be activated unless:

- Passive acoustic monitoring for the presence of marine mammals has been carried out by a qualified PAM operator for at least 30 minutes before activation; and
- The qualified observer has not detected any vocalising cetaceans in the relevant mitigation zones.

Soft Starts

The Mohua 2D MSS acoustic source will not be activated at any time except by soft start, unless the source is being reactivated after a single break in firing (not in response to a marine mammal observation within a mitigation zone) of less than 10 minutes immediately following normal operations at full power, and the qualified observers have not detected marine mammals in the relevant mitigation zones.

A soft start consists of gradually increasing the source's power, starting with the lowest capacity acoustic source, over a period of at least 20 minutes and no more than 40 minutes. The operational capacity defined in this MMIA (2,360 in^3) is not to be exceeded during the soft start period.

Additional requirements for start-up in a new location in poor sighting conditions

In addition to the normal pre-start observation requirements above, when the *Aquila Explorer* arrives at a new location for the first time, the initial acoustic source activation must not be undertaken at night or during poor sighting conditions unless either:

- MMOs have undertaken observations within 20 nautical miles (Nm) of the planned start up position for at least the last two hours of good sighting conditions preceding proposed MSS operations, and no marine mammals have been detected; or
- Where there has been less than two hours of good sighting conditions preceding proposed operations (within 20 Nm of the planned start up position), the acoustic source may be activated if:
    - PAM monitoring has been conducted for two hours immediately preceding proposed MSS operations;
    - Two MMOs have conducted visual monitoring in the two hours immediately preceding proposed MSS operations;
    - No Species of Concern (DOC, 2013 – Schedule 2) have been sighted during visual monitoring or detected by PAM in the relevant mitigation zones in the two hours immediately preceding proposed MSS operations;

- No fur seals have been sighted during visual monitoring in the relevant mitigation zone in the 10 minutes immediately preceding proposed MSS operations; and
- No other marine mammals have been sighted during visual monitoring or detected on the PAM system in the relevant mitigation zones in the 30 minutes immediately preceding proposed MSS operations.

2.2.1.4 Delayed Starts and Shutdowns

Species of Concern with calves within a mitigation zone of 1.5 km

If during pre-start observations or while the acoustic source is activated (which includes soft starts), a qualified observer detects at least one Species of Concern with a calf within 1.5 km of the source, start-up will be delayed or the source will be shut down and not reactivated until:

- A qualified observer confirms the group has moved to a point that is more than 1.5 km from the source; or
- Despite continuous observation, 30 minutes has elapsed since the last detection of the group within 1.5 km of the source, and the mitigation zone remains clear.

Species of Concern within a mitigation zone of 1 km

If during pre-start observations or while the acoustic source is activated, a qualified observer detects a Species of Concern within 1 km of the source, start-up will be delayed or the source will be shut down and not reactivated until:

- A qualified observer confirms the Species of Concern has moved to a point that is more than 1 km from the source; or
- Despite continuous observation, 30 minutes has elapsed since the last detection of a Species of Concern within 1 km of the source, and the mitigation zone remains clear.

Other Marine Mammals within a mitigation zone of 200 m

If during pre-start observations prior to initiation of the Mohua 2D MSS acoustic source soft start procedures, a qualified observer detects a marine mammal within 200 m of the source; start-up will be delayed until:

- A qualified observer confirms the marine mammal has moved to a point that is more than 200 m from the source; or
- Despite continuous observation, 10 minutes has elapsed since the last detection of a NZ fur seal within 200 m of the source and 30 minutes has elapsed since the last detection of any other marine mammal within 200 m of the source, and the mitigation zone remains clear.

Once all marine mammals that were detected within the relevant mitigation zones have been observed to move beyond the respective mitigation zones, there will be no further delays to the initiation of soft start procedures.

2.3 Areas of Ecological Importance

MSS operations within an AEI require more comprehensive planning requirements and consideration, including additional mitigation measures to be developed and implemented through the MMIA process.

The locations and extent of the AEI in NZ continental waters were determined from DOC's database of marine mammal sightings and strandings, fisheries-related data maintained by Ministry for Primary Industries (MPI) and the National Aquatic Biodiversity Information

System (NABIS). Where data was incomplete, technical experts have helped refine the AEI maps where data was absent or incomplete.

Within the Code of Conduct it states that under normal circumstances a MSS will not be planned in any sensitive ecologically important areas or during key biological periods where Species of Concern are likely to be feeding or migrating, calving, resting, feeding or migrating, or where risk are particularly evident such as in confined waters. There is the potential that during the timing of the Mohua 2D MSS that blue whales may be present within the South Taranaki Bight if weather and oceanographic conditions permit upwelling to arise from the Kahurangi Shoals; resulting in plankton blooms that the blue whales feed on. The Mohua Operational Area is located within an AEI, as shown in Figure 20.

OMV has a work commitment to the NZ Government that they have to acquire and process a minimum of 100 km's of 2D seismic data in order to meet the requirements stipulated in PEP 53537. The timing of the Mohua 2D MSS is scheduled to coincide with vessel availability and the settled summer weather period, allowing the Mohua 2D MSS to be undertaken in the shortest possible timeframe, essentially reducing any excess noise being emitted to the marine environment for a longer period due to weather delays. There is a considerable expense to mobilise a specialised seismic vessel to NZ waters; therefore OMV have contracted the *Aquila Explorer* to undertake the Mohua 2D MSS which is currently in NZ. It is also noted that information gathered from the MMO reports following the completion of the MSS undertaken to date in the South Taranaki Bight has provided a greater awareness and knowledge of blue whale distribution within this area.

2.4 Marine Mammal Sanctuaries

There are six gazetted Marine Mammal Sanctuaries (MMS) around NZ that were implemented to protect marine mammals from harmful human impacts, particularly in vulnerable areas such as breeding grounds or migratory routes. However, the most important aspect of a MMS is the presence of the general habitat of an endangered species, namely Hectors and Maui's dolphins. All MMS are administered and managed by DOC in accordance with the Marine Mammals Protection Act 1978, Marine Mammals Protection Regulations 1992 and in line with Conservation General Policy. A MMS does not exclude all fishing or seabed mining activities; however a MMS places restrictions on seismic surveys to prevent and minimise disturbance of marine mammals in which the MMS was gazetted to protect.

The closest MMS to the Mohua Operational Area is the West Coast North Island MMS which was gazetted in 2008 and stretches from Maunganui Bluff to Oakura Beach, Taranaki in the south (Figure 18) and extending out to 12 Nm has an approximate area of 1,200,086 hectares and covers 2,164 km of coastline. As stated above there are restrictions in place for seismic surveys within MMS, however, they can still be undertaken as long as they are undertaken in accordance with the Marine Mammals Protection (West Coast North Island Sanctuary) Notice 2008. The West Coast North Island MMS was gazetted to protect Maui's and Hector's dolphins.

In 2013 the Minister of Conservation varied the West Coast North Island MMS to prohibit commercial and recreational set net fishing between 2 – 7 Nm offshore between Pariokariwa Point and the Waiwhakaiho River, Taranaki under the Marine Mammals Protection Act 1978. This area covers 350 km^2 of the MMS. The purpose of the variation to the MMS was to provide greater protection to Maui's dolphins from the risks resulting from set net fishing (commercial and recreational).

The Mohua Operational Area is located 50 km southwest of the West Coast North Island MMS southwest boundary corner.

3 Project Description

3.1 Marine Seismic Surveys

The basic principle behind a MSS is that an acoustic source releases a shot of compressed air, releasing a directionally focused acoustic wave at low frequency that travels several kilometres through the earth. As the acoustic wave travels through the earth, portions are reflected by the underlying rock layers and the reflected energy is recorded by receivers (hydrophones) deployed in streamers. Depths and spatial extent of the strata can be calculated and mapped, based on the difference between the time of the energy being generated and subsequently recorded by the receivers.

The details of a specific MSS can vary enormously, however there are two principle categories of MSS's – 2D and 3D and the complexity between the two varies greatly. A 2D MSS can be described as a fairly basic survey method which involves a single source and a single streamer towed behind the seismic vessel (Figure 2). However, although the MSS is simplistic in its underlying assumptions, it has been and still is today used very effectively to discover oil and gas reservoirs. Using this method the reflections from the subsurface are assumed to lie directly below the sail line that the seismic vessel traverses. Sail lines are generally acquired several kilometres apart, on a broad grid over a large area. This methodology is generally used for frontier exploration areas to produce a general understanding of the regional geological structure and to identify more prospective areas which can be comprehensively examined through a 3D MSS.

Whereas, 3D MSS is a more complex method and involves a greater investment and much more sophisticated equipment compared to a 2D MSS. The purpose of a 3D MSS is to focus on a specific area over known geological targets considered likely to contain hydrocarbons, generally discovered by previous 2D MSS. Extensive planning is undertaken to ensure the survey area is precisely defined and the direction of the survey lines are calculated to ensure the best results are obtained of the underlying geology in the received seismic images for interpretation. A sail line separation within the survey area for 3D surveys is normally 200 – 400 m apart, often with two acoustic sources and up to 10 streamers, typically 100 m apart, producing a three-dimensional image of the subsurface (Figure 2).

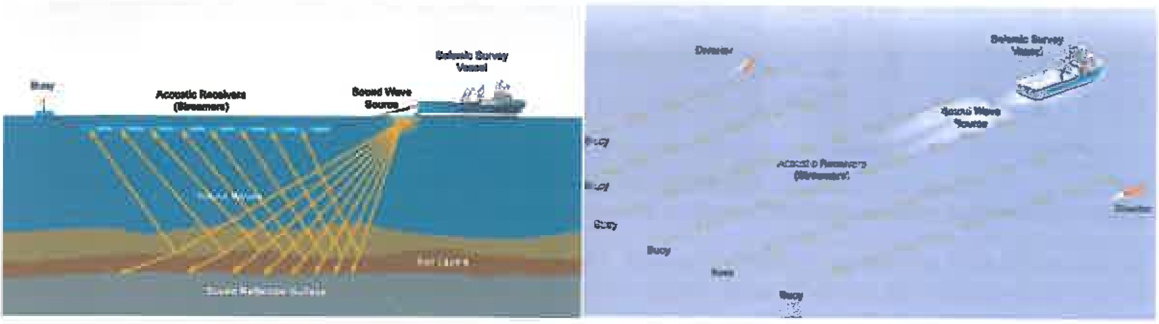

Figure 2: Schematic of a 2D MSS (left) and 3D MSS (right)

The acoustic source comprise of two high pressure chambers; an upper control chamber and a discharge chamber (Figure 3). High pressure air (~2,000 psi) from compressors onboard the seismic vessel is continuously fed to the acoustic sources towed behind the vessel via an air hose. This forces the piston downwards, and the chambers fill with high-pressure air while the piston remains in the closed position (Figure 3).

The acoustic source is activated by sending an electrical pulse to the solenoid valve which opens, and the piston is forced upwards, allowing the high pressure air in the lower chamber to discharge to the surrounding water through the airports. The air from these ports forms a bubble, which oscillates according to the operating pressure, the depth of operation, the temperature and the volume of air vented into the water. Following this release the piston is forced back down to its original position by the high-pressure air in the control chamber, so that once the discharge chamber is fully charged with high-pressure air, the acoustic source can be fired again. The compressors are capable of recharging the acoustic source's rapidly and continuously which enables the acoustic source arrays to be fired every 8 – 10 seconds during seismic acquisition.

Acoustic source arrays are designed so that they direct most of the sound energy vertically downwards (Figure 3) although there is some residual energy which will dissipate horizontally into the water. The amplitude of sound waves generally declines with distance from the acoustic source, where the weakening of the signal with distance (attenuation), is frequency dependent, with stronger attenuation at higher frequencies. In practice, the decay of sound in the sea is dependent on the local conditions such as water temperature, water depth, seabed characteristics and depth at which the acoustic signal is generated.

Typical source outputs used in MSS operations will emit ~220 – 250 dB when measured relative to a reference pressure of one micropascal (re 1μPa/m) (IAGC, 2002). However, this does depend on how many acoustic sources are fired together; generally they are activated alternatively. To place this in perspective, low level background noise in coastal regions with little wind and gentle wave action is ~ 60 dB, while in adverse weather conditions, the background noise increases to 90 dB (Bendell, 2011).

The sound frequencies emitted from an acoustic source are broad band, where most of the energy is concentrated in the 10 – 250 Hz with lower levels in the 200 – 1,000 Hz range although the largest amplitudes are usually generated in the 20 – 100 Hz frequency band.

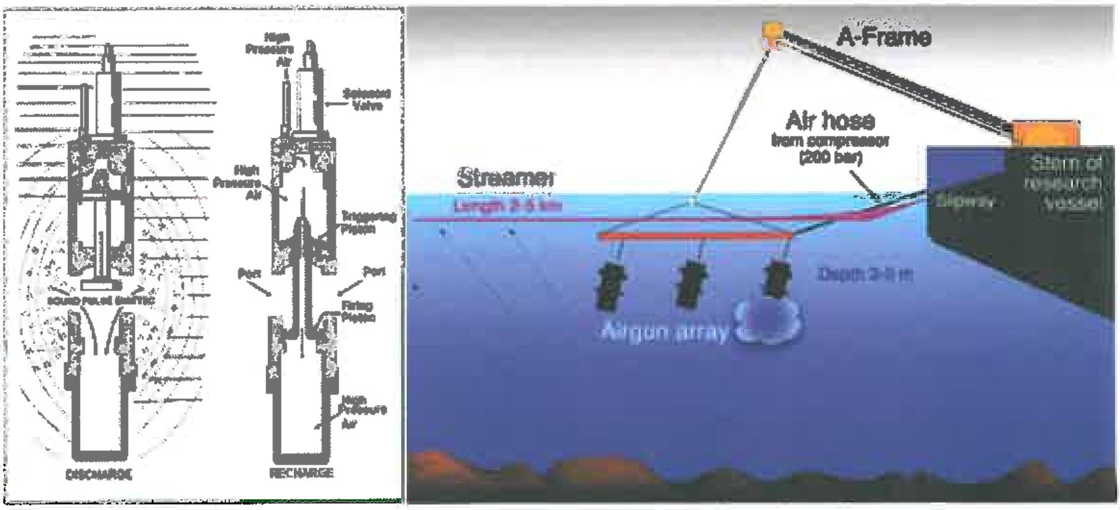

Figure 3: Schematic cross section of a typical acoustic source and a sub-surface array

For 2D MSS one streamer is towed behind the seismic vessel, whereas for a 3D MSS up to 10 streamers can be towed, and these can be influenced by wind, tides and currents, causing feathering, or the streamers being towed in an arc offset from the nominal sail line. When the acoustic source is released the streamers detect the very low level of reflection energy that is reflected back up from the geological structures below the seabed using pressure sensitive devices called hydrophones. Hydrophones convert the reflected pressure signals into electrical energy that is digitised and transmitted along the streamer to the recording system onboard the seismic vessel.

Each streamer is divided into sections, 50 – 100 m in length to allow for modular replacement of damaged components. Solid streamers are more often used now, and are constructed of extruded foam to make them neutrally buoyant. The generation of solid streamers has many advantages over the older fluid filled streamers, where they are: more robust and resistant to damage (i.e. shark bites); are less sensitive to weather and wave noise (provides higher quality seismic images); require less frequent repairs; and the modern streamers are steerable allowing greater control of the streamers, resulting in less infill lines, reducing the cumulative sound energy introduced into the marine environment.

Towing the streamers underwater removes the streamers from the surface weather and noise which limits the usability of the recorded data and other technical requirements. The deeper the tow depth, the quieter the streamer in regards to weather and surface noise, but this also results in a narrower bandwidth of the data. Typically the range of operating depths varies from 4 – 5 m for shallow high resolution surveys in relatively good weather to 8 – 12 m for deeper penetration and lower frequency targets in more open waters.

At the end of each streamer, a tail buoy is connected to provide both a hazard warning (lights and radar reflector) of the submerged towed streamer between the tail buoy and vessel, and to act as a platform for positional systems of each streamer (Figure 4). During the Mohua 2D MSS, the *Aquila Explorer* will be travelling at 4.5 kts so the streamer tail buoy will be travelling approximately 50 minutes behind the vessel.

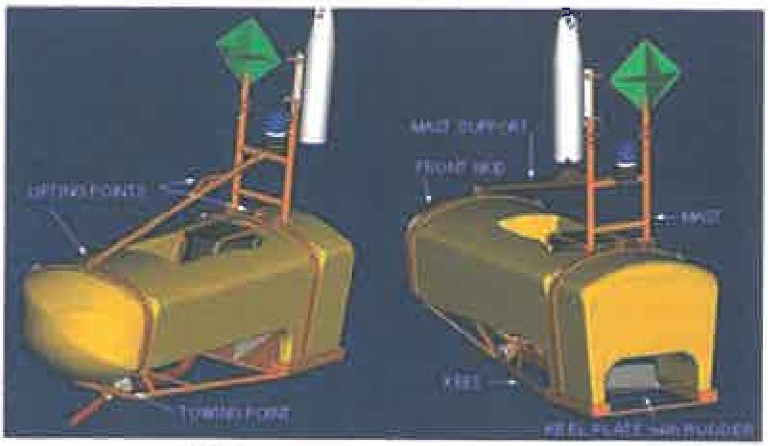

Figure 4: Example of a tail buoy with light and radar reflector

3.2 Mohua 2D Marine Seismic Survey

The Mohua 2D MSS will use the seismic vessel *Aquila Explorer* and will tow one solid streamer, 8 km in length. OMV will utilise a 2,360 in^3 acoustic source comprising of four sub-arrays located at a depth of 5 m below the sea surface and > 50 m behind the *Aquila Explorer*. This acoustic source has been selected to ensure the source volume enables the survey to be run effectively in regards to data acquisition, but to also minimise the potential environmental disturbance. In the case of dropouts during acquisition, the gun array may operate at a slightly lower capacity for a short period of time. Sound Transmission Loss Modelling (STLM), as required when operating a MSS in an AEI, was conducted by Curtin University and was based on the specific acoustic source volume and operating pressure of the Mohua 2D MSS outlined within this MMIA. The STLM is further discussed in Section 5.1.2.1 and is attached in Appendix 5.

The acoustic sources will have an operating pressure of 2,000 psi and fired at a shotpoint interval of 18.75 m apart, where for a typical boat speed of 4.2 – 4.5 knots (kts), relates to a shot being fired every 8 – 8.5 seconds.

The Mohua Operational Area encapsulates and extends outside PEP 53537 (Figure 1). OMV are planning to acquire the Mohua 2D MSS at the start of April 2014 depending on the completion of prior surveys and is scheduled to take approximately 3 days. MSS operations will be conducted 24 hours per day, subject to suitable weather conditions and marine mammal encounters within the mitigation zones. The technical specifications of the *Aquila Explorer* are provided in

Table 1. One support vessel, the *Amaltal Mariner* (Figure 6) will be contracted for the duration of the MSS and will be in close proximity to the *Aquila Explorer* at all times.

There are four main components involved with the acquisition of the Mohua 2D MSS:

- **Mobilisation of the *Aquila Explorer* to the Mohua Operational Area:** After the *Aquila Explorer* has completed the Waru 2D MSS for New Zealand Oil and Gas (NZOG) it will mobilise to the Mohua Operational Area (approximately 50 km offshore from the Waru Survey Area). The *Amaltal Mariner* will accompany the *Aquila Explorer* at all times during the passage to the Mohua Operational Area. During transit to the Mohua Operational Area, a MMO will be on the bridge to observe for any marine mammals that would add to the knowledge and distribution of marine mammals around NZ (Section 5.3.2.3);
- **Deployment of Streamer:** The streamer will be left deployed following the NZOG Waru 2D MSS for the mobilisation to the Mohua Operational Area. Once the *Aquila Explorer* approaches the Mohua Operational Area the MMO's will begin the pre-start observations as required under the Code of Conduct when arriving at a new location (Section 2.2.1.2). Once these procedures have been followed and adhered to, a soft start can begin for commencement of the Mohua 2D MSS;
- **Data Acquisition:** The *Aquila Explorer* will follow the predetermined survey lines (Figure 1) which have been calculated to get the best images from the data and provide greater interpretation of the underlying geology. The four MMOs on board will monitor for marine mammals throughout the 24 hour period for the duration of the MSS to ensure compliance with a Level 1 survey under the Code of Conduct. There will be no continuous acquisition (acquiring seismic data through the line turns) for the Mohua 2D MSS, so the acoustic source will be stopped at the end of each survey line and the MMOs will commence pre-start observations prior to each survey line; and
- **Demobilisation:** Once the *Aquila Explorer* has completed the Mohua 2D MSS, the acoustic source will be stopped and the seismic array will be retrieved for mobilisation to the Aquila Explorer's next destination.

If the vessel has to go on standby during the MSS due to certain adverse weather conditions, it is likely that the acoustic source array would be retrieved to reduce any potential damage, while the streamer may be left deployed.

Figure 5: Seismic Survey Vessel – *Aquila Explorer*

Figure 6: Seismic Support Vessel – *Amaltal Mariner*

Table 1: *Aquila Explorer* Technical Specifications

Seismic Survey Vessel – General Specifications	
Vessel Name	*Aquila Explorer*
Vessel Owner	Aquila Explorer Inc.
Engine Details	2 x MAK 6M AK 1770KW
Fuel Capacity	1,254 m^3
Seismic Survey Vessel – Dimensions and capacities	
Vessel Length	71 m
Vessel Beam	17.5 m
Max Draft	5.45 m
Gross Tonnage	3,057 t
Cruising Speed	11 knots

Table 2: Mohua 2D Seismic Specifications

Parameter	Specifications
Total array volume	1 x 2,360 in^3
Acoustic source	Bolt 1900 LLXT
Number of arrays	1
Number of sub-arrays	2
Source length	14 m
Source width	10 m
Nominal operating pressure	2,000 psi
Tow depth	9 m (+/- 1m)
Distance from the stern	>50 m
Number of streamers	1
Streamer length	8 km
Streamer manufacturer/model	Sercel Seal
Towing depth	~12 m (+/- 1m)

3.3 Navigational Safety

During the Mohua 2D MSS, the *Aquila Explorer* will be towing one streamer, 8 km in length and in doing so will be 'restricted in its ability to manoeuvre'. At the operational speed while acquiring seismic data of ~4.5 kts the vessel cannot turn quickly so avoidance of collision relies on all vessels obeying the rules of the road and the International Regulations for the Prevention of Collisions at Sea (COLREGS) 1972 which is implemented in NZ under the Maritime Transport Act regime. A Notice to Mariners will be issued and will be broadcast daily on maritime radio advising of the Mohua Operational Area and the presence of the *Aquila Explorer* and her restriction in ability to manoeuvre while towing the MSS array.

The consultation process has identified all potential users of that area of ocean, while the presence of the support vessel will be utilised to notify any boats that are unaware of the seismic operations or those vessels that cannot be reached via VHF radio. In accordance with International Maritime Law the *Aquila Explorer* will display the appropriate lights and day shapes while undertaking the survey; mainly being restricted in its ability to manoeuvre and towing an array of gear behind the boat. A tail buoy will mark the end of the streamer and has a light and radar reflector for detection both during day and night.

3.4 Analysis of Alternatives

Most seismic surveys conducted throughout the world these days use an acoustic source, as they generate low frequency sources which can image the underlying geology several kilometres below the seafloor. Each component of the Mohua 2D MSS has the requirement to not only gather the best information of the underlying geology and hydrocarbon potential within the Mohua Survey Area and tie in to known geological structures but to also reduce any adverse effects on the marine environment to the fullest extent practicable.

OMV will use Bolt 1900 LLXT acoustic sources for the Mohua 2D MSS, with four sub arrays. The acoustic source array configuration was selected so that it provides sufficient seismic energy to acquire the geological objective of the survey, whilst minimising the environmental disturbance through limiting excess noise to the environment.

As part of the Mohua 2D MSS design, OMV were offered the selection of 4,230 in^3 or 2,360 in^3 acoustic sources that are onboard the *Aquila Explorer* to acquire the Mohua 2D MSS. In keeping with the nature of the Code of Conduct, OMV selected the lesser of the two, 2,360 in^3 to reduce the amount of noise emitted to the marine environment.

The acquisition period for the Mohua 2D MSS will utilise the settled late-summer early-autumn period to reduce weather-induced down-time to ensure that the survey duration is as short as possible.

The main migration period of humpback whales to the South Pacific Breeding grounds is through June-July, although it is known to extend either side of this as they make their way through the Cook Strait. At this stage the Mohua 2D MSS is expected to commence at the start of April 2014 and as discussed previously take approximately three days to complete. If there are significant delays to the *Aquila Explorer's* seismic programme and the Mohua 2D MSS is delayed until late-April or May, there is the potential for humpback whales to be in the general South Taranaki Bight Area. Therefore if the Mohua 2D MSS was being acquired during the migratory period of humpback whales and they were in close proximity to the Mohua Operational Area, there is the potential that the humpback whales may alter their migratory path, however the exact extent of this is unknown. If a delay of this nature was to occur, DOC would be advised as soon as this was known and OMV and DOC would discuss whether any additional mitigation measures are required.

Southern right whales are known to make migrations down to the Southern Ocean to feed during the summer months, while their northern migrations appears to pass through the Taranaki region between May-October. Southern right whales also appear to have a coastal habitat use pattern, especially when they are on their breeding or calving grounds (Torres, 2012). Most sightings around the Taranaki have also being coastal, so it is believed that the southern right whales are therefore not likely to be impacted on any of their migratory routes or breeding grounds during the Mohua 2D MSS.

Blue whales have been observed in the South Taranaki Bight throughout the year which indicates the South Taranaki Bight is an important feeding ground to the blue whales. It is believed that the blue whales are feeding on large aggregations of krill as a result of the upwelling from the Kahurangi shoals propagating north into the South Taranaki Bight. Weather patterns appear to play an important factor in the presence of blue whales in the South Taranaki Bight. If upwellings result in large aggregations of krill being present, blue whales are often observed, however if no upwelling occurs or rough seas break up any aggregations of krill, the blue whales will continue searching for food, due to their high daily food requirements. OMV's KAKA 3D conducted in early January did not result in any positively identified blue whales during the 12 day survey, whereas a NIWA voyage towards the end of January found a large number of blue whales present in the South Taranaki Bight. As a result it is not possible to avoid blue whale feeding events as they have been found to occur year round and it is difficult to predict when and where they will be present. Compliance to the Code of Conduct and the short duration (~3 days) of the Mohua 2D MSS will help mitigate any adverse effects on blue whales or their ability to feed on the aggregations of krill.

OMV have work programme commitments, agreed with NZP&M to assess the petroleum potential of PEP 53537; of which a minimum of 200 km's of 2D seismic data acquisition is required. As a result there is no 'do nothing' option in regards to a 2D seismic survey.

4 Environmental Description

4.1 Physical Environment

4.1.1 Meteorology

Anticyclones are a major feature of the weather in the Australian-NZ region and migrate eastwards every six to seven days across NZ, where the centres generally pass across the North Island; northerly paths are followed during spring and southerly paths during autumn and winter.

Troughs of low pressure are between the anticyclones with cold fronts associated, orientated northwest to southeast. As these cold fronts arrive from the west, northwesterly winds become stronger and cloud levels increase, followed by a period of rain for several hours as the front passes over. After the front has gone through there is a change to cold showery southwest winds.

The South Taranaki Bight is subject to high winds and seas due to being directly exposed to weather systems that approach from the Tasman Sea. Within this area prevailing winds and swells approach from the west to southwest, and although there are few climatic extremes the weather can be very changeable. During winter, the weather conditions are more unsettled and cooler compared to summer months.

Weather conditions from New Plymouth have been used as indicative for the Mohua Operational Area, where summer daytime temperatures can range from 19°C to 24°C, whereas the relatively mild unsettled winterers have temperatures from 10°C to 14°C (NIWA, 2014). The mean monthly weather parameters at New Plymouth is shown in Table 3.

Table 3: Mean Monthly weather parameters at New Plymouth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	54	83	68	104	112	123	110	101	105	117	102	106
Temp – avg. day (°C)	21	22	20	18	16	14	13	13	14	16	17	19
Temp – avg. night (°C)	14	14	13	11	10	8	7	7	8	10	10	13
Avg. wind speed (kts)	9	9	9	9	10	10	10	10	11	12	11	10
Max. wind speed (kts)	30	38	30	33	35	37	36	31	47	58	31	37

(Source: Weather 2, 2014)

4.1.2 Oceanography

During the development of OMV's Exploration, Appraisal & Development Drilling Programme 2013 – 2014 Environmental Impact Assessment (Govier & Calder, 2013) modelling reports that were produced for this project have been used as part of the background environmental description to this MMIA.

4.1.2.1 Wind Climate

Within the South Taranaki Bight, MetOcean Solutions Limited (MSL) produced wind roses for the Maari and Matuku-1 well locations and showed that two dominant wind directions are present; the prevailing wind arrives from the west-southwest quarter, while the strongest wind (> 18 m/s) arrives from the southeast quarter (Figure 7). The windiest month in the South Taranaki Bight is June while the month of least wind is January (MSL, 2010a; MSL, 2010b). The Matuku-1 exploration well is located within the northeast section of the Mohua Operational Area, where the two tie lines cross to pick up the logged data from the recently drilled Matuku-1 well.

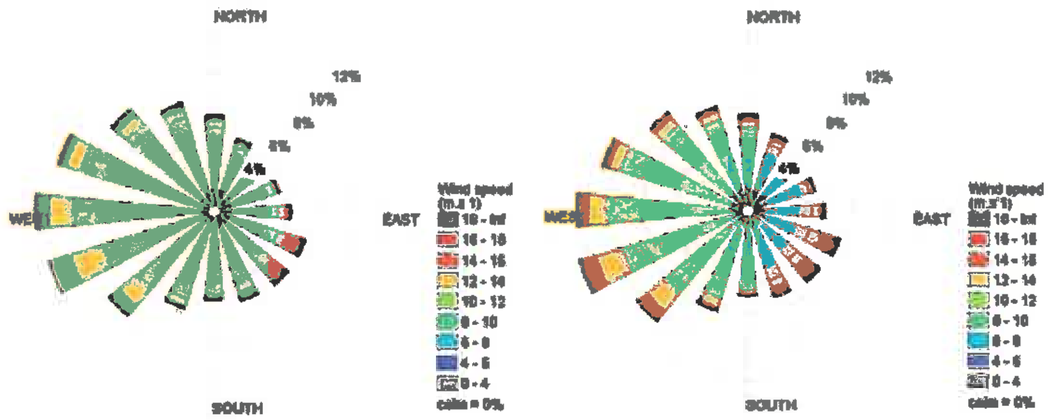

Figure 7: Maari (left) and Matuku-1 (right) well location annual wind roses

4.1.2.2 Wave Climate

The Mohua Operational Area has a high energy wave environment present due to its location in relation to the Tasman Sea in the west and the Greater Cook Strait to the southeast. The Southern Ocean can generate long period swells; often enhanced by the predominant west to southwest winds. Waves from the south are often fetch-limited but due to the strong southeast winds (Figure 7), result in steep and energetic seas.

MSL hindcasted the wave climate from 1998 – 2009 for the South Taranaki Bight and was validated by a number of locations around NZ. The modelling showed that during this period the largest significant wave height was 10.88 m with a mean wave height of 2.55 m, with June being the most energetic month (~2.9 m) while January is the calmest (~2.15 m) (MSL, 2010a & 2010b).

4.1.2.3 Bathymetry

Each major land mass is surrounded by a flat, gently sloping zone known as the Continental Shelf which extends from the coast out to a water depth of approximately 100 – 200 m. Beyond the Continental Shelf, the slope of the seabed steepens and passes into the Continental Slope which descends relatively rapidly from the edge of the shelf down to depths greater than 4,000 m. At the foot of the Continental Slope, the seaward gradient flattens out into the Ocean Basin which is a wide undulating but relatively flat zone lying at the 4,000 to 5,000 m and covers most of the central parts of the major oceans (Te Ara, 2014a).

The surface of the Continental Shelf is predominantly flat although diversified by local banks and reefs, whereas the slope is more irregular, being cut in many areas by the large marine valleys known as submarine canyons. These tend to occur in slope areas of relatively steep gradient and generally run from the edge of the Continental Shelf to the foot of the Continental Slope.

The NZ coastline's Continental Shelf varies in width from one area to another; where the narrowest parts are found off the east coast of NZ between Kaikoura and Cape Kidnappers with a width that varies between 1 – 15 Nm. Whereas other parts of NZ have a more extensive Continental Shelf that can be up to 40 Nm wide, with the western Cook Strait and south of Stewart Island having a Continental Shelf which extends to over 100 Nm (Te Ara, 2014a).

The gradient of the Continental Slope varies a lot around NZ, although there is a broad correlation between steepness of the Continental Slope and the narrowness of the Continental Shelf.

The Taranaki Continental Shelf has a 150 km wide opening to the Tasman Sea, occupying 30,000 km² and slopes gently towards the west with an overall gradient of <0.1° and locally less than 0.5° (Nodder, 1995).

The bathymetry through the Mohua Operational Area is sloping to the southwest on a gently sloping gradient towards the shelf break with a water depth from the inside boundary of approximately 110 m to ~ 200 m on the offshore boundary (Figure 8).

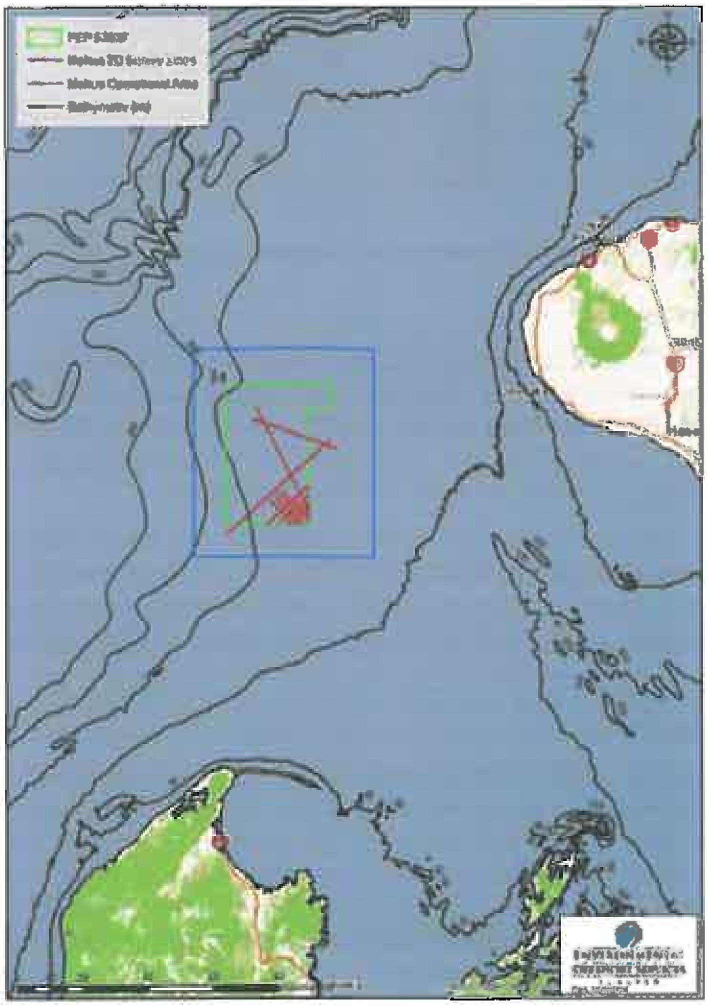

Figure 8: Bathymetry of the Mohua Operational Area

4.1.2.4 Current Regime

New Zealand lies in the path of eastward-flowing currents, which are driven by winds that blow across the South Pacific Ocean. This results in NZ being exposed to the southern branch of the South Pacific subtropical gyre, driven by the southeast trade winds to the north and the Roaring Forties westerly winds to the south (Gorman *et al.*, 2005). The anti-clockwise circulation of the gyre is initiated by the winds but is then further modified by the spin of the earth (Coriolis Effect).

Around the NZ coastline the current regime is dominated by three different components; wind-driven flows, low-frequency flows and tidal currents. The net current flow is a combination of all three of these components and is often further influenced by the bathymetry relative to the location.

The West Auckland Current (WAUC) flows south along the west coast of the North Island and is met by the north-flowing currents in the North Taranaki Bight (Figure 9). Along the west coast of the South Island the Westland Current (WC) flows in a northerly direction before it merges with the D'Urville Current (DC) and moves into the South Taranaki Bight. The DC flows into the Cook Strait from the northwest where it mixes with water from the Southland Current (SC) and East Cape Currents (ECC) (Figure 9).

Within the South Taranaki Bight, MSL (2010a & 2010b) showed that the dominant ocean currents are caused by the local and regional wind stresses on the ocean's surface in combination with tidal flows. Strong and persistent wind stress within the South Taranaki Bight is supported by a hindcasted current speed average of 0.81 $m.s^{-1}$ at 10 m below the sea surface, whereas at 10 m above the seabed, the model predicted a current flow of 0.57 $m.s^{-1}$. Current rose plots using a combination of tidal and wind driven flows shows that the dominant current and tidal flows are towards the north and south (MSL, 2010a; MSL, 2010b).

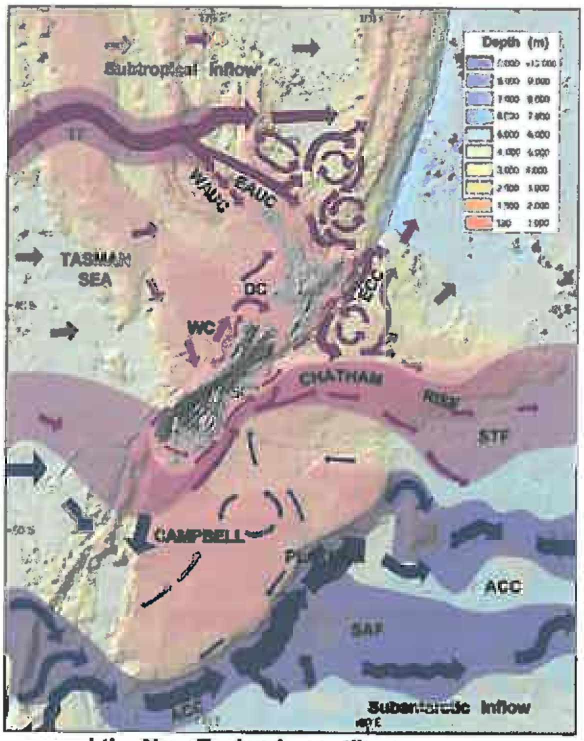

Figure 9: Ocean Circulation around the New Zealand coastline
(Source: http://www.teara.govt.nz/en/map/5912/ocean-currents-around-new-zealand)

4.1.2.5 Thermoclines and Sea Surface Temperature

During spring and summer month's thermal stratification of the water column becomes evident as a result of solar heating of the upper water column (i.e. 40 – 50 m below the sea surface). The range and form of the stratification varies with weather conditions, with storm conditions causing significant vertical mixing and breakdown of thermal structure. Likewise the local environmental conditions can also play a part in formation of thermoclines such as tides and currents. As a result a well-defined thermocline is not always present.

Thermoclines can be observed through processed seismic data, where a thermocline can be characterised by a negative sound speed gradient, so the thermocline reflects an acoustic signal off this layer in the ocean. This is a result from a discontinuity in the acoustic impedance of water created by the sudden change in density which is derived from temperature differences. As water temperature decreases with depth, the speed of sound decreases, where a change in temperature of 1°C can result in a change of speed by 3 ms^{-1} (Simmonds *et al*., 2004).

MSL (2012) used satellite data from 1988-2008 to gain representative sea surface temperatures from a location in the South Taranaki Bight which showed the seasonal average temperature over this period for each season was:

- Summer – 17.3 °C;
- Autumn – 16.85 °C;
- Winter – 13.63 °C; and
- Spring – 13.72 °C.

The monthly sea surface temperatures have been further delineated; where temperature readings from the Maari well head platform have provided monthly averaged readings. These results are presented below:

- January – 17.62 °C;
- February – 18.48 °C;
- March – 17.94 °C;
- April – 17.18 °C;
- May – 15.94 °C;
- June – 14.64 °C;
- July – 13.72 °C;
- August – 13.21 °C;
- September – 13.27 °C;
- October – 13.62 °C;
- November – 14.47 °C; and
- December – 15.91 °C.

4.1.3 Geological Setting

A sedimentary basin is formed by a depression in the earth's crust into which sediments have been deposited over millions of years. Within NZ, the sedimentary basins that are likely to contain oil and gas are young (<80 million years) and most have many faults that offset the rock layers.

NZ's key sedimentary basins started forming after the breakup of Gondwana (~85 million years ago) and the opening of the sea floor in the Tasman Sea. Erosion of land by rivers transported sediments containing organic material into these basins. This resulted in shoreline sands being deposited, followed by marine silts and mud several kilometres thick, which were compacted by the weight of the overlying sediment. Due to being both porous and permeable, they made ideal reservoir rocks, while the impermeable overlying silts, mud and carbonates formed the seals.

There are eight sedimentary basins around NZ (Figure 10); both onshore and underlying the continental shelf, with known or potential hydrocarbons present; however, only the Taranaki Basin has produced commercial quantities of oil, gas and condensate. In addition there are also several deep-water basins offshore (Figure 10).

The NZ sedimentary basins can be subdivided into 'Petroleum Basins' and 'Frontier Basins', where the petroleum basins are based on modern, industry-standard seismic surveys over at least a part of each basin or from well logs. As a result, all or part of each petroleum basin has been licenced for exploration.

Basin boundaries are mainly determined by major geological structures or seafloor physiography, i.e. regions with stratigraphic continuity and a common geological history are included within a single basin.

Figure 10: NZ Sedimentary Basins
(Source: GNS)

The Mohua Operational Area is located within the Taranaki Basin which lies at the southern end of a rift that developed sub-parallel to the Tasman Sea rift, and now separates Australia and NZ. The Taranaki Basin occupies the site of a late Mesozoic extension on the landward side of the Gondwana margin, covering ~ 330,000 km^2 (Figure 11). Within the basin the structure is controlled by the movement along the Taranaki, Cape Egmont and Turi fault zones.

Petroleum exploration in Taranaki first began in 1865 with the Alpha-1 well in New Plymouth which is the first recorded well to produce oil in the British Empire; which has now increased to over 400 offshore and onshore exploration and production wells drilled in the Taranaki Basin (Figure 11). Over the years there have been a large number of 2D and 3D MSS in the Taranaki region. The proposed Mohua 2D MSS will help gather more subsurface information to build onto the existing knowledge of the Taranaki Basin and underlying strata and tie in to the existing data already acquired by OMV within the South Taranaki Bight.

The Taranaki basin is a Cretaceous and Tertiary sedimentary basin where there is a grading from fine to medium sand to silt and muds with an increasing depth range across the Taranaki shelf. The prevailing west-southwest storm generated waves and currents are most likely the predominant sediment transport agents along the Taranaki coastline. Within the offshore South Taranaki Bight surrounding the installations and including the Mohua Operational Area there are no known reef structures or sensitive environments (Johnston & Forrest, 2012; Johnston *et al.*, 2012; Govier & Calder, 2013).

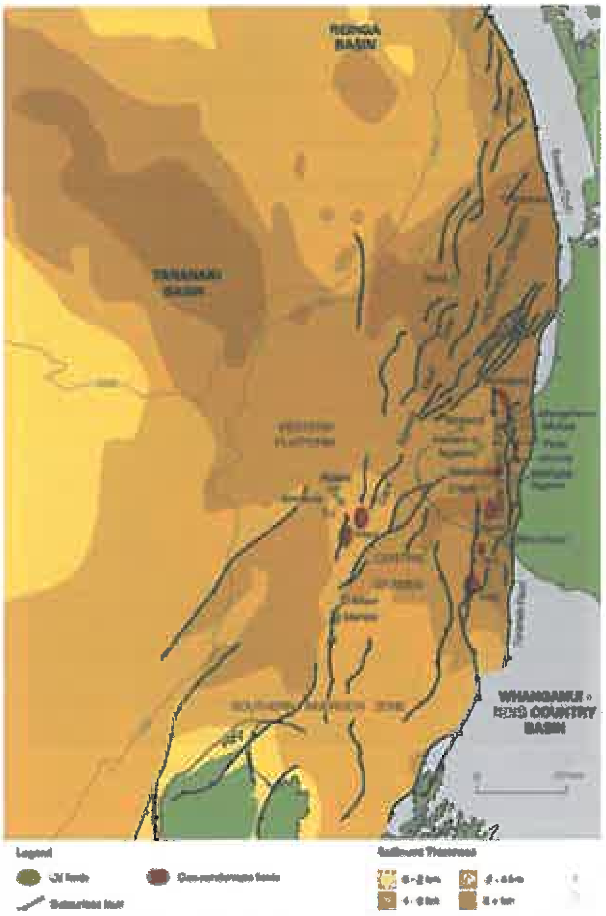

Figure 11: Taranaki Basin
(Source: http://www.nzpam.govt.nz/cms/pdf-library/petroleum-basins/taranaki-basin.pdf)

4.2 Biological Environment

4.2.1 Regional Coastal Environment

The Taranaki region has a coastline that stretches 295 km and is exposed to the Tasman Sea from the west; often resulting in high energy wind and wave conditions. The Taranaki coastline comprises of rocky shores and cliffs, sandy beaches, a marine protected area, two marine reserves, marine mammal sanctuary, subtidal reefs, river mouths and estuaries; providing a wide range of ecological habitats for native plant and animal species. Due to the rugged and exposed nature of the Taranaki coastal environment, much of this coastline has retained its distinctive natural character; this includes natural coastal processes, marine life and ecosystems, coastal landscapes and seascapes.

Taranaki people value the landscape, natural character and amenity recreational values of the coast and the area is particularly significant for local iwi and hapu as kaitiaki (guardians) of the coast.

The intertidal reef systems along the south Taranaki coastline generally have a lower diversity and abundance of species compared to similar type systems elsewhere in NZ. This is believed to be a result of the high energy wave environment which results in abrasive and turbulent shoreline conditions, high water turbidity, suspended silt and sand inundation. Waters within the South Taranaki Bight are well known for their high turbidity, which is due to fluvial run-off combined with high rainfall. In addition, the energetic wave climate frequently re-suspends sediments, often resulting in prolonged turbid periods, even during dry weather.

Taranaki has more intertidal rocky reefs compared to sandy beaches and those reefs with larger rocks present have a higher species diversity as they provide more habitat and shelter to intertidal species. Taranaki's intertidal shore from Urenui around Cape Egmont to Hawera, is almost entirely boulder-lined, consisting of hard andesite boulders, cobbles and pebbles eroded out of the laharic breccias that from the low coastal cliffs (Hayward & Morley, 2004). The laharic breccias were formed by lahars that flowed down from Mt Taranaki and its predecessors creating the ring plan that surrounds the mountain. These breccias consist of andesite clasts set in a matrix of relatively soft volcanic mud and sand, which in many places form a wave-cut low to mid-tidal shore platform on which the boulders and cobbles sit (Hayward & Morley, 2004). The wave-cut platform overlays compacted Pliocene mudstones/siltstone deposits. Periodically large patches of mobile sand is moved inshore and may bury and smother parts of the boulder shore and underlying rock platforms, but this has been a common occurrence over many years along the Taranaki coastline and intertidal species either adapt or rapidly recolonise an area once the sand has moved on.

Over 270 species live on the exposed rocky shores of the Taranaki coastline. At the more exposed northern intertidal reefs and cliffs, biodiversity is low (56 species) due to pounding surf and sand scouring and inundation, while at New Plymouth 180 species are present as the coast becomes more sheltered from Cape Egmont and the substrates are harder and more stable with a greater range of microhabitats (Hayward *et al*., 1999). These low lying shore platforms and gravel deposits, interspersed with boulders extend subtidally, and are believed to extend offshore for about 3 km to depths of approximately 20 m, while the boulder beaches are interspersed with scattered sand beaches. Beyond 3 km and the boulders and reef areas give way to extensive sand dominated areas with occasional shelly material and coarse gravels.

Offshore habitats vary from sand and muddy bottoms to the volcanic platforms and rocky reefs. The inshore Taranaki marine environment provides a wide range of different habitats for a number of aquatic species such as snapper, blue cod, gurnard, warehou, trevally, moki, tarakihi, kahawai, starfish, sea anemones, crabs, crayfish, sea cucumbers, mussels, pipi, paua, sponges whelks and a number of seaweed species. However, the nearshore subtidal area often supports a low diversity of plant and animal species as a result of high energy wave action, highly turbid water and episodic sand inundation of reefs.

Estuaries and river mouths make up 16% of Taranaki's 295 km coastline, which are shallow, sheltered areas of extremely productive nursery habitats for a variety of marine life. The soft substratum – consisting of productive topsoil carried down by rivers mixed with detrital materials (e.g. leaves), supports a range of burrowing animals such as worms, cockles and pipi. Estuarine areas are ideal refuges for juvenile fish of many species. They also provide essential nesting, breeding and feeding habitats for other native wildlife – particularly in relation to birds.

There are certain areas of the Taranaki coastal environment that are considered to have outstanding coastal value and are outlined in the Taranaki Regional Coastal Plan (TRC, 2009) and the Taranaki Regional Council inventory of coastal areas of local or regional significance in the Taranaki region (TRC, 2004).

These significant areas are further discussed in Section 4.2.13, however some of the more important coastal areas are discussed briefly here. The Sugar Loaf Island Marine Protected Area (SLIMPA), Paraninihi and Tapuae marine reserves have statutory protection and are managed for conservation purposes; however there are other coastal areas, without formal protection which are considered by the Taranaki community to be of outstanding coastal value (i.e. Tongaporutu and Mohakatino coastline in the north and Waitotara and Whenuakura estuaries in the south).

To the south of the Mohua Operational Area is the top of the South Island; where a number of important coastal features and landscapes are present, namely Farewell Spit, Golden Bay, Abel Tasman coastline, Tasman Bay and the Marlborough Sounds. These areas and their outstanding coastal values are discussed in further detail in Section 4.2.14.

4.2.2 Planktonic Communities

Within NZ, the productivity of the ocean is a result of many factors; namely ocean currents, climate and bathymetry which causes upwelling creating nutrient rich waters – ideal conditions for plankton growth and the animals that feed on them (MPI, 2014a).

Plankton are a drifting organism (animals, plants or bacteria) that occupy the pelagic zone of oceans and seas around the world. Plankton are the primary producers of the ocean, they travel with the ocean currents although some plankton species can move vertically within the water column. Nutrient concentrations and the physical state of the water column (i.e. settled or well-mixed) influence the abundance of plankton. There are three broad functional groups for plankton:

- Bacterioplankton – play an important role in nutrient cycles within the water column;
- Phytoplankton – microscopic plants which capture energy from the sun and take in nutrients from the water column via photosynthesis. They create organic compounds from CO_2 dissolved in the ocean and help sustain the life of the ocean; and
- Zooplankton – consists of small protists, metazoans (i.e. crustaceans), larval stages of fish and crustaceans and feed on the phytoplankton and bacterioplankton. Although zooplankton are primarily transported by ocean currents, many are able to move, generally to either avoid predators or to increase prey encounter rates. Zooplankton primarily live in the surface waters where food resources are abundant.

During spring and summer, cold nutrient rich water from the Kahurangi shoals off Cape Farewell create highly productive plumes that propagate north to the South Taranaki Bight. These upwelling events are intermittent and driven by strong westerly wind events which are common to the region (Shirtcliffe *et al*., 1990). These onshore winds upwell nutrient rich water from depths of about 100 m, creating rotating eddies that are transported downstream (north and northeast) with a life span of > two weeks (Foster & Battaerd, 1985; Shirtcliffe *et al*., 1990). As the phytoplankton are entrained within this cold nutrient-rich water they begin to reproduce rapidly and often results in phytoplankton and zooplankton blooms. By the time these eddies reach the Taranaki region they are often nutrient-depleted and phytoplankton-rich and contains high levels of chlorophyll-α; an indicator for plankton productivity, and during spring and summer months this phase is cyclical.

It has been shown that the Taranaki Bight and Cook Strait areas have some of the most extensive zooplankton biomass (exceeding 300 mg m^{-3}) of all coastal regions in NZ (Shirtcliffe *et al*., 1990). The euphausiids *Nyctiphanes australis* is a common zooplankton species in this upwelling system, and found most abundantly downstream of the upwelling area (Bradford & Chapman, 1988). The sampling locations within Bradford & Chapman (1988) did not extend up into the Mohua Operational Area so no empirical data is present on the zooplankton composition within this area, however based on their findings and trends in results it is possible that *N. Australis* is abundant within the Mohua Operational Area due to plumes carried downstream from the upwelling area (Torres, 2012).

It has been shown in a number of studies around the world that increased sightings of foraging blue whales occur in association with dense aggregations of euphausiids which form downstream of cold water coastal upwelling systems due to wind-forcing currents and euphausiids biology. It appears from the MMO observations from MSS undertaken in the South Taranaki Bight and studies on the zooplankton concentrations in the Greater Cook Strait and South Taranaki Bight environment that blue whales and high concentrations of euphausiids can be found within the South Taranaki Bight year round. Torres (2012) compared the observation results of blue whales in the South Taranaki Bight to the chlorophyll-α concentrations and found that there was a higher number of sightings during June and November which correlated to increased primary productivity relative to sightings in other months. However, a MSS acquired in March 2013 also found large numbers of blue whales present where they were observed to be foraging, milling, resting and travelling. Large patches of krill were observed in the water during this particular MSS. However, following a period of bad weather during the survey, the number of whales decreased and was correlated with a decreased distribution of the euphausiids the whales were feeding on. It is most likely that the rough weather broke up the aggregations of euphausiids the blue whales were feeding on and reduced the upwelling conditions and thermocline present which had resulted in the bloom conditions.

In OMV's recent acquisition of the KAKA 3D MSS in early-mid January 2014, only a few unidentified large cetaceans and one potential blue whale was observed, certainly not the numbers that were anticipated to be present. However, towards the end of January 2014, NIWA identified large numbers of blue whales in the South Taranaki Bight that were observed to be feeding on krill. Feeding blue whales were also observed off the Waikato coast during the Anadarko drilling campaign when MMO's were onboard during the vertical seismic profiling.

There could be high levels of euphausiids present during the Mohua 2D MSS, although this appears to be weather dependent. If large aggregations of zooplankton are present in the South Taranaki Bight coinciding with the Mohua 2D MSS, studies have shown that mortality of these communities can occur within 5 m of the acoustic source (DIR, 2007). However, given the large planktonic populations and their high natural mortality rate from stochastic events; any mortality imposed on these communities within close proximity to the acoustic source would be considered negligible.

4.2.3 New Zealand Marine Environmental Classification

MfE, MPI and DOC commissioned NIWA to develop an environmental classification called the NZ Marine Environment Classification (MEC). The MEC covers NZ's Territorial Sea and EEZ to provide a spatial framework for structured and systematic management, where geographic domains are divided into units that have similar environmental and biological characters (NZMEC, 2005).

Physical and biological factors (depth, solar radiation, sea surface temperatures (SST), waves, tidal current, sediment type, seabed slope and curvature) were used to classify and map marine environments around NZ.

The Mohua Operational Area falls within MEC groups 60 and 63 representing the moderately shallow to moderate depth waters on the continental shelf (Figure 12), and are further described below:

- **Class 60**: occupies moderately shallow waters (mean = 112 m) on the continental shelf. It experiences moderate annular solar radiation and wintertime SST and has moderately high average chlorophyll-*α* concentrations. Some of the most commonly occurring fish species are barracouta, red gurnard, john dory, spiny dogfish, snapper and sea perch, while arrow squid are also frequently caught in trawls. The most commonly represented benthic invertebrate families are Dentaliidae, Cardiidae, Carditidae, Nuculanidae, Amphiuridae, Pectinidae and Veneridae.
- **Class 63**: is extensive on the continental shelf including much of the Challenger Plateau and the Chatham Rise. Waters are of moderate depth (mean = 754 m) and have moderate annual radiation and wintertime SST. Average chlorophyll-*α* concentrations are also moderate. Characteristic fish species include orange roughy, Johnson's cod, Baxter's lantern dogfish, hoki, smooth oreo and javelin fish. The most commonly represented benthic invertebrate families are Carditidae, Pectinidae, Dentaliidae, Veneridae, Cardiidae, Serpulidae and Limidae.

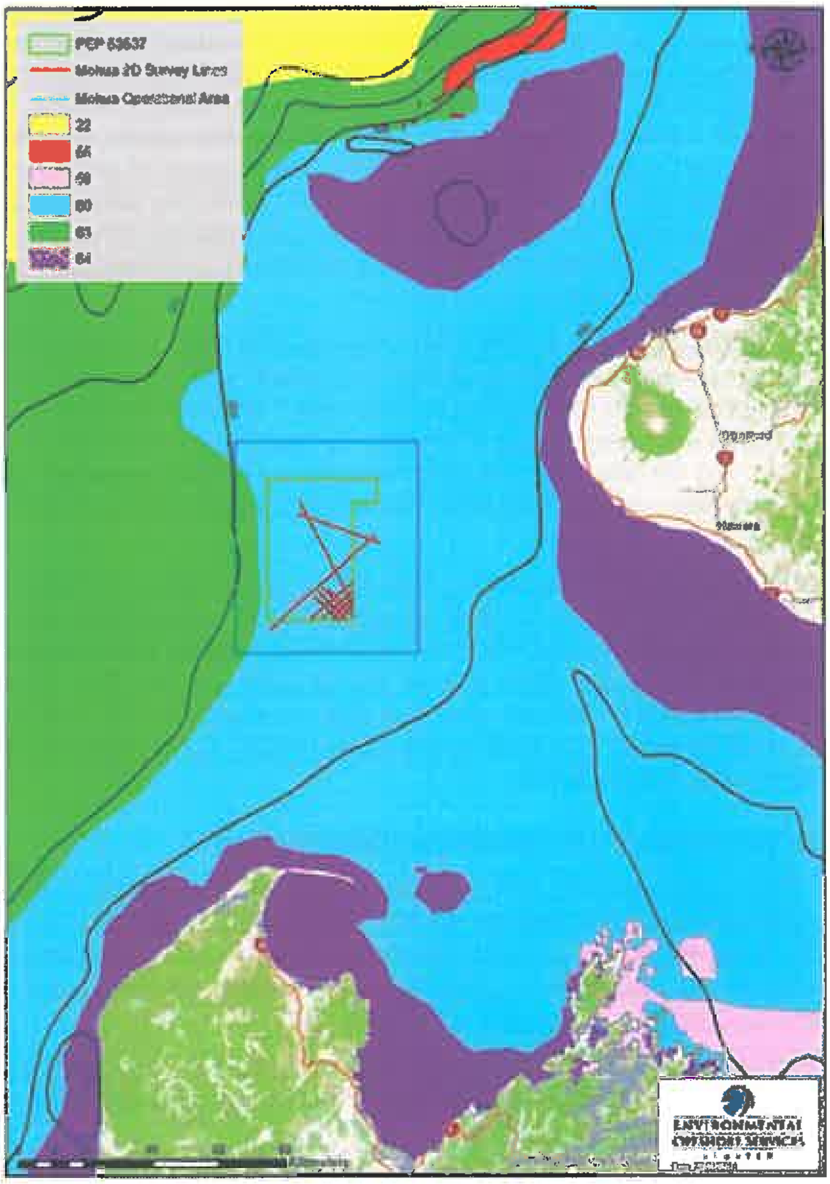

Figure 12: The NZMEC showing the 20-class grouping level

4.2.4 Fish Species

In the South Taranaki Bight fish populations comprise of various demersal and pelagic species, which have a wide distribution across NZ – from shallow to deeper waters over the shelf break. General distribution of fish species around the Taranaki coastline and South Taranaki Bight is listed in Table 4.

During summer months, warmer water moves south, bringing with it a number of pelagic species to the Taranaki coastline that are following the abundance of food within the warmer currents. Pelagic species commonly encountered are sunfish, marlin, tuna (albacore and skipjack) and sharks (mako and blue).

MPI prepared a fisheries assessment for the OMV Exploration, Appraisal and Development Drilling campaign in 2012 which also encompasses the Mohua Operational Area. This assessment identified jack mackerel and barracouta are the two most commonly caught commercial fish species within this area (Section 4.4.2).

Table 4: Distribution of fish species around the Taranaki coastline

Water column	Likely fish species
Pelagic	Albacore tuna, skip jack tuna, southern bluefin tuna, mako sharks, blue sharks, and marlin.
Shallow to mid-shelf (<200 m)	Snapper, trevally, kahawai, gurnard, blue warehou, blue cod, blue nose, john dory, hapuku, rig, school shark, spiny dogfish, blue mackerel, jack mackerel leather jacket, red cod, tarakihi and kingfish.
Coastal shelf region (<500 m)	Elephant fish, school shark, giant stargazer, Gould's and Sloan's arrow squid, tarakihi, red cod, frost fish, silver dory, gem fish, barracouta, hapuku, spiny dogfish, red bait, rig and jack mackerel.
Waters < 800 m	Bass, hake, ling, spiny dogfish and hapuku.
Deep water < 1,500 m	Ling and hoki

4.2.5 Threatened Marine Species

Under the NZ threat classification list, NZ has 368 threatened marine species. This includes 4.5% of the seaweeds, 2.4% of the invertebrates, 4.2% of the fish and 62.3% of NZ's 122 species of seabirds (excluding waders and shorebirds) (Hitchmough *et al.*, 2005). Eight of NZ's 50 species of marine mammals are also threatened (Hitchmough *et al.*, 2005; Baker *et al.*, 2010).

Great white sharks occur throughout Taranaki waters, they are at risk of extinction and are classified as being in 'gradual decline' under the NZ Threat Classification System and as 'vulnerable' by the International Union of Conservation of Nature (IUCN). They are fully protected in NZ waters under the Wildlife Act 1953 and are further protected on the high seas under the Fisheries Act, prohibiting NZ flagged vessels taking great white sharks beyond the EEZ. Satellite tagging of NZ great white sharks has shown that they migrate seasonally from March to September, between aggregation sites at Stewart Island and the Chatham Islands to the tropical and subtropical Pacific (i.e. northern New South Wales and Queensland, Norfolk Island, New Caledonia, Vanuatu, Fiji and Tonga) (DOC, 2014a). Within NZ waters other protected marine species include: basking sharks, whale shark, oceanic whitetip shark, deepwater nurse shark, manta ray and spiny-tailed devil ray.

4.2.6 Marine Mammals

There is a diverse community of marine mammals in NZ waters; over half of the world's whale and dolphin species can be found here. Forty one cetaceans (whales and dolphins) and nine species of pinnipeds (seals) have been recorded in NZ waters (Suisted & Neale, 2004). Whales are further divided into two main types: toothed whales and baleen whales. Baleen whales are often large and generally solitary animals; they don't have teeth, they have a fringe of stiff hair-like material, or baleen hanging from their upper jaw which they use to filter small animals out of the seawater (DOC, 2007). However, most of the whale species are toothed whales and generally spend their life in social groups, feeding, navigating and communicating with each other using underwater vocalisations or sound.

In May-June, 2011 OMV acquired the Matuku 3D MSS within PEP 51906, which adjoins PEP 53537 to the east. A total of 72 marine mammal detections were detected from visual observations; comprising of NZ fur seals (27%), common dolphins (25%), blue whales (15%), humpback whale (1%), with unidentified cetaceans comprising the remaining 32%, most of which were believed to be blue whales (Blue Planet Marine, 2011). The Matuku 3D MSS was acquired during autumn/winter with weather conditions reported as generally poor to average, resulting in a significant number of days with no seismic acquisition, however no PAM detections of vocalising cetaceans were recorded. These results, along with similar BPM reported observations of blue whales during a MSS in the similar area in May 2010 suggest the importance of this South Taranaki Bight area to blue whales during May-June (Blue Planet Marine, 2011).

In March 2012 OMV acquired a 200 km^2 3D MSS within PMP 38160 around the Maari field from the seismic vessel *Polarcus Alima*. This survey was undertaken in accordance to the DOC Guidelines for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations (2006) and the Draft Code of Conduct (2011). A total of 24 cetacean sightings were documented over the duration of the Maari MSS, representing a minimum of 44 individuals (RPS, 2012). Two sightings were of the long-finned pilot whale, while the remaining 22 sightings could not be identified to species level but were recorded as either an unidentified cetacean or unidentified baleen whale. Many sightings were difficult to identify during the survey due to the distance of the animal and in cases of poor visibility due to weather conditions.

In January 2014 OMV acquired a 400 km^2 3D MSS within PEP 51910 there were three weeks of MMO observations during the MSS both on and off survey location. A total of 71 cetaceans were documented, consisting of 2 pods of unidentified delphinid species, 6 unidentified large cetaceans, 3 pods of long finned pilot whales, one unidentified large baleen whale – likely to be a blue, one unidentified large baleen whale, two pods of dusky dolphins (northwest of Farewell Spit) and three possible Bryde's or sei whales. Most of the visual sighting conditions during the MSS were regarded as good as defined in the Code of Conduct. Three shutdown procedures occurred due to marine mammals within the mitigation zones while the acoustic source was active. The three Bryde's or sei whales were first observed outside the mitigation zone but moved towards the vessel, entering the mitigation zone resulting in the acoustic source being immediately shut down. These whales were tracked leaving the mitigation zones and the start-up procedures were followed to commence the MSS again.

For the preparation of this MMIA, the National Aquatic Biodiversity Information System (NABIS) database was accessed as well as the DOC sighting database, DOC stranding database and available literature to identify potential marine mammal species which could potentially be encountered throughout the Mohua Operational Area (MPI, 2014b). The NABIS database has collated records and data from marine mammal sightings, strandings and DOC to identify the locations where each marine mammal species could occupy. The marine mammal species identified that could be present or transitory in the vicinity of the Mohua Operational Area are listed in Table 5 with a basic ecological summary of some of the more common and likely marine mammal species to be present summarised below.

Table 5: Marine mammals likely to be present in or around the Mohua Operational Area

Whales	Dolphin Family	Pinnipeds
Humpback whale (*Megaptera novaeangliae*)	Common dolphin (*Delphinus delphis*)	NZ fur seal (*Arctocephalus forsteri*)
Blue whale (*Balaenoptera musculus*)	Killer whale (*Orcinus orca*)	
Bryde's whale (*Balaenoptera edeni*)	Bottlenose dolphin (*Tursiops truncates*)	
Fin whale (*Balaenoptera physalus*)	Maui's dolphin (*Cephalorhynchus hectori maui*)	
Minke whale (*Balaenoptera acutorostrata* & *B. bonaerensis*)	Long-finned pilot whale (*Globicephala macrorhynchus*)	
Sei whale (*Balaenoptera borealis*)	Hector's dolphin (*Cephalorhynchus hectori*)	
Southern right whale (*Eubalaena australis*)	Dusky dolphin (*Lagenorhynchus obscurus*)	
Toothed Whales		
Beaked whales (11 species)		
Sperm whale (*Physeter macrocephalus*)		
Pygmy sperm whale (*Kogia breviceps*)		

As discussed in Section 4.2.5, eight species of marine mammal have been included in the NZ threat classification list; either as nationally critical, nationally endangered or range restricted (Table 6) (Baker *et al.*, 2010). Four species have been identified that could be present within the Mohua Operational Area during the Mohua 2D MSS (Bryde's whale, killer whale, southern right whale and bottlenose dolphin).

During spring most of the large whales living in the Southern Hemisphere migrate from the Pacific Islands down to the Antarctic Ocean to feed. They return back to the Pacific Islands during autumn-winter for the breeding season (May-July) (DOC, 2007). The distribution and migration paths around NZ for humpback, sperm, Bryde's and southern right whales are shown in (Figure 13). The northern migration routes back up to the Pacific Islands are relatively well known, however the southwards routes are not.

Figure 13: Whale distribution and migration pathways in NZ waters
(Source: http://www.teara.govt.nz/en/map/7052/whales-in-new-zealand-waters)

The DOC sighting database, current up until the end of 2013 had the geographical positions of 2,600 sightings of marine mammals, of which MSS's around the Taranaki coastline have contributed significantly to this database and have been utilised as part of the assessment within this MMIA. The database was plotted on GIS mapping software to see distributions of marine mammals around NZ, however care has to be taken with sighting data, as the lack of sightings does not mean the marine mammals do not reside there, only the fact that there is either little boating activity in that particular area, no observations have occurred during dedicated observational surveys, are beyond easily accessible areas of coastline/harbours or that sighting information has not been submitted to DOC.

The DOC stranding database has also been accessed up until the end of 2013 and plotted on GIS mapping software which has been used as part of the assessment for potential marine mammal species within the Mohua Operational Area. A summary of the DOC stranding database was undertaken by Brabyn (1991), where at that time of writing 88% of the 1,140 whale strandings in NZ comprised of three species; pilot whales, false killer whales and sperm whales.

Within NZ, pilot whales are the most frequent herd stranders of all cetaceans with the largest single stranding recorded being 450 whales at Kawa Bay, Great Barrier Island in 1985 (Brabyn, 1991). Farewell Spit has a large number of strandings every summer as the shallow extensive sandy beaches result in a number of whales stranding each year. In January 2014 there were a number of stranding events at the base of Farewell Spit, with many refloated, however a number also died or were euthanased.

The DOC database of marine mammal strandings and observations in relation to the Mohua Operational Area is plotted below in Figure 14. Within the Mohua Operational Area there have been observations of blue whales, NZ fur seals, killer whale, pilot whale and common dolphins. Blue whales have the highest frequency of observations within the Mohua Operational Area so it is highly likely that they will be observed during the Mohua 2D MSS, especially if the weather conditions result in upwelling providing an abundance of krill in the South Taranaki Bight during the MSS period.

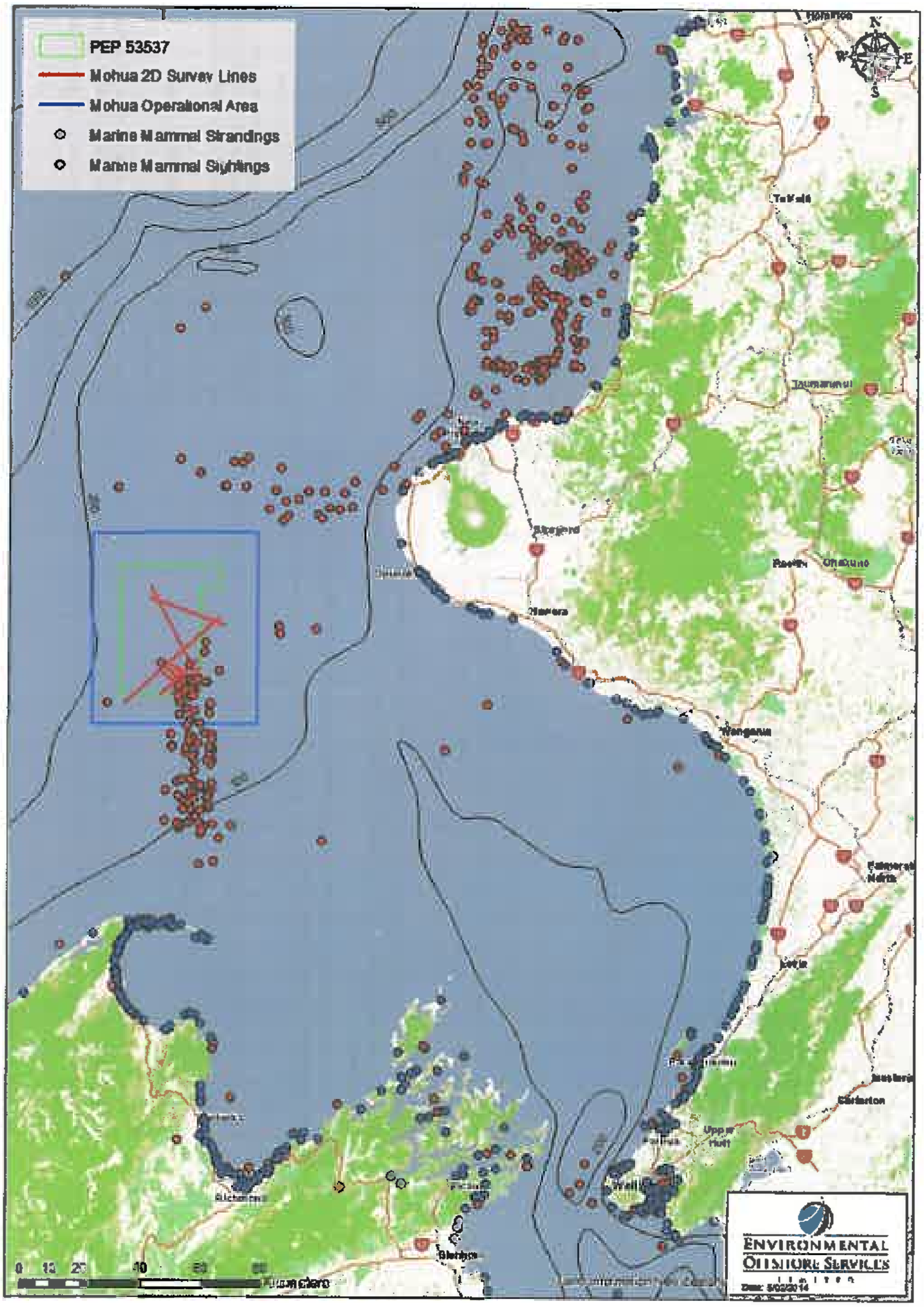

Figure 14: DOC records of marine mammal strandings and sightings

Table 6: Marine mammals on NZ threat classification list (DOC, 2007; Baker *et al.*, 2010)

Marine Mammal Species	NZ Threat Classification	IUCN Classification	Summary	Distribution	Likely to be in Survey Area
Bryde's whale *(Balaenoptera edeni)*	Nationally critical	Data deficient	Generally a coastal species but does live in the open ocean. Bryde's whales prefer temperate waters and are observed off the NZ coast generally north of the Bay of Plenty. This species of whale is believed to rarely venture beyond 40 degrees south.	Have a preference for warmer waters, they have been observed in the wider Taranaki waters during summer months. Potentially observed during the KAKA 3D MSS.	✓
Killer whale *(Orcinus orca)*	Nationally critical	Data deficient	Feeds on a variety of animals which include other marine mammals and fish species. They are believed to breed throughout the year and appear to migrate based on the availability of prey.	Largely unknown but tend to travel according to the availability of food. Killer whales are widely found in all oceans of the world although more dominant in cooler waters. Previous observations within Mohua Operational Area from DOC sighting database. Likely to occur in the Mohua Operational Area.	✓
Maui's dolphin *(Cephalorhynchus hectori maui)*	Nationally critical	Critically Endangered	World's smallest dolphin and found in inshore waters on the west coast of the North Island. Considered a subspecies of Hector's dolphin	Generally live close to shore (within 4 nautical miles) although the 100 m depth contour has been indicated as being their offshore distribution given current scientific understanding. Only found in the North Island. Unlikely to occur in the Mohua Operational Area, however if any observations were made DOC would be notified immediately.	×
Southern elephant seal *(Mirounga leonina)*	Nationally critical	Least concern	They are the largest species of seal and feed on squid, cuttlefish and large fish. Generally only comes ashore in spring/summer on offshore islands and some mainland areas to breed and moult; otherwise lives mostly at sea. They have an inflatable proboscis (snout) which is most present in adult males which is meant to increase the bull elephant seals roar.	Primary range includes the Antipodes, Campbell, Auckland, Snares Islands and the surrounding Southern Ocean. Occasionally they are found on the mainland from Stewart Island to the Bay of Islands. Not likely to occur in the Mohua Operational Area.	×
Southern right whale *(Eubalaena australis)*	Nationally endangered	Least concern	Present both offshore and inshore and their diet consist of krill, particularly copepods. Mate and calve during winter months in sheltered sub Antarctic harbours such as Auckland Islands and Campbell Island. Are baleen feeders and often travel well out to sea during feeding season; but they give birth in coastal areas (American Cetacean Society, 2010).	Likely to occur as a transient species in the Mohua Operational Area.	✓
Hector's dolphin *(Cephalorhynchus hectori)*	Nationally endangered	Decreasing	One of the smallest dolphin species (less than 1.5m long). Generally live inshore although have been sighted up to 18 Nm from the coast. Little known about migratory, reproductive, or feeding habits.	Patchily distributed around the South Island coast. Not likely to occur in the Mohua Operational Area due to their affinity for inshore waters, however the 100 m depth contour has been indicated as being their offshore distribution given current scientific understanding. If any observations are made DOC will be notified immediately.	×
NZ sea lion *(Phocarctos hookeri)*	Nationally critical	Decreasing	Feeds on fish, invertebrates, and occasionally birds or other seals. Breeding occurs in summer months with pupping occurring in December/January with the pups being weaned in July/August.	Known to forage along continental shelf breaks with primary range including the Auckland, Campbell, and Snares Islands. Unlikely to be encountered in the Mohua Operational Area due to distance offshore.	×
Bottlenose dolphin *(Tursiops truncatus)*	Nationally endangered	Least concern	Are found worldwide in temperate and tropical waters, generally north of 45 degrees south. Population density appears to be higher near shore. Resident bottlenose dolphins are found off the east coast of the North Island, the northern tip of the South Island, and in Doubtful Sound.	Possibly observed in the Mohua Operational Area.	✓

4.2.6.1 Humpback Whale

Humpback whales are a baleen whale belonging to the rorqual family; the head is broad and rounded but slim in profile, a round body shape and unusually long pectoral fins. The top of the humpback's head and lower jaw have rounded bump-like knobs which have at least one stiff hair, believed to help detect movement in nearby waters. During summer humpbacks feed in polar waters for up to 80 – 100 days and can consume up to two tonnes of krill per day; then in winter migrate north to tropical or sub-tropical waters (i.e. Tonga) for mating and calving where they fast and live off their fat reserves built up from the polar region. Whaling in the southern hemisphere reduced the population from ~120,000 animals to 15,000 but the population is now currently recovering (Suisted & Neale, 2004).

The migration route of humpbacks sees them travel from their summer feeding grounds in the Antarctic up the east coast of the South Island, through the Cook Strait and up the west coast of the North Island on the way to the tropics and their winter breeding grounds (Shirihai, 2002). As discussed in Section 1.4, OMV provide sponsorship to the DOC Cook Strait Monitoring project which is undertaken in June – July to coincide with the northern migration of the humpback whales to the South Pacific Breeding grounds. This migration north will occur after the Mohua 2D MSS is complete.

The southern migration back to the feeding grounds is along the west coast of the South Island and is led by the lactating females and yearlings who are followed by the immature whales, and lastly the mature males and females. The pregnant females are last to migrate south in late spring (Gibbs & Childerhouse, 2000).

Sighting records and the DOC database has shown that humpback whales are present around the Taranaki coastline, however it is likely that this area is mainly used as a migratory pathway for the humpback whales as they travel north or south along the west coast of NZ (Torres, 2012).

4.2.6.2 Blue Whale

Blue whales are the largest animals to ever live; adults can reach up to 33 m long and weigh up to 150 tonnes (Croll *et al.*, 2005). They are long-lived, slow reproducing animals and it is estimated that fewer than 2,000 blue whales can be found in the southern hemisphere. There are only four blue whale foraging areas documented in the Southern Hemisphere outside Antarctic waters (Torres, 2013). During summer they travel to their feeding grounds in the Antarctic while in winter they spend their time in equatorial waters.

Despite blue whales being such large animals, they are fairly elusive and little is known about their distribution or habitat use patterns. Torres (2013) published a paper on a previously unrecognised blue whale foraging ground in the South Taranaki Bight and completed two research voyages to the South Taranaki Bight in January/February 2014 to further study the blue whales. In the first voyage on 28th – 29th January 2014 they observed 47 blue whales and were able to take 9 biopsy samples, faecal samples, krill samples, oceanographic sampling with a conductivity, temperature, depth (CTD) instrument and took hundreds of photographs and video footage. Observations were made of the blue whales lunge feeding on the large krill swarms at the surface. Blue whales have been observed in the South Taranaki Bight during MSS programmes over recent years, and appear to be using this area to feed on euphausiids (krill) as a result of the upwelling from the Kahurangi shoals. The waters north of Cook Strait and within the South Taranaki Bight therefore appear to be an important foraging area on their migratory pathway. Blue whales have the highest prey demands of any predator and can consume up to two tonnes per day (Rice, 1978; DOC, 2007), therefore large aggregations of food in upwelling areas is important to these whales.

Blue whales can feed at depths of more than 100 m during the day and surface feed at night due to the distribution of krill which they feed on (Wikipedia, 2014a). Dive times are typically ten minutes when feeding, although dives of up to 20 minutes are common. Blue whales feed by lunging forward at aggregations of krill, taking the krill and a large quantity of water into its mouth. Excess water is squeezed out through the baleen plates by pressure from the ventral pouch and tongue. Once the mouth is clear of water, the remaining krill, unable to pass through the plates, are swallowed.

In the Southern Hemisphere there are two subspecies of blue whales; Antarctic (or true) blue whales and pygmy blue whales but are difficult to distinguish at sea so is not surprising that all sightings have been recorded as blue whales. Pygmy blue whales are present off the Taranaki coastline; a 22 m pygmy blue whale was washed ashore at Waiinu Beach along the South Taranaki Bight on 30 April 2011 and a 20 m pygmy blue whale at Himatangi Beach in October 2013. It is possible that both sub-species of blue whale use this South Taranaki habitat, but only further research will confirm this, such as testing of genetic samples from the NIWA blue whale survey in the South Taranaki Bight undertaken in January 2014.

Antarctic blue whales are generally found south of 55°S during the Austral summer, while pygmy blue whales are believed to remain north of 54°S (Branch *et al.*, 2007). It has been assumed that Antarctic blue whales migrate to temperate waters for mating and calving during the winter and return to the Antarctic in the summer months for feeding (Torres, 2012). However, there is recent evidence around the world from a number of locations (including NZ) that some Antarctic blue whales do not migrate south every winter (Branch *et al.*, 2007). The distribution of pygmy blue whales has been documented to show that they do migrate to Antarctic waters during summer. Torres (2012) undertook an analysis of marine mammal strandings in NZ, and up to 1991 it was shown that five of the 11 blue whale stranding events in NZ occurred around the Farewell Spit, South Taranaki Bight and Cape Egmont region. It was proposed in Torres (2012) that during summer months when blue whales have been observed in the South Taranaki Bight; given most of the Antarctic blue whales are believed to be feeding in Antarctic waters, that the sighting of blue whales in the South Taranaki Bight are likely to be pygmy blue whales.

The IUCN red list of threatened species currently lists the Antarctic blue whale as *Critically Endangered* and the pygmy blue whale as *Data Deficient*. However under the NZ threat classification system blue whales are currently classified as a 'migrant' and therefore does not designate a threat status (Torres, 2013) but blue whales are listed as a Species of Concern under the Code of Conduct.

Blue whales vocalise at a low frequency (0.01 – 0.04 kHz); resulting in their vocalisations being able to travel a very long distance through the water. This distance, which can be up to a couple of hundred kilometres, is a result of efficient propagation of a low-frequency sound emitted in water and is the reason that MSS emit low frequency acoustic signals to penetrate down through the seabed. The communication calls of blue whales partially overlap with the acoustic energy emitted from MSS (Table 8). Blue whale vocalisations are also very loud, where their calls can reach levels of up to 188 dB (WDCS, 2014; WWF, 2014). It has been shown that blue whales will increase their calls (emitted during social encounters and feeding) when a MSS is operational within the area (Section 5.1.2.5). It is believed that blue whale increases their calling when a MSS is operational to increase the probability that communication signals will be successfully received by conspecifics and compensate for the masking of communications by noise (Di Iorio & Clark, 2009).

4.2.6.3 Bryde's Whale

Around the NZ coastline Bryde's whales are the most common baleen whales. Given they prefer warmer waters (above 20°C) they are generally found in northern NZ (Suisted & Neale, 2004). During the Mohua 2D MSS the average water temperature for March 2014 within the Mohua Operational Area is expected to be 17.94°C (Section 4.1.2.5). Bryde's whales are the second smallest baleen whale within NZ waters; they can grow up to 12 – 15 m in length and weigh up to 16 – 20 tonnes. Bryde's whales are distinct to most other baleen whales in the polar regions; as they will also feed on fish (pilchards, mackerel and mullet). There has been a sighting of a Bryde's whale within the Mohua Operational Area from the

DOC sighting database, three potential sightings during the KAKA 3D MSS and one stranding record on the coast between Wanganui and Patea; so the potential for observing them during the Mohua 2D MSS is possible.

4.2.6.4 Minke Whale

There are three species of minke whales: the northern minke (*Balaenoptera acutorostrata*) (confined to northern hemisphere), the Antarctic or southern minke (*Balaenoptera bonaerensis*) and a sub-species, the dwarf minke which is present in NZ waters. The southern minke is confined to the southern hemisphere, including NZ, and although most commonly observed south of NZ feeding in Antarctic waters, they have been observed close to shore at Cape Egmont. A number of Minke whales have stranded at Farewell Spit and Golden Bay as well as along the Wanganui and Kapiti coastlines. Therefore there is the potential that a minke whale could be encountered during the Mohua 2D MSS.

4.2.6.5 Sei Whale

Sei whales are a medium sized baleen whale with an average length of 15 – 18 m and weigh 20 – 25 tonnes. Sei whales are among the fastest swimming cetaceans; swimming at speeds of 50 km/hr and have travelled up to 4,320 km in ten days. During February-March, Sei whales migrate south to Antarctica where there is an abundance of food then return to the waters between the South Island and Chatham Islands to calve. Occasional observations have been made over the summer months in the South Taranaki Bight but there has been no strandings in the vicinity of the South Taranaki Bight, so although the Sei whales are likely to be either in or on their way to Antarctic waters, they could potentially be observed during the Mohua 2D MSS. During the KAKA 3D MSS there were three whales sighted that were unconfirmed whether they were sei whales or Bryde's whales.

4.2.6.6 Southern Right Whale

Southern right whales are a large baleen whale that can grow up to 15 – 18 m in length and the lack of a dorsal fin allows for their easy identification. The upper jaw and facial area of the southern right whale has callosities (hardened patches of skin) that are often white due to infestations from whale lice, parasitic worms and barnacles making them more distinguishable. They are a slow moving whale, often swimming at speeds less than 9 km/hr, making them vulnerable to ship-strikes.

Southern right whales are the only baleen whale to breed in NZ waters; during winter months calving occurs in coastal waters whereas in summer they migrate to the Southern Ocean (sub-Antarctic and Campbell Islands) to feed. Their northern migration sees them go through the Taranaki region between May-October, although sighting observations have been recorded outside of this period.

The population was heavily reduced by whaling, where numbers dropped from ~17,000 to ~1,000 (Suisted & Neale, 2004; Carroll *et al.*, 2011a) and is a priority for DOC to collect sighting data and genetic samples. Within NZ southern right whales are regarded as nationally endangered but it appears they are making a recovery. Genetic evidence suggests that southern right whales seen around mainland NZ and the NZ subantarctic represent one stock, as there is no differentiation between the two regions based on the analysis of mitochondrial or nuclear loci (Carroll *et al.*, 2011b). It is now thought that there is currently one NZ population of southern right whales with a range that includes two wintering grounds: the primary wintering ground in the NZ subantarctic and secondary wintering ground of mainland NZ (Carroll *et al.*, 201b). Rayment & Childerhouse (2011) estimated the population of southern right whales in the subantarctic using annual photo-ID surveys from 2006-2011. The survey resulted in 511 individuals being identified and through modelling estimated that the whales associated with the survey area during the course of the study was estimated to be 1,286 (689-2,402) in 2011.

Southern right whales have been observed around the Taranaki coastline, where all but one of the nine observations have occurred during the winter period (Torres, 2012) and again all but one of these sightings have been very coastal between Okato and New Plymouth. This seasonal trend depicts the migration cycle of southern right whales, with the winter sightings most likely reflecting animals on breeding or calving grounds (Torres, 2012). This is typical of the southern right whales with a habitat use pattern at this life history stage to be in protected coastal waters with the least threat of predation from predators such as killer whales and sharks (Torres, 2012). A southern right whale sighting has been observed to the northeast of the Mohua Operational area towards Cape Egmont, although this was during winter. It is therefore unlikely a southern right whale would be observed during the Mohua 2D MSS scheduled for March 2014 when these whales are down in Antarctic waters to feed.

4.2.6.7 Beaked Whale

Due to the limited sightings at sea, very little is known about the distribution of beaked whales around the NZ coastline. Eleven species of beaked whales are present in NZ, however it is difficult to identify specific habitat types and behaviour for each individual species, as most of the information comes from stranded whales, and in some cases provides the only knowledge that they exist within NZ waters. Beaked whales are mostly found in small groups in cool, temperate waters with a preference for deep ocean waters or continental slope habitats at depths down to 300 m.

Along the Taranaki coastline seven species of beaked whales have been recorded from the DOC stranding database and include: Blainville's; Gray's; Layard's/strap-toothed; Shepherd's; Cuvier's; Arnoux's and pygmy. Due to the relative frequency of beaked whale strandings throughout the year it is assumed they are present all year round and could therefore be observed during the Mohua 2D MSS, although they are difficult to observe at sea.

4.2.6.8 Sperm Whale

Sperm whales are globally distributed and are the largest of the toothed whales. Males can reach 18 m in length and weigh up to 51 tonnes; whereas females are usually half the weight and two-thirds the length. They are an intelligent animal, with a brain weighing on average 8 kg it is heavier than any other animal (Te Ara, 2014b; Wikipedia, 2014b). Squid is their most common food but they are also known to eat demersal fish (Torres, 2012).

Sperm whales prefer the open ocean environment of shelf breaks and deep canyons at depths down to 1,000 m where dives can last for over an hour, so they rely heavily on acoustic senses for navigation and communication (Torres, 2012). Within NZ, the main population of sperm whales resides in Kaikoura and includes both resident and transient individuals. Under the IUCN sperm whales are currently listed as vulnerable.

During summer months sperm whales migrate to the poles, males more so than females and juveniles, however they have been observed in the deep offshore waters of the South Taranaki Bight over summer months. From the DOC stranding database a large number of sperm whales have been recorded stranded along the south Taranaki, Wanganui and Kapiti coastlines as well as in Golden Bay and Farewell Spit, so they could be observed during the Mohua 2D MSS.

4.2.6.9 Pygmy Sperm Whale

Pygmy sperm whales (*Kogia breviceps*) are slightly larger than dolphins, they can grow up to 3.5 m in length and weigh 400 kg. Pygmy sperm whales have no teeth in their upper jaw, only sockets, which the 10 – 16 pairs of teeth in the lower jaw fit into.

They have a very timid behaviour, lack a visible blow, and with their low profile/appearance in the water are often difficult to observe at sea unless weather conditions are calm with little or no swell. As a result most of the knowledge on these whales is derived from stranded whales.

Over recent years pygmy sperm whales have stranded ashore along the Wanganui and South Taranaki coastlines; a whale washed ashore at Waiinu Beach in May 2011, in February 2013 there was a stranding in the entrance of the Raglan Harbour, and a whale washed ashore at Ototoko Beach, Whanganui in October 2013 indicating their presence along the general west coast of the North Island. The DOC stranding database has shown a number of pygmy sperm whales have stranded along the shore from Waverley Beach south to Wellington indicating this species is relatively common along this stretch of coast. Therefore, it is assumed that pygmy sperm whales may be present in the Mohua Operational Area, but they could be difficult to observe in most sea conditions.

4.2.6.10 Dwarf Sperm Whale

Dwarf sperm whales (*Kogia sima*) are rare in NZ waters (Te Ara, 2014b) and are not often sighted at sea, so most of the known information comes from stranded whales. The dwarf sperm whales are the smallest species commonly known as a whale, where they can grow up to 2.7 m in length and weigh up to 250 kg, often smaller than some of the larger dolphins. These whales make slow, deliberate movements with little splash or blow and usually lies motionless when they are at the sea surface, making them hard to be observed in anything but very calm seas.

The dwarf sperm whale is very similar in appearance to the pygmy sperm whale, making identification difficult at sea, however, the dwarf is slightly smaller and has a larger dorsal fin. The DOC stranding database only has four records of dwarf sperm whales and they have been in the Auckland and Northland region, indicating it is unlikely that this species would be observed during the Mohua 2D MSS.

4.2.6.11 Maui's Dolphin

Maui's dolphins are the world's smallest dolphin and are only found off the west coast of the North Island (Maunganui Bluff in Northland to Oakura Beach, Taranaki) although most sightings occur between Manukau Harbour and Port Waikato (Blue Planet Marine, 2011).

Under the Marine Mammals Protection Act 1978, Maui's dolphins, believed to be a sub-species of Hector's dolphins, are a protected species; classified as 'nationally critical' in the NZ threat classification and 'nationally endangered' by the IUCN. It is estimated that the population of Maui's dolphins is 55 animals over 1 year of age (95% confidence intervals of 48 – 69), which is significantly lower than the 2005 estimate of 111 individuals (95% confidence intervals of 48 – 252) (Hamner *et al.*, 2012), although the results are not comparable due to different survey methods being used. During the Hamner *et al.* (2012) study, two female Hector's dolphins were observed in the North Island from the west coast South Island population. This was the first documented contact between these two species and indicates there could be the potential for interbreeding, although there is no evidence to suggest this has occurred.

Maui's dolphins have a coastal distribution, generally in water depths of less than 20 m as most sightings occur within 4 Nm of the coastline (Figure 15). However, they have been sighted up to 7 Nm from the shore (Du Fresne, 2010) and at 19 Nm from the Māui A platform, although this sighting must be treated with caution as it was a public sighting without photo/video evidence. DOC have previously advised that the 100 m depth contour is more likely to correlate to the offshore distribution (T Ross-Watt pers. comm. 2012), based on their best available information for Maui's/Hector's dolphins and is the reason the AEI was implemented along the west coast of the North and South Island.

Over the last ten years mammal surveys have extended well south of Raglan and Kawhia but no Maui's dolphins have been observed (Ferriera & Roberts, 2003; Slooten *et al.*, 2005; Webster & Edwards, 2008). Possibly due to these areas being beyond the core range of

Maui's dolphins, although visited occasionally, or there are Maui's dolphins resident in these southern areas but the surveys just missed them due to their low numbers (Du Fresne, 2010). However there is evidence that Maui's/Hector's dolphins visit the stretch of Taranaki coastline from a photograph and reports of a Maui's/Hector's dolphin in Port Taranaki in 2007, video footage of a Maui's/Hector's dolphin off the Waiongana Stream in December 2009 and a Maui's/Hector's dolphin caught in a set net near Cape Egmont in January 2012.

The Mohua 2D MSS is being acquired in relatively deep water (>110 m), and although the Mohua Operational Area is located within the AEI, it is unlikely that a Maui's dolphin would be observed. Even though it is highly unlikely, there is the potential for a Maui's/Hector's dolphin to be observed moving between the west coast South Island and west coast North Island populations.

If a Maui's dolphin sighting was made during the Mohua 2D MSS it would be notified immediately to DOC and would be highly significant to the distribution and study of this dolphin species. If the sighting was reliable, DOC staff would mobilise a fixed-wing aircraft and the DOC boat to try and gather a biopsy sample. The biopsy sample would be used to verify sub-species (Hector's or Maui's dolphin) using genetic (DNA) analysis and would add to the knowledge about the southern extent of Maui's dolphin, their offshore range and whether sightings off South Taranaki/Whanganui are of Maui's or Hector's dolphins.

Figure 15: Maui's and/or Hector's dolphin sightings from 1970 – 2013

4.2.6.12 Hector's Dolphin

Like Maui's dolphins, Hector's dolphins are only found in NZ waters and at 1.2 – 1.5 m in length they are one of the smallest cetaceans in the world. Over the last 40 years their numbers have declined significantly and are classified as 'nationally endangered' by the NZ threat classification list and as 'endangered' on the IUCN list as they are among the most rare of the world's 32 marine dolphin species. Hector's dolphins have a patchy distribution, generally living in three geographically distinct groups around the South Island. The most frequently sighted Hector's dolphins are found on the west coast between Jackson Bay and Kahurangi Point, on the east coast between Marlborough Sounds and Otago Peninsula and on the south coast between Toetoes Bay and Porpoise Bay as well as in Te Waewae Bay (MPI, 2013). Smaller population densities are also found in Fiordland, Golden Bay and south Otago coast. There is significant genetic differentiation among the west, east and south coast populations, with little or no gene flow connecting them (Hamner *et al.*, 2012). Hector's dolphins have also being observed within the Maui's dolphin area in north Taranaki (Hamner *et al.*, 2012).

MPI funded survey programmes were conducted to assess abundance and distribution of the south coast South Island and east coast South Island populations of Hector's dolphin (Clement *et al.*, 2011; MacKenzie *et al.*, 2012; MacKenzie & Clement, 2013). The survey programme involved aerial surveys during summer and winter months with the number of Hector's dolphins recorded along transect lines. The sighting data was analysed using mark-recapture distance sampling and density surface modelling techniques to yield estimates of density and total abundance. It was estimated that the south coast South Island population was estimated to be 628 dolphins (95% CI = 301 - 1,311).

For the east coast South Island surveys a total of 354 dolphin groups sighted in summer and 328 dolphin groups sighted in winter. After the results were analysed using the modelling techniques above to yield estimates of density and total abundance, an estimate of 9,130 (95% CI = 6,342 - 13,144) was determined for summer and 7,465 (95% CI = 5,224 - 10,641) for winter. Hector's dolphin numbers are believed to have increased within the Banks Peninsula MMS and are now routinely reported around the Marlborough Sounds (Hamner *et al.*, 2012). The South Island west coast population is estimated at about 5,400 (MPI, 2014c).

It is believed set nets used are responsible for ~75% of the known Hector's dolphin's deaths but many more may go unreported (MPI, 2014c; Project Jonah, 2013). Hector's dolphins are often observed close to shore as they prefer shallow, turbid coastal waters with water depths of less than 100 m. However, occasional sightings have occurred beyond the 100 m isobaths at distances out to 20 Nm off Banks Peninsula (MacKenzie & Clement, 2013) and a sighting of a Hector's/Maui's dolphin from the Māui platform. There have been three others within the South Taranaki Bight (Torres, 2012) and could possibly be dolphins moving between the west coast/Marlborough Sounds and west coast North Island populations.

The DOC stranding database shows there have been Hector's dolphins stranded at Farewell Spit, Waikanae, Wanganui, Opunake, and Oakura indicating that this species does move north of the South Island, and as indicated potentially travel north to the west coast of the North Island.

Given the water depth of the Mohua Operational Area, it is unlikely that a Hector's dolphin would be present but there is the potential if dolphins were moving between the two different populations.

4.2.6.13 Common Dolphin

The common dolphin has a distinctive colouring of purplish-black to dark grey on top to white and creamy tan on the underside. They can grow to 1.7 – 2.4 m in length, weigh 70 – 110 kg and feed on a variety of prey (fish (anchovies), small mid-water fish (jack mackerel) and squid) (Meynier *et al.*, 2008). The maximum ages of the common dolphin is up to 29 years old which scientists calculated from a fresh carcass, the oldest on record for this species, with sexual maturity at 7 – 12 years for males and 6 – 7 years for females (DOC, 2014b).

Common dolphins are distributed around the entire NZ coastline, generally remaining within a few kilometres of the coast and can often form groups of several thousand individuals. In the Bay of Islands the mean water depth of sightings is 80 m, but range from 6 – 141 m (Constantine & Baker, 1997). The principal predators of common dolphins are killer whales.

This species of dolphin is common around the Taranaki coastline and has been observed in the South Taranaki Bight (Torres, 2012) and within the Mohua Operational Area. The stranding database shows records of dolphins stranding along most of the top of the South Island, especially at Farewell Spit, and the entire stretch of coastline between Wellington and New Plymouth. Given common dolphins generally prefer the coastal waters, they are most likely to be observed when the *Aquila Explorer* is mobilising to and from the Mohua Operational area.

4.2.6.14 Bottlenose Dolphin

Bottlenose dolphins are among the largest of dolphin species, ranging from 2.4 – 4 m in length and 250 - 650 kg in weight. Throughout the world, bottlenose dolphins are widely distributed in cold temperate and tropical seas, with NZ being the southernmost point of their range.

Within NZ there are three main coastal populations of bottlenose dolphins; approximately 450 live along the northeast coast of Northland, 60 live in Fiordland and there is a population living in the Marlborough Sounds to Westport region. The three populations each have differences within their DNA indicating little or no gene flow between the populations (Baker *et al.*, 2010). A sub-population of offshore bottlenose dolphins also exists that travels more widely and often in larger groups.

Bottlenose dolphins are now listed as 'Nationally Endangered' on the NZ threat classification list, largely due to their low abundance and concerns over potential decline in populations.

Bottlenose dolphins have been observed within the South Taranaki Bight (Torres, 2012) with one stranding recorded on the coast north of Opunake. The only other strandings in the surrounding waters of the Mohua Operational Area have been at Manawatu, Paekakariki, Tasman Bay and Golden Bay. If any bottlenose dolphins were observed during the Mohua 2D MSS it is highly likely that they would belong to the sub-population of the offshore bottlenose dolphins.

4.2.6.15 Dusky Dolphin

Dusky dolphins are slightly smaller than common dolphins; growing up to 2 m in length, 50 – 90 kg in weight and are characterised by having virtually no beak. They prefer cool inshore waters but have can be found as far offshore as the continental shelf. In NZ waters they mainly live south of East Cape and are the second largest population of dolphin species around NZ. The population of dusky dolphins within NZ is believed to be 12,000 – 20,000 individuals and are not regarded as threatened (Markowitz *et al.*, 2004). No defined seasonal migrations exist but they are known to make offshore seasonal and diurnal movements. During late spring and summer, dusky dolphins spend the mornings inshore resting and socialising then late afternoon move 6 – 15 km offshore. In winter dusky dolphins generally spend more time in deeper water.

Dusky dolphins consume a variety of fish (e.g. anchovies) and squid species as part of their diet, often forming large feeding groups. Admiralty Bay is regularly used by 200 – 300 dolphins as a winter foraging habitat. Dusky dolphins have been observed in the South Taranaki Bight (Torres, 2012) so they could be observed within the Mohua Operational Area. During the KAKA 3D MSS two pods of dusky dolphins were observed northwest of Farewell Spit in deep water.

4.2.6.16 Killer Whale

Killer whales are the largest member of the dolphin family; males can grow to 6 – 8 m and weigh in excess of six tonnes. They have the second heaviest brains among all mammals and are very intelligent. It is believed two populations exist within NZ waters; one inshore and one offshore although this is still not verified. During the summer NZ fur seal breeding season, killer whales are often found inshore.

The resident NZ killer whale population is small (mean = 119 ± 24 SE) with broad distribution patterns around both North and South Islands (Visser, 2000). Within the NZ threat classification list killer whales are classified as 'nationally critical' (Suisted & Neale, 2004). On 12 February 2014 nine killer whales stranded at Blue Cliffs Beach, near Tuatapere (South Coast of NZ) which was a tragic stranding, being NZ's third largest stranding of killer whales and possibly one of the 10 largest internationally. As part of this stranding, Visser was quoted as saying there are fewer than 200 killer whales now living off the NZ coast.

Killer whales do frequent the Taranaki region, but generally exhibit a coastal distribution although there has been a sighting of a killer whale within the Mohua Operational Area, however it is important to note that there are limitations within sighting databases and collecting data on marine mammals that have low numbers with wide temporal and spatial distributions. It is unlikely killer whales will be observed during the Mohua MSS although not impossible, however it is possible that killer whales could be observed when the *Aquila Explorer* is mobilising to and from the Mohua Operational Area.

4.2.6.17 Pilot Whale

Pilot whales are a member of the dolphin family; males are larger than females and can grow up to 6 m long and weigh three tonnes. There are two species of pilot whales; long-finned and short-finned, of which the long-finned is more likely to be found in NZ waters. Long finned pilot whales are a migratory species; they prefer cold temperate coastal waters and along shelf breaks, where they feed on fish and squid in deeper water.

Pilot whales are notorious for stranding along the NZ coastline, which generally peaks in spring and summer (O'Callaghan, 2001), with Farewell Spit renown for a number of whale strandings each year. The most recent have occurred within ten days of each other in January 2014, where a number of pilot whales stranded at the base of Farewell Spit.

They are a very social whale and can often travel in groups of over 100; it was originally thought the family relationships among the pilot whales was the cause of strandings as a result of their 'care-giving' behaviour. Where if one or a few whales stranded due to sickness or disorientation, a chain reaction is triggered which draws the healthy whales into the shallows to support their family members (Oremus *et al.*, 2013). However from genetic data gathered from stranded whales in NZ and Tasmania, it was proven that stranded groups are not necessarily members of one extended family and many stranded calves were found with no mother present (Oremus *et al.*, 2013).

Pilot whales are abundant within the Taranaki region and South Taranaki Bight (Torres, 2012), and along with common dolphins are one of the most observed cetaceans from recent seismic surveys in the Taranaki region; therefore it is highly likely they will be observed in the Mohua Operational Area. They were observed during the KAKA 3D MSS in the adjacent PEP 51906 in January 2014 and the sighting database shows records within the Mohua Operational Area.

4.2.7 Pinnipeds

Within NZ waters the NZ fur seal is the most common of the pinnipeds. They are distributed around NZ, with a population estimate of 50,000 – 60,000 but this is likely to be significantly underestimated. NZ fur seals forage for food along continental shelf breaks up to 200 km offshore but are generally distributed inshore, in water depths of less than 100 m.

NZ fur seals can hold their breath for 10 – 12 minutes, enabling very deep dives (~ 200 m) to feed on fish (small mid water fish, conger eels, barracouta, jack mackerel and hoki), squid and octopus; which is further aided by being able to slow their heart rate down to help conserve oxygen.

NZ fur seals are present year round in offshore Taranaki waters with a continual presence at the offshore Taranaki platforms and Floating Production Storage and Offloading Installations (FPSO) in the South Taranaki Bight. The NZ fur seals spend time hauled out on the platform braces and associated structures when they are not foraging for fish which are attracted to these installations. Several NZ fur seal breeding colonies and haul-out areas are present on the west coast of the North Island; the closest being the Sugar Loaf Island Marine Protected Area (SLIMPA). Their breeding season extends from mid-November to mid-January; the adult males arrive first in late October, followed by females in late November. Pups are usually born in January and weaned in July-August when the females return to sea. Previous sightings of NZ fur seals have occurred within the Mohua Operational Area and it is highly likely that NZ fur seals will be observed within the Mohua Operational Area.

4.2.8 Marine Reptiles

Off the coast of NZ, seven marine reptile species are known to live: the loggerhead turtle (*Caretta caretta)*, green turtle (*Chelonia mydas)*, hawksbill turtle (*Eretmochelys imbricate)*, olive Ridley turtle (*Lepidochelys olivacea)*, leatherback turtle (*Dermochelys coriacea*) yellow-bellied sea snake (*Pelamis platurus)*, and the banded sea snake (*Laticauda colubrine)*. Most of the marine reptiles are generally found in warm temperate waters, and within NZ this mainly occurs off the northeast coast of the North Island.

Within Taranaki waters the leatherback turtle and the yellow-bellied sea snake have been observed (DOC, 2014c). These are rare visitors to Taranaki waters and if any reptiles are recorded during the MSS they would be recorded and further increase the knowledge of NZs marine reptiles. A study which exposed captive sea turtles to an approaching acoustic source indicated that turtles displayed a general alarm response at ~2 km from the acoustic source with avoidance behaviour estimated to occur at 1 km (McCauley *et al*., 2000).

4.2.9 Seabirds

There are 86 species of seabirds in NZ waters which include albatross, cormorants, shags, fulmars, petrels, prions, shearwaters, terns, gulls, penguins and skuas (DOC, 2014d). NZ is often considered to be the seabird capital of the world and important breeding grounds, with NZ having the greatest variety of albatrosses and petrels. Most of the seabirds identified in this MMIA breed on coastal headlands and offshore islands and some use the Mohua Operational Area as foraging habitat.

A number of sources (DOC, NABIS, and Matuku MSS MMO Report) have been used to identify the likely seabirds that could be present within and around the South Taranaki Bight and includes:

- **Albatross** – wandering, southern royal, northern royal, light-mantled sooty, antipodean, Campbell, Gibson's, grey headed, Chatham, pacific and white capped;
- **Mollymawks** – Salvins, black-browed and Buller's;
- **Shearwaters** – short tailed, little, Buller's, flesh-footed, sooty, Hutton's, common-diving and fluttering;
- **Petrels** – black, common diving, grey, grey-faced, Kermadec white-faced storm, northern giant, Westland, NZ storm, Giant (Nelly), Cape, Mottled and white chinned;
- **Terns** – Caspian, white and white-fronted;
- **Penguins** – northern little blue and blue; and

- South polar skua, black-backed gull, red-billed gull, black-billed gull, cape pigeon, masked booby, fairy prion and Australasian gannet.

Sea birds that feed by plunge diving (i.e. Australasian Gannet) or that rest on the sea surface and dive for food (i.e. sooty shearwater) have the potential to be affected by underwater noise from MSS's. However it is believed that acoustic damage to birds could only be experienced if a bird was diving in close proximity to the acoustic source array (i.e. within 5 m of the array) (Bendell, 2011).

Diving seabirds are all highly mobile and are likely to flee from approaching sound sources. The potential for physiological effects from MSS noise on diving bird species is considered to be of high intensity but would only be in close proximity to the acoustic source and limited to the MSS duration. Likewise, any avoidance behaviour of birds from the Mohua Operational Area, if indeed it does occur, would only last for the MSS duration.

It is highly likely that the Australasian Gannet will be in the Mohua Operational Area during the proposed commencement date in March; given these birds often follow the sub-tropical water that moves south carrying an abundance of food for the gannets, where gannets can be observed along a large part of the west coast of NZ and throughout the top of the South Island. These birds feed on the pelagic baitfish (i.e. pilchards, saurie, anchovies) that are present in this sub-tropical water, and it is likely that if these baitfish move away from the Mohua Operational Area due to the sound levels emitted during the Mohua 2D MSS, the likelihood of any seabirds diving in close proximity to the acoustic source is considered remote. Gannets have very good eyesight and only enter the water when they can view these baitfish, often travelling many kilometres until they find food.

4.2.9.1 Breeding Colonies

Surrounding the Mohua Operational Area, five bird species are known to have breeding colonies. These birds, listed below along with their listing in the NZ threatened species classification, have their breeding colonies plotted in Figure 16.

- Sooty shearwater – declining;
- Caspian tern – nationally vulnerable;
- King shag – vulnerable;
- Grey-faced petrel – declining; and
- Flesh-footed shearwater – declining.

Figure 16: Breeding colonies of seabirds surrounding the Mohua Operational Area

4.2.10 Deep Sea Corals

NZ has a rich and diverse range of corals that are present from the intertidal zone down to 5,000 m (Consalvey *et al.*, 2006). Corals can live for up to hundreds of years and exist either as individuals or colonies.

The potential effects of acoustic noise on corals is not well publicised due to a lack of literature. It has been suggested that sound emission from an acoustic source could either remove or damage polyps on the coral calcium carbonate skeleton but has not been reported so far. A 3D MSS was undertaken around Scott Reef in Western Australia in 2007 by Woodside Energy Ltd and a pre- and post-seismic survey field experiment was conducted at the same time. Results did not show any detectable effects of acoustic source noise emissions on any coral species (Woodside, 2007).

Black coral is protected within NZ's EEZ under the Wildlife Act, 1953 and is distributed off the west coast of the North Island, along the shelf break from Cape Egmont to northern NZ (Figure 17) (MPI, 2014b). The Mohua Operational Area is located 34 km southeast of the southern distribution of black coral in the offshore Taranaki waters.

During the corals planktonic or pelagic phase of their lifecycle, mortality has been observed of the plankton if they are at close range (< 5 m) of the acoustic source (DIR, 2007). However, given the abundance of the planktonic populations and their high natural mortality rates from stochastic events, these effects on the plankton in close to the acoustic source would be considered negligible.

Figure 17: Black coral distribution around the Mohua Operational Area

4.2.11 Protected Natural Areas

Protected Natural Area's (PNA) are put in place for biodiversity conservation and receive protection as a result of their recognised natural ecological values. There are a number of PNAs surrounding the Mohua Operational Area; the closest being Tapuae Marine Reserve and Westhaven (Te Tai Tapu) Marine Reserve (Figure 18).

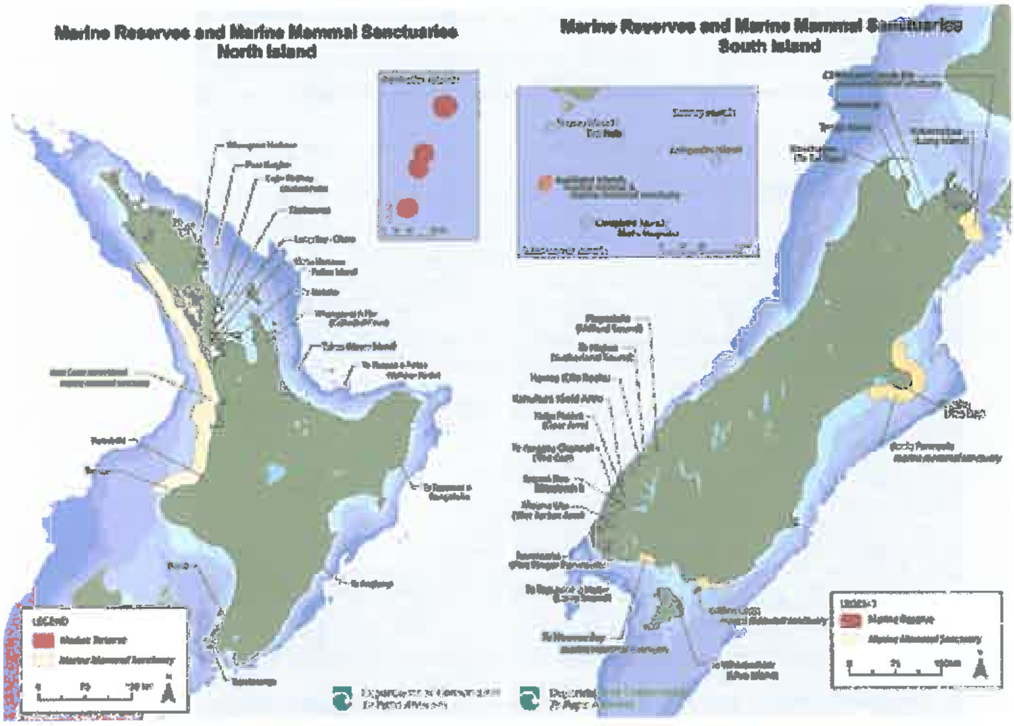

Figure 18: Protected Natural Areas and Marine Mammal Sanctuaries in New Zealand

4.2.12 Benthic Protection Areas

The Government established 17 Benthic Protection Areas (BPA) in 2007; closing large areas of seabed to bottom trawling and shellfish dredging. As a result 1.2 million km^2 of seabed was protected which equates to ~32% of the EEZ. The nearest BPA to the Mohua Operational Area is on the Challenger North Plateau, 150 km to the west (Figure 19).

Figure 19: Benthic Protected Areas in relation to the Mohua Operational Area

4.2.13 Taranaki Areas of Significant Conservation Value

The Taranaki Regional Coastal Plan (TRC, 1997) defines a number of areas within the coastal marine area with significant conservation values that have policies in place to protect them from any adverse effects of use or development. The Mohua Operational Area is located well offshore from these significant areas; however, the significant areas of relevance within the Taranaki region to the Mohua Operational Area are shown in Figure 20 and discussed further below.

- **Sugar Loaf Islands Marine Protected Area** – is the remnants of an old volcano formed 1.75 million years ago that has eroded away leaving a group of low sea stacks and seven islands providing a unique semi-sheltered environment with a diverse range of underwater habitats and marine life, along an otherwise exposed coastline (DOC, 2014e). A diverse range of subtidal marine habitats provides habitat for at least 89 species of fish, 33 species of encrusting sponges, 28 species of bryozoans and 9 nudibranchs (DOC, 2014e). SLIMPA is predator free and there are 19 species of seabirds found on and around the island, with ~10,000 seabirds nesting there each year. The NZ fur seal also use SLIMPA as breeding grounds;
- **Tapuae Marine Reserve** – covers 1,404 ha and has a diverse range of habitats including canyons and boulder fields; providing a safe haven and nursery for a wealth of underwater marine life (DOC, 2014f). It adjoins SLIMPA and extends south to Tapuae Stream and has a contrast of marine environments within the reserve. To the northwest of the reserve are islands, remnants of an ancient volcano with caves, canyons, boulder fields, while to the southwest it is less sheltered and is a classic example of the wild Taranaki coastline (DOC, 2014f). A diverse range of fish, invertebrate and algal species live in the reserve and is an important breeding and haul out area for NZ fur seals;
- **Whenuakura Estuary** – a relatively unmodified estuary providing habitat for the threatened Caspian tern and rare variable oystercatcher. The estuary is a route for migratory birds and is an important whitebait spawning habitat;
- **North and South Traps** – an unusual feature on an otherwise sandy coastline with an extensive *Ecklonia radiata* kelp forest present which is diverse and abundant in marine life;
- **Waverley Beach** – is regarded as an outstanding natural landscape with eroding stacks, caverns, tunnels and blowholes;
- **Waitotara Estuary** – an unmodified estuary with a number of sub-fossil totara stumps present. It provides habitat to a number of threatened birds (Australian bittern, NZ shoveller and black swan) as well as being a stopover point for migratory wading birds and international migrant birds; and
- **Waiinu Reef** – has limestone rock outcrops which extend from shore out to 500 m offshore. Many well-preserved fossils are present in the hard rock platforms and there is an abundance of marine life around these outcrops and platforms.

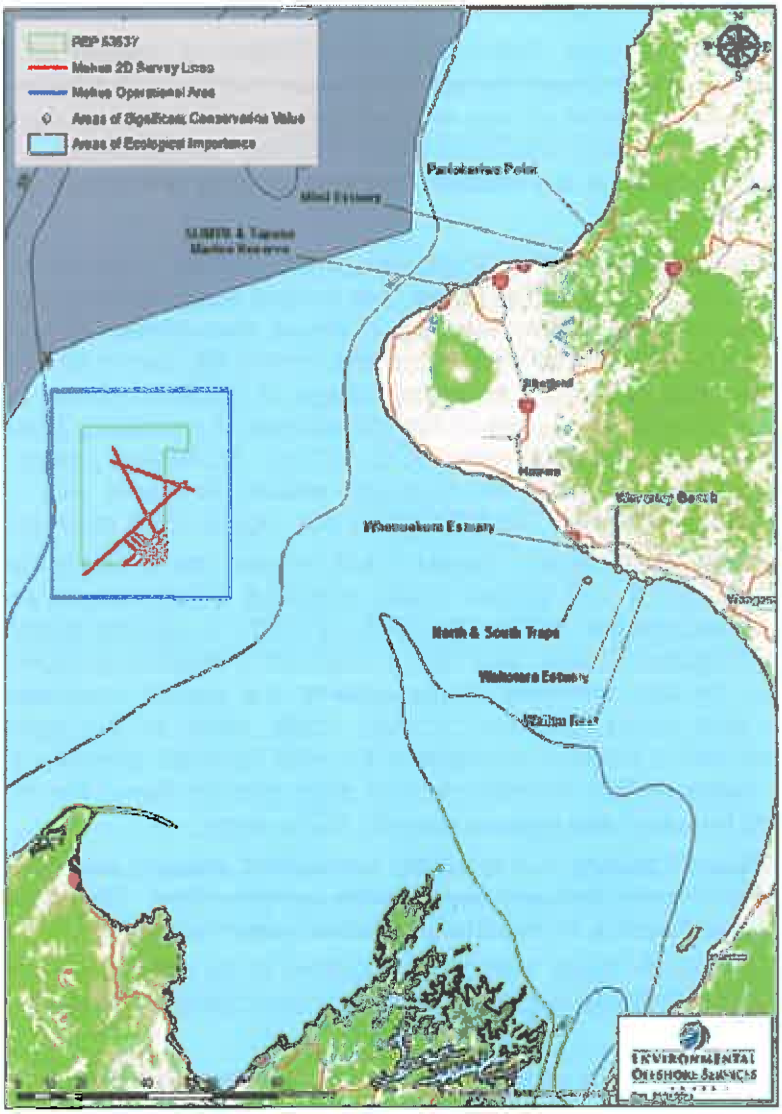

Figure 20: Taranaki Areas of significant conservation value and DOC Area of Ecological Importance

4.2.14 Tasman Areas of Significant Conservation Value

A large number of areas are identified within the Tasman District Council Resource Management Plan – Coastal Marine Area (Tasman, 2013) as having significant conservation value. The Tasman District in the top of the South Island is unique due to a number of marine reserves, national parks, landforms, estuaries and sheltered bays. A few of the more significant areas within the Tasman region are discussed below and are shown in Figure 21.

- **Whanganui Inlet (Westhaven)** – is surrounded by a combination of forest and pasture and covers an area of 2,774 ha. It is the first estuary in NZ to be protected by both a marine reserve and wildlife reserve. The Westhaven (Te Tai Tapu) marine reserve covers 536 ha of tidal sandflats and channels (DOC, 2014g), while the Westhaven Wildlife Management Reserve covers 2,112 ha of sandflats and channels. It is believed ~30 species of marine fish use the inlet at some stage in their life cycle while the inlet is also an important breeding and nursery area for snapper, flatfish, kahawai and whitebait;
- **Farewell Spit** – is a narrow sand spit at the northern end of the South Island, with Cape Farewell being the South Islands northern most point. It forms the northern side of Golden Bay and is NZ's longest sand spit which stretches above sea level for

26 km and then a further 6 km underwater. Farewell Spit is regarded as a wetland and landform of international importance. Large tides in the area can recede up to 7 km exposing 80 km^2 of mud flats. DOC have administered the spit as a seabird and wildlife reserve due to the fact that many sea birds use the rich feeding grounds present, although it is kept closed to the public except through organised tours. Farewell Spit is an important staging area for migratory shorebirds, and is home and breeding ground for colonies of Australasian gannet, Caspian tern, south black-backed gull, red-billed gull and variable oyster catcher;

- **Golden Bay** – is sheltered by Farewell Spit to the north and offers a variety of coastal features including sandy beaches and sheltered estuaries. There are 12 areas within Golden Bay that have nationally important ecosystem values (Tasman, 2013) which provide nesting, roosting and feeding habitat for estuarine species and wading birds;
- **Abel Tasman National Park** – established in 1942 is well renowned for its golden beaches, rocky outcrops (granite with some limestone and marble), unmodified estuaries and the Abel Tasman Coast Track. Although it is NZ's smallest national park it is a very important tourist area for both national and international visitors who visit to undertake walking, sea kayaking and sailing activities. There are a number of significant areas along the Abel Tasman coastline, and given the scale of the map in Figure 21 they have not been shown, but the entire stretch of coastline between Separation Point in the north down to Marahau can be classified as having significant conservation value;
- **Tonga Island Marine Reserve** – covers an area of 1,835 ha, extending 1 Nm offshore from mean high water springs of Tonga Island and the coast. It is the third marine reserve created alongside a national park.

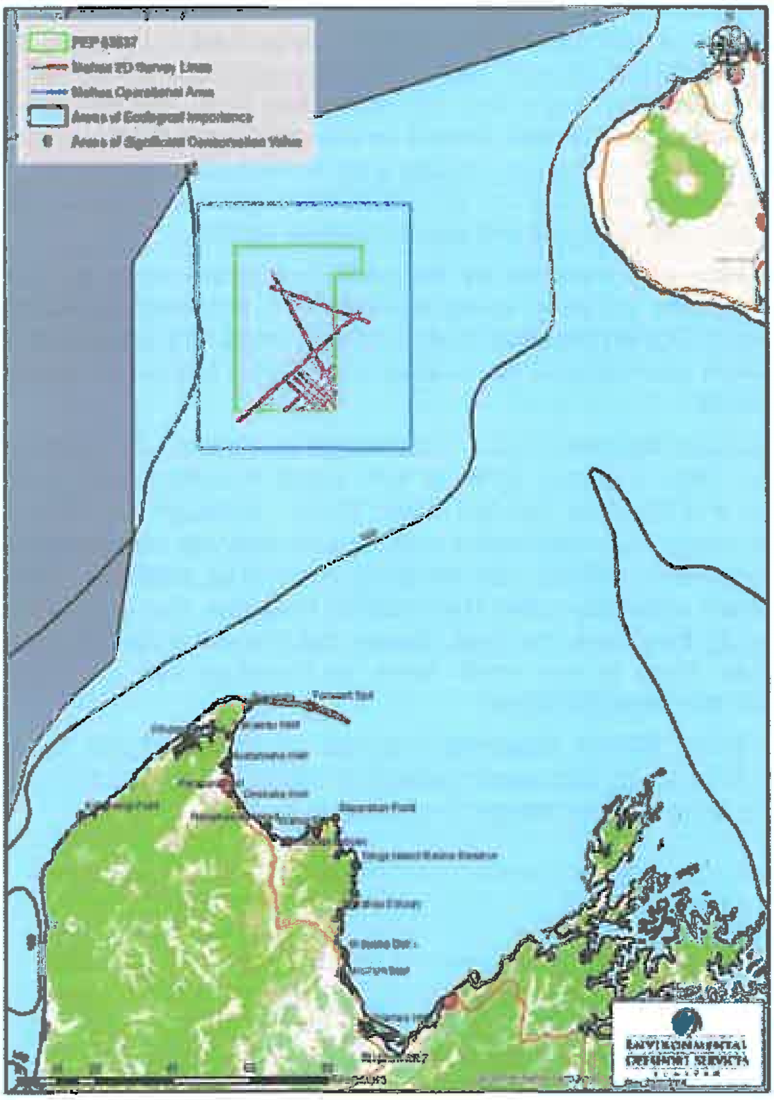

Figure 21: Tasman District Council areas of significant conservation value and DOC Area of Ecological Importance

4.3 Cultural Environment and Customary Fishing

Maori have a strong relationship with the sea and the collection of kaimoana is a fundamental part of their life, and for coastal hapu, kaimoana is often vital to sustain the mauri (life force) of tangata whenua. Collection of kaimoana allows Maori to provide a food source for whanau (family) and hospitality to manuhiri (guests).

The Taranaki coastline and the top of the South Island is home to a number of iwi and hapu, where the coastal marine area is culturally important for collecting kaimoana and protection of spiritual values (Figure 22).

There are a number of marine species which iwi value highly and include: snapper, kahawai, blue cod, flat fish, small sharks, grey mullet, sea urchin (kina), scallops, mussels, paua, pipi, toheroa, cockles and tuatua (MPI, 2014d).

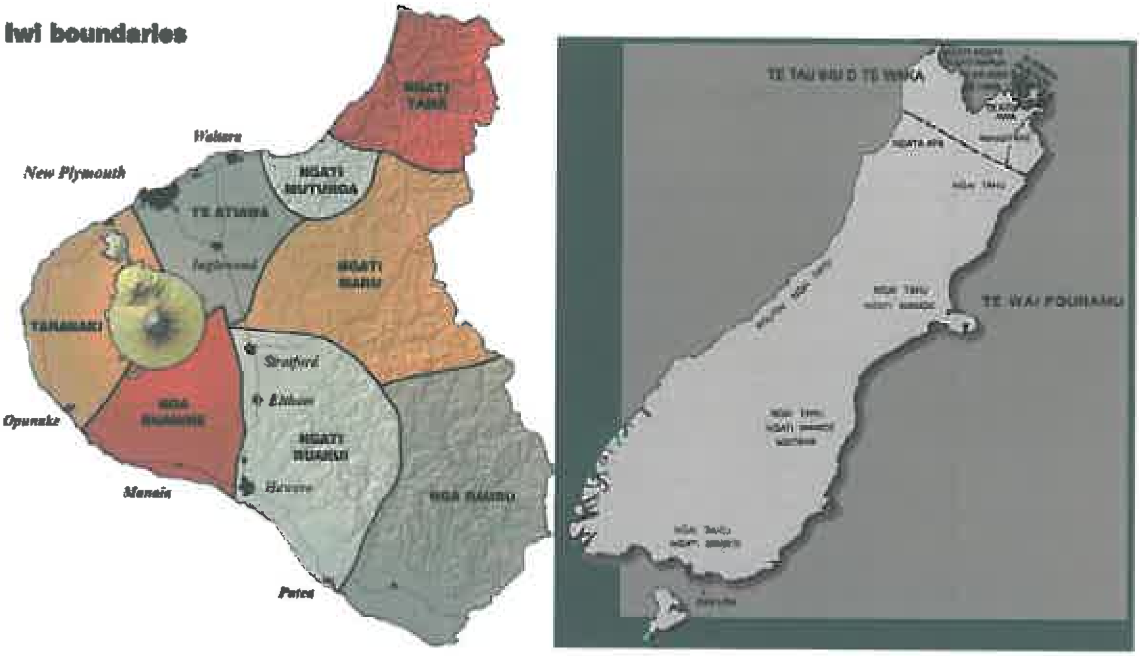

Figure 22: Taranaki Iwi boundaries and South Island Iwi map

Fishing and gathering of kaimoana along the Taranaki coastline is a fundamental part of being a Maori and living along the Taranaki coast, where tangata whenua hold a very strong relationship with the sea. Traditional management entails a whole body of knowledge about the resources from the sea and how and when to access it. Customary knowledge is held sacred by tangata whenua and only passed on to those who will look after that knowledge.

The Fisheries (Kaimoana Customary Fishing) Regulations (1998) allows traditional management to govern the fishing practices within an area that is deemed significant to tangata whenua. Under these regulations, tangata whenua are able to establish management areas (mataitai reserves) to oversee fishing within these areas and create management plans for their overall area of interest.

Mataitai comprise of traditional fishing grounds established for the purpose of recognising and providing kaimoana collection and customary management practices. Commercial fishers cannot fish within a Mataitai reserve, however recreational fishers can. Tangata whenua are also able to exercise their customary rights through a customary fishing permit under the Fisheries (Amateur Fishing) Regulations 1986.

A Taiapure can be put in place under the Fisheries Act (1996) and Kaimoana Customary Fishing Regulations (1998) to allow local management of an area. These areas are required to be customarily or significant to an iwi or hapu as either a food source or for cultural or spiritual reasons. A Taiapure does not stop all fishing, it simply allows tangata whenua to be involved in the management of both commercial and non-commercial fishing in their area.

A rohe moana comprises of areas where Kaitiaki are appointed for the management of customary kaimoana collection within the area/rohe under the Kaimoana Customary Fishing Regulations (1998). The Customary Fishing Regulations allow hapu to: appoint Tangata Kaitiaki; establish management controls; give authorisation (or permits) to exercise customary take; specify responsibility for those acting under the customary fishing regulations; provide penalties to be imposed for breach of the regulations; and to allow for restriction or prohibitions over certain fisheries areas to prevent depletion or over-exploitation.

Within the Mohua Operational Area there are no established customary areas under the Fisheries Act or Kaimoana Customary Fishing Regulations (Figure 23). Over recent years OMV have undertaken extensive consultation with Ngati Ruanui, Nga Ruahine and Taranaki

Iwi Trust in regards to the exploration, appraisal and development drilling campaign in the South Taranaki Bight over 2013 – 2014. These iwi have also been advised of the proposed Mohua 2D MSS scheduled for March 2014 and a summary of the engagement is provided in Appendix 2.

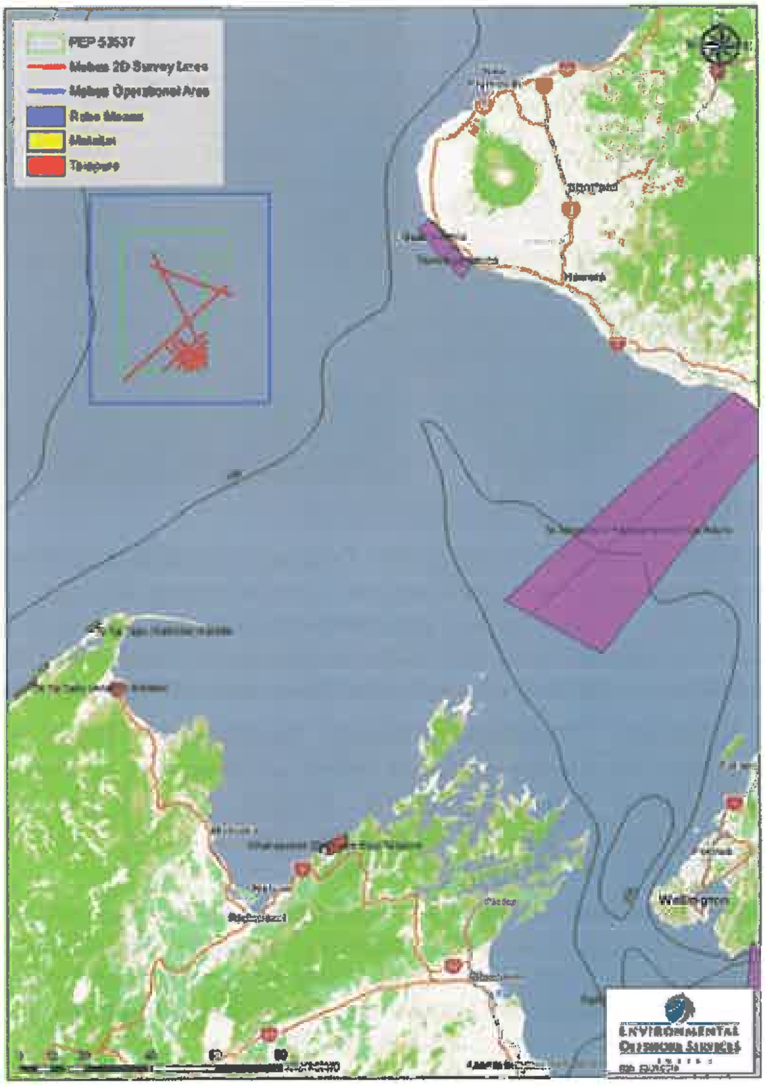

Figure 23: Culturally important areas surrounding the Mohua Operational Area
(**Note**: Rohe Moana boundaries may not be accurately representative of each particular hapu)

4.4 Anthropogenic Environment

This section focuses on the users of the environments surrounding the Mohua Operational Area; with particular emphasis on recreational and commercial fishing, shipping, and the oil and gas industry.

4.4.1 Recreational Fishing

The waters inshore of the Mohua Operational Area in both the North and South Island support significant recreational fisheries for snapper, kingfish, hapuku/bass, trevally, kahawai, tarakihi, gurnard and crayfish. During the summer months when sub-tropical waters bringing warm water to the south, billfish, tuna and other pelagic species visit Taranaki and the South Taranaki Bight. Taranaki waters are one of NZ's most significant big-game fisheries and is growing in popularity, although most gamefish are generally caught in north Taranaki waters.

The marine environment is now being accessed for recreational fishing by an increasing number of people with a relative degree of success; mainly due to improving technology and bigger faster boats. However, the Mohua Operational Area is not often fished by recreational fishers due to its distance offshore and away from any local boat launching ramps. The seabed in the general South Taranaki Bight region is also relatively flat with no significant reef structures (Johnston & Forrest, 2012; Johnston *et al.*, 2012) to concentrate fish numbers for fishers to target.

4.4.2 Commercial Fishing

Ten Fisheries Management Areas (FMA) have been implemented within NZ waters to manage the Quota Management System (QMS) and is regulated by MPI (Figure 24). Over 1,000 fish species live in NZ waters (Te Ara, 2014c) of which the QMS provides for commercial utilisation of 96 species while ensuring sustainability (MPI, 2014e). These species are divided into separate stocks and each stock is managed independently to ensure the sustainable utilisation of that fishery.

Figure 24: Fisheries management areas within NZ waters

Within NZ the commercial fishing activities are monitored closely; in 2009 the calculated asset value of NZ's commercial fish resource was $4.017 billion, an increase of 47% from 1996 (Statistics NZ, 2014). The top 20 species of fish contributed 91% of the value of NZ's commercial fish resource; with hoki contributing 20% alone.

MPI undertook an analysis of fishing effort for the OMV exploration, appraisal and development drilling campaign, and the assessment area also covers the Mohua Operational Area and has been used within this MMIA to provide a summary of commercial fishing activities and what species are targeted (Figure 25).

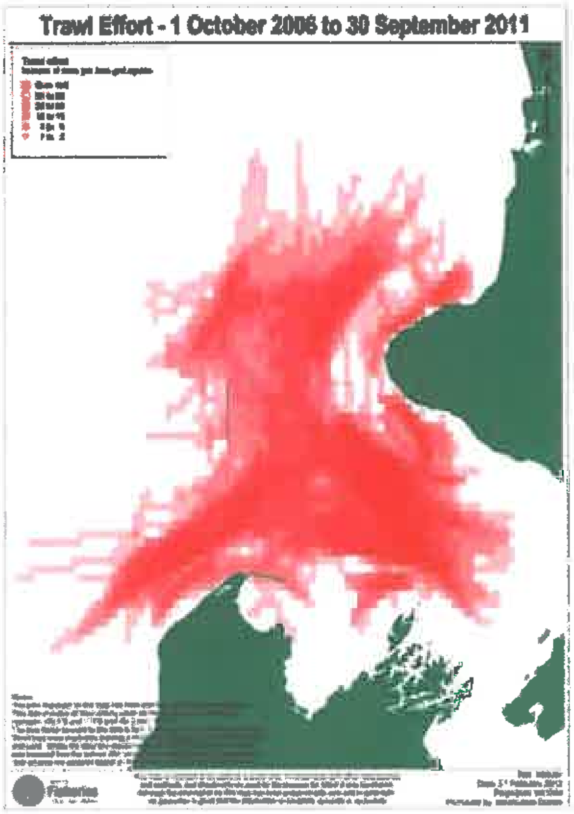

Figure 25: Trawl effort in the South Taranaki Bight

The fisheries assessment was undertaken for the period 1 October 2006 to 30 September 2011 within OMV's Area of Interest (AOI) for their drilling programmes. Trawling is the most commonly used fishing method; the total catch from trawls that started, ended or passed through the AOI was 24,827 tonnes, of which jack mackerel and barracouta accounted for 92% of the total landings. Within the South Taranaki Bight the jack mackerel fishery is primarily conducted during December-January and then again during June-July (Table 7), whereas the least amount of fishing occurs in February-May. The jack mackerel trawl fleet consists of 6 – 7 foreign charter vessels contracted to NZ operators who have all been advised of the Mohua Operational Area and the potential commencement date of the Mohua 2D MSS.

Table 7: Trawl Catch History within OMV's area of interest for the drilling campaign (2006-2011)

	Fishing Activity					
	Dec-Jan	**Feb-May**	**Jun-July**	**Aug-Sep**	**Oct-Nov**	**Total**
Tonnes	7,966	1,957	7,671	3,435	3,798	**24,827**
%age of catch	32.1%	7.9%	30.9%	13.8%	15.3%	**100%**

Consultation has been undertaken with Egmont Seafoods, Deepwater Group, Sanfords, Independent Fisheries, Maruha (NZ) Ltd, Talley's, Sealord, Taranaki Commercial Fisherman's Associated, Challenger Finfisheries, Southern Inshore Fisheries Management Company Limited and NZ Federation of Commercial Fisherman to advise of the proposed Mohua 2D MSS and the length of gear that will be towed behind the *Aquila Explorer*. These companies will be provided with the contact details of the vessel closer to the commencement date. A Notice to Mariners will be issued for the Mohua 2D MSS and broadcast over maritime radio.

4.4.3 Shipping and Taranaki Precautionary Area

There are thirteen major commercial ports and harbours within NZ, consisting of major ports, river ports and breakwater ports. Ports are important gateways for freight, transport and trading both nationally and internationally. The closest port to the Mohua Operational Area is Port Taranaki which is the major servicing base to the petroleum industry in the South Taranaki Bight and has been since the beginning of the major Taranaki offshore and onshore oil exploration in the 1960s.

Commercial shipping vessels generally use the most direct path when travelling between ports; the general shipping routes between NZ ports are shown in Figure 26. The Mohua Operational Area is located astride the shipping route between Port Taranaki and Westport/Greymouth. During consultation the Port Taranaki harbour master has been advised of the proposed Mohua 2D MSS and did not foresee any issues arising. Between Port Taranaki and any other NZ port there is no dedicated shipping lane; vessels will generally take the shortest route with consideration of the weather conditions and forecast at the time. A Notice to Mariners will be issued ahead of the Mohua 2D MSS commencing and with adherence of all vessels to the COLREGS there should be no conflict between shipping vessels and the *Aquila Explorer*. The routes for foreign destinations from NZ ports is likely to vary and has not been included in Figure 26, although it is likely they will pass through or in close proximity to the Mohua Operational Area.

The International Maritime Organisation (IMO) established a precautionary area for Taranaki waters in 2007 which warns all ships travelling through this area that they must navigate with caution due to the high level of petroleum activity in the area. This precautionary area is a standing notice in the annual Notice to Mariners which are issued each year in the NZ Nautical Almanac. The navigational hazards within this precautionary area listed in the almanac include the Pohokura, Māui, Maari, Tui and Kupe fields. Therefore, all vessels travelling through this area should be aware of the petroleum production and exploration activities and if they are following good practice, safety at sea and adhering to the COLREGS, any risk of collision should be avoided. The Mohua Survey Area is located seaward, just to the west of the Taranaki precautionary Area (Figure 27).

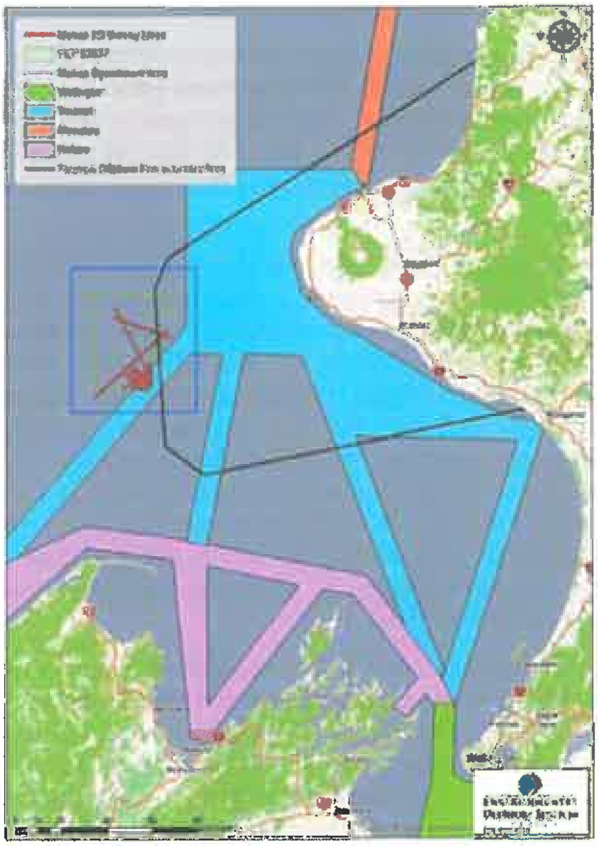

Figure 26: General shipping routes surrounding the Mohua Operational Area

Figure 27: Taranaki Precautionary Area and offshore installations

4.4.4 Petroleum Exploration and Production

Exploration and production activities have occurred off the Taranaki coastline for more than 40 years and have increased in activity over the last ten years. Taranaki is NZ's hydrocarbon province and is the only region where oil and gas has currently been found in sufficient quantities to be economically viable. As a result Taranaki and the associated petrochemical industry is very important to NZ's economy.

Since the 1960's seismic surveys have been common off the Taranaki coastline with hundreds of thousands of kilometres acquired from both 2D and 3D MSS. The current extent of the Taranaki offshore oil and gas production operations in the Taranaki Basin is shown in Figure 28.

Figure 28: Taranaki producing oil and gas fields
(Source: http://www.teara.govt.nz/en/map/8934/taranaki-oil-and-gas-fields-2006)

5 Potential Environmental Effects and Mitigation Measures

This section presents a review of the potential environmental effects which may arise from the operation of the Mohua 2D MSS programme in the marine environment, although they are specifically focused on effects to marine mammals. A literature review was undertaken in conjunction with EOS's knowledge of the environmental sensitivities within the South Taranaki Bight, to summarise the potential environmental effects which may result from the Mohua 2D MSS, from both planned and unplanned activities. Mitigation measures that will be implemented for the Mohua 2D MSS are also discussed for each activity.

The significance of each of these potential environmental effects was determined under the assumption that the proposed mitigation measures are in place. Four categories were determined for the scale of effects on marine mammals and the marine environment; ranging from negligible to major and are summarised below:

- Negligible Effect – marine mammals beyond 1.5 km from the acoustic source will be unaffected; based on the Code of Conduct mitigation zones for species of concern with calves present for a Level 1 MSS. No significant effects are expected within the marine environment or on other marine fauna. After exposure to the sound source, no recovery or mitigation measures are required;
- Minor Effect – Marine mammals between 1.5 km and 1 km from the acoustic source could be slightly influenced by sound levels, which is derived from the mitigation zone within the Code of Conduct and from the STLM which showed that beyond 1 km the SEL was below 169 dB re 1 $\mu Pa^2.s$ which is within the 171 dB re 1 $\mu Pa^2.s$ sound level stipulated for behavioural effects of marine mammals within the Code of Conduct. No noticeable effects observed within the marine environment or on other marine fauna. No mitigation measures are required to return to the original behaviour or environmental conditions;
- Moderate Effect – the behaviour of marine mammals is likely to be influenced between 1,000 m and 200 m from the acoustic source. This is based on the STLM results, where beyond 1,000 m from the acoustic source the SEL is below 169 dB re 1 $\mu Pa^2.s$ and beyond 200 m from the acoustic source the SEL is below 181 dB re 1 $\mu Pa^2.s$. The STLM showed that the SEL of 171 dB re 1 $\mu Pa^2.s$ specified in the Code of Conduct as likely to affect behaviour of marine mammals was determined to be at 900 m, while the SEL of 186 dB re 1 $\mu Pa^2.s$ which could potentially cause injury to marine mammals was determined at 100 m from the acoustic source. Behavioural effects to marine mammals are likely to occur and physical effects may develop closer to the source, but this is presumed to be temporary. Mitigation measures may be required; most likely operating to best practice for a return to the original environmental condition or behaviour; and
- Major Effect – environmental effect requires mitigation measures to be implemented, and once implemented the original situation takes a relatively long period of time to recover, in some cases not at all. For marine mammals this is likely to occur within 200 m of the acoustic source, based on the STLM. Modelling showed that the SEL is greater than 181 dB re 1 $\mu Pa^2.s$ within 200 m of the source (Duncan, 2014) with an SEL greater than 186 dB re 1 $\mu Pa^2.s$ within 100 m of the source which is the SEL believed to result in some form of injury to marine mammals as defined in the Code of Conduct. No recovery is anticipated from this type of environmental effect. The STLM results will be validated and ground truthed as per the requirements of the Code of Conduct when operating a MSS in an AEI. The details of the STLM validation are provided in Section 5.3.2.1.

To accurately assess the potential environmental effects that could potentially result from a MSS, both the planned and unplanned activities have to be taken into account. The following sections assess these potential effects and what mitigation measures will be implemented for the Mohua 2D MSS to keep environmental effects to ALARP.

5.1 Planned Activities – Potential Effects & Mitigation Measures

5.1.1 Physical presence of the *Aquila Explorer* and the Seismic Array

The *Aquila Explorer* and the associated seismic array towed behind the vessel, as well as the support vessel has the potential to interfere with a number of commercial, recreational, social and environmental operations and resources. This potential interference is discussed further in the following sections.

5.1.1.1 Interference with the fishing community and marine traffic

There is the potential for the Mohua 2D MSS to interfere with fishing activities due to the 8 km streamer that will be towed behind the *Aquila Explorer*. During the Mohua 2D MSS, fishing vessels (mainly commercial) will be caused a temporary loss or reduction of access to any fishing grounds within the Mohua Operational Area; however, this would only occur for the duration of the Mohua 2D MSS (~3 days). Commercial fishers who use the Mohua Operational Area as part of their fishing grounds have been advised of the Mohua 2D MSS and will be contacted closer to commencement with further details. To date the communications have been positive with the commercial fishing industry and no concerns were raised of the proposed Mohua 2D MSS. The acquisition of the Mohua 2D MSS could also cause temporary displacement of fish stocks; particularly pelagic species such as jack mackerel which is the most commonly targeted and caught species in these offshore Taranaki waters (Section 4.4.2).

Trawling is the most common method of commercial fishing in offshore Taranaki waters, it is a mobile method of fishing, so no fishing gear is left deployed on the seabed which has the potential to cause conflict between both operations if set nets were left within the Mohua Operational Area. As discussed in Section 3.1, a tail buoy will be on the end of the streamer to mark the overall extent of the streamer and to avoid any uncertainty as to how far the streamer extends behind the *Aquila Explorer*.

To ensure that the potential environmental effects are minimised to ALARP, OMV will operate 24 hours a day (weather and marine mammal encounters permitting) to minimise the overall duration of survey; comply with the COLREGS (radio contact, day shapes, navigation lights etc.); have a support vessel present at all times; notify commercial fishers of the Mohua 2D MSS and Mohua Operational Area; issue a Notice to Mariners and have a tail buoy attached to the end of the streamer to mark its end.

With the mitigation measures in place, the relatively short survey duration (~3 days), the effects from the Mohua 2D MSS on any fishing activities, commercial or private vessels is believed to be ***minor***.

5.1.1.2 Interference with Marine Archaeology, Cultural Heritage or Submarine Infrastructure

The seismic array used for the Mohua MSS will not come into contact with the seabed or coastline inshore of the Mohua Operational Area. The solid streamer used in the Mohua MSS has self-recovery devices fitted which release once the streamer reaches a certain depth (i.e. 55 m) bringing the streamer back to the surface for retrieval should it be severed and start sinking. Most of the areas that are culturally significant are on the intertidal and shallow subtidal reefs located well inshore of the Mohua Operational Area. It would only be the result of a rupture to the vessels fuel tank that could cause them to be influenced, but with the mitigation measures in place as discussed through this MMIA, this should not occur. Therefore it is considered that the potential interference with any marine archaeology, cultural heritage or submarine infrastructure is ***negligible***.

5.1.1.3 Changes in Abundance or Behaviour of Fish

It has been reported that MSS acquisition can temporarily alter the behavioural patterns of certain fish species; often causing them to dive deep and away from the acoustic source or tightening up in their school structure (McCauley *et al.*, 2000). Anecdotally it is believed that pelagic fish such as tuna are harder to catch off the Taranaki coastline based on fishers experience when previous MSS have been undertaken, however WesternGeco undertook a 3D MSS in January 2013 and no effects were observed on the Taranaki gamefish season. In fact it was the best gamefish season the province has had for six years (see catch records from New Plymouth Sportfishing & Underwater Club below), with marlin even being hooked in front of the seismic vessel under acquisition.

- 2004/05 – 90 (45 weighed & 50 tagged and released);
- 2005/06 – 25 (9 weighed & 16 tagged and released);
- 2006/07 – 10 (6 weighed & 4 tagged and released;
- 2007/08 – 120 (66 weighed & 54 tagged and released);
- 2008/09 – 19 (14 weighed & 5 tagged and released);
- 2009/10 – 30 (13 weighed & 17 tagged and released);
- 2010/11 – 43 (21 weighed & 22 tagged and released);
- 2011/12 – 36 (5 weighed & 31 tagged and released); and
- 2012/13 – 67 (25 weighed & 42 tagged and released).

Due to operating 24 hours a day, (weather and marine mammal encounters permitting) the Mohua 2D MSS duration will be as short as possible (~3 days), and any potential effect on fish species within close proximity to the Mohua Operational Area is considered to be ***minor***.

5.1.1.4 Changes in Seabird Behaviour

Seabirds can interact with vessels at sea; they can use the vessels for perching opportunities that would not otherwise be available as well as negative interactions which could include injury to birds through collision or entanglement in the vessels rigging, particularly at night. Research has shown artificial lighting can cause disorientation in seabirds, although this is mainly for fledglings and novice flyers, particularly when vessels are operating close to shore (Telfer *et al.*, 1987). It is believed seabirds use starlight to navigate, hence the potential for artificial lights to interfere with their ability to navigate (Black, 2005; Guynup, 2003).

Seabirds have good eyesight and are agile flyers so the risk of any collisions during the day is unlikely compared to at night.

There is limited experimental data on the reaction of seabirds to MSS operations. A study undertaken in the Wadden Sea (intertidal zone of the North Sea) concluded that bird counts showed no significant deviation in the numbers and seasonal distribution of shorebirds and waterfowl as a result of a seismic survey (Webb & Kempf, 1998). Although temporary avoidance of individual areas of distances up to 1 km was observed due to the activities of the boats and crew.

Acoustic damage to birds could arise if one was to dive in very close proximity to the acoustic source while it was active. Although there is potential for some birds to be alarmed as the seismic array passes by them, they are likely to be beyond any harmful range (Macduff-Duncan & Davies, 1995), and once the acoustic source is operating, it is not likely that birds will be in the water close to the array.

Various aspects of the Mohua 2D MSS will reduce the potential for any long term interference or damage to seabirds or reduce their ability to navigate and include: the short duration of the Mohua 2D MSS; the seismic and support vessels will always be underway and any diving birds in close proximity to the acoustic source are unlikely to do so due to their prey (baitfish) are likely to have fled the immediate area around the operating acoustic source. As a result the proposed Mohua 2D MSS is considered to have ***negligible*** effects on seabirds.

5.1.1.5 Introduction of Marine Pest or Invasive Species

Ballast water discharges, sea chests and hull fouling on vessels has the potential to introduce and spread marine pests or invasive species to NZ waters.

Most MSS vessels have their hulls regularly cleaned and painted with antifouling to prevent the establishment and growth of fouling communities. The *Aquila Explorer* was slipped in November 2013 where the hull was cleaned and new antifoul paint was applied. This dry-docking will have minimised the risk of any invasive species entering NZ waters on the *Aquila Explorer's* hull or seachests.

The support vessel *Amaltal Mariner* is based in NZ and poses no risk associated with ballast water or hull fouling of new organisms entering NZ waters, although there is the potential for invasive species within NZ to be transferred between regions. Therefore, the potential to introduce marine pests or invasive species as a result of the Mohua 2D MSS is ***negligible***.

5.1.1.6 Interaction of the Seismic Vessel Aquila Explorer *with Marine Mammals*

Within the Mohua Operational Area, under the NZ threat classification list, two marine mammals classified as 'nationally critical' (Bryde's whale and killer whale) and two as 'nationally endangered' (southern right whale and bottlenose dolphin) could potentially be present during the Mohua 2D MSS (Table 6). In NZ blue whales are currently classified as a 'migrant' under the NZ threat classification system and therefore does not designate a threat status (Torres, 2013), however, blue whales will be within the Mohua Operational Area and are listed as 'endangered' within the IUCN red list classification and as a Species of Concern within the Code of Conduct.

The potential to disrupt the behaviour of an individual or group of marine mammals would be a result of an interaction or collision with a vessel involved in the Mohua 2D MSS or entanglement with the seismic array. Studies on a total of 292 records of confirmed or possible ship strikes to large whales have shown that 11 marine mammal species were confirmed as victims (Jensen & Silber, 2003); seven of which have been identified that could occur within the Mohua Operational Area (killer, minke, sei, southern right, sperm, humpback and blue whales). From the study, the most commonly reported species of marine mammal hit was the finback whales (75 strikes) and humpback whales (44 strikes).

Jensen & Silber (2003) showed that vessel-type plays a role in the likelihood of mortality from any vessel interaction. Of the 292 mammal strikes; in 134 cases the vessel type was known of which navy vessels and container/cargo ships/freighters were the most common. Seismic vessels (described as research) accounted for one of the 134 known vessel marine mammal strikes. During acquisition the *Aquila Explorer* will be travelling at <4.5 kts, well below the mean speed which has accounted for most of the ship strikes (18.6 kts).

The *Aquila Explorer's* operations will be operating in adherence to the Code of Conduct and will also have 4 MMO's onboard for the duration of the Mohua 2D MSS (operating procedures and mitigation measures further detailed in Section 2.2.1 and Section 5.3). Therefore as a result of compliance with the Code of Conduct, general operating procedures in accordance with best practice and the mitigation measures implemented, it is assumed that the effects of interactions with the *Aquila Explorer* on marine mammals arising from the Mohua 2D MSS would be ***minor***.

5.1.2 Acoustic Source Sound Emissions

Sound emissions associated with the Mohua 2D MSS have the potential to disturb marine mammals and other fauna through a number of ways, however these disturbances will be reduced by operating to the Code of Conduct and mitigation measures implemented. The potential effects to marine mammals could include: physiological effects from exposure to sound; behavioural disturbance or displacement; deep diving mammals surfacing too quickly which can result in 'decompression sickness'; disruption to feeding, breeding or nursery activities; interference with the use of acoustic communication signals or indirect effects such as changes in abundance or behaviour of prey for marine mammals, seabirds and fish.

Low frequency sound sources produced in MSS's are directed downwards towards the seafloor and propagate efficiently through the water with little loss due to attenuation (absorption and scattering). Attenuation depends on propagation conditions; in good conditions background noise levels may not be reached for >100 km, while in poor propagation conditions it may reach background levels within a few tens of kilometres (McCauley *et al.*, 1994).

Sound waves decay exponentially and travel until they either come in contact with an object or are dissipated by normal decay of the signal. Low frequency sound attenuates slowly and is why it is generally used in MSS; however most of the sound energy attenuates very close to the acoustic source.

When an acoustic source is activated, most of the emitted energy is low frequency (0.01 – 0.3 kHz), but pulses also contain higher frequency energy (0.5 – 1 kHz), although these higher frequencies are often weak (Richardson *et al.*, 1995). The low frequency component of the sound spectrum attenuates slowly while the high frequency sound attenuates rapidly to levels similar to those produced from natural sources.

The acoustic pulse associated with a MSS produces a steep-fronted detonation wave which is transformed into a high-intensity pressure wave (shock wave with an outward flow of energy in the form of water movement). This results in an instantaneous rise in maximum pressure, followed by an exponential pressure decrease and drop in energy. The environmental effects on marine mammals and other fauna associated with MSS's focus on these sound waves generated from the acoustic source.

There is the potential for MSS operations to have an adverse effect on marine mammals and was the underlying principle for the development of the Code of Conduct and the associated mitigation zones from the acoustic source. Within the Code of Conduct – Schedule 2, it classifies all the cetaceans listed as Species of Concern and includes all NZ cetacean species except common dolphins, dusky dolphins and NZ fur seals (DOC, 2013).

Most marine mammals are believed to stay away or avoid an operating acoustic source used in a MSS, as a means of reducing their exposure to the higher sound levels. However during soft starts or using mitigation guns some species of marine mammals (e.g. killer whales) have been attracted to the acoustic source. During other MSS's in North Taranaki, whenever the seismic vessel approached the shallower waters, common dolphins were observed heading straight for the vessel to come and bow ride while the vessel was under acquisition and the acoustic source was firing.

Pinnipeds are often observed approaching an active acoustic source running at full capacity, suggesting that their inquisitive nature may override any fright or discomfort these animals may experience. A desktop study is nearly complete that focusses on pinnipeds behaviour around an operating seismic vessel, as well as those seals that were observed to be in a known sleeping position, and whether they are woken by the approaching seismic vessel. The data used within this study has drawn on all of the MMO reports that have been completed in NZ waters and any interactions or behavioural responses observed and recorded for NZ fur seals around the seismic vessel. The results from this desktop study are expected in early 2014.

5.1.2.1 Sound Transition Loss Modelling

Curtin University conducted STLM in accordance with the Code of Conduct for undertaking a MSS within an AEI. Acoustic propagation modelling was used to predict received SEL's from the Mohua 2D MSS to assess for compliance with the mitigation zones in the Code of Conduct.

The STLM indicated that 100% of receptions of sound are predicted to be below 186 dB re 1 $\mu Pa^2.s$ (injury criteria) at a range of 100 m, and below 171 dB re 1 $\mu Pa^2.s$ (behaviour criteria) at a range of 900 m from the acoustic source (Duncan, 2014). This supports the use of the mitigation zones for a Level 1 MSS within the Code of Conduct which result in either a shutdown to operations or a delay to starting operations if marine mammals are observed within the respective mitigation zones. Figure 29 shows mitigation zones of the Code of Conduct, indicated by the solid black circle (200 m), dashed black circle (1 km) and dash-dot black circle (1.5 km) relative to the maximum received SEL's.

The STLM was predicted for the proposed operating source that will be operational for the Mohua 2D MSS (2,360 in^3) and was based on a water depth of 110 m which is found in the northeast corner of the Mohua Survey Area. The acoustic source was modelled to be operating 8 m below the sea surface - received sound levels in the water column increase with increasing array depth. The shallowest depth within the Mohua 2D Survey Area was utilised as the highest short range received sound levels occur in shallow water due to the contribution of acoustic energy reflected from the seabed, therefore, lower received SEL's would be expected if the source was in deeper water than the 110 m modelled, i.e. the rest of the Mohua 2D Survey Area (Duncan, 2014).

For the Mohua 2D MSS, the proposed survey lines run in a northeast-southwest and southeast-northwest direction. The STLM used vertical and horizontal cross-sections through the frequency dependent beam patterns of the array to demonstrate the strong angle and frequency dependence of the radiation from the acoustic source array. The horizontal beam pattern showed that the bulk of the high-frequency energy is radiated in the cross-line direction, which is generally the case for acoustic source arrays, particularly those consisting of a small number of subarrays. The directionality of received levels in the horizontal plane is due to the directionality of the acoustic source array, which produces its highest energy levels in the cross-line direction (azimuths of 90° and 270°), and is very pronounced for this particular source due to it consisting of only two subarrays (Figure 29).

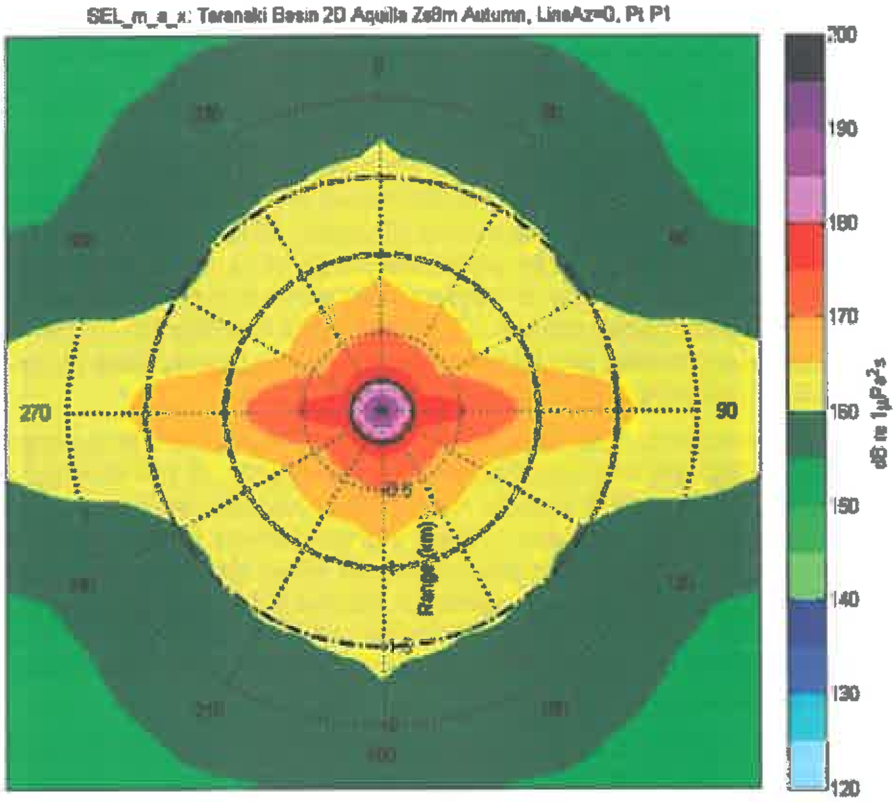

Figure 29: Maximum received SELs at any depth from the acoustic source within Mohua Survey Area

Bathymetry plays a part in the modelling results; upslope propagation into shallower waters results in more rapid attenuation and lower sound levels compared to the downslope propagation. As sound levels travel downslope, direction rays are flattened on each subsequent seabed reflection, reducing the number of seabed interactions and therefore attenuation rate. A reduction in sound speed with increasing depth results in downward refraction, where the highest sound levels occur in the lower portion of the water column. For sound travelling upslope from the acoustic source, the rays steepen on each subsequent seabed reflection, increasing the attenuation rate and distributing the sound energy more evenly through the water column.

5.1.2.2 Physiological Effects on Marine Mammals and Fauna

Most marine mammals are highly sound orientated, relying on sound for foraging, navigation, communication, social behaviour, reproduction, parental care, avoidance of predators and overall awareness of the environment. Whales may use sound to attract mates, repel rivals, communicate within a social group or between groups, navigate or find food.

Sound intensities that would result in physiological effects are largely unknown for most marine animals, with current knowledge based on a limited number of experiments (Richardson *et al.*, 1995; Gordon *et al.*, 2003). However, it is believed that to cause immediate serious physiological damage to marine mammals, SEL's need to be very high (Richardson *et al.*, 1995); and these are only found close to the acoustic source. The STLM showed that 100% of received SEL's for injury criteria as identified in the Code of Conduct is at a range of less than 100 m from the acoustic source.

Most free-swimming marine mammals have been observed to swim away from an acoustic sound well before they are within range that any physiological effects could occur. There is a lack of conclusive data on the physiological effects of acoustic sound on marine mammals. Marine mammals are protected species so they cannot be sacrificed for physical examinations and the physical size of most marine mammals does not generally allow captive studies to occur. It is generally considered unlikely that marine mammals would remain for any length of time close to any noise source that causes discomfort (Richardson *et al.*, 1995) assuming the initial noise levels received did not cause injury that prevented such movement, hence the pre-observations and soft start requirements within the Code of Conduct. In the KAKA 3D MSS, three large whales, believed to be either Bryde's or sei whales were first observed beyond the relevant 1 km mitigation zone. The acoustic source was active and the whales headed into the mitigation zone towards the seismic vessel, resulting in the acoustic source being shut down immediately.

In adherence to the Code of Conduct, pre-observations and soft start procedures will help minimise any potential risk to marine mammals to as far as practicably possible prior to commencing the Mohua 2D MSS. Likewise, if a marine mammal approaches the seismic vessel or acoustic source and enters the relevant mitigation zone, then the trained and qualified MMO's onboard the vessel have the authority to shut down the acoustic source in accordance to the Code of Conduct.

A study was undertaken on the changes in occurrence of harbour porpoises across a 2,000 km^2 survey area during a commercial 2D MSS in the North Sea (Thompson *et al.*, 2013). Passive acoustic monitoring and digital aerial surveys were used to assess the response of the harbour porpoises from a 470 in^3 acoustic source array over ranges of 5 – 10 km, at received peak-to-peak sound pressure levels of 165-175 dB re 1 µPa and SEL's of 145 – 151 dB re $1\mu Pas^{-1}$. It was shown that animals were typically detected again at affected sites within a few hours, and the level of response declined throughout the 10 day survey period. The number of acoustic detections within the survey area decreased significantly during the MSS period in the impact area compared to the control area, but this effect was small in relation to natural variation (Thompson *et al.*, 2013). It was concluded from the Thompson *et al.* (2013) study that prolonged seismic survey noise did not lead to broader-scale displacement into suboptimal or higher-risk habitats, and suggested that impact assessments should focus on sub-lethal effects resulting from changes in foraging performance of animals within affected sites.

For the South Taranaki Bight, the water column and benthic substrate characteristics are very similar with no particular areas identified for concentrating marine mammals other than the upwelling eddies that propagate north from the Kahurangi Shoals. The upwelling events are at the mercy of the weather, where weather conditions can either break up large aggregations of euphausiids or prevent the upwelling from occurring. If blue whales are in close proximity to the Mohua 2D Survey Area feeding on euphausiids the Code of Conduct will be followed at all times to ensure that any effects from acoustic noise are ALARP utilising the mitigation zones which have been validated by STLM (Duncan, 2014). From previous studies on blue whales during social and feeding encounters it was found that the blue whales increased their calls while a MSS is operational, presumably to increase the probability that the communications signals are heard (Di Iorio & Clark, 2009). However, the exact impact on blue whale behaviour and whether the blue whales would leave a feeding area with an operational MSS nearby is currently unknown. During the Mohua 2D MSS, the MMO's onboard the *Aquila Explorer* will be following the Code of Conduct and will ensure that the active acoustic source will not be any closer than 1 km to any Species of Concern or 1.5 km if a calf is present at all times.

For marine fauna which cannot flee from an approaching seismic vessel and acoustic source (i.e. plankton, fish eggs and some sessile organisms) they could be at risk of physiological effects from sound exposure.

Elevated SEL's can lead to a threshold shift in hearing, which in most cases is believed to only be temporary, while exposure to an extreme SEL or multiple or prolonged exposure to a loud sound could cause a permanent threshold shift. Studies on beluga whales and dolphins have shown that temporary threshold shift occurred until SEL's were in the order of 225 –

230 dB, which for a MSS is within a few tens of metres from the acoustic source (OGP/IAGC, 2004). The Mohua 2D MSS will be operating in accordance with the Code of Conduct, to minimise the risks to marine mammals as far as practicably possible.

Studies undertaken on fathead minnows (*Pimephales promelus*) have shown that threshold shift in hearing is directly correlated to the frequency and duration of sound exposure (Skolik & Yan, 2002). Temporary threshold shift (less than 24 hours) was observed after one hour of exposure to white noise at >1 kHz, but no threshold shift occurred at 0.8 kHz. The frequency of the acoustic sound for the Mohua 2D MSS is between 2 – 250 Hz, and the sound emissions will only occur every 8 – 8.5 seconds during acquisition. Another study on northern pike (*Esox lucius*), broad whitefish (*Coregonus nasus*) and lake chub (*Couesius plumbeus*) exposed to a 730 in^3 acoustic source (although significantly smaller than the Mohua 2D MSS acoustic source – 2,360 in^3) found varying degrees of threshold shift, but recovery occurred within 24 hours of exposure (Popper *et al.*, 2005). For the Mohua 2D MSS there is the potential that the acoustic source could induce temporary effects on fish species that are in close proximity to the acoustic source, but any lasting physiological effects of the Mohua 2D MSS on fish species would likely be ***negligible***.

Larval stages of fish and invertebrates generally live in the surface waters where they have a pelagic lifecycle in their early developmental stages, feeding on phytoplankton and zooplankton. It is at this stage in their life cycle that they could be exposed to acoustic noise if a MSS is being conducted in close proximity. Studies have shown that mortality of plankton communities can occur if they are within 5 m of an active acoustic source (DIR, 2007).

A study conducted in NZ at the Leigh Marine Laboratory exposed scallop larvae (*Pecten novaezelandiae*) to seismic pulses in tanks to assess the effect of acoustic noise on the early development stages of scallop larvae (Aguilar de Soto *et al.*, 2013). Scallop larvae were placed in noise flasks in a thin plastic mesh and suspended at a depth of 1 m in a tank filled with seawater (2 m diameter and 1.3 m deep). The noise flasks were suspended 5-10 cm in front of a sound transducer emitting a pulse every 3 seconds. Noise exposure started immediately after the flasks were put into the tank, which was within one hour after fertilisation. Control samples were also used with no acoustic source present. A total of 4,881 scallop larvae were utilised in the study and were sampled at seven fixed intervals (24, 30, 42, 54, 66, 78, and 90 hours) after fertilisation to observe the development through the different larval phases.

At completion of the Aguilar de Soto *et al.* (2013) study, 46% of the noise-exposed larvae showed malformations, which were evident as abnormal growth, with localised bulges in the soft body of the larvae, but not in the shell. In the tanks with no noise exposure, no malformations were found in the four control flasks. It appears that the Aguilar de Soto *et al.* (2013) study is the first evidence that continual sound exposure can cause growth abnormalities in larvae. It was concluded in the study that the small size of the scallop larvae and the absence of strong tissue density gradients in early developmental phases that the observed damage was related to particle motion rather than the pressure component of the noise exposure. Recordings within the tank showed that the sound levels within the tank during the experiment was 160 dB re 1 μPa at 1m, but the particle velocities experienced by the larvae imply far-field pressure levels of 195-200 dB re 1 μPa. The report further concluded that given the strong disruption of larval development, weaker but still significant effects could be expected at lower exposure levels and shorter exposure durations. From the STLM, a SEL of 195-200 dB re 1 μPa is confined within 200 m of the acoustic array.

However these results have to be treated with caution when applying them to industry standard MSS's. In the Aguilar de Soto *et al.* (2013) study, the acoustic source was activated within a small confined tank, 5-15 cm from the larvae at a shotpoint interval of 3 seconds, compared to most MSS where they have a shotpoint interval of approximately 8-11 seconds. The study was undertaken on larvae that had only been fertilised one hour previously; the Mohua 2D Operational Area is located 50 km offshore from Cape Egmont and 90 km from Golden Bay, where the nearest scallop and mussel beds can be found, so the likelihood that larvae that have just been fertilised from a shellfish species is very low. During acquisition the *Aquila Explorer* will be continuously moving at 4.5 kts, so any larvae present in the immediate vicinity of the acoustic source will not be exposed to the acoustic sound for the periods that the scallop larvae were exposed to in the Leigh Marine Laboratory. In Aguilar de Soto *et al.* (2013) it clearly shows there is strong evidence that acoustic sound can cause malformations in larvae, however the exposure times of larval phases during the Mohua 2D MSS should be much less than those in the scallop larval study. It is assumed that the exposure results of Aguilar de Soto *et al.* (2013) could be applied to other shellfish and fish in early larval developmental stages, but due to the distance offshore, the continual movement of the vessel, the effects on fish and shellfish larvae is believed to be ***minor - moderate*** if they are in close proximity to the acoustic source.

There is currently little information on how marine organisms process and analyse sound, making assessments about the impacts of artificial sound sources in the marine environment difficult (Andre *et al.*, 2011). Research has shown that effects of acoustic noise produced from a MSS on macroinvertebrates (scallop, sea urchin, mussels, periwinkles, crustaceans, shrimp, gastropods and squid) results in very little mortality below sound levels of 220 dB re 1µPa@1m, while some show no mortality at 230 dB re 1µPa@1m (Royal Society of Canada, 2004). Sound levels required to cause mortality, based on the STLM would only be reached in very close proximity to the acoustic source (Duncan, 2014). The effects that have been observed generally occur in shallow water, and given the depth of the Mohua Operational Area (>110 m) the effects on benthic invertebrates is believed to be ***minor***.

Of the three main forms of marine macrofauna (mammals, fish and invertebrates), cephalopods belong to the last group, which is also the least understood. Situated in the food chain between fish and marine mammals, they are also key bio-indicators for ecosystem balance in vast and complex marine ecosystems (Andre *et al.*, 2011). Although startle responses have been observed in caged cephalopods exposed to acoustic sources (McCauley *et al.*, 2000), studies addressing noise-induced morphological changes in these species have been limited (Andre *et al.*, 2011). However, in Andre *et al.* (2011) four cephalopod species were exposed to low frequency sounds (50-400 Hz sinusoidal wave sweeps with a 1 second sweep period for two hours) which identified the presence of lesions in the statocysts, which are believed to be involved in sound reception and perception. The sound levels received from these sound waves were measured with a calibrated hydrophone within the tanks which showed sound levels of 157 ± 5 dB re 1 µPa, with peak levels at 175 re 1 µPa. It was therefore concluded that the effects of low frequency acoustic noise for a long period of time could induce severe acoustic trauma to cephalopods (Andre *et al.*, 2011). Based on the STLM, the peak sound levels of 175 re 1 µPa would be observed within 800 m from the Mohua 2D MSS acoustic source (Figure 29).

Both squid and octopus are species of cephalopod and are present in Taranaki waters during the summer months, however octopus generally live a cryptic lifestyle around reef structures, of which there are no reef areas in close proximity to the Mohua Operational Area. Squid are a pelagic species that form part of the marine food chain and are found in Taranaki waters, with majority of the commercial squid fishing throughout NZ taking place during the months from January through to May (MPI, 2014f). However, most of the commercially caught squid within NZ waters are caught around the South Island and Auckland Islands. Squid are a very short lived but fast growing species, only living for one year with spawning occurring between May and July (MPI, 2014g). Squid are caught in the Taranaki region during late summer when the warmer water is present (Section 4.1.2.5). The Mohua 2D MSS will be commencing in the middle of the squid fishing season throughout southern NZ, so it is possible that squid could be some squid present within the Mohua Operational Area, although not in commercial volumes, and if they were present and in close proximity (<500 m) to the operating acoustic source there is the potential for trauma to cephalopods that could have a ***moderate*** effect. However, the adaptations these species have in place to reflect their short life cycle, i.e. fast growth rates and high fecundity levels, there is not anticipated to be any overall significant effects on any cephalopod populations in the South Taranaki Bight.

The mitigation measures and operational procedures in place for the duration of the Mohua 2D MSS to minimise potential effects of acoustic noise on marine macrofauna include; the acoustic sound wave is directed downwards from the source; the observed avoidance behaviour of marine mammals and other mobile fauna while the acoustic sources are operating and adherence to the Code of Conduct.

From the summary above it is believed that overall the Mohua 2D MSS could have ***moderate*** physiological effects on marine mammals and fauna.

5.1.2.3 Behavioural Effects on Marine Mammals and Fauna

In response to an operating MSS, behaviours of marine mammals and fauna can include fright, avoidance and changes in vocal behaviour (McCauley *et al.*, 1998; McCauley *et al.*, 2003). This has been observed in Mysticetes (baleen whales) as they operate at lower sound frequencies (moans at 10 – 25 Hz). Whereas Odontocetes (toothed whales and dolphins) are not likely to be detrimentally affected, as they operate at sound frequencies far higher than those generated by an acoustic source (> 5 kHz). The Mohua 2D MSS will operate at a sound frequency of between 2 – 250 Hz.

Observations have shown that MSS may cause some changes in localised movements and behaviours of cetaceans; generally swimming away from the acoustic source but in some instances rapid swimming at the surface and breaching (McCauley *et al.*, 1998; McCauley *et al.*, 2003). Although acoustic noise from a MSS does not appear to cause any changes to the regional migration patterns of cetaceans (McCauley *et al.*, 2003). If the acoustic source from the Mohua 2D MSS resulted in blue whales moving away from areas they were feeding in, it could potentially reduce their ability to capture large aggregations of krill. However, there is uncertainty on how close an active acoustic source would have to be to move a feeding blue whale from its food source. The short duration of the Mohua 2D MSS, compliance with the Code of Conduct and the continual movement of the *Aquila Explorer* through the Mohua Operational Area during the acquisition period will contribute towards mitigating any potential affects.

It has been observed that humpback whales exposed to seismic surveys, consistently changed course and speed to avoid any close encounters with an operating seismic array (McCauley, *et al.*, 2000). Sound levels for this avoidance response to occur were estimated at 160 – 170 dB re 1 µPa peak to peak. From the Mohua 2D MSS STLM, these sound levels appear to be present within approximately 1.5 km in front and behind the acoustic source, while at angles of 90° and 270° from the acoustic source this distance extends out to approximately 3.0 km (Figure 29). These distances from the acoustic source would become important if the Mohua 2D MSS is delayed significantly and the survey period coincided with the migratory pathway of humpback whales north through the Cook Strait and South Taranaki Bight. As discussed earlier, if a significant delay to the Mohua 2D MSS eventuates a discussion will be held between OMV and DOC for the best way forward and whether any additional mitigation measures are required to be implemented.

A study on pink snapper held in captivity and exposed to acoustic source signals demonstrated minor behavioural responses ranging from startle to alarm, suggesting that fish may actively avoid an active seismic source in the wild (McCauley *et al.*, 2003).

The Mohua 2D MSS will only be acquired over a relatively short duration (~3 days) and is located within relatively deep water (>110 m) over a flat muddy seabed (no reef fish present). However, there is the potential that pelagic fish and marine mammals may either avoid or move away from the active acoustic source while the Mohua 2D MSS is being acquired. As a result there would be a behavioural effect resulting in some fish or marine mammals moving beyond their core habitat at that time of year or potentially moving away from an easily accessible food source. As a result the Mohua 2D MSS has the potential to have ***moderate*** effects on marine mammals and fish behaviour.

5.1.2.4 Disruption to Feeding Activities

The potential effects to marine species identified in this MMIA that could be present in the Mohua Operational Area include disturbance to feeding activities and displacement of habitat for the MSS duration. Any marine mammals that are in close proximity to the acoustic source are likely to move away from the immediate area when the acoustic source is active to avoid the increased noise levels. It is now known that blue whales use the South Taranaki Bight as an important feeding area and there is the potential that blue whales will be present during the Mohua 2D MSS. If blue whales are forced to leave large aggregations of krill as a result of the Mohua MSS acoustic noise, it is a deviation from their natural behaviour and could have an impact on their ability to capture prey easily, forcing them to expend more energy hunting for food.

Thompson *et al.* (2013) indicated that prolonged seismic survey noise did not lead to broader-scale displacement into suboptimal or higher-risk habitats, and animals were typically detected again at affected sites where a MSS had been conducted within a few hours following the acoustic source being stopped, and the level of response declined throughout the 10 day survey period.

If the blue whales feeding on large aggregations of krill are disturbed by acoustic noise, it is likely they will move away from these feeding aggregations and force them to hunt for prey in areas where krill may not be so easily found or aggregated. If this occurs the blue whales will have a higher energy consumption as they find the volume of prey they need to meet their daily food requirements. However, the Mohua 2D MSS has a short survey duration which will help minimise disturbance to the blue whales and based on the Thompson *et al.*, (2013) study should not displace the blue whales from the area for a long period. Blue whales appear to aggregate in numbers when upwelling events have occurred in the South Taranaki Bight and large volumes of krill are present. It is not known whether there will be any blue whales or feeding aggregations during the Mohua 2D MSS but the MMOs onboard the *Aquila Explorer* will be advised to be aware that blue whales are likely to be present within or surrounding the Mohua Operational Area and the general South Taranaki Bight area.

Once the seismic vessel and acoustic array has passed through an area, or once the Mohua 2D MSS is complete (~3 days), the sound source within the marine environment will have dissipated and there will be no further environmental effects on any species residing there. As a result the potential disruption and disturbance to the feeding activities of marine mammals encountered within or adjacent to the Mohua Operational Area is believed to be ***moderate***.

5.1.2.5 Interference with Acoustic Communication Signals

Vocalisations from cetaceans, used for communication and navigation, are the most studied and understood forms of acoustic communication in the marine environment. The ability to perceive biologically important sound is very important to marine mammals and any acoustic disturbance through human generated noise has the potential to interfere with their natural functions (Di Iorio & Clark, 2009).

If a MSS emits sound in the same frequency range as the sounds generated by cetaceans and interferes with or obscures signals in locations which are biologically significant to cetaceans, there is the potential for significant environmental effects (Richardson *et al.*, 1995).

The known frequencies of echolocation and communication calls for selected species of toothed whales and dolphins is summarised in Table 8. The known spectrum of echolocation signals are at much higher frequencies (6 – 130 kHz) than the high end of the operational range of MSS acoustic sources (<1 kHz). The greatest potential for interference of acoustic signals is at the highest end of the seismic spectrum and the lowest end of whales and dolphins communication spectrum.

Table 8: Cetaceans communication and echolocation frequencies

Species	Communication Frequency (kHz)	Echolocation Frequency (kHz)
Bottlenose dolphin	0.8 – 24	110 – 130
Common dolphin	0.2 – 16	23 – 67
Dusky dolphin	7 – 16	7 - 16
Killer whale	0.5 – 25	12 – 25
Long finned pilot whale	1 – 18	6 – 117
Sperm whale	0.1 – 30	2 – 30
Blue whale	0.01 – 0.04	0.01 – 0.4
Humpback whale	0.02 - 2	0.02 - 2
Bryde's whale	0.07 – 0.9	0.07 – 0.09

Toothed whales communication calls partially overlap with the high end of acoustic source's operational range, the acoustic energy emitted from the acoustic source array for the Mohua 2D MSS is between 0.02 – 0.25 kHz; well below the lower frequency limits of most toothed whales. Sperm whale, common dolphin, humpback, Bryde's and blue whales all vocalise at frequencies that could be influenced from the frequencies emitted during a MSS (Table 8).

Blue whales have been shown to increase their calls (emitted during social encounters and feeding) when a MSS using a low-medium power source is operational compared to non-exploration days (Di Iorio & Clark, 2009; Melcon *et al.*, 2012). A mean sound pressure used in this study was relatively low (131 dB re 1µPa (30 – 500 Hz) with a mean sound exposure level of 114 dB re 1µPa^{2}s. It is at these SEL's that blue whales will change their calling behaviour in response to a low-medium acoustic source and was presumed to have a minor environmental effect (Duchesne *et al.*, 2007). The STLM for the Mohua 2D MSS is confined to approximately 3 km from the acoustic source and does not show the SEL of 114 dB re 1µPa^{2}s that results in blue whales changing their calling behaviour. However from the STLM it could be assumed that the area around the operating acoustic source where blue whales will change their calling behaviour could be quite extensive. As a result this has the ability to interfere with how blue whales communicate with each other, where the whales will need to increase their calling to try and increase the probability that their signal is successfully received by conspecifics. This communication interference could influence the potential for blue whales to find mates or find aggregations of krill if their calls are not heard.

In the study by Di Iorio & Clark (2009) the survey area was crossed by a busy shipping lane and vessel noise was common. It was concluded that noise from shipping did not account for any changes in acoustic behaviour of the blue whales. From the available literature the effects of seismic surveys on blue whales are unknown, other than increasing their calling when an acoustic source is operating (Di Iorio & Clark 2009). NIWA completed a research voyage in January 2014 to study blue whales further in the South Taranaki Bight to try and increase the understanding of these marine mammals which have been often observed over the last few years of MSS's conducted in this area.

Humpback whales have also being shown to decrease their calling while an acoustic source was emitted from an Ocean Acoustic Waveguide Remote Sensing experiment. The occurrence of humpback whale songs were compared prior, during and after the experiment and again two years later and it was shown that vocalising cetaceans can be effected by anthropogenic sound (Risch *et al.,* 2012). However, due to the timing of the Mohua 2D MSS, there is not expected to be any humpback whales present during the survey scheduled for the start of April 2014.

From the reviewed studies and literature available as well as the uncertainty of the exact distance what a blue whales calling could be influenced, it is believed that the Mohua 2D MSS could have a ***moderate*** effect on marine mammal's use of naturally produced acoustic signals. However, once the Mohua 2D MSS is complete there will be no more influence or interference with any mammal's communication or echolocation frequencies.

5.1.3 Solid and Liquid Wastes

During the Mohua 2D MSS various types of waste will be produced (sewage, galley waste, garbage and oily water) and if inappropriate management occurred there is the potential for an environmental effect. Each type of waste requires correct handling and disposal; the volume of waste generated will depend on the number of crew onboard each vessel and the MSS duration.

5.1.3.1 Generation of Sewage and Greywater

The liquid wastes that will be generated during the Mohua 2D MSS will include sewage and greywater (wastewater from toilets, washrooms, the galley and laundry). The *Aquila Explorer* and *Amaltal Mariner* have onboard sewage treatment plants which ensures a high level of treatment before the sewage is discharged. All vessels involved in the Mohua 2D MSS also have an International Sewage Pollution Prevention Certificate (ISPPC).

As a result of the high level of treatment the sewage generated by the vessels involved in the Mohua 2D MSS receives, it is believed that only ***negligible*** effects on the marine environment would occur.

5.1.3.2 Generation of Galley Waste and Garbage

In accordance with the NZ Marine Protection Rules, only biodegradable galley waste, mainly food scraps will be discharged to sea after it has been comminuted and can pass through a 25 mm screen. Comminuted waste can be discharge beyond 3 Nm from shore and given the high energy offshore marine environment, these discharges will rapidly dilute to non-detectable levels very quickly.

All solid and non-biodegradable liquid wastes will be retained onboard for disposal to managed facilities ashore through the waste management contractor.

For all disposal options MARPOL Annex V stipulations will be followed with records kept detailing quantity, type and approved disposal route of all wastes generated and will be available for inspection. All wastes, including hazardous returned to shore will be disposed of in strict adherence to local waste management requirements with all chain of custody records retained by OMV.

As a result of these operating procedures in place and adherence to MARPOL the environmental effects from galley waste and garbage on the marine environment is likely to be ***negligible***.

5.1.3.3 Generation of Oily Waters

Oily waters on any vessel is generally derived from the bilges. The *Aquila Explorer* has a bilge water treatment plant that achieves a discharge that is superior to NZ and MARPOL requirements of 15 ppm.

All vessels involved in the Mohua 2D MSS have approved International Oil Pollution Prevention Certificates (IOPPC) and have a Shipboard Oil Pollution Emergency Plan (SOPEP) in place.

As a result of operating in compliance to the above procedures, the environmental effects of any discharges to the marine environment would be ***negligible***.

5.1.3.4 Atmospheric Emissions

Exhaust gasses from the *Aquila Explorer's* engines, machinery and air compressor generators are the principle sources of air emissions (combusted exhaust gasses) likely to be emitted to the atmosphere. Most of these gaseous emissions will be in the form of carbon dioxide, although smaller quantities of other gasses (oxides of nitrogen, carbon monoxide and sulphur dioxide) may be emitted. The *Aquila Explorer* has an International Air Pollution Prevention Certificate (IAPPC) which ensures that all engines and equipment are regularly serviced and maintained.

Potential adverse effects from these emissions are related to the reduction in ambient air quality in populated areas and potential adverse effects/health effects on personnel. However, given the short duration of the Mohua 2D MSS, the distance offshore (>66 km) and exposed nature of the Mohua Operational Area and the anticipated low level of emissions, the environmental effects arising from the Mohua 2D MSS is believed to be ***negligible***.

5.2 Unplanned Activities – Potential Effects & Mitigation Measures

Unplanned activities are rare during MSS operations; however if they were to occur, would likely be a result of a streamer break or loss, fuel/oil spill or a vessel collision. All marine operations have some potential risk, no matter how low and this assessment has covered the potential of this occurring.

5.2.1 Streamer Break or Loss

The potential for damage to occur to a seismic streamer could result from snagging with floating debris; or potential rupture from abrasions, shark bites or other vessels crossing the streamer.

The streamer to be used in the Mohua 2D MSS is a solid streamer so if it were to break or be severed there is little potential for an environmental effect on the marine environment. The solid streamer is negatively buoyant and requires movement to maintain depth so if the streamer was severed it would start sinking. The streamer has Self Recovery Devices (SRD) which deploy for retrieval once the streamer sinks below 48 m depth. This will prevent any potential for crushing of the benthic communities, even though the Mohua Operational Area has a flat muddy seabed with no reef communities present.

The Mohua 2D MSS will be undertaken by experienced personnel using international best practice and as a result of the streamer type to be used for the Mohua 2D MSS, if the streamer was severed or lost the environmental effect would be ***negligible***.

5.2.2 Fuel or Oil Spills

The potential for a fuel or oil spill during the Mohua 2D MSS could arise from; leaking equipment or storage containers or hull/fuel tank failure due to a collision or sinking. The largest potential for an environmental effect would result from a hull/fuel tank failure as the other potential for spills would be generally contained on the vessel.

If a spill from the *Aquila Explorer's* fuel tank did occur, the maximum possible spill if the fuel tanks were full would be 1,254 m^3 of marine gas-oil. However for this to occur there would have to be a complete failure of the vessel's fuel containment system or catastrophic hull integrity failure, especially given that the hull of the *Aquila Explorer* is ice class rated. The high-tech navigational systems onboard, adherence of the COLREGS and operational procedures to international best practice will ensure that the potential for a spill is unlikely to occur.

All vessels involved in the Mohua 2D MSS have an approved and certified SOPEP and IOPPC as per MARPOL 73/78 and the Maritime Protection Rules Part 130A and 123A which are onboard the vessels at all times. In addition the *Aquila Explorer* has a HSE Management Plan and Emergency Response Plan which would be used in the event of an emergency, including fuel spills.

Therefore, due to the safety, environmental and maritime requirements that will be implemented for the Mohua 2D MSS, the risk of a fuel or oil spill occurring is considered to be ***negligible***.

5.2.3 Vessel Collision or Sinking

If a collision occurred whilst the *Aquila Explorer* was at sea, the biggest threat to the environmental would be the vessel reaching the sea floor and the release of any hazardous substances, fuel, oil or lubricants. However, this is very unlikely as the risks are mitigated through the presence of a support vessel at all times and adherence to the COLREGS. As a result, the potential risk for a vessel collision or sinking is considered to be ***negligible***.

5.3 Mitigation Measures

OMV will adhere to the mitigation measures identified in the Code of Conduct for operating a Level 1 MSS to minimise any adverse effects to marine mammals from the MSS operation (DOC, 2013). Due to the Mohua Operational Area being within an AEI and as a measure of best operator practice, OMV will implement additional mitigation measures, over and above the Code of Conduct. While undertaking the Mohua 2D MSS, if there are any instances of non-compliance to the Code of Conduct and the mitigation measures identified below, the Director-General will be notified immediately.

The operational procedures that OMV will follow will be detailed in the MMMP (Appendix 4) and circulated among the MMO's and crew, with a summary of these operating procedures and mitigation measures listed in the following sections.

5.3.1 2013 Code of Conduct Mitigation Measures

The 2013 Code of Conduct was updated following the 2012 – 2013 summer period where a number of MSS's were acquired in the Taranaki Basin, with operators voluntarily adhering to the 2012 Code of Conduct. During these surveys a number of operational issues were identified and led to a review of the 2012 Code of Conduct before the next MSS season (2013 – 2014 summer period). For the Mohua 2D MSS the requisite mitigation measures specific to a Level 1 MSS are identified in Section 2.2.1. However, due to the Mohua 2D MSS operating in an AEI and OMV's desire to operate to best operator practice, additional mitigation measures are to be implemented. These additional measures are discussed in Section 5.3.2.

5.3.2 Additional Mitigation Measures for the Mohua 2D MSS

5.3.2.1 Sound Transmission Loss Modelling

As discussed in Section 5.1.2.1 STLM has been undertaken to predict SEL's at various distances from the *Aquila Explorer's* operating acoustic source; with the modelling based on the specific configuration of the acoustic source to be used for the Mohua 2D MSS and the environmental conditions (i.e. bathymetry, substrate, water temperature and underlying geology) of the Mohua Operational Area.

Results were used to validate the mitigation zones identified for a Level 1 MSS in the Code of Conduct. The modelled SEL's were well within the required SELs at these mitigation zones, however had they been higher, the mitigation zones would have been increased to compensate or the acoustic source reduced in volume. The Code of Conduct requires for MSS undertaken in an AEI that the STLM has to provide the relative distances from the acoustic source which behavioural criteria (171 dB re 1µPa².s) and injury criteria (186 dB re 1µPa².s) could be expected.

The STLM showed that for the Mohua 2D MSS, compliance will be achieved with the Code of Conduct criteria (behaviour criteria < 900 m and injury criteria < 100 m). The modelling also showed that at a range of 200 m from the acoustic source, the acoustic source array would produce a maximum SEL of 181 dB re 1µPa².s and at a range of 1 km a maximum SEL of 169 dB re 1µPa².s. As a result adherence to the Code of Conduct mitigation zones for a Level 1 MSS should minimise the potential risk of negative effects to marine mammals.

As per the requirements in Appendix 1 of the Code of Conduct, the STLM will be validated during the Mohua 2D MSS and the results will be provided to DOC. At the start of seismic operations, a vessel self-noise assessment will also be undertaken by the PAM Operators.

The STLM validation will be undertaken by the *Aquila Explorer's* Chief Field Geologist and the lead MMO onboard the *Aquila Explorer*. To complete this validation, sound exposure levels (dB re 1µPa) will be recorded by receivers in the streamer located at three different offsets from the acoustic source; 200 m, 1,000 m and 1,500 m. These recordings will take place within the Mohua Operational Area across the different depth measurements, with sound exposure levels measured at varying water depths, as sound exposure levels are likely to decrease in the deeper waters (Duncan, 2014). A heading will be selected along one of the track lines and the test sequence will be performed along this line. In order to confirm and provide a reference to the first suite of results, another test sequence will be performed before the end of the MSS, most likely on the opposite heading.

5.3.2.2 Any Maui's Dolphin sightings will be notified immediately

If a Maui's dolphin is observed at any stage during the Mohua 2D MSS or while the *Aquila Explorer* is mobilising to and from the Mohua Operational Area, DOC National Office (Ian Angus) and DOC Taranaki Area Office (Callum Lilley &/or Bryan Williams) will be notified immediately.

DOC are keen to help with further research of this endangered species and if a sighting was to occur, depending on the location DOC may mobilise either a fixed wing plane for verification and/or a vessel to try and obtain a biopsy sample. However, given the water depth and remote offshore location of the Mohua Operational Area, the chances that a Maui's dolphin is sighted within the Mohua Operational Area is low.

5.3.2.3 Additional marine mammal observations outside the Mohua Operational Area

The *Aquila Explorer* will travel to the Mohua Operational Area following the completion of the NZOG Waru 2D MSS ~50 km inshore from the Mohua Operational Area. On transit to the Mohua Operational Area, a MMO will be on the bridge to observe for any marine mammals that would add to the knowledge and distribution of marine mammals around NZ.

Any marine mammal observations outside the Mohua Operational Area will be recorded in the 'Off Survey' forms developed by DOC. Any Maui's dolphins observed will be reported immediately to DOC as per Section 5.3.2.2.

5.3.2.4 Necropsy will be undertaken on any stranded marine mammals

If any marine mammals are stranded or washed ashore during the Mohua 2D MSS inshore of the Mohua Operational Area along the south Taranaki, Wanganui, Manawatu, Kapiti/Wellington and top of the South Island coastline, OMV would engage Massey University to undertake a necropsy to try and determine the cause of death and whether it was a result of any pressure-related or auditory injuries. DOC will be responsible for all aspects of undertaking the necropsy and coordination with pathologists at Massey University; however OMV will cover the associated costs. OMV will meet these costs for any necropsies required during the Mohua 2D MSS and for a period of two weeks after MSS completion.

5.4 Cumulative Effects

The Taranaki Basin and South Taranaki Bight is currently used for shipping, fishing and hydrocarbon exploration and production activities. Studies on blue whales, where the survey area was overlapped by a busy shipping lane concluded that shipping noise did not account for any changes in the acoustic behaviour of blue whales (Di Iorio & Clark, 2009); hence noise from shipping traffic has not been considered in this cumulative effects assessment.

At the time of preparation of this MMIA and through consultation with DOC National Office, at the same time as the Mohua 2D MSS there is the potential that a check-shot survey could be undertaken from the Kan Tan IV (discussed below) and possibly a site survey which is also scheduled for some time in March 2014. The site surveys will only be for a short duration and will utilise a small acoustic source volume (<150 in^3) so are therefore not subject to the Code of Conduct. As a result the cumulative effects from two concurrent MSS operating has not be considered as part of this assessment. For quality of data the operators do not also want MSS to overlap that are close in nature as this has potential implications for the survey results acquired.

Check-shot surveys are significantly different to a vessel based 2D or 3D MSS; the acoustic source is limited to a single location and the shots are spaced over a relatively short duration (approximately four hours). Check-shot surveys are a form of borehole seismic survey and are used to correlate sub-surface seismic data from previous 3D MSS and the actual depth to geological intervals determined from drilling the well. The check-shot surveys utilise a small source volume (2 x 150 in^3) and fire approximately 150 shots at an operating capacity of 1,800 psi with an anticipated duration of approximately 4 hours. In comparison to a 2D or 3D MSS, if the acoustic source for a check-shot was fired at the same rate (~8-10 seconds), the check-shot survey would be completed in 25 minutes. The Kan Tan IV is operating the check-shot surveys to a Level 2 survey under the Code of Conduct and will have trained and qualified MMOs onboard for the check-shot survey duration. The check-shot surveys are undertaken after each well is drilled, generally at the end of a 40 – 60 day drilling programme; and given delays that can occur within the drilling programmes it is unsure whether any check-shot surveys will coincide with the Mohua 2D MSS. As a result it is believed the activity of check-shot surveys will provide a low risk to marine mammals, and likewise any cumulative effects of the check-shot survey and the Mohua 2D MSS occurring simultaneously, would be ***negligible*** or ***minor***.

There is the potential that during a MSS, if animals avoid an area due to the increased sound exposure; these species could result in additional exposure to predators as well as the loss of foraging or mating opportunities. However, once the Mohua 2D MSS is complete, any resonant noise within the Mohua Operational Area or surrounding marine environment would diminish. Following this the potential effects from increased sound exposure to marine mammals and fauna would cease and the animals could return to their preferred habitat. This was shown in the study by Thompson *et al.* (2013) where harbour porpoises returned to a seismic survey area within a few hours after the acoustic source had stopped and was concluded that seismic survey noise did not lead to broader-scale displacement into suboptimal or higher-risk habitats.

It is noted that the *Aquila Explorer* it is contracted to undertake the Waru 2D MSS for NZOG within PEP 54857, approximately 50 km inshore of the Mohua Operational Area prior to acquiring the Mohua 2D MSS. The same acoustic source will be used for the two MSS's and any sound attenuation out of the Waru Operational Area is not anticipated to influence any marine mammals that may be in the Mohua Operational Area.

The requirements and mitigation measures for a Level 1 MSS will be adhered to for the Mohua 2D MSS; the *Aquila Explorer* will use the minimum acoustic source required to achieve the objectives of the Mohua 2D MSS, essentially reducing the exposure risk to marine mammals and will either shut down or delay starts if any marine mammals are within the relevant mitigation zones.

Therefore, given it is likely that only the Mohua 2D MSS will be operating in the South Taranaki Bight in the middle of March 2014 (given NZOG's Waru 2D MSS will occur prior to the Mohua 2D MSS), the short duration of the Mohua 2D MSS (~3 days) and the mitigation measures in place; the potential cumulative effects on marine mammals, marine fauna or the marine environment from the Mohua 2D MSS will be ***minor***.

5.5 Summary of Environmental Effects and Mitigation Measures

The potential environmental effects and associated mitigation measures that will be implemented for the Mohua 2D MSS as identified in this MMIA are summarised in Table 9.

Table 9: Mohua 2D MSS planned and unplanned activities and the potential effects and mitigation measures to be implemented

Aspect or Source	Potential Environmental Effect	Likelihood of Occurrence or Exposure	Proposed Mitigation Measures	Residual Effect
Planned Activities				
Physical presence of the *Aquila Explorer* and the seismic array.	Interference with the fishing community and marine traffic.	Very low with mitigation measures in place.	24/7 operations to minimise overall duration of MSS (~3 days). Compliance with COLREGS, support vessel present at all times and notice to mariners issued.	Minor.
	Interference with marine archaeology, cultural heritage or submarine infrastructure.	Extremely unlikely given distance offshore and the streamer will not come in contact with the seabed.	Best Practice. Solid streamer with SRD.	Negligible.
	Changes in abundance or behaviour of fish.	Low.	24/7 operations (weather & cetacean observations permitting) to minimise overall duration of MSS.	Minor.
	Changes in seabird behaviour.	Likely - vessels may provide resting opportunities. Collisions or entanglements are unlikely during daylight, but could occur at night.	No mitigation options available. MMO's will record any seabird strikes that are witnessed.	Negligible.
	Introduction of marine pests or invasive species.	Low.	Recent dry-dock of the *Aquila Explorer* (November 2013) and new antifouling paint. Adherence to ballast water and hull fouling regulations.	Negligible.
	Interaction with marine mammals.	Low.	Compliance with the Code of Conduct and mitigation zones. Two MMO's and two PAM operators will be observing for mammals 24 hours/day.	Minor.
Acoustic Source Sound Emissions.	Physiological effects on marine mammals and fauna.	Low.	Compliance with Code of Conduct. Four trained MMO/PAM operators with use of PAM 24/7. Pre-start observations, soft start and delay start/shut down procedures. STLM showed that 100% of receptions were predicted to be below the SEL for injury criteria at a range beyond 100 m, and below the SEL for behaviour change at a range beyond 900 m from the acoustic source.	Moderate.
	Behavioural effects on marine mammals and fauna.	Potential to occur.		Moderate.
	Disruption to feeding activities.	Potential to occur.		Moderate.
	Interference with acoustic communication signals.	Will occur.		Moderate.
Solid and liquid wastes.	Generation of sewage and greywater.	Will occur.	Only biodegradable waste will be discharged and will dilute to non-detectable levels. On-board sewage treatment plant, adherence to MARPOL and approved ISPPC.	Negligible.
	Generation of galley waste and garbage.	Will occur.	Waste management plan where only biodegradable and comminuted waste will be discharged. Adherence to MARPOL.	Negligible.
	Generation of oily waters.	Will occur.	Adherence to MARPOL and approved IOPPC and SOPEP.	Negligible.
Atmospheric emissions.	Atmospheric emissions.	Will occur.	Approved IAPPC. Regular maintenance of motors, equipment and generators and monitoring of fuel consumption.	Negligible.
Unplanned Activities				
Streamer break or loss.	Water or seabed impact.	Low.	Solid streamer with SRD fitted and support vessel present at all times.	Negligible.
Fuel or oil spills.	Water and coastal impact.	Low due to mitigation measures.	Compliance with COLREGS and SOPEP in place.	Negligible.
Vessel collision or sinking.	Water and coastal impact.	Extremely unlikely.	24/7 operations to minimise duration of survey. Compliance with COLREGS and support vessel present at all times. Notice to Mariners issued and broadcast on Maritime Radio. All users of Mohua Operational Area have been advised of the Mohua 2D MSS operation.	Negligible.

6 Environmental Management Plan

The management of environmental risks associated with OMV's activities is integral to their business decision-making processes. Potential environmental risks/hazards are identified during planning stages and throughout operations, and their associated risks are assessed and managed via a structured management system. These mechanisms ensure that OMV's high environmental standards are maintained, the commitments specified in this MMIA are achieved and that any unforeseen aspects of the proposed Mohua 2D MSS are detected and addressed.

The Environmental Management Plan (EMP) is essential for the successful implementation of the Mohua 2D MSS; highlighting the key environmental objectives, the mitigation measures and monitoring programmes to be followed as well as the regulatory and reporting requirements and commitments outlined in this MMIA.

The mitigation measures for the Mohua 2D MSS will be implemented to eliminate, offset, or reduce any identified environmental effects which could arise to ALARP.

The *Aquila Explorer* also has its own independent EMP which documents the implementation of their environmental management system as part of their Health, Safety and Environmental Quality Planning process for their operations, waste accounting system, waste management plan and emergency response plan, including for small oil and fuel spills.

The EMP for the Mohua 2D MSS is provided in Table 10 and will be undertaken in conjunction with the MMMP (Appendix 4).

6.1 Implementation

All contractors involved in the Mohua 2D MSS have their own management systems that are consistent with the requirements of the Mohua 2D MSS. To ensure environmental performance and before any contracts were signed OMV assessed contractors previous environmental performance; included clauses in the contract documents specifying contractor responsibilities; indicated the requirements for contractor training and the requirements for appropriate monitoring, feedback and sharing information between OMV and the contractor (i.e. weekly waste-generation reports).

The *Aquila Explorer* will have specific personnel with designated responsibilities in regard to environmental protection, supervision and execution of the EMP. However, the Master will have ultimate responsibility for ensuring the *Aquila Explorer* is operated with a high regard for environmental protection.

The Mohua 2D MSS will be conducted in accordance to (but not limited to) the Code of Conduct, all relevant Maritime regulations, Marine Protection Rules, Environmental Best Practice Guidelines for the Offshore Petroleum Industry (MfE, 2006) and the Health and Safety in Employment (Petroleum Exploration and Extraction) Regulations 2013 (HSE, 2013). As a result of compliance with the Code of Conduct, if any marine mammals are observed within the relevant mitigation zones, the four qualified observers onboard the *Aquila Explorer* have the authority to delay or shut down an active acoustic source.

Table 10: Mohua 2D MSS Environmental Management Plan

Environmental Objectives	Parameters to be Controlled	Control Frequency	Proposed Actions	Legislation and Protocols to be Applied
Minimise interference with fisheries community.	Presence of fishing boats.	Pre-survey. Continuous.	24/7 operation to minimise MSS duration. Information provided to fishing authorities, fishing and boating clubs. Support boat investigation and Notice to Mariners issued.	COLREGS. International best practice.
Minimise introduction of marine pests.	Hull fouling. Ballast water discharge.	Continuous.	Antifouling systems in place (last slipped in November 2013). Adherence to ballast water regulations. Regular maintenance undertaken.	International best practice. Import Health Standard for Ships' Ballast Water from All Countries (Biosecurity Act 1993). Draft Craft Risk Management Strategy for Vessel Biofouling.
Minimise disruption and physiological effects to marine mammals and marine fauna.	Presence of marine mammals within mitigation zones while acoustic source is active.	Continuous observation 24 hours per day by four qualified observers. Use of PAM 24/7.	Compliance with Code of Conduct and Section 5.3.2. 24/7 operation to minimise MSS duration. Presence of two qualified MMO's and two qualified PAM operators (PAM used 24/7). Pre-start observations, soft start and delay start/shut down procedures.	The Code of Conduct. Marine Mammals Protection Act 1978 & Marine Mammals Protection Regulations 1992.
Minimise effects on sea water quality.	Liquid wastes.	Continuous.	Discharge to sea in accordance with MARPOL and NZ regulations.	MARPOL 73/78. NZ Maritime Transport Act 1994.
	Oil and other waste.	Continuous.	Disposed at an approved shore reception facility in compliance with legal procedures and maintain a waste disposal log. Approved SOPEP and IOPPC.	MARPOL 73/78. NZ Maritime Transport Act 1994.
	Bio-degradable wastes.	Continuous.	Can be discharged overboard beyond 12 Nm from the coastline or 3 Nm if comminuted.	MARPOL 73/78. NZ Maritime Transport Act 1994.
Solid waste management.	Solid waste.	Continuous.	Dispose at an approved shore reception facility in compliance with local regulatory requirements. Waste disposal log will be kept.	MARPOL 73/78. NZ Maritime Transport Act 1994.
	Bio-degradable wastes.	Continuous.	Discharged overboard from seismic and support vessels, will be comminuted so can occur beyond 3 Nm from coastline.	MARPOL 73/78. NZ Maritime Transport Act 1994.
Minimise effects on air quality.	Atmospheric emissions.	Continuous.	Proper maintenance of equipment and generators. Approved IAPPC and regular monitoring of fuel consumption.	Best practice.
Minimise accidental events.	Streamer break or loss. Collisions. Fuel/oil spills.	Continuous.	24/7 operations to minimise survey duration. Hull is built to Ice Class. Solid streamer used with SRD's fitted. COLREGS and presence of a support vessel. Approved SOPEP in place.	Best Practice. COLREGS.

7 Conclusion

Within the petroleum industry, a MSS is considered a routine activity and a requirement to discover and further develop oil and gas fields. Well-established standard operating procedures are in place within the petroleum industry to reduce any potential environmental effects that could arise from a MSS to ALARP.

For the Mohua 2D MSS, OMV will comply with the Code of Conduct, NZ Maritime Rules, NZ Marine Protection rules, OMV's internal HSE documents and implement international best practice to ensure there is no harm to any marine mammals, marine fauna, the marine environment or any personnel.

As well as adhering to the Code of Conduct, OMV will implement additional mitigation measures as a reflection of conducting the Mohua 2D MSS in an AEI. The mitigation zones within the Code of Conduct for a Level 1 MSS have been validated by STLM to ensure that if compliance with the mitigation zones is achieved, the Mohua 2D MSS should not result in any injury to marine mammals. OMV will have four independent and suitably qualified MMO's on board the *Aquila Explorer*, and with the use of PAM, observations will be carried out 24/7 while the acoustic source is active.

There is a long history of MSS's around the NZ coastline and to date there has been no significant environmental effects on marine mammals or the marine environment which have been recorded by independent MMO's.

The *Aquila Explorer* is a specialised MSS vessel that has advanced seismic acquisition technology and operational equipment onboard in order to reduce any environmental effects on marine mammals or the marine environment to ALARP.

This MMIA identifies and discusses the potential environmental effects from the Mohua 2D MSS and the mitigation measures that will be implemented to ensure that any potential effects are ALARP.

From the information provided in this MMIA, it is believed that the potential for any adverse effects on the marine environment or marine mammals are ***minor*** if the Mohua 2D MSS is undertaken in compliance with the Code of Conduct and the mitigation measures discussed in this MMIA.

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Appendices

This report contains the following appendices.

Number	Title
1	Mohua 2D MSS Information Sheet
2	Consultation Register with Key Stakeholders
3	Technical Details of the PAM system
4	Marine Mammal Mitigation Plan for the Mohua 2D MSS
5	Sound Transmission Loss Modelling

APPENDIX 1

Mohua 2D MSS Information Sheet

OMV New Zealand Limited
Mohua 2D Marine Seismic Survey – Taranaki Basin
Information Sheet

Environmental Offshore Services Limited (EOS) have been engaged by OMV New Zealand Limited (OMV) to prepare a Marine Mammal Impact Assessment (MMIA) for a 2D Seismic Survey in the Taranaki Basin (Figure 1).

The Mohua 2D Seismic Survey will be located within Petroleum Exploration Permit 53537, where approximately 200 lineal km of 2D seismic survey lines will be acquired. The purpose of the Mohua 2D survey is to gather a general understanding of the regional geological structures and identify more prospective areas for hydrocarbons which can be comprehensively assessed at a later stage through a 3D seismic survey. Figure 1 shows the operational area within which the Mohua 2D seismic survey will occur with the proposed survey lines shown, although the exact survey lines are still to be finalised.

The Mohua 2D Seismic Survey is scheduled to commence mid-March 2014 and will take approximately 3 days to complete depending on weather constraints and marine mammal encounters. OMV have contracted the seismic vessel *Aquila Explorer* to undertake the 2D seismic survey (Figure 2). The 71 m *Aquila Explorer* will tow one streamer, up to 8 km long just below the surface behind the vessel that will restrict its ability to manoeuvre. The end of the streamer is marked with a tail buoy that can be observed day and night due to flashing lights and a radar reflector. During seismic acquisition the vessel will be travelling at approximately 4.5 kts so the streamer tail buoy will be travelling approximately 50 minutes behind the vessel.

The *Amaltal Mariner* (Figure 3), a 37 m support vessel will accompany the *Aquila Explorer* to ensure the survey area is clear of obstructions and inform other users of the presence of the seismic vessel if they cannot be contacted via VHF radio. A Notice to Mariners will be issued and will be broadcast daily on maritime radio advising of the Mohua 2D Seismic Survey for the duration of the survey.

Behind the *Aquila Explorer* an acoustic source will release a sound wave from compressed air which travels down through the water column into the underlying rock. The streamer has hydrophones positioned along it to pick up and record sound that is reflected by layers in the rock. These recordings can then be processed to provide an image of the subsurface geology directly below the acoustic source.

OMV will operate the Mohua 2D Seismic Survey in accordance to the '2013 Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Operations' (Code of Conduct). Under the EEZ Act 2013, seismic surveys are classified as Permitted Activities as long as the operator complies with the Code of Conduct. This requires a MMIA to be prepared and that the mitigation measures for a Level 1 seismic survey under the Code of Conduct are adhered to in order to prevent any adverse effects on the marine environment or marine mammals. The Director-General of Department of Conservation has to give formal sign off to the MMIA before the Mohua 2D Seismic Survey can commence.

Contact Details

If you have any further questions or matters you would like to discuss or you would like any further information in regards to the Mohua 2D Seismic Survey, please contact Dan Govier of EOS.

Dan Govier
Environmental Consultant
Environmental Offshore Services Ltd

dan@eosltd.co.nz

Figure 1: Mohua 2D Seismic Survey and Operational Area

Figure 2: Seismic Survey Vessel – *Aquila Explorer*

Figure 2: Seismic Support Vessel – *Amaltal Mariner*

APPENDIX 2

Consultation Register with Key Stakeholders

Stakeholder	Consultation Summary
Taranaki Iwi Trust	Discussions were held with Taranaki Iwi Trust to advise them of the upcoming Mohua 2D MSS, however due to work schedules and commitments, a meeting could not be held. Taranaki Iwi Trust were engaged with in December 2013 regarding the KAKA 3D MSS located to the east of the Mohua 2D MSS. OMV are to provide a draft MMIA to Taranaki Iwi Trust and keep them updated on the survey and anticipated commencement date. These updates will be ongoing through the duration of the MSS.
Ngati Ruanui 12/2/2014	A presentation was given to Ngati Ruanui which summarised the previous KAKA 3D MSS as well as introducing the Mohua 2D MSS. Ngati Ruanui will be provided a copy of the MMIA and STLM report once finalised.
Nga Ruahine Iwi Authority 12/02/2014	Provided a summary and findings of the KAKA 3D MSS and had a good general discussion on MSS's and effects of, as well as the research that is being undertaken. OMV will provide Nga Ruahine with copies of the marine mammal observation report it commissioned with NIWA and will also provide the MMIA. Nga Ruahine will be kept informed if any incidents occurred during the MSS.
DOC – Taranaki Office 12/02/2014	Introduced the Mohua 2D MSS and Survey Area and discussed the potential sensitivities in the area and the likelihood of Maui's/Hector's dolphins.
Rochelle Constantine University of Auckland	Introduced the seismic survey area and provided the Information Sheet used in the consultation process. Rochelle said that the main sensitivities within the area could be Maui's dolphins and blue whales. Rochelle said that assuming the Mohua MSS is adhering to the Code of Conduct and has MMO's onboard, she cannot really comment on it as she is not directly involved with any work on these species.
Liz Slooten University of Otago	The Mohua MSS and the survey duration etc. was introduced to Liz and she was sent the information sheet attached in Appendix 1. Discussion was held over the validation methods to the STLM and the process. Liz is keen to be notified early with any surveys along the South Islands east coast so that students from the University can undertake research listening to sound levels at known distances to the source vessel as part of their own validation of the STLM, and to see how marine mammals respond to the sound source when the acoustic source is a long way away.

Dan Govier

From: Idq#P fGrxjdo#D#Frp sdvv#Jrvh#Ilvklqj
Sent: P rqgd|/#6#P dufk#5347#7=8;#sp 1
To: Gdq#Jrylhu
Subject: Uh=#Vhlvp lf#Vxuyh|v#P dufk#5347

Thanks Dan,
We will keep an eye on Waru but will not interfere with us for such a short time. Mohua will not have any impact at all.
Cheers

Compass Rose Fishing Ltd.

From: Dan Govier
To:

Sent: Monday, 3 March 2014 3:40 PM
Subject: Seismic Surveys March 2014

Hi all,

Please find information attached for two proposed 2D seismic surveys which will be undertaken by New Zealand Oil & Gas Ltd and OMV NZ Ltd

The seismic surveys are proposed to be undertaken in the middle to late March 2014 in the South Taranaki Bight.

The seismic survey vessel *Aquila Explorer* will be used for both surveys, where it will undertake NZOG's Waru 2D Seismic Survey first and then move offshore to complete OMV's Mohua 2D Seismic Survey.

The surveys will only occur for a short duration, the inshore Waru Seismic Survey is proposed to take five days, while the offshore Mohua Seismic Survey is expected to take three days.

A Notice to Mariners will be issued and a tail buoy with lights and a radar reflector will mark the end of the single seismic streamer being towed.

If you have any questions or concerns over the attached sheet please let me know

Cheers
Dan

Dan Govier

From: Mrkq#Fdndd##IYP V
Sent: P rqgd|/#5#P dufk#5347#7=53#s1p 1
To: *Vhuj hl#Vkhdnvw#*#Yddnul#Ehory*#Wlp #Ddz *#Kdp lvk#Wlvhq*#ER\OH/#G rqdo*
Cc: *Ulfkdug#Z hov*#G dq#J rylhu*
Subject: IZ =#Vhlvp lf#Vxuyh|v#P dufk#5347
Attachments: Z dux#5G#Lqirup dwlrq#Vkhhw1sgi#P rkxd#5G#Lqirup dwlrq#Vkhhw1sgi

Hi all

Just quick note, for those who might have vessels on JMA7 , Seismic survey off the South Taranaki Bight mid to late March/ shouldn't effect deepsea trawlers, at that time, position looks shallow water & close to shore, but just in case areas/positions attached

---

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Monday, 3 March 2014 3:41 p.m.
To:
Subject: Seismic Surveys March 2014

Hi all,

Please find information attached for two proposed 2D seismic surveys which will be undertaken by New Zealand Oil & Gas Ltd and OMV NZ Ltd

The seismic surveys are proposed to be undertaken in the middle to late March 2014 in the South Taranaki Bight.

The seismic survey vessel *Aquila Explorer* will be used for both surveys, where it will undertake NZOG's Waru 2D Seismic Survey first and then move offshore to complete OMV's Mohua 2D Seismic Survey.

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A Notice to Mariners will be issued and a tail buoy with lights and a radar reflector will mark the end of the single seismic streamer being towed.

If you have any questions or concerns over the attached sheet please let me know

Cheers
Dan

Dan Govier
Environmental Consultant
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P.O. Box 2065
Nelson 7041

ENVIRONMENTAL OFFSHORE SERVICES LIMITED

Dan Govier

From:	Odzv#Lqvkruh,
Sent:	Prqgd|/#6#Pdufk#5347#7=46#s1p1
To:	*Gdq#Jryhu*
Cc:	mhuhp|C lqvkruh1fr1q}
Subject:	UH=#Vhlvplf#Vxuyh|v#Pdufk#5347

Dan

Please note Jeremy's new email address as above.

Jeremy is now the new CE for Fisheries Inshore New Zealand Ltd

regards

Laws

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Monday, 3 March 2014 3:41 p.m.
To:

Subject: Seismic Surveys March 2014

Hi all,

Please find information attached for two proposed 2D seismic surveys which will be undertaken by New Zealand Oil & Gas Ltd and OMV NZ Ltd

The seismic surveys are proposed to be undertaken in the middle to late March 2014 in the South Taranaki Bight.

The seismic survey vessel *Aquila Explorer* will be used for both surveys, where it will undertake NZOG's Waru 2D Seismic Survey first and then move offshore to complete OMV's Mohua 2D Seismic Survey.

The surveys will only occur for a short duration, the inshore Waru Seismic Survey is proposed to take five days, while the offshore Mohua Seismic Survey is expected to take three days.

A Notice to Mariners will be issued and a tail buoy with lights and a radar reflector will mark the end of the single seismic streamer being towed.

If you have any questions or concerns over the attached sheet please let me know

Cheers
Dan

Dan Govier
Environmental Consultant
+64 (0) 274 898 628
www.eosltd.co.nz
P.O. Box 2065
Nelson 7041
ENVIRONMENTAL OFFSHORE SERVICES LIMITED

Dan Govier

From: Wlp #Ddz
Sent: P rqgd|/#5#P dufk#5347#7=3;#slp 1
To: Gdq#Jrylhu
Subject: UH=#Vhlvp lf#Vxuyh|v#P dufk#5347

Thank you Dan,
Our vessel is currently in the area but may have left by Mid-March.
Please update on the start date when it becomes clear.
Tim

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Monday, 3 March 2014 3:41 p.m.
To:
Subject: Seismic Surveys March 2014

Hi all,

Please find information attached for two proposed 2D seismic surveys which will be undertaken by New Zealand Oil & Gas Ltd and OMV NZ Ltd

The seismic surveys are proposed to be undertaken in the middle to late March 2014 in the South Taranaki Bight.

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Nelson 7041

ENVIRONMENTAL OFFSHORE SERVICES LIMITED

Dan Govier

From: Ddlq#P hdrg|#SQV#Qhz#Sdp rxwk,
Sent: Wxhvgd|/#7#P dufk#5347#k=5;#dp 1
To: 'gdqC hrvowg1fr1q}*
Cc: 'Urz dq#\dqgdn*
Subject: IZ =#Vhlvp lf#Vxuyh|v#P dufk#5347
Attachments: P rkxd#5G#Iqirup dwlrq#Vkhhw1sgi#Z dux#5G#Iqirup dwlrq#Vkhhw1sgi

Thanks Dan, we appreciate the notice.
Whilst it does not directly affect us it is good to know what is going on.
I will pass it on to the committee at the next meeting,.

regards

New Plymouth Sportfishing and Underwater Club
New Plymouth

From:
Sent: Monday, 3 March 2014 6:08 p.m.
To:
Subject: Fwd: Seismic Surveys March 2014

Begin forwarded message:

From: Dan Govier <dan@eosltd.co.nz>
Date: 3 March 2014 4:18:56 PM
To: '

Subject: Seismic Surveys March 2014

Hi all,

Please find information attached for two proposed 2D seismic surveys which will be undertaken by New Zealand Oil & Gas Ltd and OMV NZ Ltd

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If you have any questions or concerns over the attached information please let me know

Cheers

Dan

Dan Govier
Environmental Consultant
+64 (0) 274 898 628
www.eosltd.co.nz
P.O. Box 2065
Nelson 7041

ENVIRONMENTAL OFFSHORE SERVICES LIMITED

Dan Govier

From: Qhz#]hdodqg#Shwurdxp#)#Plqhudov
Sent: Prqgd|/#6#Pdufk#5347#7=83#sp1
To: Gdq#Jryhu
Subject: UH=#Vhlvplf#Vxuyh|v#Pdufk#5347

Hello Dan,

Thank you for letting us know, I have sent the details on to the interested teams.

Regards,

Feedback on our service? Fill in our customer satisfaction survey.

Free email publications - http://www.nzpam.tx.co.nz/go/to/t/subscribe/

From: Dan Govier [mailto:dan@eosltd.co.nz]
Sent: Monday, 3 March 2014 4:08 p.m.
To:

Subject: Seismic Surveys March 2014

Hi all,

Please find information attached for two proposed 2D seismic surveys which will be undertaken by New Zealand Oil & Gas Ltd and OMV NZ Ltd

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Nelson 7041

ENVIRONMENTAL
OFFSHORE SERVICES
LIMITED

APPENDIX 3

Technical Details of the PAM System

Appendix 2:

Specifications of the PAM equipment

Hardware

Blue Planet Marine can provide various customised passive acoustic monitoring systems suitable for detecting and monitoring cetaceans during seismic survey. The full specifications of this system are not included in this document, however can be supplied on request.

The towed hydrophone streamers are based on a well-established design by Ecologic in the United Kingdom. This design, which is a modern iteration of systems originally developed on a pioneering project funded by Shell UK to develop PAM for mitigation in the mid 1990s, has proven highly robust and reliable. It provides flexibility allowing the inclusion of various combinations of hydrophones and other sensors and can, if necessary, be disassembled and repaired in the field. Seismic PAM hydrophones operate in an environment in which the risk of hydrophone loss or damage is significant and options for external assistance are limited. While spare equipment is always provided, the use of a system that can be repaired in the field is, a distinct advantage. The systems that BPM would use for the survey will have a 340 m tow cable and an 80 m deck cable.

The variety of cetacean species likely to be encountered during seismic survey mitigation produce vocalisations over an extremely broad frequency range, from the infrasonic 15-30Hz calls of large baleen whales to the 130kHz pulses of harbour porpoise and Hectors dolphin. To be able to capture all of these, while reducing unwanted noise the PAM system uses two different hydrophone/pre-amp pairs with widely overlapping frequency sensitivity: a low/medium frequency pair and a high frequency pair. These hydrophone pairs can be monitored, filtered and sampled independently.

Filtering and amplification hardware is custom-built by Magrec to meet the specification required for cetacean monitoring. Important features include: adjustable low frequency filters from 0Hz to 3.2kHzs which can be applied to reduce low frequency noise allowing the available dynamic range to be conserved for capturing marine mammal vocalisations within the frequency bands used each species. The Magrec preamp also provides an output with a fixed 20kHz low cut filter to optimise detection of the very high frequency vocalisations of porpoise, Hectors dolphins, beaked whales and Kogia. Additional, highly configurable digital band-pass and band-stop filtering is provided by on board signal processing within the specialised USB sound card.

Audio and low-ultrasonic frequency bands (up to 96 kHz) are digitised using a USB sound card. Ultra high frequency click detection (which is particularly useful for porpoise, Hector's dolphins, Kogia, etc.) is achieved by using a National Instruments Digital Acquisition card with a sampling rate of 1.2 mega samples s-1.

Systems like this have been used from a wide variety of platforms ranging from sailing yachts to ocean-going ice breakers and in waters from the tropics to the Antarctic. However, the need to monitor acoustically for mitigation has been a driver for much of the system's development. Seismic survey mitigation monitoring has been conducted from guard vessels and from the main seismic survey vessel itself. Operation from the seismic vessel has proven most straightforward and would be favoured in most situations.

Software

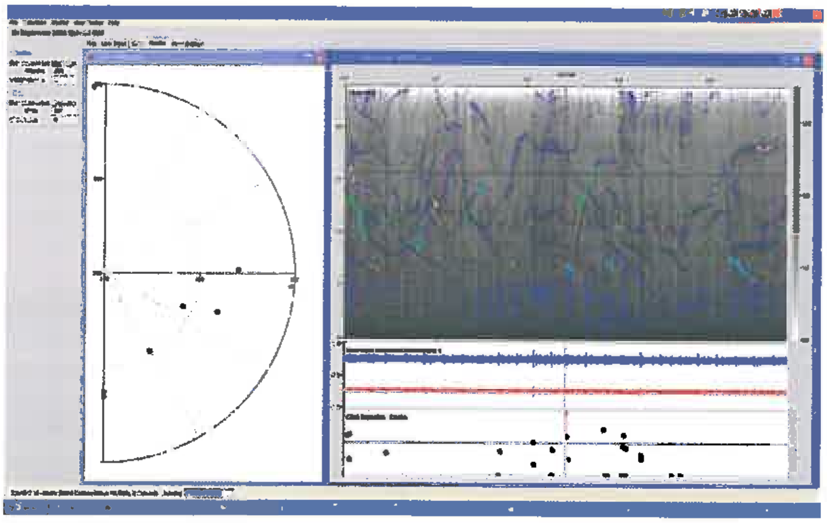
The system is optimised for use with PAMGUARD. A software suite specifically designed for detecting, classifying and localising a wide variety of marine mammals during seismic surveys. Much of the funding for the development came from the oil exploration industry. Ecologic was part of the team that initiated the PAMGUARD project and remains closely associated with its development. The hardware described here, has been developed in parallel with the PAMGUARD software.

PAMGUARD is an extremely flexible program with a range of modules that can be combined to provide customised configurations to suit particular applications. It includes modules for detecting both transient vocalisations (clicks) and tonal calls (e.g. whistles and moans). Cetacean click vocalisations range from the medium frequency clicks of sperm whales that can be detected at ranges of several miles, through the powerful broadband clicks produced by most delphinids to the specialised narrow band pulses of beaked whales, harbour porpoises and Hector's dolphins. High frequency tonal sounds include the whistle vocalisations produced by delphinids while low frequency tonals are produced by baleen whales. When data from two or more hydrophone elements are available PAMGUARD can calculate bearings to these vocalizations and provide locations by target motion analysis.

PAMGUARD also includes routines for measuring and removing background noise, and for vetoing particularly intense sounds such as Airgun pules.

In addition PAMGUARD collects data directly from certain instruments. For example, it measures and displays the depth of the hydrophone streamer and takes NMEA data (such as GPS locations) from either the ship's NMEA data line or from the stand-alone GPS units provided with the equipment.

The ship's track, hydrophone locations, mitigation zones, airgun locations and locational information for acoustic detections are all plotted on a real-time map.



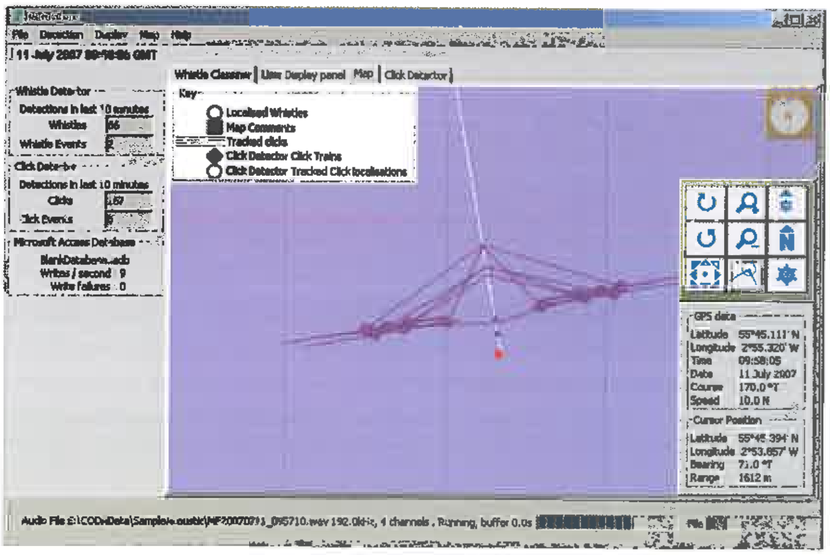


Figure 1 Screen shot from PAMGUARD Whistle and Click Detection and Mapping and Localisation Modules typical of a Seismic Mitigation configuration

Species Detection

The frequency range, call type and vocal behaviour of cetaceans varies enormously between species and this affects the degree to which PAM provides additional detection power, especially in the noisy environment of a seismic survey. This system has proven very effective in detecting small odontocetes and sperm whales, increasing detection reliability by an order of magnitude during trials (funded by Shell) conducted off the UK. PAM is particularly effective for the detection of sperm whales as they can be heard at significant ranges (several miles) and are consistently vocal for a large proportion of the time. Smaller odontocetes such as dolphins, killer whales, pilot whales and other "black fish" can be detected at useful ranges from both their whistle and click vocalisations but they often move so quickly that target motion may be difficult. The effective range for harbour porpoise (~400 m) is limited by the high rate of absorption of their ultra-high frequency clicks. This is usually within proscribed mitigation ranges so that any reliable detection should lead to action. Towed hydrophones of this type have been very effective in picking up vocalisations from beaked whales during surveys and the narrow bandwidth and characteristic upsweep in their clicks greatly assists with their classification. However, beaked whales clicks are highly directional and vocal output can be sparse and intermittent so overall detection probability may remain low.

The value of PAM in mitigating the effects of seismic operations with baleen whales has yet to be fully explored. These whales generally vocalise at low frequencies, increasing vulnerability to masking by vessel and flow noise. Further, although some baleen whale vocalisations are very powerful, they appear to be less consistently vocal than most odontocetes. Many of their vocalisations appear to be breeding calls and may be produced seasonally and either solely or predominantly by males.

Standard Seismic Mitigation Acoustic Monitoring System	
Towed Hydrophone	
Acoustic Channels	2 x Medium Frequency Benthos AQ4. **–201 dBV re 1µPa** (+/- 1.5 dB 1-15kHz) with Magrec HP02 broad band preamps (LF cut filter @ 100Hz or 50Hz as required) Near-flat Sensitivity 50Hz- 15kHz with good sensitivity to higher frequencies
	2 x High Frequency Magrec HP03 units, comprising a spherical ceramic and HP02 preamp (Low cut filter set at 2kHz) Near flat sensitivity 2kHz - 150kHz, +/-6 dB 500Hz to 180kHz
Depth Sensor	Keller 4-20Ma 100m range Automatically read and displayed within PAMUARD
Streamlined housing	5m, 3 cm diameter polyurethane tube. Filled with Isopar M.
Cable	340m multiple screened twisted pair, with strain relief and Kellum's grip towing eye, Length deployed may vary to suit application
Connectors	19 pin Ceep IP68 waterproof
Deck cable	~75m 19pin Ceep to breakout box
Topside Amplifier Filter Unit	
Unit	Magrec HP/27ST
Supply Voltage	10-35 V DC
Supply current	200mA at 12 V

Standard Seismic Mitigation Acoustic Monitoring System	
Input	Balanced input
Gain	0,10,20,30,40,50 dB
High Pass Filter	-6db/octave selectable 0, 40, 80, 400,1.6k, 3.2k
Output	2 X Balanced output via 3 pin XLR
Ultra HF Output	2 X Balanced output via 3 pin XLR (with 20kHz high pass filter for porpoise detection)
Headphone	Dual output via ¼" jack
Overall Bandwidth	10Hz-200kHz +/–3dB
GPS	
Input	Serial to USB adapter to interface with ship's NMEA supply
Backup	Standalone USB unit provided as independent backup
Computers	
	Up to date Laptop Computers
Digitisers	
Digitiser	NI USB 6251 high speed Digital Acquisition (if required for porpoise detection)
Sound Card	High quality sound card 192kHz sampling rate e.g. Motu Ultralite Mk3 Hybrid, Or RME Fireface 400
Software	
General	PAMGUARD with appropriate configurations
Porpoise Detection	Rainbow Click / Logger

APPENDIX 4

Marine Mammal Mitigation Plan for the Mohua 2D MSS

Marine Mammal Mitigation Plan:

OMV Mohua 2D Marine Seismic Survey

BPM-14-OMV-Mohua 2D MSS-MMMP-v1.3

26/03/2014

BLUE PLANET MARINE

Document Distribution List

Date: 26/03/2014

Title: Marine Mammal Mitigation Plan: OMV Mohua 2D Marine Seismic Survey

Company/Organisation	Position or Location & name of individual	Copy No.
OMV	Mick Lord, Operations Manager	1
OMV	Eva Reid, Exploration Geophysicist	2
EOS Ltd	Dan Govier, Environmental Consultant	3
BPM	David Paton, Managing Director	4
BPM	Simon Childerhouse, Senior Research Scientist	5
BPM	Rob Slade, Operations Manager	6

Document Revision Record

Rev.	Date	Description	Prepared	Reviewed	Approved
1.0	20/03/2014	Version 1	SC	LD, DG, ER	SC
1.1	21/03/2014	Comments incorporated	LD	SC	ER
1.2	25/03/2014	DOC's comments from Waru MMMP incorporated	SC	LD	SC
1.3	26/03/2014	DOC 'for sake of clarity' comments incorporated	LD	SC	SC

Document Reference Number: BPM-14-OMV-Mohua 2D MSS-MMMP-v1.3

Prepared by: Simon Childerhouse

Last updated: 26/03/2014

www.blueplanetmarine.com

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1. Introduction

This document has been developed by Blue Planet Marine (BPM) for OMV New Zealand Ltd (OMV) in order to meet the requirements for a Marine Mammal Mitigation Plan (MMMP) for the Mohua 2D Marine Seismic Survey (the survey). The survey area will be largely located within Petroleum Exploration Permit (PEP) 53537 with the exception of three tie lines. One tie line is planned to go through the West Cape-1 well and the other two lines will go through the Matuku-1 well and into the Kahurangi trough.

This MMMP outlines the procedures to be followed by observers and crew in order to guide survey operations. It should be read in conjunction with the *2013 Code of Conduct for Minimising Disturbance to Marine Mammals from Seismic Survey Operations* (the Code) and the OMV Marine Mammal Impact Assessment (MMIA) developed by Environmental Offshore Services Ltd (EOS) specifically for this survey. The Code is the primary tool for describing mitigation and reporting required for seismic surveys consistent with NZ legislation. It should be the primary reference for MMO and PAM operators during a survey. This MMMP provides additional and supplemental information useful in the completion of MMO and PAM roles.

2. The OMV Mohua 2D Marine Seismic Survey

EOS was engaged by OMV to prepare a MMIA for an approximate 200 line km 2D survey in the Taranaki Basin, scheduled to commence in March 2014. The survey area will be largely located within PEP 53537 with the exception of three tie lines. One tie line is planned to go through the West Cape-1 well and the other two lines will go through the Matuku-1 well and into the Kahurangi trough. Information provided in the draft MMIA for the Mohua survey area has been used by BPM in the development of this MMMP.

The survey area will be bound by the Mohua Operational Area; allowing for the operation of line turns, acoustic source testing and soft start initiation (Figure 1). It is anticipated that the survey will take approximately three days to complete, depending on weather constraints and marine mammal encounters. The actual commencement date of the survey is dependent on the seismic vessel, *Aquila Explorer*, completing prior surveys. The current schedule anticipates commencement at the start of April 2014.

The survey will acquire approximately 200 km of 2D seismic data in order to provide a general understanding of the geological structure within PEP 53537. It will also identify more prospective areas for further investigation utilising a 3D MSS.

The *Aquila Explorer* will tow one solid streamer, 8 km in length. OMV will utilise a 2,360 in^3 acoustic source comprising of four sub-arrays located at a depth of 9 m below the sea surface and >50 m behind the *Aquila Explorer*. In the case of dropouts during acquisition, the gun array may operate at a slightly lower capacity for a short period of time. The acoustic source will have an operating pressure of 2,000 psi and be fired at a shotpoint interval of 18.75 m apart, where for a typical boat speed of 4.2 – 4.5 knots, relates to a shot being fired every 8 – 8.5 seconds.

Given the volume of the airguns being used, the survey is classified as a Level 1 survey under the Code. The mitigation procedures set out in this MMMP will adhere to the requirements of a Level 1 survey as stipulated in the Code.

Figure 1: Location of the Mohua 2D Marine Seismic Survey with indicative survey lines.

(NOTE: exact survey lines are still under review. Figure reproduced courtesy of EOS 2014. Observers to refer to the VADAR system for the coordinates of the survey Operational Area.)

3. Record Keeping and Reporting

The observers (MMOs and PAM operators) are responsible for maintaining records of all marine mammal sightings/detections and mitigation measures taken throughout each survey period. Observers are also required to monitor and record seismic operations, the power output of the acoustic source while in operation, observer effort and sighting conditions. These and other reporting requirements are detailed in Appendix 2 of the Code.

Observers are to accurately determine distances/bearings and plot positions of marine mammals whenever possible throughout the duration of sightings. Positions of marine mammals should be plotted in relation to the vessel throughout a detection. GPS, sextant, reticle binoculars, compass, measuring sticks, angle boards, or any other appropriate tools should be used to accurately determine distances/bearings and plot positions of marine mammals.

The operator will ensure that information relating to the activation of an acoustic source and the power output levels employed throughout survey operations is readily available to support the activities of the qualified observers in real time by providing a display screen for acoustic source operations.

Please review Appendix 2 of the Code carefully. Note that you are required to record the power levels (and timing) of at least one random soft start per swing[1].

Note: the Code is mandatory within the NZ EEZ, as such record keeping should be of a high standard as it may form the basis of compliance or enforcement action by the authorities.

All data must be recorded in a standardised Department of Conservation (DOC) Reporting Form. Datasheets are available from www.doc.govt.nz/notifications and are in Excel format. With regard to these forms please note the following advice from DOC:

- Always save the forms in MS Excel 2003 version, with macros enabled;
- Do not attempt to use the forms on a Macintosh device; and
- Do not cut/paste within the document (copy/paste should be okay, but cutting and pasting causes problems with formulas and validation).

It is recommended that observers test the functionality of the datasheets prior to mobilisation and become familiar with their use. In particular, note that macros <u>must</u> be enabled.

All raw datasheets shall be submitted by the qualified observer directly to the Director-General (refer Appendix 5 of the Code for postal and email addresses) within 14 days of a completed MMO/PAM operator rotation or end of the survey. Prior to submission to DOC, these data sheets are to be reviewed by the BPM Project Manager so please ensure that sufficient time is made for that.

There are a number of situations that require immediate notification to DOC. These are listed in Table 1, in Section 6. Where uncertainty or ambiguity in application of the Code arises, clarity can be sought from the Director-General.

It is recommended that observers provide the client with a daily summary detailing marine mammal sightings, mitigation measures taken and instances of non-compliances.

The Team leader is responsible for compiling an end of survey summary report based on the data collected throughout each survey. The contents of this report are summarised in Appendix 2 of the Code.

3.1 Contact details for the Department of Conservation

During the survey, the first point of contact within DOC is Ian Angus [redacted] or [redacted] a response is required urgently then telephone but in all other circumstances use email. Should Ian Angus be unavailable, please phone 0800DOCHOT and state the following:

1) You wish to provide information to the Marine Species and Threats team, National Office;
2) The name of the MMO/PAM operator, the seismic survey and boat you are currently on;
3) The time and date; and
4) The issue/enquiry they wish to pass on to Ian Angus.

[1] Note: Text in blue boxes are recommendations or further explanations to observers from BPM and/or DOC.

3.1.1 Communication protocol

The communication protocol to be followed for reporting to DOC is as follows:

For **general reporting of non-urgent issues** to DOC the communication protocol **is**:

- MMO Team Leader to contact BPM Project Manager ashore (,,
- BPM to contact OMV (.... ,,
- OMV to contact EOS (Dan Govier); and
- EOS to contact DOC (Ian Angus or other).

For **urgent communications**, the MMO Team Leader can contact DOC directly either by email or by phone under the following conditions:

- Team Leader must inform the Party Chief (or nominated OMV person) and the Client Reps of the issue and intention to contact DOC, and keep these people informed of discussions and associated events;
- The BPM Project Manager and onshore OMV personnel .., must be kept informed;
- If the contact is by email, then the Team Leader should consider making a phone call advising DOC of the situation; and
- All direct contacts to DOC via phone must be followed up by an email to DOC and OMV at the earliest opportunity to provide written confirmation of the message.

4. Mitigation Measures Required Under the Code

The survey is classified as a Level 1 survey under the Code. Within the operational area, the marine mammal impact mitigation measures required can be divided into three principal components:

1) The use of dedicated observers (i.e. MMOs and PAM operators);
2) The mitigation measures to be applied; and
3) The mitigation actions to be implemented, should a marine mammal be detected.

4.1 Dedicated observers (MMOs and PAM operators)

As this is a Level 1 survey, there will be two MMOs and two PAM operators on board the *Aquila Explorer* for the duration of the survey. The training and experience of the observers will meet the requirements stipulated in Section 3.4 of the Code. There will be at least one MMO (during daylight hours) and one PAM operator on watch at all times while the acoustic source is in the water in the operational area. Observers may stand down from active observational duties while the acoustic source is in the water but inactive for extended periods. Note; an "extended period" does not apply to when the acoustic source may be off during line turns (refer below).

It is recommended that:

- MMOs conduct daylight observations from half an hour before sunrise to half an hour after sunset;

- Fatigue and effective watch-keeping be managed by limiting watches to a maximum of 4 hours; and

- The maximum on-duty shift duration must not exceed 12 hours in any 24-hour period.

The primary role of the observers is to detect and identify marine mammals and guide the crew through any mitigation procedures that may be required. Any qualified observer on duty has the authority to delay the start of operations or shut down an active survey according to the provisions of the Code. In order to work effectively, clear lines of communication are required and all personnel must understand their roles and responsibilities with respect to mitigation.

It is recommended that:

- Where possible, both MMOs are on watch during pre-start observations and soft starts;

- While on transit to the prospect the observers deliver a presentation to crew members detailing observer roles and mitigation requirements;

- The observers hold briefings with key personnel prior to the commencement of seismic operations; and

- The observers provide posters detailing mitigation procedures and communications protocols and display these in the instrument room, at the PAM station and on the Bridge (refer Addenda 2 and Addenda 3 of this document).

Undertaking work-related tasks, such as completing reporting requirements, while monitoring equipment is allowed during duty watch, but PAM operators must not be distracted by non-work activities such as listening to music or watching TV/DVDs etc.

4.1.1 Safety drills

Attendance at a safety drill at least once during each rotation is typically mandatory (e.g. the vessel HSE plan will specify the number). Although not specified in the Code, safety of personnel takes priority over mitigation. Safety drills may be conducted when the acoustic source is active. In this case, endeavours should be made to arrange rosters such that observers attend alternate drills, thus enabling mitigation to be maintained. In all cases, observers must comply with the mandatory safety code of the vessel.

4.1.2 PAM not operational

Section 4.1.2 of the Code states: "At all times while the acoustic source is in the water, at least one qualified MMO (during daylight hours) and at least one qualified PAM operator will maintain watches for marine mammals".

The Code defines PAM as "calibrated hydrophone arrays with full system redundancy". BPM has provided full redundancy for this survey by providing two full sets of PAM equipment plus an additional backup PAM hydrophone cable. However, there may be occasions where PAM is not operational.

The Code was first implemented in 2012. In 2013 it was updated. One update relates to times when PAM is not operational. Section 4.1.2 of the Code states that:

"If the PAM system has malfunctioned or become damaged, operations may continue for 20 minutes without PAM while the PAM operator diagnoses the issue. If the diagnosis indicates that the PAM gear must be repaired to solve the problem, operations may continue for an additional 2 hours without PAM monitoring as long as all of the following conditions are met:

- It is daylight hours and the sea state is less than or equal to Beaufort 4

- No marine mammals were detected solely by PAM in the relevant mitigation zones in the previous 2 hours
- Two MMOs maintain watch at all times during operations when PAM is not operational
- DOC is notified via email as soon as practicable with the time and location in which operations began without an active PAM system
- Operations with an active source, but without an active PAM system, do not exceed a cumulative total of 4 hours in any 24 hour period."

It is recommended that MMOs and PAM operators familiarise themselves with this revision to the Code, including the conditions. For clarity, the period that a survey may operate without PAM is a maximum of 2 hours 20 minutes and only when the conditions identified in Section 4.1.2 of the 2013 code are satisfied. Once this time is exceeded, the source must be shut down until PAM is operational again.

4.2 Mitigation procedures

The proponent will observe the following mitigation practices:

4.2.1 Operational area

Under the Code, an operational area must be designated outside of which the acoustic source will not be activated. This includes testing of the acoustic source and soft starts. For these surveys, the operational area is defined in the MMIA.

4.2.2 Operational capacity

The operational capacity of the acoustic source is notified in the MMIA an outlined in Section 2 of this MMMP. This operational capacity should not be exceeded during the survey, except where unavoidable for source testing and calibration purposes only[2]. All occasions where activated source volume exceeds notified operational capacity must be fully documented in observer reports. It is the responsibility of the operator to immediately notify the qualified observers if operational capacity is exceeded at any stage[3].

4.2.3 Sighting conditions

Good sighting conditions means in daylight hours, during visibility of more than 1.5 km, and in a sea state of less than or equal to Beaufort 3.

Poor sighting conditions means either at night, or during daylight visibility of 1.5 km or less, or in a sea state of greater than or equal to Beaufort 4.

[2] D Lundquist, DOC (25 March 2014): "Please note that if the operational capacity is exceeded at any other time (including soft starts), this is a non-compliance incident and should be reported as such."
[3] D Lundquist, DOC (25 March 2014): "qualified observer should be able to monitor this via a dedicated screen as described in section 3 above"

Beaufort 3

- Gentle breeze: 7–10 kts
- Wave height: 0.5–1 m
- Large wavelets. Crests begin to break; scattered whitecaps

BEAUFORT FORCE 3
WIND SPEED: 7-10 KNOTS

SEA: WAVE HEIGHT .6-1M (2-3FT), LARGE WAVELETS, CRESTS BEGIN TO BREAK, ANY FOAM HAS GLASSY APPEARANCE, SCATTERED WHITECAPS

Beaufort 4

- Moderate breeze: 11-16 kts
- Wave height: 1–2 m
- Small waves with breaking crests. Fairly frequent whitecaps.

BEAUFORT FORCE 4
WIND SPEED: 11-16 KNOTS

SEA: WAVE HEIGHT 1-1.5M (3.5-5FT), SMALL WAVES BECOMING LONGER, FAIRLY FREQUENT WHITE HORSES

4.2.4 Pre-start observations

A Level 1 acoustic source can only be activated if it is within the specified operational area, and no marine mammals have been observed or detected in the relevant mitigation zones as outlined in Section 4.4.

The source cannot be activated during daylight hours unless:

- At least one qualified MMO has continuously made visual observations all around the source for the presence of marine mammals, from the bridge (or preferably an even higher vantage point) using binoculars and the naked eye, and no marine mammals (other than fur seals) have been observed in the relevant mitigation zone for at least 30 minutes, and no fur seals have been observed in the relevant mitigation zones for at least 10 minutes; and
- Passive Acoustic Monitoring for the presence of marine mammals has been carried out by a qualified PAM operator for at least 30 minutes before activation and no vocalising cetaceans have been detected in the relevant mitigation zones.

It is recommended that MMOs and PAM operators are notified at least 45 minutes prior to activation of the source to ensure that the 30 min of pre-start observations can be conducted.

The source cannot be activated during night-time hours or poor sighting conditions unless:

- Passive Acoustic Monitoring for the presence of marine mammals has been carried out by a qualified PAM operator for at least 30 minutes before activation, and
- The qualified observer has not detected vocalising cetaceans in the relevant mitigation zones.

Note: If a marine mammal is observed to move into a relevant mitigation zone during pre-start observations and then observed to move out again there is no requirement to delay soft start (providing that at least 30 minutes of pre-start observations have been completed). The important criterion is that there are no marine mammals inside the relevant mitigation zones when the acoustic source is activated at the beginning of soft start and that at least 30 minutes of pre-start observations had been undertaken immediately prior.

Another update to the Code in 2013 relates to commencement of operations in a new location in the survey programme for the first time (Section 4.1.3). When arriving at a new location, the initial acoustic source activation must not be undertaken at night or during poor sighting conditions unless either:

- MMOs have undertaken observations within 20 nautical miles of the planned start up position for at least the last 2 hours of good sighting conditions preceding proposed operations, and no marine mammals have been detected; or
- Where there have been less than 2 hours of good sighting conditions preceding proposed operations (within 20 nautical miles of the planned start up position), the source may be activated if[4]:
    - PAM monitoring has been conducted for 2 hours immediately preceding proposed operations, and
    - Two MMOs have conducted visual monitoring in the 2 hours immediately preceding proposed operations, and

[4] D Lundquist, DOC (25 March 2014): "Please note that this option may only be used if there have not been two hours of good sighting conditions preceding operations. It cannot be used if there were 2 or more hours of good sighting conditions and marine mammals were sighted (i.e., the second option may only be used if weather conditions prevented the first condition being met, not if marine mammal presence prevented the first condition being met)"

- No Species of Concern have been sighted during visual monitoring or detected during acoustic monitoring in the relevant mitigation zones in the 2 hours immediately preceding proposed operations, and
- No fur seals have been sighted during visual monitoring in the relevant mitigation zone in the 10 minutes immediately preceding proposed operations, and
- No other marine mammals have been sighted during visual monitoring or detected during acoustic monitoring in the relevant mitigation zones in the 30 minutes immediately preceding proposed operations.

It is recommended that MMOs and PAM operators familiarise themselves with this revision to the Code including the conditions.

4.2.5 Soft starts

The soft start procedure will be followed every time the source is activated. That is: the gradual increase of the source's power to the operational power requirement over a period of at least 20 minutes and no more than 40 minutes, starting with the lowest power gun in the array. The MMIA for the survey (section 2.2.1.3) describes the soft start procedures to be conducted as:

"A soft start consists of gradually increasing the source's power, starting with the lowest capacity acoustic source, over a period of at least 20 minutes and no more than 40 minutes. The operational capacity defined in this MMIA (2,360 in^3) is not to be exceeded during the soft start period."

Soft starts will also be scheduled so as to minimise the interval between reaching full power and commencing data acquisition.

The only exception to the requirement to use the soft start procedure is when the acoustic source is being reactivated after a single break in firing of less than 10 minutes (not related to an observation of marine mammal), immediately following normal operations at full power (see Section 3.8.10 of the Code). However, it is not permissible to repeat the 10-minute break exception from soft start requirements by sporadic activation of acoustic sources at full or reduced power within that time.

Note: for each swing, at least one random sample of a soft-start should be recorded in the standard form and submitted to DOC for every rotation (see Appendix 2 of the Code).

4.2.6 Line turns

As recommended in the Code (Section 3.8.11) and the MMIA (Section 3.2), the acoustic source will be shut down during line turns. The acoustic source will be reactivated according to pre-start observations (Section 4.1.3 of the Code) and soft start procedures (Section 3.8.10 of the Code). Figure 2 depicts the recommended seismic operations mitigation procedure.

4.3 Species of Concern

The full list of Species of Concern (SOC) as defined by the Code is shown in Addenda 1 below.

Note: given the timing of the survey, blue whales may be present within the South Taranaki Bight if weather and oceanographic conditions permit upwelling to arise from the Kahurangi Shoals, resulting in plankton blooms on which the blue whales feed.

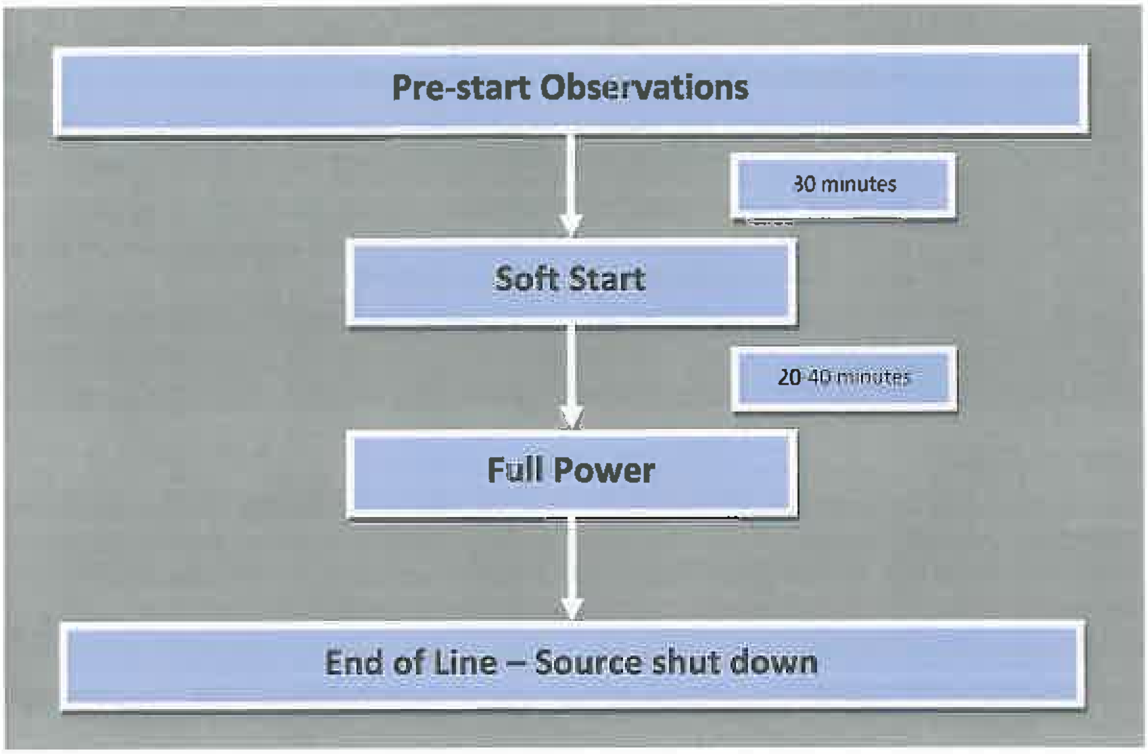


Figure 2: Seismic operations mitigation procedure.

4.4 Mitigation zones

The Code stipulates standard mitigation zones for Level 1 surveys. The mitigation zones for this survey are (Figure 3):

1) 1.5 km from the centre of the acoustic source for SOC **with** calves;
2) 1.0 km from the centre of the acoustic source for SOC **without** calves; and
3) 200 m from the centre of the acoustic source for all other marine mammals.

4.4.1 PAM and calves

PAM cannot distinguish calves from adults, the Code therefore requires the proponent to apply the precautionary principle and the 1.5 km mitigation zone for any cetacean SOC detected by PAM.

PAM operators must be familiar with this requirement.

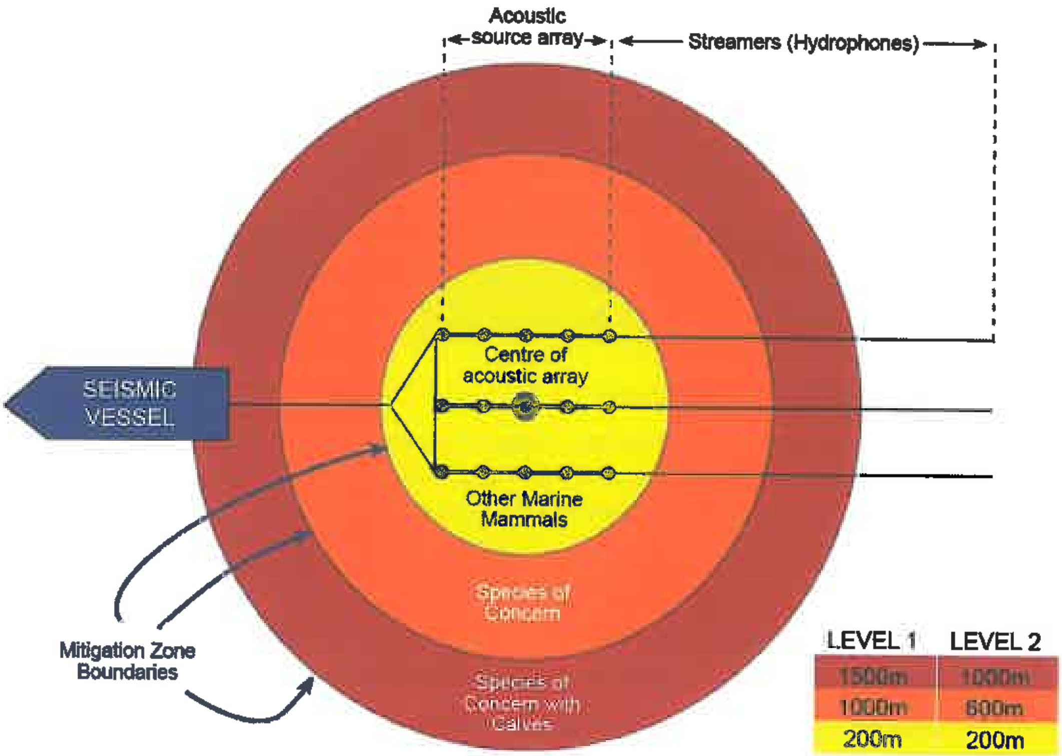


Figure 3: Mitigation Zone Boundaries for the Mohua 2D Marine Seismic Survey.

4.5 Mitigation actions

In the event that marine mammals are detected by the observer within the designated mitigation zones of **1.5 km**, **1.0 km** and **200 m**, the observer will either delay the start of operations or shut down the source. These mitigation actions will apply to:

4.5.1 Species of Concern with calves

If during pre-start observations or when the acoustic source is active (including soft starts) the observer (MMO or PAM operator) detects at least one cetacean SOC with a calf within 1.5 km of the source, start up will be delayed, or the source will be shut down and not reactivated until:

1) The observer confirms the group has moved to a point that is more than 1.5 km from the source; or
2) Despite continuous observation, 30 minutes has elapsed since the last detection of the group within 1.5 km of the source, and the mitigation zone remains clear.

In regard to cetacean SOC with a calf: note that the requirements above apply to the entire group containing that calf. An explanatory note from DOC[5]: " *Yes, whole group has to be seen to move beyond zone, or not be seen for 30 mins*", and "*The intent of this provision is that since a group of marine mammals containing one calf has potential to contain more (and at distance it may be hard to follow movement of the cow/calf pair), the same precaution should apply to all the individuals*".

[5] Email to BPM from Mr Tara Ross-Watt, DOC Senior Adviser - International and Marine; 17 December 2012.

Due to the limited detection range of current PAM technology for ultra-high frequency cetaceans[6] (<300 m), any such bioacoustic detections will require an immediate shutdown of an active survey or will delay the start of operations, regardless of signal strength or whether distance or bearing from the acoustic source has been determined. Shutdown of an activated acoustic source will not be required if visual observations by a qualified MMO confirm that the acoustic detection was of a species falling into the category of 'Other Marine Mammals'.

It is also recommended that observers monitor the area immediately beyond the 1.5 km mitigation zone. If SOC are approaching this zone, observers notify the seismic operator that a shutdown may be required.

4.5.2 Species of Concern without calves

If during pre-start observations or when the acoustic source is active (including soft starts) the observer (MMO or PAM operator) detects a SOC (without calves) within 1.0 km of the source, start up will be delayed, or the source will be shut down and not reactivated until:

1) The observer confirms the SOC has moved to a point that is more than 1.0 km from the source; or
2) Despite continuous observation, 30 minutes has elapsed since the last detection of the SOC within 1.0 km of the source, and the mitigation zone remains clear.

It is recommended that due to the range limitations of PAM, all acoustic detections of cetaceans using ultra high frequency vocalisations (e.g. Maui's or Hector's dolphins) trigger an immediate shutdown of an active survey or delay the start of operations unless a MMO confirms that vocalisations do not emanate from such a SOC. This is because the maximum effective detection range of ultra-high frequency vocalisations from the PAM equipment under these general operational conditions (i.e. background noise levels) is in the order of 300-400 m.

4.5.3 Other Marine Mammals

If, during pre-start observations prior to initiation of a Level 1 acoustic source soft start, a qualified observer detects a marine mammal within 200 m of the source, start up will be delayed until:

- A qualified observer confirms the marine mammal has moved to a point that is more than 200 m from the source, or
- Despite continuous observation, 10 minutes has passed since the last detection of a New Zealand fur seal within 200 m of the source and 30 minutes has elapsed since the last detection of any other marine mammal within 200 m of the source, and the mitigation zone remains clear.

If all mammals detected within the relevant mitigation zones are observed moving beyond the respective areas, there will be no further delays to initiation of soft start.

Note: The presence of "Other Marine Mammals" within 200 m of the source will not result in a shutdown if the source is active, it can only result in a delay to start up of the source.

MMOs should pay particular attention to the reactions and behaviour of NZ fur seals in close proximity to the source, with particular attention paid to their behaviour when the acoustic source is fired. The aim is to build knowledge of the effects of seismic noise on the behaviour of this species.

[6] For the purposes of the Code, ultra-high frequencies are defined as those between 30 and 180 kHz - e.g. Maui's or Hector's dolphins.

4.5.4 Mitigation posters and summary

Refer to Addenda 2 of this MMMP for posters detailing mitigation action procedures.

5. Further Mitigation Measures

The following additional mitigation measures will be implemented during this survey and are over and above those identified in the Code. They have been agreed by DOC following discussions between OMV and DOC.

1) **Autopsy of any stranded marine mammals during the survey**

   If any marine mammals are stranded or washed ashore during the survey inshore of the Mohua Operational Area along the south Taranaki, Wanganui, Manawatu, Kapiti/Wellington and top of the South Island coastline, OMV would engage Massey University to undertake a necropsy to try and determine the cause of death and whether it was a result of any pressure-related or auditory injuries. MMOs should report any dead marine mammals seen in the operational area to DOC immediately.

2) **Notification of any Maui's dolphin sighting**

   If a Maui's dolphin is observed at any stage during the survey or while the *Aquila Explorer* is mobilising to and from the Mohua Operational Area, DOC National Office (Ian Angus: and DOC Taranaki Area Office (Callum Lilley:) will be notified immediately. If neither are available, please call 0800DOCHOT to report the sighting.

   DOC are keen to help with further research of this endangered species and if a sighting was to occur, depending on the location DOC may mobilise either a fixed-wing plane for verification and/or a vessel to try and obtain a biopsy sample.

3) **MMOs to maintain observations when outside the operational area**

   The *Aquila Explorer* will travel to the Mohua Operational Area from its previous seismic survey. On transit to the Mohua Operational Area, an MMO will be on the bridge to observe for any marine mammals that would add to the knowledge and distribution of marine mammals around NZ.

   Any marine mammal observations outside the Mohua Operational Area will be recorded in the 'Off Survey' forms developed by DOC. Any Maui's dolphins observed will be reported immediately to DOC as per item 2 above.

6. Notifications to DOC

A written report will be submitted to the Director-General of DOC at the earliest opportunity, but no longer than 60 days after completion of survey.

If a situation arises that requires a more direct line of communication from the observers to DOC, then the MMO Team Leader is to inform the Party Chief of the issue and intended action. The following table summarises the situations when DOC (in effect, the Director General) should be notified immediately. During this survey, the first point of contact within DOC is Ian Angus (or If a response is required urgently then telephone, but in all other circumstances use email. Should Ian Angus be unavailable, please phone 0800DOCHOT and state the information as outline in Section 3.1.

In the instance of a Maui's/Hector's dolphin sighting please contact Callum Lilley from the Taranaki office of DOC on - ly (after notifying the Party Chief) rather than following the communication protocol below.

Table 1: Events that require DOC to be notified.

Situation	Timing of notification	Comments
The PAM system becomes non-operational	Immediate	This refers to when both primary and backup systems are non-operational
Any confirmed sighting of Maui's/Hector's dolphin	Immediate	This applies to both in transit and in the survey operational area
Any instances of non-compliance with the Code	Immediate	This is a standard requirement under the Code and includes instances where the operational capacity notified in the MMIA is exceeded – refer section 4.2.2 of this MMMP.
Observation of any dead marine mammals seen in the operational area	Immediate	MMOs should report to DOC immediately any dead marine mammals seen in the survey operational area
If PAM is being repaired, and operations continue without active PAM for maximum of 2 hours 20 mins per event	As soon as practicable	DOC is notified via email as soon as practicable with the time and location in which operations began without an active PAM system (Code 4.1.2)

Addenda 1: Species of Concern as defined in the Code

Common name	Latin name
Andrew's beaked whale	*Mesoplodon bowdoini*
Antarctic minke whale	*Balaenoptera bonarensis*
Arnoux's beaked whale	*Berardius arnuxii*
Blainville's beaked whale	*Mesoplodon densirostris*
Blue whale	*Balaenoptera musculus*
Bottlenose dolphin	*Tursiops truncatus*
Bryde's whale	*Balaenoptera edeni*
Cuvier's beaked whale	*Ziphius cavirostris*
Dwarf Minke whale	*Balaenoptera acutorostrata subsp.*
Dwarf sperm whale	*Kogia simus*
False killer whale	*Pseudorca crassidens*
Fin whale	*Balaenoptera physalus*
Ginkgo-toothed whale	*Mesoplodon ginkgodens*
Gray's beaked whale	*Mesoplodon grayi*
Hector's beaked whale	*Mesoplodon hectori*
Hector's dolphin	*Cephalorhynchus hectori*
Humpback whale	*Megaptera novaeangliae*
Killer whale	*Orcinus orca*
Long-finned pilot whale	*Globicephala melas*
Maui's dolphin	*Cephalorhynchus hectori maui*
Melon-headed whale	*Peponocephala electra*
New Zealand sea lion	*Phocarctos hookeri*
Pygmy/Peruvian beaked whale	*Mesoplodon peruvianus*
Pygmy blue whale	*Balaenoptera musculus brevicauda*
Pygmy killer whale	*Feresa attenuata*
Pygmy right whale	*Caperea marginata*
Pygmy sperm whale	*Kogia breviceps*
Sei whale	*Balaenoptera borealis*
Shepherd's beaked whale	*Tasmacetus shepherdi*
Short-finned pilot whale	*Globicephala macrorhynchus*

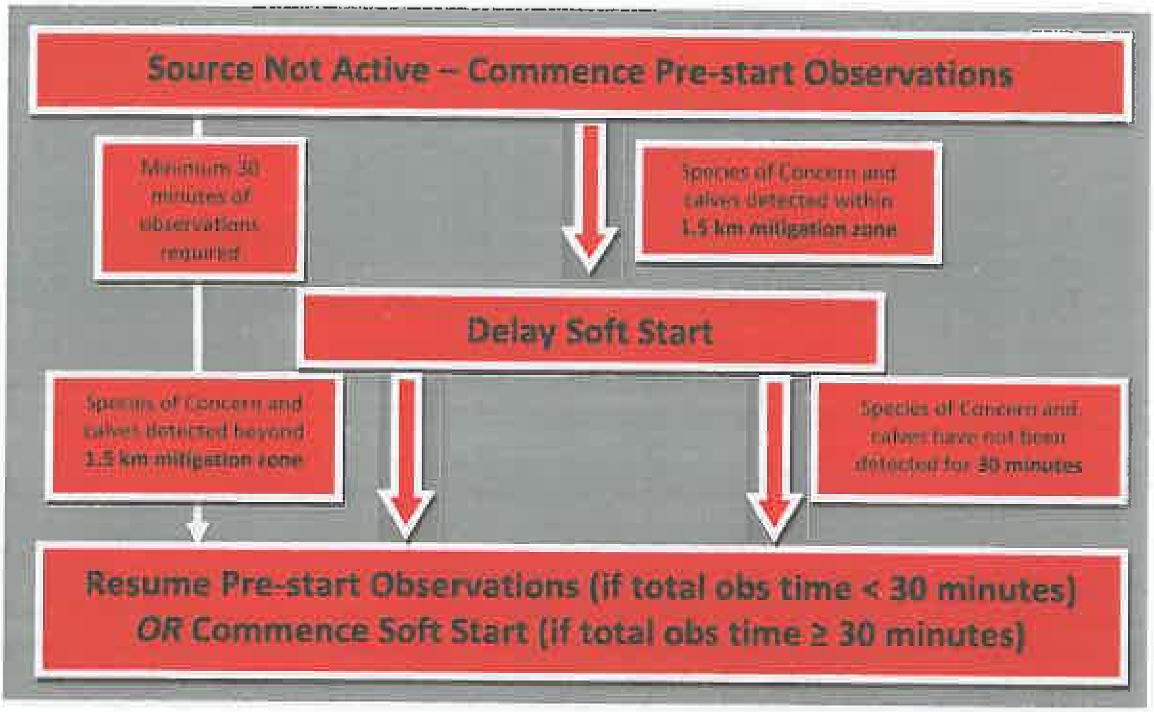
Southern Bottlenose whale	*Hyperoodon planifrons*
Southern right whale	*Eubalaena australis*
Southern right whale dolphin	*Lissodelphis peronii*
Sperm whale	*Physeter macrocephalus*
Strap-toothed whale	*Mesoplodon layardii*
True's beaked whale	*Mesoplodon mirus*

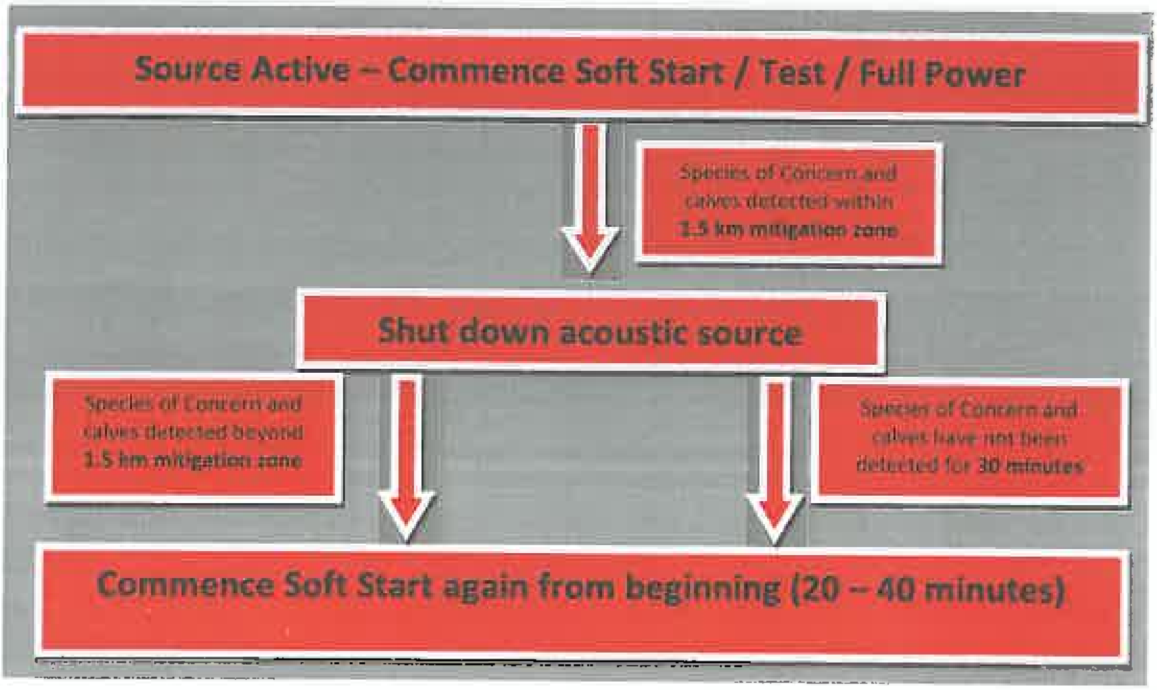
BLUE PLANET MARINE

Addenda 2: Mitigation Procedures – Good Sighting Conditions (poster format)

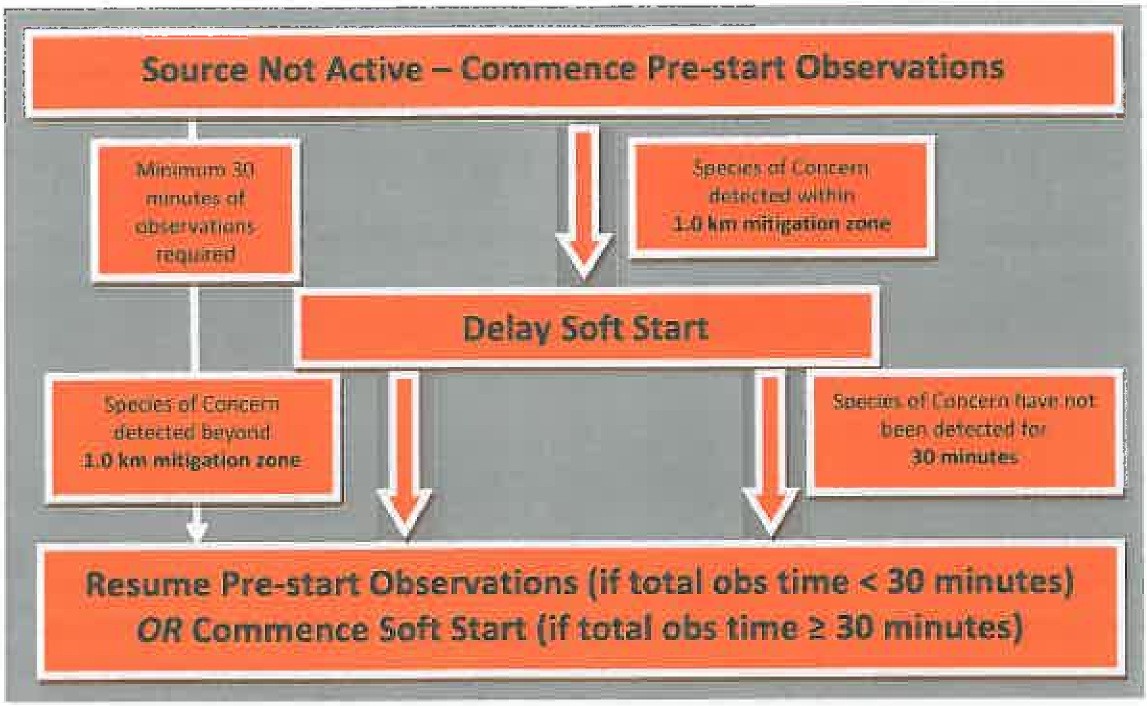
The following posters depict mitigation procedures. It is recommended they be posted in the instrument room, the PAM station and on the bridge. Operational flowcharts are also found in Appendix 4 of the Code.

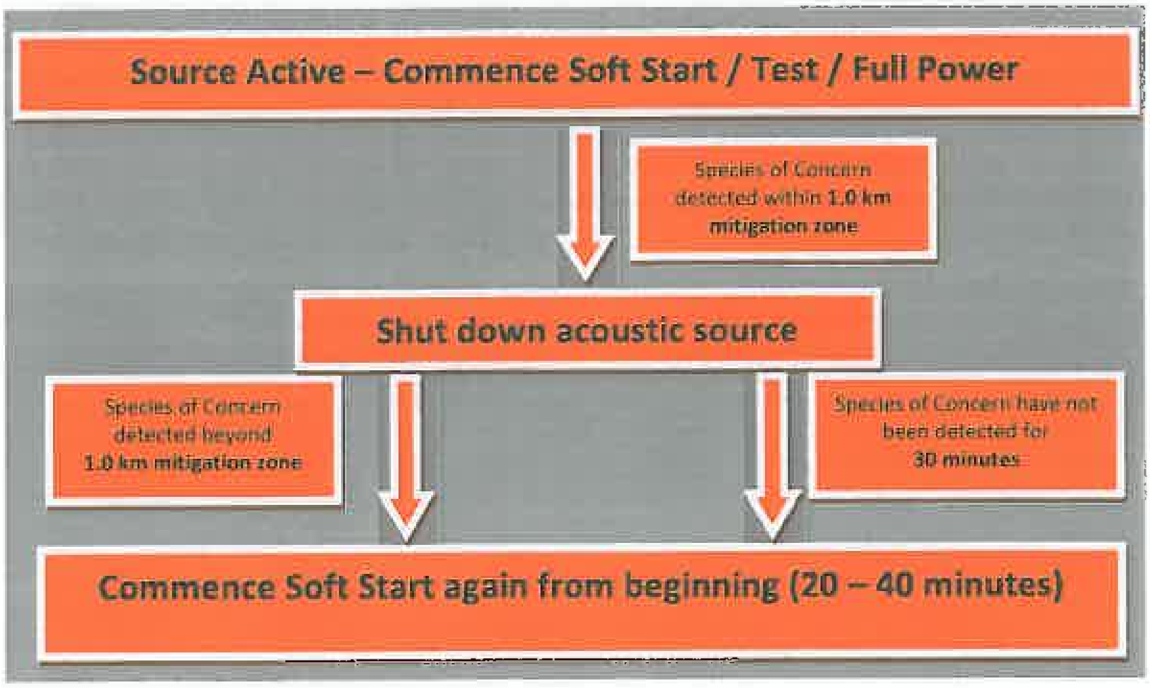
Species of Concern with Calves within 1.5 km of Acoustic Source





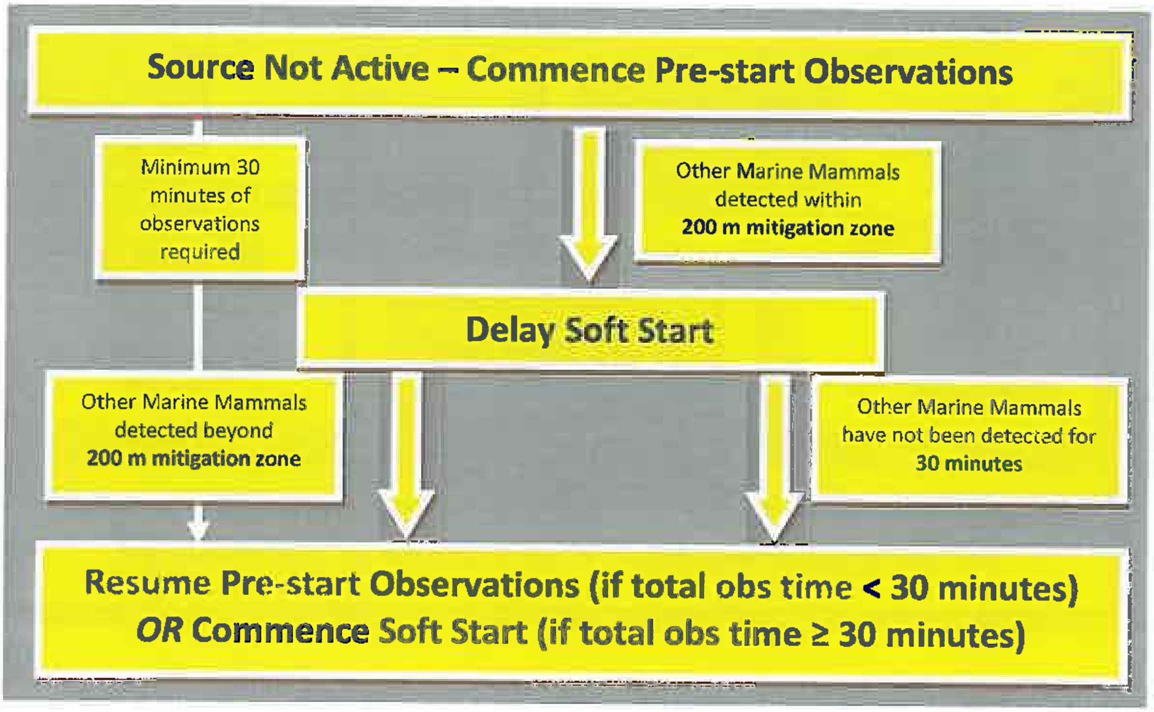
Species of Concern (no Calves) within 1.0 km of Acoustic Source



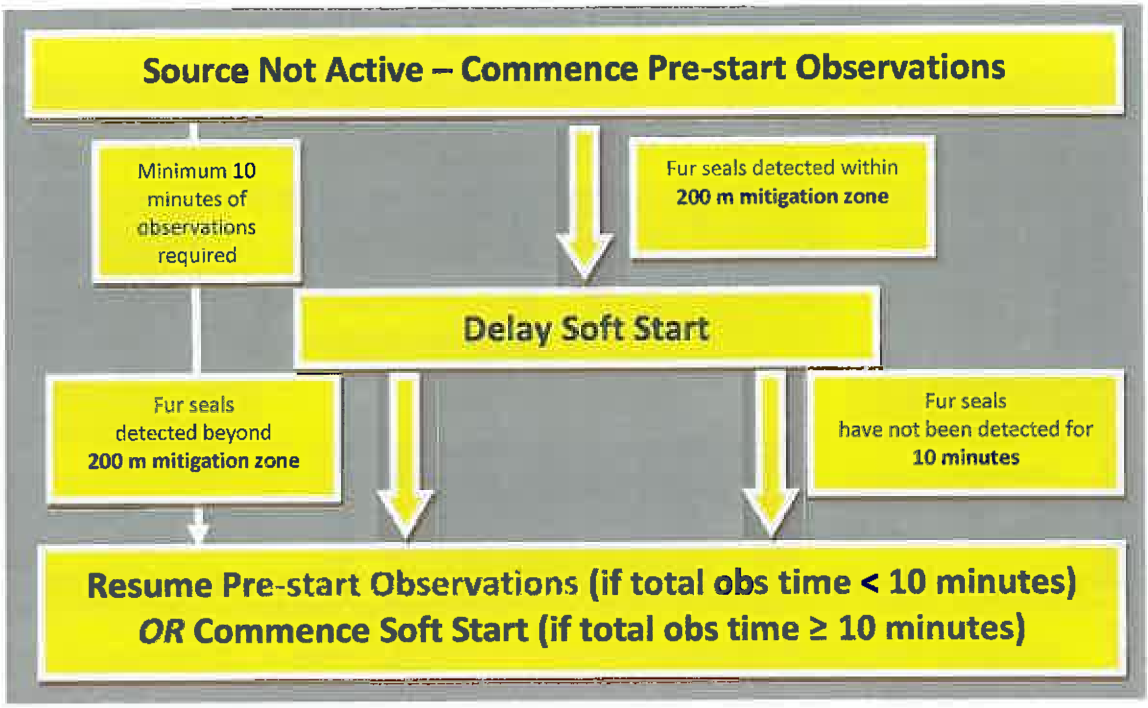


Other Marine Mammals within 200 m of Acoustic Source

(excluding fur seals – see below)



Fur seals within 200 m of Acoustic Source



Addenda 3: Recommended Communication Protocols (poster format)

Note: Seismic control room to immediately notify observers (MMO and PAM) of any changes in the status of seismic guns

Normal Operations - No Marine Mammal Sighting/Detection

45 minutes before commencement of soft start, Seismic notify observers to begin pre-start observations

↓

Prior to soft start, seismic call observers for ALL CLEAR

↓

Seismic notify observers time of soft start

↓

Seismic call observers to confirm time of full power

↓

Seismic notify observers time of end of acoustic source shutdown

Seismic must notify observers immediately if operational capacity is exceeded at any stage

BLUE PLANET MARINE

Delayed Soft Start or Shutdown – Marine Mammal Sighting/Detection

Pre-start observations

Soft Start

Full power acquisition

Observers detect:

SOC with calf approaching 1.5 km mitigation zone *OR*
SOC approaching 1.0 km mitigation zone *OR*
Other Marine Mammals approaching 200 m mitigation zone*
*Only applies to pre-start observations

Observers notify seismic to go on standby

During pre-start observations - observers notify seismic to DELAY SOFT START if:

SOC with calf within 1.5 km *OR*
SOC within 1.0 km *OR*
Other Marine Mammals within 200 m mitigation zone

During soft start or full power acquisition, observers notify seismic to SHUTDOWN if:

SOC with calf within 1.5 km
OR
SOC within 1.0 km mitigation zone

Observers notify seismic of resumption of pre-start observations or to commence soft start when:

Marine mammal is seen beyond relevant mitigation zone boundary *OR* has not been detected within it for at least 30 minutes or at least 10 minutes if fur seal

Seismic notify observers time of soft start, full power and end of acoustic source shutdown

APPENDIX 5

Sound Transmission Loss Modelling

Curtin University

Centre for Marine Science and Technology

Mohua 2D Seismic Survey Underwater Sound Level Modelling for the Aquilla 2360 cui Seismic Source

Prepared for:

OMV New Zealand Ltd

Prepared by: Alec Duncan

PROJECT CMST 1284
REPORT 2014-8

12th February 2014

Abstract

This report describes acoustic propagation modelling that was carried out to predict received sound exposure levels from the Mohua 2D seismic survey southwest of Cape Egmont, New Zealand.

Modelling predicted that the Aquilla 2360 cui array operating within the Mohua 2D survey area would produce maximum received sound exposure levels of 181 dB re 1 $\mu Pa^2.s$ at a range of 200m and 168.6 dB re 1 $\mu Pa^2.s$ at a range of 1km, which are below the respective thresholds of 186 dB re 1 $\mu Pa^2.s$ and 171 dB re 1 $\mu Pa^2.s$ specified in the New Zealand Department of Conservation 2013 Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations. The survey is therefore expected to meet the requirements of the Code of Conduct.

Contents

List of Figures

1 Introduction

This report describes acoustic propagation modelling that was carried out to predict received sound exposure levels from the Mohua 2D seismic survey proposed by OMV New Zealand Ltd in order to establish whether the survey meets the sound exposure level requirements of the New Zealand Department of Conservation 2013 Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations. The Code requires modelling to determine whether received sound exposure levels will exceed 186 dB re 1 $\mu Pa^2.s$ at a range of 200m from the source, or 171 dB re 1 $\mu Pa^2.s$ at ranges of 1km and 1.5km.

The survey area is southwest of Cape Egmont, New Zealand, and is shown in Figure 1. The detailed bathymetry of the area, plotted in Figure 2, shows that the survey is in a relatively flat area with only modest variations in water depth.

Section 2 describes the methods used to carry out the modelling and the results are presented in Section 3.

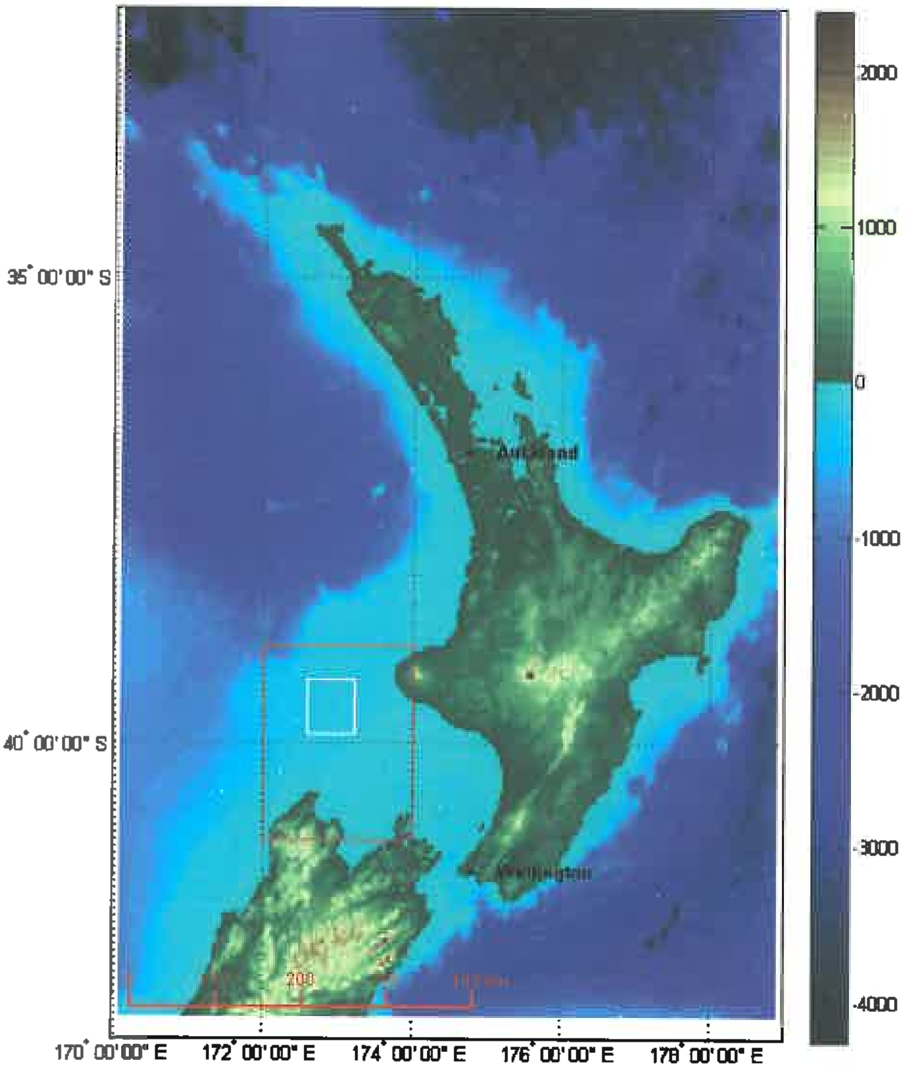


Figure 1. Map of New Zealand showing the survey area (white rectangle). The red rectangle shows the bounds of the region plotted in the next figure.

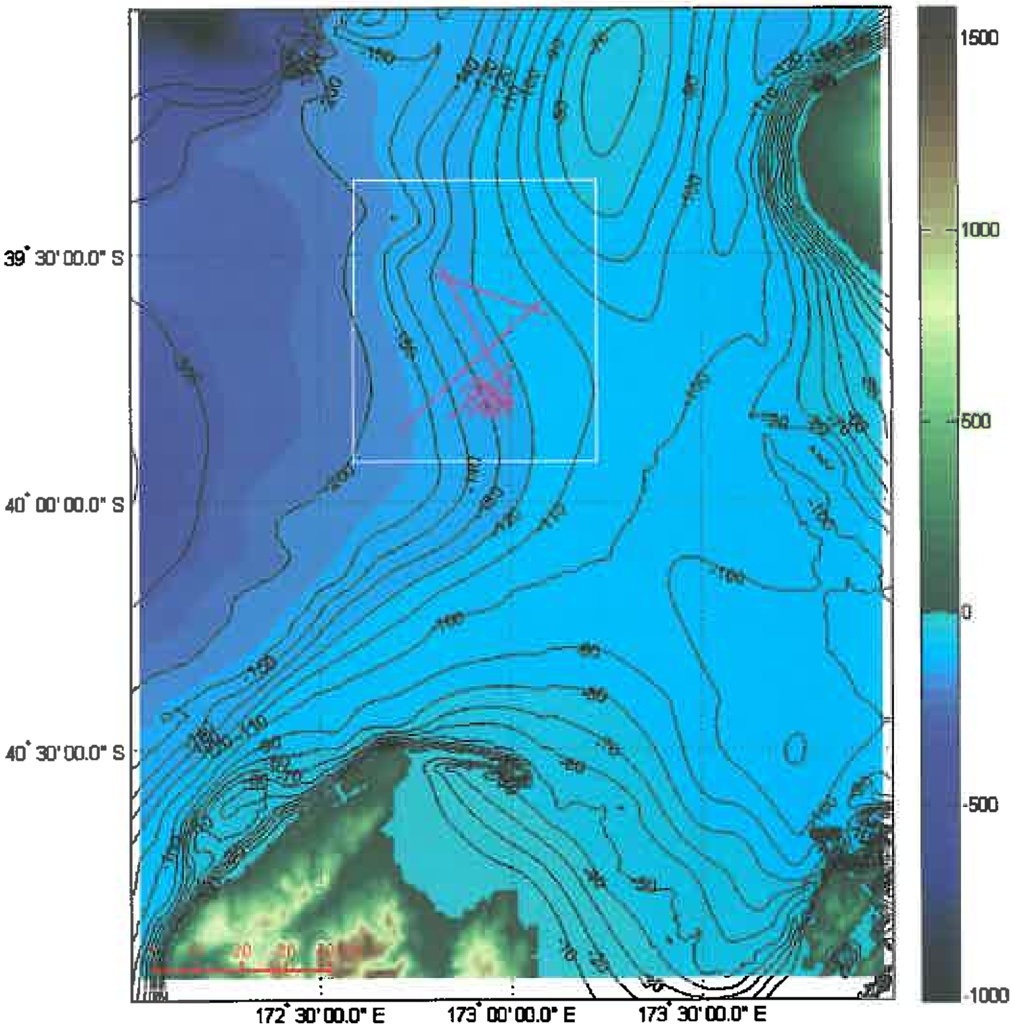


Figure 2. Survey bounding polygon (white) and survey lines (magenta) showing detailed bathymetry contours. Bathymetry is from the NIWA 250m elevation and bathymetry database (NIWA 2008)

2 Methods

2.1.1 Source modelling

The airgun array proposed for this survey is the Aquilla 2360 cubic inch array shown in Figure 3, and the proposed source depth is 8m.

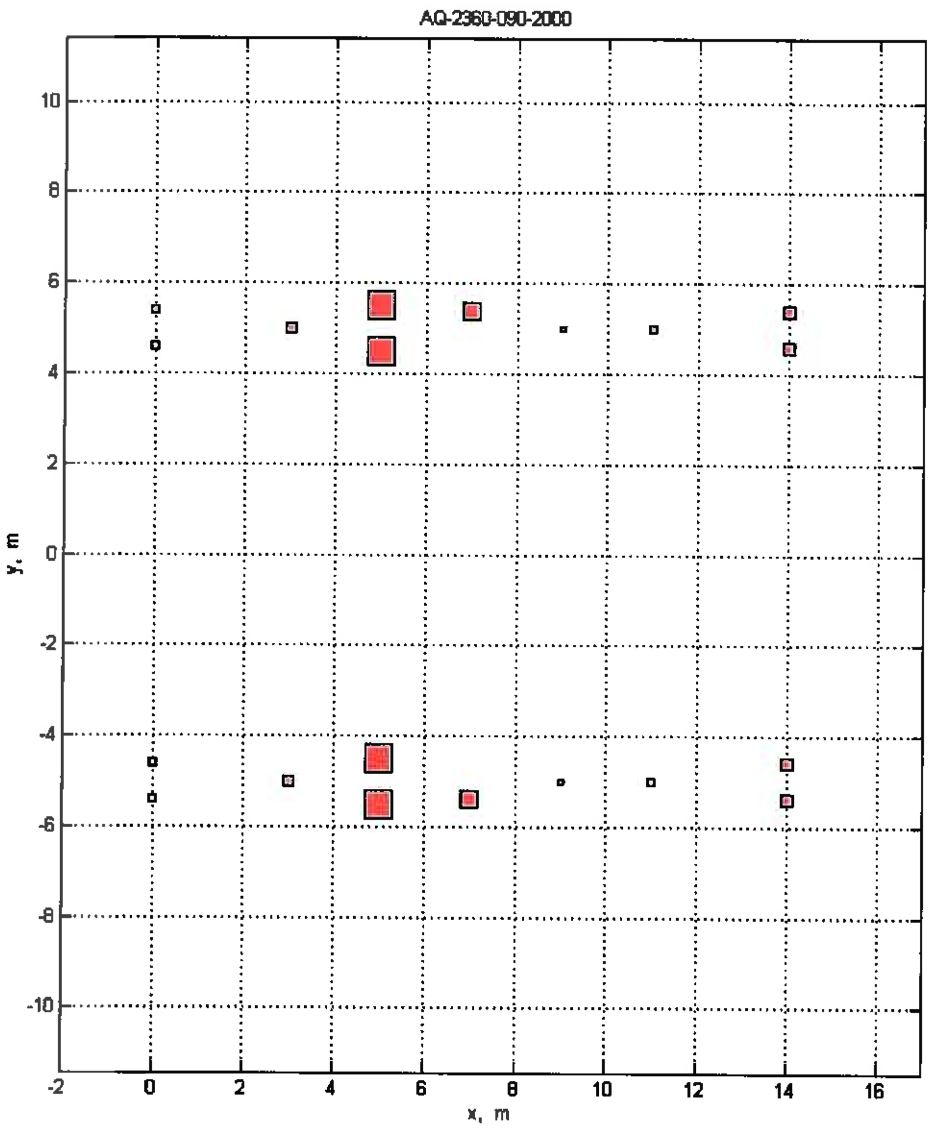


Figure 3. Plan view of the Aquilla 2360 cui array. Array elements are shown much larger than actual size but are scaled proportional to the cube root of their volume.

2.1.2 Modelling and calibration methods

Acoustic signals required for this work were synthesised using CMST's numerical model for airgun arrays. The procedure implemented for each individual source element is based on the bubble oscillation model described in Johnson (1994) with the following modifications:

- An additional damping factor has been added to obtain a rate of decay for the bubble oscillation consistent with measured data;
- The zero rise time for the initial pressure pulse predicted by the Johnson model has been replaced by a finite rise time chosen to give the best match between the high frequency roll-off of modelled and measured signal spectra;
- For the coupled-element model used in this work, the ambient pressure has been modified to include the acoustic pressure from the other guns in the array and from the surface ghosts of all the guns. Including this coupling gives a better match between the modelled signal and example waveforms provided by seismic contractors, but only has a minor influence on the spectrum of this signal and hence on the modelled received levels.

The model is subjected to two types of calibration:

- The first is historical and was part of the development of the model. It involved the tuning of basic adjustable model parameters (damping factor and rise time) to obtain the best match between modelled and experimentally measured signals, the latter obtained during sea trials with CMST's 20 in^3 air gun. These parameters have also been checked against several waveforms from larger guns obtained from the literature.

The second form of calibration is carried out each time a new array-geometry is modelled, the results of which are presented below. Here, the modelled gun signals' amplitudes are scaled to match the signal energy for a far-field waveform for the entire array computed for the nadir direction (including ghost) to that of a sample waveform provided by the Client's seismic contractor. When performing this comparison the modelled waveform is subjected to filtering similar to that used by the seismic contractor in generating their sample, or additional filtering is applied to both data sets to emphasise a section of the bandwidth of the supplied data which CMST regards as being most reliable.

The beam patterns for the calibrated array that are plotted below were built up one azimuth at a time as follows:

- The distances from each gun to a point in the far-field along the required azimuth were calculated. (The far-field is the region sufficiently far from the array that the array can be considered a point source);
- The corresponding time delays were calculated by dividing by the sound speed;
- Computed signals for each gun were delayed by the appropriate time, and then these delayed signals were summed over the guns;
- The energy spectral density of the resulting time domain waveform was then calculated via a Fourier transform;
- During this procedure care was taken to ensure that the resulting spectrum was scaled correctly so that the results were in source energy spectral density units: dB re 1 $\mu Pa^2 s/Hz$ @ 1m.

2.1.3 Source modelling results

Figure 4 shows a comparison between the example waveform and spectrum for the vertically downward direction provided by the client and those produced by the CMST airgun model after calibration. There are differences in detail but the general agreement is excellent.

The provided example waveform was for an array depth of 9 m, so the array calibration was carried out with the modelled array at this depth. All further results presented in this report were calculated for theplanned array depth for this survey, which is 8 m. The CMST airgun array model is physics based and automatically compensates for the effect of the change in hydrostatic pressure on the airgun array output due to the decrease in source depth from 9 m to 8 m.

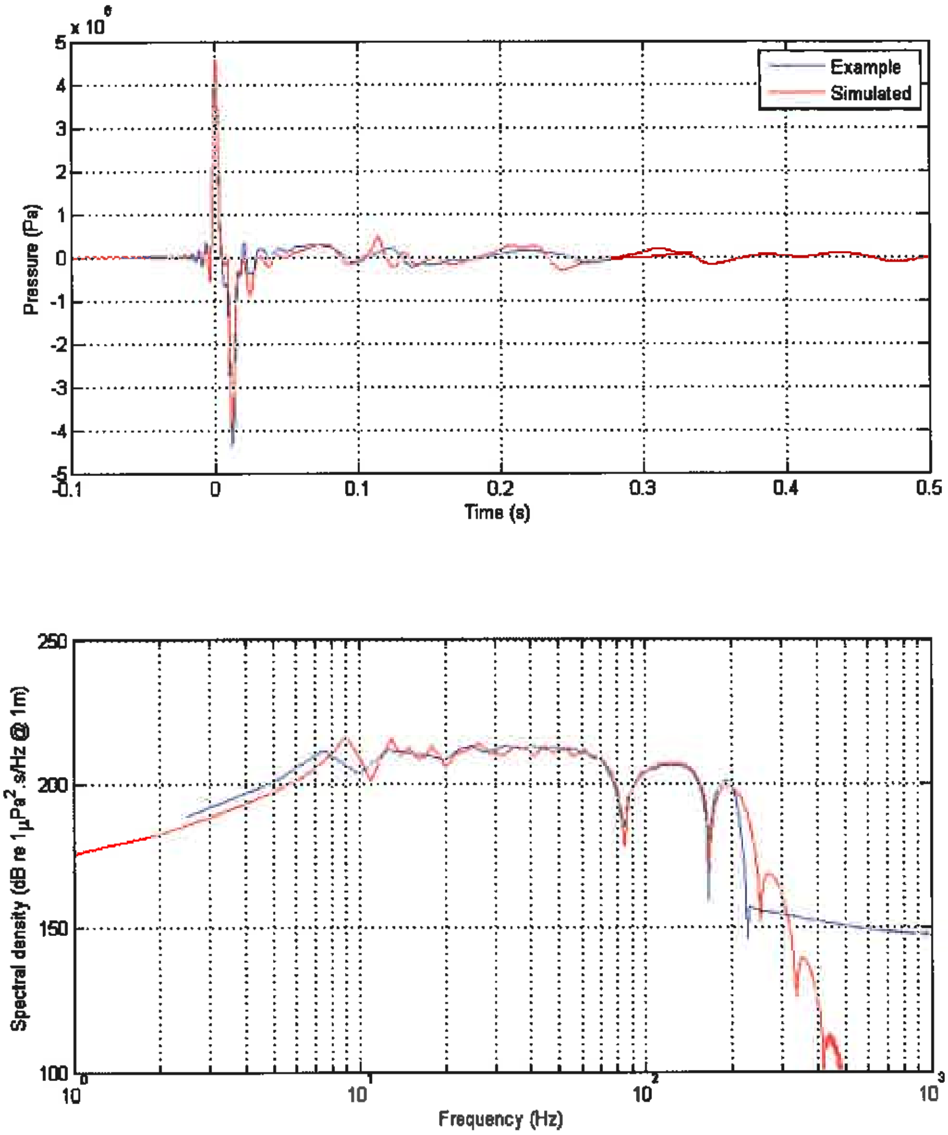


Figure 4. Comparison between the waveforms (top) and spectra (bottom) of the example signal for the vertically downward direction provided by the client (blue) and the signal produced by CMST's airgun array model (red).

Vertical and horizontal cross-sections through the frequency dependent beam pattern of the array are shown in Figure 5. These beam patterns demonstrate the strong angle and frequency dependence of the radiation from the airgun array. The horizontal beam pattern shows that the bulk of the high-frequency energy is radiated in the cross-line direction, which is generally the case for seismic airgun arrays, particularly those consisting of a small number of subarrays.

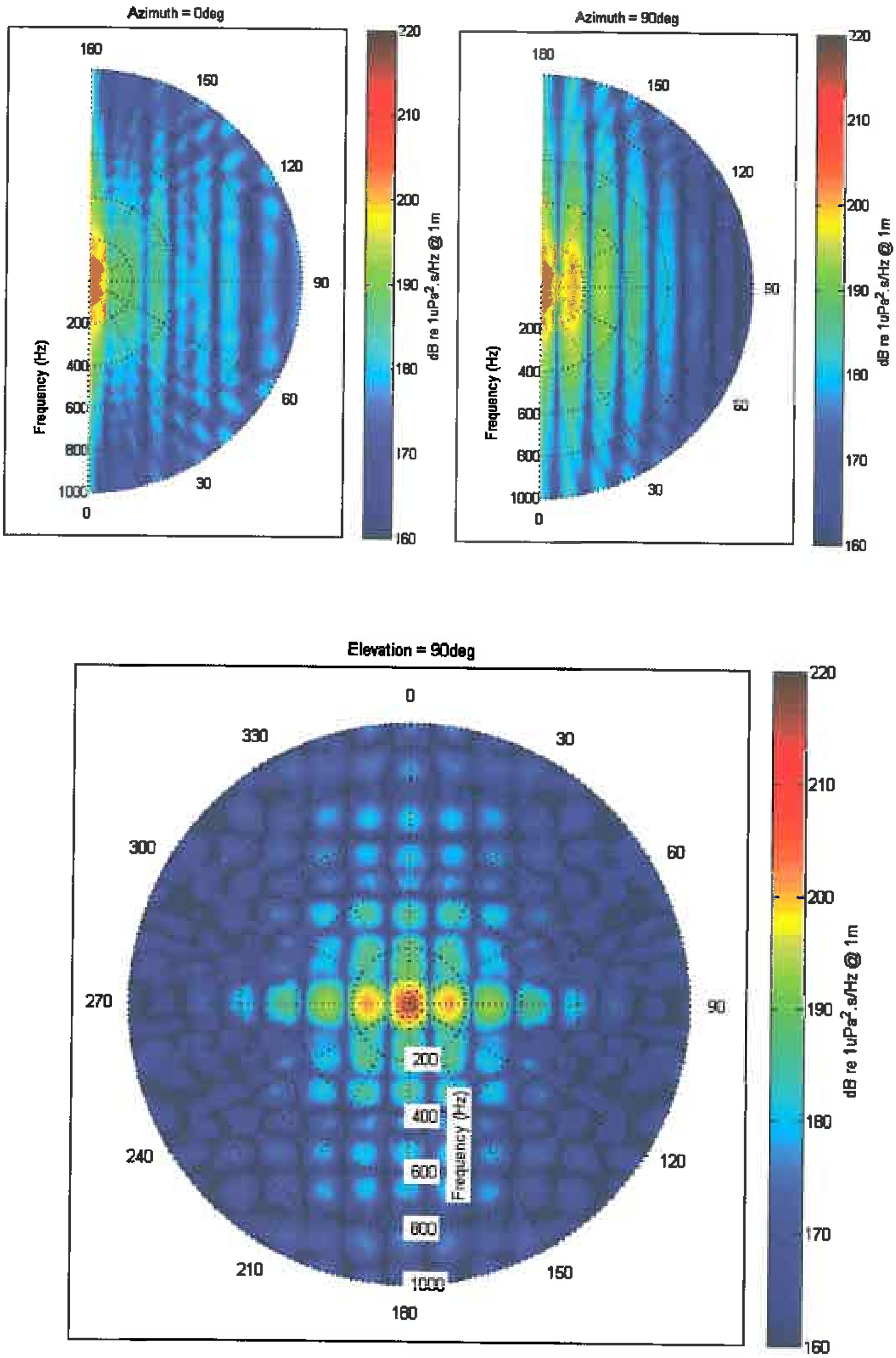


Figure 5. Array far-field beam patterns for the Aquilla 2360 cui array at 8m depth as a function of orientation and frequency (radial coordinate). The top two plots are for the vertical plane for the in-line direction (left) and cross-line direction (right). Zero elevation angle corresponds to vertically downwards. The bottom plot is for the horizontal plane with 0° azimuth corresponding to the in-line direction.

2.1.4 Propagation modelling

2.1.4.1 Water-column properties

The Mohua survey is planned for March 2014, and a representative sound velocity profile was therefore calculated from temperature and salinity data from the the nearest grid point of the World Ocean Atlas (NOAA, 2005) for the southern hemisphere autumn. This sound speed profile is plotted in Figure 6.

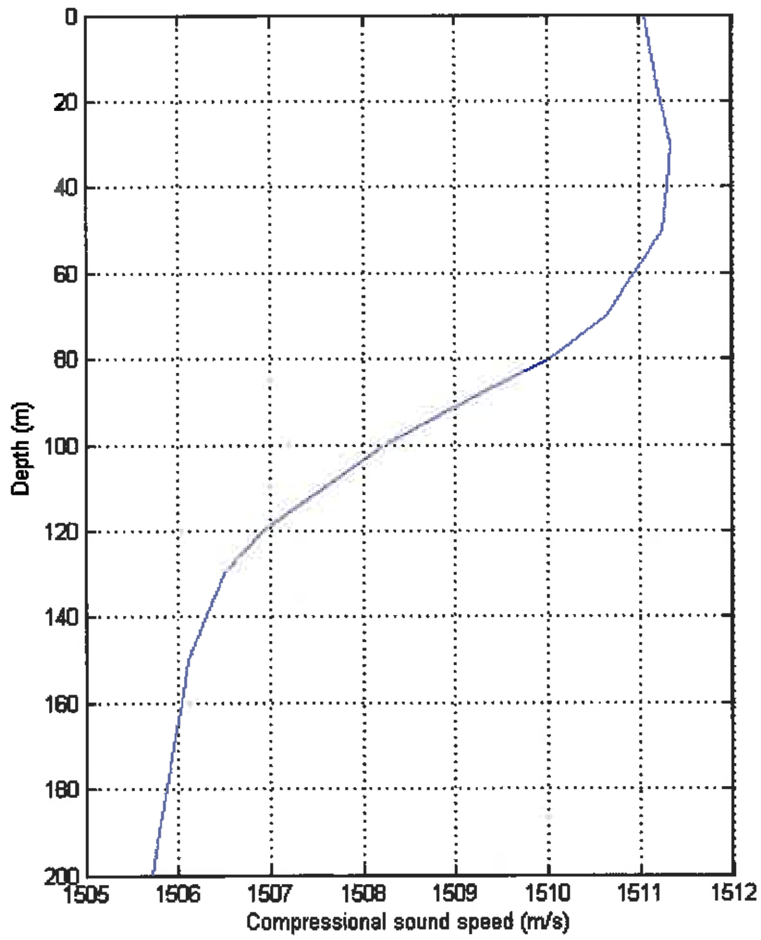


Figure 6. Sound velocity profile obtained from NOAA World Ocean Atlas (southern autumn).

2.1.4.2 Bathymetry and geoacoustic model

The bathymetry data shown in Figure 2 was obtained from the NIWA 250m New Zealand elevation and bathymetry grid, NIWA (2008).

The client provided the following statement on the seabed geology in the survey area:

> "Information from benthic surveys and shallow cores indicate silty sediments at the surface and these are likely to continue for the top 200 metres."

This description is consistent with the information given in Carter (1975).

The geoacoustic model defined in Table 1 was constructed as being suitable for a silt seabed. Parameter values at the water-silt interface were taken from Jensen et. al. (1994), and the depth dependencies of compresional wave speed and density were based on Hamilton (1979) and Hamilton (1976) respectively. Little or no energy would be expected to return to the water column from depths in the seabed of more than 200m so the seabed below this was modelled as a half-space with the same properties as at 200m.

Table 1. Geoacoustic properties of the seabed used for modelling.

Depth in seabed (m)	Compressional wave speed (m/s)	Density (kg/m³)	Compressional wave attenuation (dB per wavelength)
0	1581	1700	1
50	1644	1750	1
100	1704	1800	1
150	1760	1850	1
>200	1814	1900	1

2.1.4.3 Choice of propagation modelling code

The relatively flat seabed in the survey area and the short ranges required for modelling made it possible to use the range independent propagation modelling code SCOOTER (Michael B. Porter, 2007). SCOOTER is a wavenumber integration code, which is stable, reliable, and can deal with arbitrarily complicated fluid and/or solid seabed layering. It cannot, however, deal with changes of water depth with range, but that is unimportant at these short ranges.

2.1.4.4 Source Location

The highest short range received levels occur in shallow water because of the contribution of acoustic energy reflected from the seabed. Modelling was therefore carried out for a source in the shallowest water depth encountered along any of the survey lines shown in Figure 2, which is just over 110m.

2.1.5 Sound exposure level (SEL) calculations

At short ranges it is important to include both the horizontal and vertical directionalities of the airgun array, which requires summing the signals from the individual airguns at each receiver location. This process is accurate but very computationally demanding, and it is not feasible to apply it at ranges of more than a few kilometres.

Calculation of received sound exposure levels was carried out using the following procedure:

1. For each source location:
    a. SCOOTER was run at 1 Hz frequency steps from 2 Hz to 1000 Hz for a source depth corresponding to the depth of the airgun array (6 m). The output of SCOOTER at each frequency and receiver location is the ratio of the received pressure to the transmitted pressure. The ratio is a complex number and represents both the amplitude and phase of the received pressure.
2. For each receiver location:
    a. The range from the receiver to each airgun in the array was calculated, and used to interpolate the results produced by the propagation modelling code, in order to produce a transfer function (complex amplitude vs. frequency) corresponding to that receiver - airgun combination.
    b. These transfer functions were inverse Fourier transformed to produce the corresponding impulse response, which was then convolved with the signal from the appropriate airgun to give a received signal due to that gun.
    c. The received signals from all guns in the array were summed to produce a received pressure signal.

The sound exposure level (SEL) at the receiver was calculated by squaring and integrating the pressure signal.

Results were calculated for receivers at 10m intervals in depth from 5m below the sea surface to the seabed, along radials spaced at 5° in azimuth out to a maximum range of 5 km.

3 Results

Plots of predicted maximum received sound exposure level at any depth as a function of range and azimuth from the source are given in Figure 7 and Figure 8 for maximum ranges of 500m and 2km respectively. The directionality of received levels in the horizontal plane is due to the directionality of the airgun array, which produces its highest levels in the cross-line direction (azimuths of 90° and 270°). This is very pronounced for this particular source due to it consisting of only two subarrays.

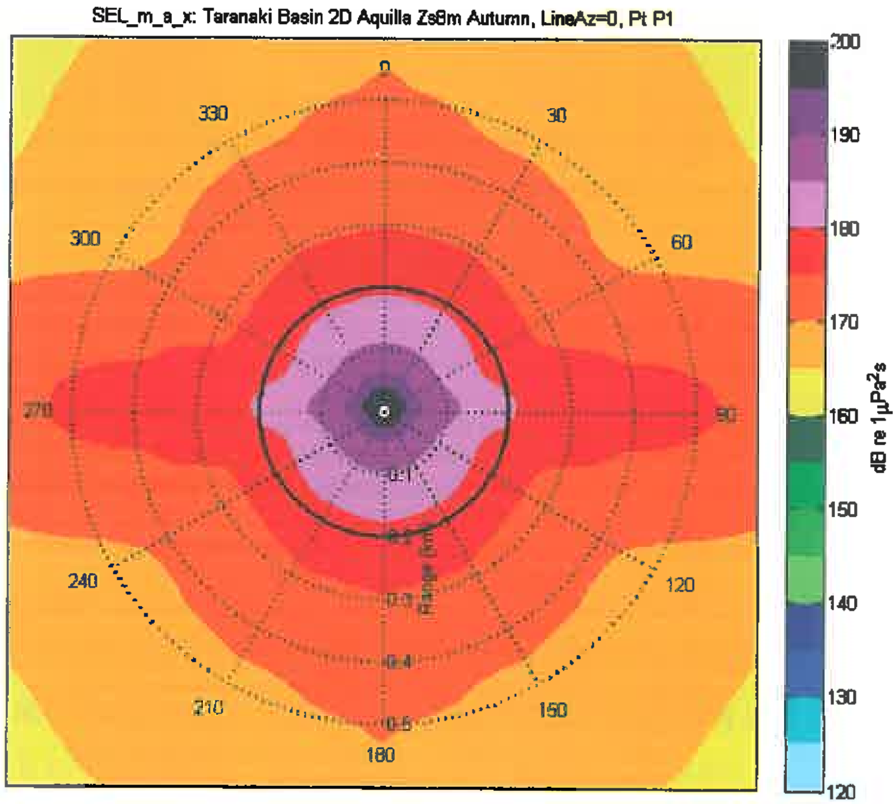


Figure 7. Predicted maximum received SEL at any depth as a function of azimuth and range from the source to a maximum range of 500m. An azimuth of 0° (up) corresponds to the in-line direction. The thick black circle corresponds to the 200m mitigation range.

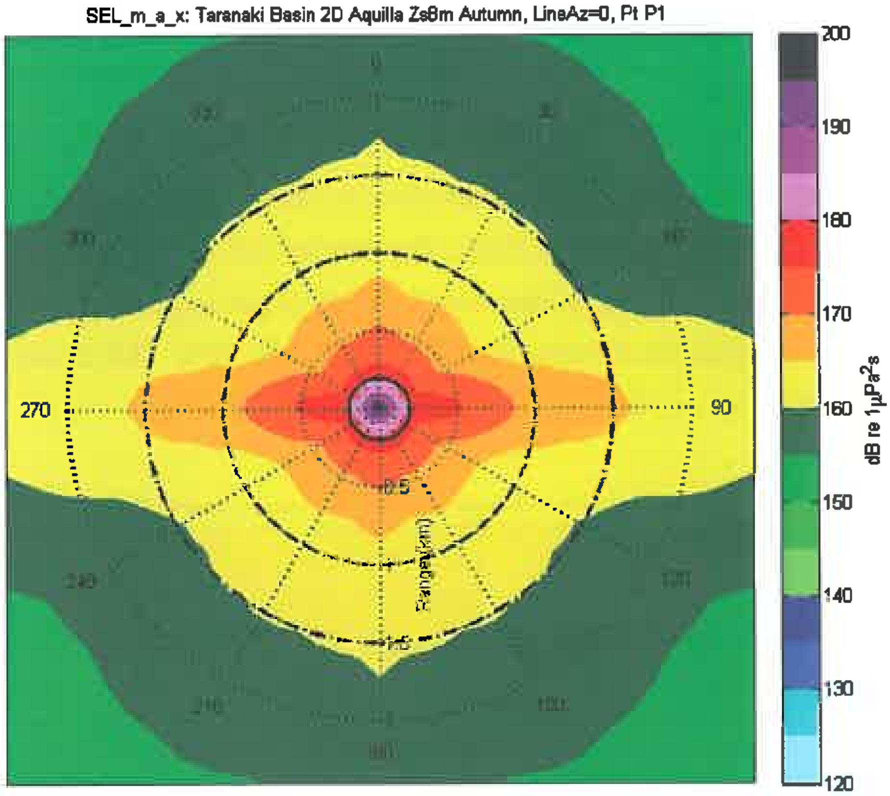


Figure 8. Predicted maximum received SEL at any depth as a function of azimuth and range from the source to a maximum range of 2km. An azimuth of 0° (up) corresponds to the in-line direction. The thick black circle corresponds to mitigation ranges of 200m (solid), 1km (dash), and 1.5km (dash-dot).

Figure 9 presents the modelling results as the percentage of received levels below standard thresholds as a function of range. The percentages are calculated over depth and azimuth. This plot shows that 100% of received levels are predicted to be below 186 dB re 1 $\mu Pa^2.s$ at a range of just over 100 m, and below 171 dB re 1 $\mu Pa^2.s$ at a range of 900m.

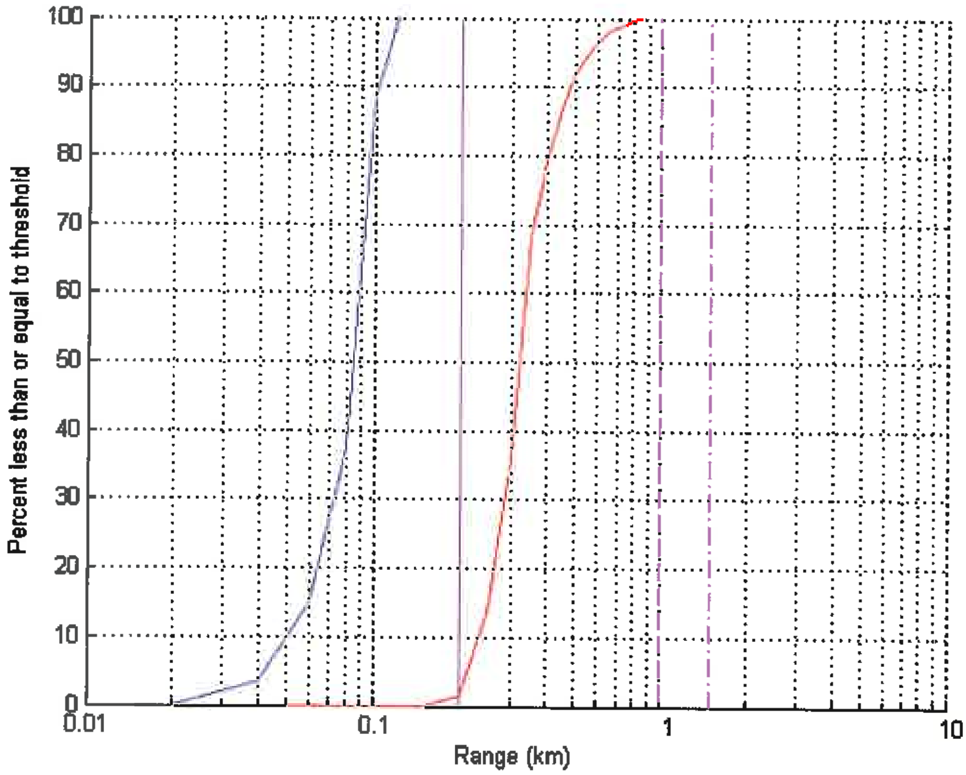


Figure 9. Percentage of received shots below thresholds of 186 dB re 1 μPa^2.s (blue) and 171 dB re 1 μPa^2.s (red) as a function of range. Percentages are calculated over all azimuths and depths.

Figure 10 shows predicted maximum received sound exposure levels in the water column as a function of range. Maximum levels are predicted to be 5 dB below the 186 dB re 1 μPa^2.s threshold at 200 m and 2.4 dB below the 171 dB re 1 μPa^2.s threshold at 1 km.

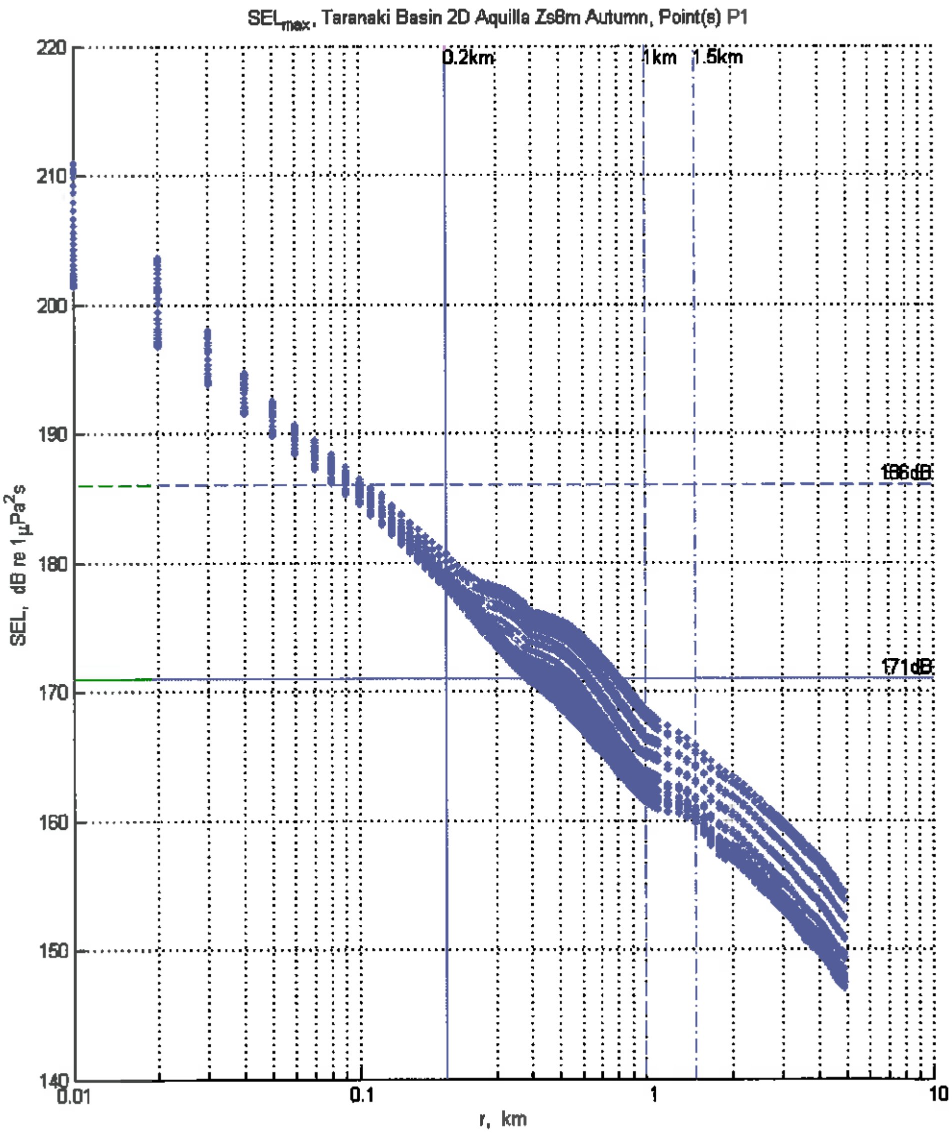


Figure 10. Predicted maximum received level over depth as a function of range for all modelled azimuths. Vertical magenta lines show mitigation ranges of 200m (solid), 1km (broken), and 1.5km (dash-dot). Horizontal green lines show mitigation thresholds of 171 dB re 1 $\mu Pa^2.s$ (solid) and 186 re 1 $\mu Pa^2.s$ (broken).

4 Conclusions

Modelling predicted that the Aquilla 2360 cui array operating within the Mohua 2D survey area would produce maximum received sound exposure levels of 181 dB re 1 $\mu Pa^2.s$ at a range of 200m and 168.6 dB re 1 $\mu Pa^2.s$ at a range of 1km, which are below the respective thresholds of 186 dB re 1 $\mu Pa^2.s$ and 171 dB re 1 $\mu Pa^2.s$ specified in the New Zealand Department of Conservation 2013 Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations. Lower received sound exposure levels would be expected if the source was in water deeper than the 110 m water depth modelled here. The survey is therefore expected to meet the requirements of the Code of Conduct.

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