ENVIRONMENTAL OFFSHORE SERVICES LIMITED

OMV New Zealand Limited

KAKA 3D Marine Seismic Survey

Marine Mammal Impact Assessment

27 December 2013

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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
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
RPS	RPS Group
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 400 km^2 3D Marine Seismic Survey (MSS) in the Taranaki Basin, scheduled to commence in January 2014. The KAKA Survey Area will be located largely within Petroleum Exploration Permit (PEP) 51906 and PEP 53537. Although the exact survey details are yet to be determined, the KAKA Survey Area will be bound by the KAKA Operational Area; allowing for the operation of line turns, acoustic source testing and soft start initiation (Figure 1). It is anticipated that the KAKA 3D MSS will take approximately 21 days to complete, depending on weather constraints, marine mammal encounters and final KAKA Survey Area. The specific commencement date of the KAKA 3D MSS is dependent on the completion of the *Polarcus Alima* conducting a MSS in the Canterbury Basin prior to acquiring the KAKA 3D MSS, however, it is anticipated to commence approximately mid-January 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 51906 and 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 3D MSS.

The KAKA 3D MSS will acquire approximately 400 km^2 of full-fold seismic data to assess hydrocarbon prospectivity within the area, and if successful, identify possible locations for an exploration well to target any potential reservoirs.

The Exclusive Economic Zone (EEZ) and Continental Shelf (Environmental Effects – Permitted Activities) Act (EEZ Act) were promulgated and came into effect on 28 June 2013. The EEZ Act manages the previously unregulated potential for adverse environmental effects of activities in the EEZ and continental shelf. MSS 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 KAKA 3D 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 KAKA 3D 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).

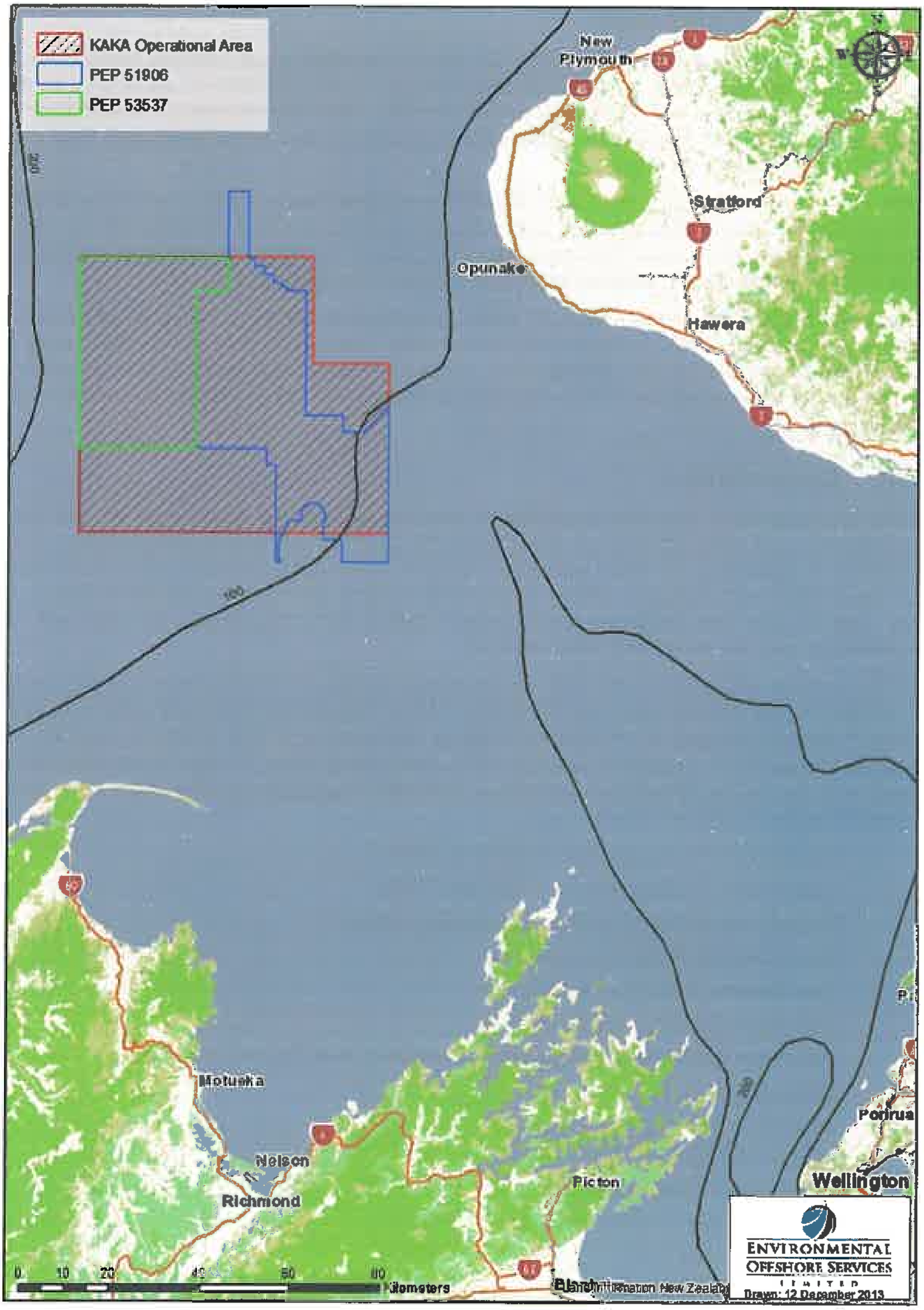

Figure 1: Location Map of the KAKA Operational Area

1.2 General Approach

As part of the preparation for the KAKA 3D MSS, the MMIA is an integral component to receive regulatory approval for OMV to undertake the KAKA 3D 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 KAKA 3D 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 KAKA 3D 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 KAKA 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 3D MSS within PEP51906, the exploration and appraisal drilling programme utilising the semi-submersible drilling rig Kan Tan IV and the upcoming development drilling with the Ensco 107 that will be cantilevered over the Maari well head platform.

For the purpose of the KAKA 3D MSS key interested parties and stakeholders were identified in relation to the seismic activities within the KAKA Operational Area and were consulted either in person, through an information sheet or contacted over the phone to describe the proposed KAKA MSS operations and the KAKA Operational Area. 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; and
- National Institute of Water & Atmosphere (NIWA).

A consultation register of OMVs engagements is included in Appendix 2.

1.4 Research

Throughout the world where MSS 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 which is relevant to the local species, habitats and conditions (DOC, 2013), while not duplicating international efforts.

OMV are contributing 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.

Under the Code of Conduct, within 60 days following the completion of the KAKA 3D MSS, a MMO report is to be submitted to DOC which is to include all the 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 then add to 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 KAKA 3D MSS; OMV will have Massey University perform a necroscopy (autopsy) on any marine mammals found dead inshore of the KAKA Operational Area, along the Taranaki, Wanganui, Manawatu, Kapiti/Wellington and top of the South Island coastline during the KAKA 3D MSS and for a period two weeks after the KAKA 3D MSS is completed. If a necroscopy 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 complete is the period in which an effective necroscopy could be undertaken due to the decomposition of the marine mammal. DOC will be responsible for all aspects of undertaking the necroscopy and coordination with pathologists at Massey University; however OMV will cover the associated costs.

OMV have provided sponsorship to DOC's Cook Strait whale monitoring projects since 2008 to observe the migrations of humpback whales to assess whale recovery since commercial whaling ended in NZ in 1964. The survey is undertaken in June – July to coincide with the humpbacks northern migration from Antarctic waters to the South Pacific breeding grounds.

As a result of the consultation process, OMV learned that NIWA are proposing to undertake a research voyage on blue whales in the South Taranaki Bight in late January 2014, which may coincide with the KAKA 3D MSS. NIWAs research vessel '*Ikatere*' will be used for the field work, where methodology will include 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. OMV and the MMOs have agreed to provide any sighting information of blue whales to NIWA if it occurs that the KAKA 3D MSS overlaps with NIWAs field work. Communication will be achieved by VHF radio where the *Ikatere* will be notified of the location and number of whales that the MMOs observe.

2 Legislative Framework

The NZ Governments 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 KAKA 3D 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** – (this classification is proposed to be added to the EEZ Act through a Supplementary Order Paper to the Marine Legislation Bill) – 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;
- **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, 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 KAKA 3D 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. Notification was provided to the Director-General on 8 November 2013 in regards to OMVs KAKA 3D MSS within PEP 51906 and PEP 53537 in the South Taranaki Bight.

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 KAKA 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 MMOs 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 KAKA 3D 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 RPS Group (RPS) 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 it is proposed to make the Code of Conduct a mandatory standard by reference under section 28 of the Marine Mammal Protection Act. This would apply in Territorial waters, EEZ and within the Marine Mammal Sanctuaries (i.e. in all NZ 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 KAKA 3D 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 KAKA 3D 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 observers role on the vessel during the KAKA 3D MSS is strictly for the detection and data collection of marine mammal sightings, and instructing crew on their requirements when a marine mammal is detected within the relevant mitigation zone; and
- 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.

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 the PAM system onboard the *Polarcus Alima* 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 Pre-start Observations

Normal Requirements

The KAKA 3D MSS acoustic source can only be activated if it is within the KAKA Operational Area (Figure 1) and no marine mammals have been observed or detected in the relevant mitigation zones (Section 2.2.1.3).

During daylight hours the KAKA 3D 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.

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 *Polarcus Alima* arrives at the KAKA Operational Area 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;
- 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 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.

2.2.1.3 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 (DOC, 2013 – Schedule 2) 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 KAKA 3D 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 DOCs 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 KAKA 3D 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 KAKA Operational Area is located within an AEI, as shown in Figure 18.

OMV has a work commitment to the NZ Government that they have to undertake a 3D MSS in order to meet the requirements stipulated in PEP 51906. The timing of the KAKA 3D MSS is scheduled to coincide with vessel availability and the settled summer weather period. Settled weather will allow the KAKA 3D MSS to be undertaken in the shortest possible timeframe; this will help reduce 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 state of the art specialist seismic vessel like the *Polarcus Alima* to NZ that can operate to the highest environmental standards; OMV have contracted the *Polarcus Alima* to undertake the KAKA 3D MSS immediately after the completion of the Endurance 3D MSS in the Canterbury

Basin. 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 the potential for blue whales to be present 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. MMS does not exclude all fishing, but may restrict different types (e.g. set netting) that may be harmful to marine mammals that occupy or pass through that particular area, as well as restrictions on seabed mining activities and seismic surveys.

The closest MMS to the KAKA 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 16) 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 KAKA Operational Area is located 50 km to the southwest of the southern boundary of the West Coast North Island MMS.

3 Project Description

3.1 Marine Seismic Surveys

The basic principle behind a MSS is that an energy source (i.e. air gun), 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.

There are two main types of MSS, 2D and 3D and the complexity between the two varies greatly. 2D MSS involve a single source and a single streamer towed behind the seismic vessel. 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 focus on a specific area over known geological targets considered likely to contain hydrocarbons, 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).

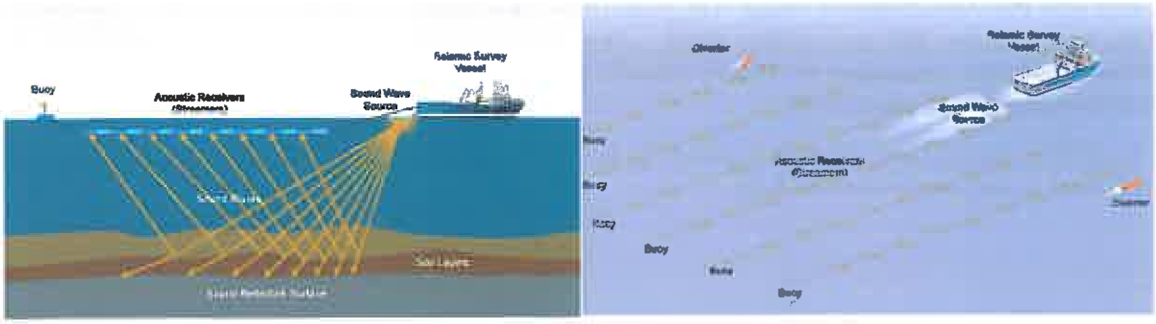

Figure 2: Schematic of a 3D Marine Seismic Survey

Airguns provide the acoustic source and 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 airguns 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 airgun 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 airgun can be fired again. The compressors are capable of recharging the airguns rapidly and continuously which enables the airgun arrays to be fired every 8 – 10 seconds during seismic acquisition.

Airgun 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 ~200 – 220 dB when measured relative to a reference pressure of one micropascal (re 1µPa/m) (IAGC, 2002; Duncan, 2013). However, this does depend on how many airguns 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 the airguns 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.

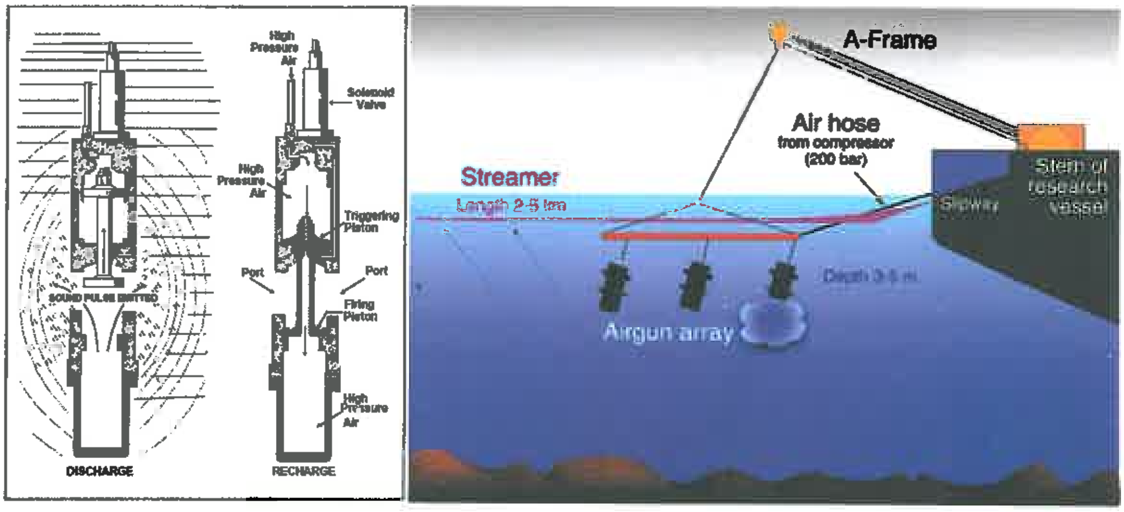

Figure 3: Schematic cross section of a typical air gun and a sub-surface air gun array

For 3D MSS, up to 10 streamers can be towed behind the seismic vessel, 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 – 10 m for deeper penetration and lower frequency targets in more open waters.

At the end of each streamer tail buoys are 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 KAKA 3D MSS, the *Polarcus Alima* will be travelling at 4.5 kts so the streamer tail buoys will be travelling approximately one hour behind the vessel.

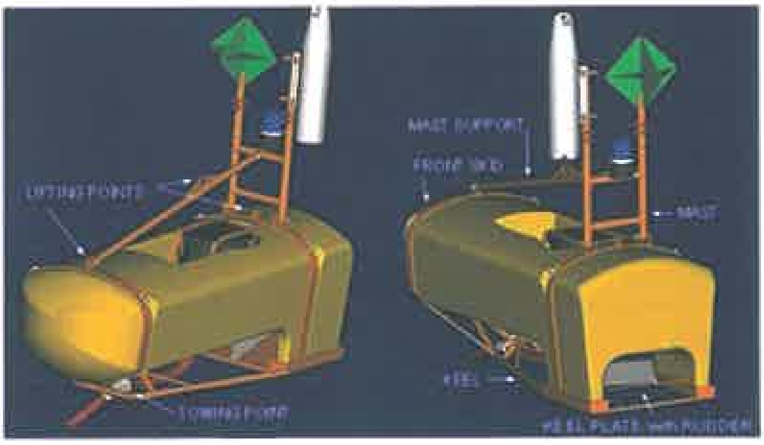

Figure 4: Example of a tail buoy with light and radar reflector

3.2 KAKA 3D MSS

The KAKA 3D MSS will use the state of the art specialist seismic vessel *Polarcus Alima* and will tow 10 solid streamers, 6 km in length. The acoustic source will consist of 2 x 2,380 in^3 air guns which will be activated alternatively in a 'flip-flop' shooting mode at a depth of 6 m below the sea surface and approximately 450 m behind the survey vessel, which will ensure the volume used enables the survey to be run effectively in regards to data acquisition, but also to 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 KAKA 3D MSS outlined within this MMIA. The STLM is further discussed in Section 5.1.2.1 and is attached in Appendix 5.

The airguns 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 KAKA Operational Area is located largely within PEP 51906 and PEP 53537, although it does extend beyond these permit areas (Figure 1). OMV are planning to acquire the MSS in January 2014 depending on the completion of the Endurance MSS in the Canterbury Basin for New Zealand Oil & Gas and is scheduled to take approximately 21 days depending on the final KAKA 3D Survey Area. MSS operations will be conducted 24 hours per day, 7 days per week, subject to suitable weather conditions and marine mammal encounters within the mitigation zones. The technical specifications of the *Polarcus Alima* are provided in

Table 1. Two support vessels (*Sealink* and *Ocean Pioneer*, Figure 6) will be contracted for the duration of the MSS and will be in close proximity to the *Polarcus Alima* at all times.

There are four main components involved with the acquisition of the KAKA 3D MSS:

- **Mobilisation of *Polarcus Alima* to KAKA Operational Area:** After the *Polarcus Alima* has completed the Endurance MSS in the Canterbury Basin, it is likely to call into Nelson for supplies and a crew change, before mobilising to the KAKA

Operational Area. The support vessels will accompany the *Polarcus Alima* at all times during the passage to the KAKA Operational Area. During transit to the KAKA 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 Streamers:** The *Polarcus Alima* will utilise the wind and currents present at the time for the successful deployment of the streamers and acoustic source and will take between 48 - 72 hours to deploy. Once all the seismic gear is deployed the MMOs 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 KAKA 3D MSS;
- **Data Acquisition:** The *Polarcus Alima* will follow predetermined survey lines 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 line acquisition (acquiring seismic data through the line turns) for the KAKA 3D 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 *Polarcus Alima* has completed the KAKA 3D MSS it will retrieve the seismic array and depart for its next contracted destination.

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

Figure 5: Seismic Survey Vessel – *Polarcus Alima*

Figure 6: Seismic Support Vessels – *Sealink* and *Ocean Pioneer*

Table 1: *Polarcus Alima* Technical Specifications

Seismic Survey Vessel – General Specifications	
Vessel Name	*Polarcus Alima*
Vessel Owner	Polarcus Ltd
Engine Details	Wartsila 4 x 9L20 + 2 x 9L26
Fuel Capacity	1,925 m^3
Seismic Survey Vessel – Dimensions and capacities	
Vessel Length	92 m
Vessel Beam	21 m
Max Draft	7.5 m
Gross Tonnage	7,894 t
Cruising Speed	12 knots (maximum – 15 knots)

Table 2: KAKA 3D Seismic Specifications

Parameter	**Specifications**
Total array volume	2 x 2,380 in^3
Air gun types	Bolt Air Guns
Number of arrays	2
Number of sub-arrays	3
Array length	15 m
Array width	15 m
Nominal operating pressure	2,000 psi
Tow depth	6 m (+/- 1m)
Distance from the stern	450 m
Number of streamers	10
Streamer length	6,000 m
Streamer manufacturer/model	Sercel Sentinel solid streamers
Towing depth	~7 – 8 m (+/- 1m)

3.3 Navigational Safety

During the KAKA 3D MSS, the *Polarcus Alima* will be towing 10 streamers of 6 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 (~2° per minute) 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 KAKA Operational Area and the presence of *Polarcus Alima* and her restriction in ability to manoeuvre while towing the streamers.

The consultation process has identified all potential users of that area of ocean, while the presence of the support and chase vessels 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 *Polarcus Alima* 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. Tail buoys will mark the end of the streamers, where each buoy has lights and radar reflectors for detection both during the day and night.

3.4 Analysis of Alternatives

Most seismic surveys conducted throughout the world these days use air guns, as they generate low frequency sources which can image the underlying geology several kilometres below the seafloor. Each component of the KAKA 3D MSS has the requirement to not only gather the best information of the hydrocarbon potential within the Survey Area but to also reduce any adverse effects on the marine environment to the fullest extent practicable.

OMV will use 'bolt air guns' for the KAKA 3D MSS, consisting of a dual sound source with each source having two sub arrays. The energy source and air gun 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 KAKA 3D MSS design, OMV had the selection of either a 3,040 in^3 or 2,380 in^3 acoustic source onboard the *Polarcus Alima* to acquire the KAKA 3D MSS. In keeping with the nature of the Code of Conduct, OMV selected the lesser of the two, 2,380 in^3 for the KAKA 3D MSS to reduce the amount of noise emitted to the marine environment.

The acquisition period for the KAKA 3D MSS will utilise the settled summer period to reduce weather-induced down-time to ensure that the survey duration is as short as possible.

OMV have work programme commitments, agreed with NZP&M to assess the petroleum potential of PEP 51906 and PEP 53537; of which 3D seismic data acquisition is required. As a result there is no 'do nothing' option in regards to a 3D seismic survey.

4 Environmental Description

4.1 Physical Environment

4.1.1 Meteorology

Anticyclones 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 KAKA 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, 2013). 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. daytime (°C)	21	22	20	18	16	14	13	13	14	16	17	19
Temp – avg. night time (°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, 2013)

4.1.2 Oceanography

During the development of OMVs Exploration, Appraisal & Development Drilling Programme 2013 – 2014 Environmental Impact Assessment (Govier & Calder, 2013) modelling results produced have been used as part of this background environmental description.

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 northern section of the KAKA Operational Area while the existing Maari field is in the southeast.

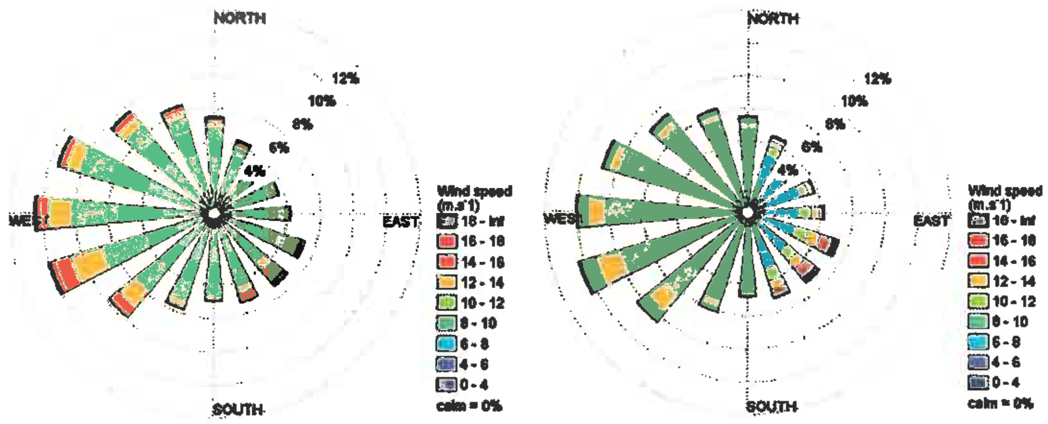

Figure 7: Maari (left) and Matuku-1 (right) well location annual wind roses

4.1.2.2 Wave Climate

The KAKA 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

The Taranaki continental shelf has a 150 km wide opening to the Tasman Sea, occupying 30,000 km^2 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 KAKA Operational Area is relatively flat where it slopes to the southwest on a gently sloping gradient towards the shelf break with a water depth from the inside boundary of approximately 100 m to ~ 150 m on the offshore boundary (Figure 8).

Figure 8: Bathymetry of the KAKA Operational Area

4.1.2.4 Current Regime

New Zealand is 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).

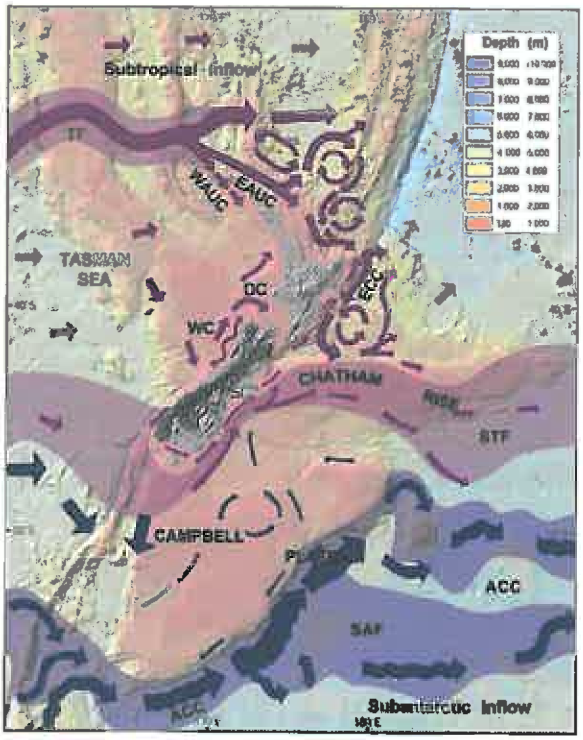

Figure 9: Ocean Circulation around the New Zealand coastline
(Source: http://www.teara.govt.nz/en/map/5912/ocean-currents-around-new-zealand)

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

The Taranaki Basin 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 and is the only producing basin of oil, gas and condensate in NZ at this stage (Figure 10). 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 10). Over the years there have been a large number of 2D and 3D MSS in the Taranaki region. The proposed KAKA 3D 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 their PEPs and PMPs in 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 KAKA Operational Area there are no known reef structures or sensitive environments (Johnston & Forrest, 2012; Johnston *et al.*, 2012; Govier & Calder, 2013).

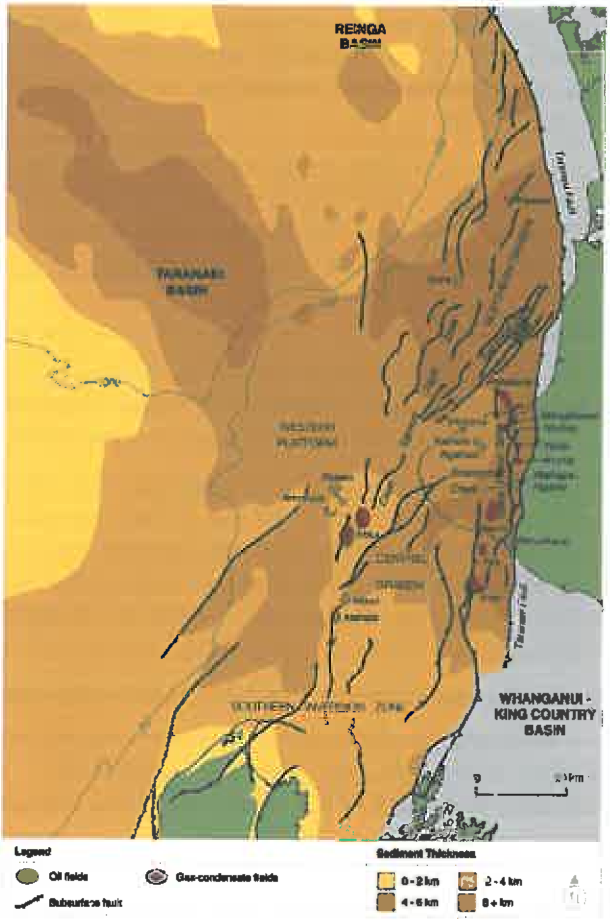

Figure 10: Taranaki Basin
(Source: http://www.nzpam.govt.nz/cms/pdf-library/petroleum-basins/taranaki-basin.pdf)

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, 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 is particularly significant for local iwi and hapu as kaitiaki (guardians) of the coast.

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 KAKA 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, 2013a).

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 creating 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 KAKA 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 KAKA 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 their main behaviour was observed to involve 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.

The KAKA 3D MSS will be acquired in January 2014 where there could be high levels of euphausiids present as a result of upwelling events, although from the summary above it is shown this is entirely weather dependent. Weather conditions play an important factor in phytoplankton and zooplankton distribution and abundance. Settled weather during summer months generally leads to the establishment of well-defined thermoclines, while the presence of westerly winds at the Kahurangi shoals has been shown to lead to the upwelling of cold nutrient rich water to the warmer surface waters in the greater Cook Strait and South Taranaki Bight no matter what time of year. However, rough weather can stop upwelling events and break up thermoclines; often dispersing any large aggregations of euphausiids. This can result in the zooplankton being harder to capture for large animals, such as blue whales.

If large aggregations of zooplankton are present in the South Taranaki Bight coinciding with the KAKA 3D 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 KAKA Operational Area falls within MEC group 60 representing the moderately shallow waters on the continental shelf (Figure 11), which is described below:

- **Class 60**: occupies moderately shallow waters (mean = 112 m) on the continental shelf. It experiences moderate annual 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.

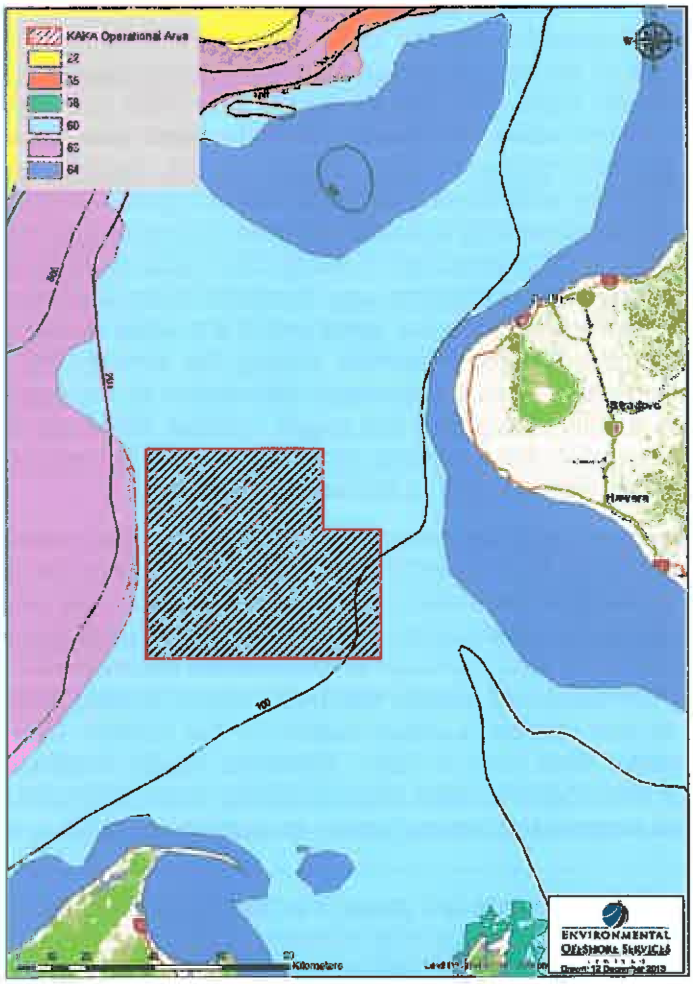

Figure 11: The NZMEC at the 20-class level

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 which also encompasses the KAKA 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 and are at risk of extinction and are classified as being in gradual decline. 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. 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, communicating with each other using underwater vocalisations or sound.

To the northwest of the KAKA Operational Area, OMV undertook the Matuku 3D MSS in May-June 2011 within PEP 51906. There was a total of 72 marine mammal detections during the MSS, all from visual observations. The observations comprised 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). These results, along with similar results reported by BPM 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). Given the Matuku 3D MSS was acquired over the autumn/winter period, weather conditions were regarded as generally poor to average resulting in a significant number of days with no seismic acquisition, however there was no PAM detections during the survey.

In March 2012 OMV undertook a 200 km 3D MSS within the Maari field over a duration of three weeks using the *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.

For the preparation of this MMIA, the National Aquatic Biodiversity Information System (NABIS) database was accessed to identify potential marine mammal species which could potentially be encountered throughout the KAKA Operational Area (MPI, 2013b). 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 KAKA Operational Area are listed in Table 5 with a basic summary of their ecology summarised below.

Table 5: Marine mammals likely to be present in or around the KAKA 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*) and Short-finned pilot whale (*G. macrorpynchus*)	
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*)		

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 KAKA Operational Area during the KAKA 3D 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 12). The northern migration routes back up to the Pacific Islands are relatively well known, however the southwards routes are not.

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

Marine Mammal Species	NZ Threat Classification	Summary	Distribution	Likely to be in Survey Area
Bryde's whale *(Balaenoptera edeni)*	Nationally critical	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.	✓
Killer whale *(Orcinus orca)*	Nationally critical	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. Likely to occur in the KAKA Operational Area.	✓
Maui's dolphin *(Cephalorhynchus hectori maui)*	Nationally critical	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 KAKA Operational Area, however if any observations were made DOC would be notified immediately.	✘
Southern elephant seal *(Mirounga leonina)*	Nationally critical	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 KAKA Operational Area.	✘
Southern right whale *(Eubalaena australis)*	Nationally endangered	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 KAKA Operational Area.	✓
Hector's dolphin *(Cephalorhynchus hectori)*	Nationally endangered	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. On east coast live between Banks Peninsula and Te Waewae Bay and Porpoise Bay in the south. Not likely to occur in the KAKA 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.	✘
NZ sea lion *(Phocarctos hookeri)*	Nationally critical	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 KAKA Operational Area due to distance offshore.	✘
Bottlenose dolphin *(Tursiops truncatus)*	Nationally endangered	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 KAKA Operational Area.	✓

Figure 12: Whale distribution and migration pathways in NZ waters
(Source: http://www.teara.govt.nz/en/map/7052/whales-in-new-zealand-waters)

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 humpbacks 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 projects where the survey is undertaken in June – July to coincide with the northern migration of the humpback whales to the South Pacific Breeding grounds.

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. A paper has recently being published on a previously unrecognised blue whale foraging ground in the South Taranaki Bight (Torres, 2013). A number of blue whales have now 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, 2013). 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. The Matuku MSS was undertaken in May 2011, however the Polarcus Alima did not leave port in Wellington until 10 May 2011, well after the whale had washed ashore. It is possible that both sub-species of blue whale use this South Taranaki habitat, but only further research will confirm this, such as the proposed NIWA survey proposed for January 2014.

Antarctic blue whales are generally found south of 55 °S during the Austral summer, while pygmy 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 International Union of Conservation of Nature (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 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, 2013; WWF, 2013). 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 the blue whale increases its calling when a MSS is operational to increase the probability that its 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 KAKA 3D MSS the average water temperature for January 2014 within the KAKA Operational Area is expected to be 17.62 °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 other baleen whales in the polar regions; as they will also feed on fish (pilchards, mackerel and mullet). There has only been one sighting of a bryde's whale in Taranaki waters (Torres, 2012) and the chance of observing them during the KAKA 3D MSS is likely to be low but 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. As a result there is the potential that a minke whale could be encountered during the KAKA 3D 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 so they could be encountered during the KAKA 3D MSS.

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 with a lack of a dorsal fin allows for 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 today (Suisted & Neale, 2004; Carroll *et al.*, 2011) 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. It is believed the NZ population of southern right whales are isolated from other regional stocks, and is potentially separated into populations in the subantarctic (~800 – 900 animals) and the mainland (~30 – ~50 animals) (Suisted & Neale, 2004), however DOC are still unsure whether this is the case.

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 in close proximity to the KAKA Operational area the South Taranaki Bight, although this was during the winter months. It is therefore believed unlikely that a southern right whale would be observed during the KAKA 3D MSS, scheduled to commence January 2014 as these whales appear to be down in the Antarctic waters to feed during the summer months.

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 the gray's beaked whale is most commonly stranded beaked whale and due to the relative frequency of strandings throughout the year, it is assumed they are present all year round. Therefore, beaked whales could be observed during the KAKA 3D MSS but they are difficult to observe at sea.

4.2.6.8 Sperm Whale

Sperm whales are globally distributed with all three species found in NZ waters (large, pygmy and dwarf) 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, 2013a; Wikipedia, 2013a). 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. Within the South Taranaki Bight, sperm whales have been recorded in the deep offshore waters so they could be observed during the KAKA 3D MSS, although they are likely to be in Antarctica feeding.

4.2.6.8.1 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. It is assumed that pygmy sperm whales may be present in the KAKA Operational Area, but could be difficult to observe in most sea conditions.

4.2.6.8.2 Dwarf Sperm Whale

Dwarf sperm whales (*Kogia sima*) are rare in NZ waters (Te Ara, 2013a) 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.

4.2.6.9 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 (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). 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 and was the first documented contact between these two species and indicates there could be the potential for interbreeding.

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 13), although they have been sighted up to 7 Nm from the shore (Du Fresne, 2010) and at 19 Nm from the Māui A platform, however, 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 are beyond the core range of Maui's dolphins, although visited occasionally, or there are Maui's dolphins resident in these southern area 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 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.

The KAKA 3D MSS is being acquired in relatively deep water (>100 m), and although the KAKA Operational Area is located within the AEI, it is unlikely that a Maui's/Hector's dolphin would be observed. Although it is 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 KAKA 3D 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.

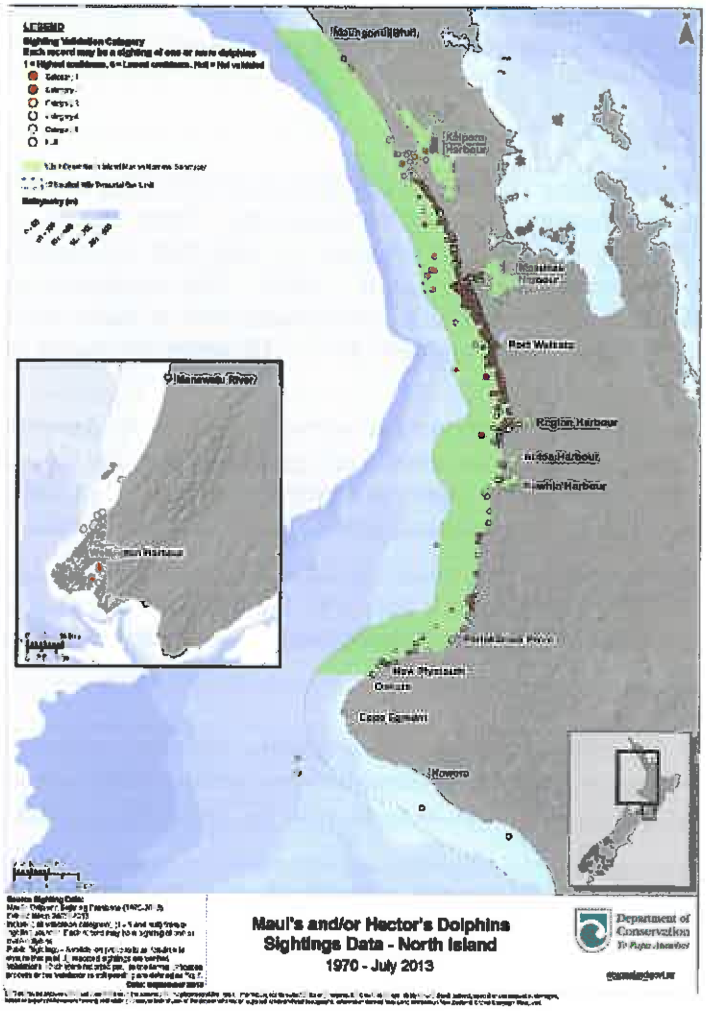

Figure 13: Maui's and/or Hector's dolphin sightings from 1970 – 2013

4.2.6.10 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 - from ~29,000 in the 1970s to ~8,000 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. It is estimated about 90 dolphins live on the south coast of the South Island, 2,600 on the east coast and about 5,400 on the west coast (MPI, 2013c). However, their numbers have increased within the Banks Peninsula MMS and are routinely reported around the Marlborough Sounds as well as being observed within the Maui's dolphin area in north Taranaki (Hamner *et al.*, 2012).

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, 2013c; Project Jonah, 2013). Hector's dolphins are often observed close to shore as they prefer shallow, coastal waters with water depths of less than 100 m. However, the sighting of a Hector's/Maui's dolphin from the Māui platform and three others within the South Taranaki Bight (Torres, 2012) is possibly dolphins moving between the west coast/Marlborough Sounds and west coast North Island populations.

Given the water depth of the KAKA 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.

4.2.6.11 Common Dolphin

Within NZ waters 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 DOC 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.

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 even though common dolphins generally prefer coastal waters, they are likely to be observed in the KAKA Operational Area.

4.2.6.12 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) and it is likely that if any were observed during the KAKA 3D MSS they would likely be the offshore bottlenose dolphins.

4.2.6.13 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 from East Cape to Kaikoura 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 KAKA Operational Area.

4.2.6.14 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 entire 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).

Killer whales do frequent the Taranaki region, but generally exhibit a coastal distribution with no sightings in the offshore South Taranaki Bight (Torres, 2012), 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 believed there is the possibility that killer whales could be observed when the *Polarcus Alima* is mobilising to and from the KAKA Operational Area.

4.2.6.15 Pilot Whale

Pilot whales are also 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 found within 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.

They are a very social whale and can often travel in groups of up to 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 KAKA 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 potentially 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. It is highly likely that NZ fur seals will be observed within the KAKA 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, 2013a). 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 air gun 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, 2013b). 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 KAKA 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 MSSs. However it is believed that acoustic damage to birds could only be experienced if a bird was diving in close proximity to the airgun 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 KAKA 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 KAKA Operational Area during the proposed commencement date in January; 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 KAKA Operational Area due to the sound levels emitted during the KAKA 3D MSS, the likelihood of any seabirds diving in close proximity to the acoustic 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 KAKA 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 14.

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

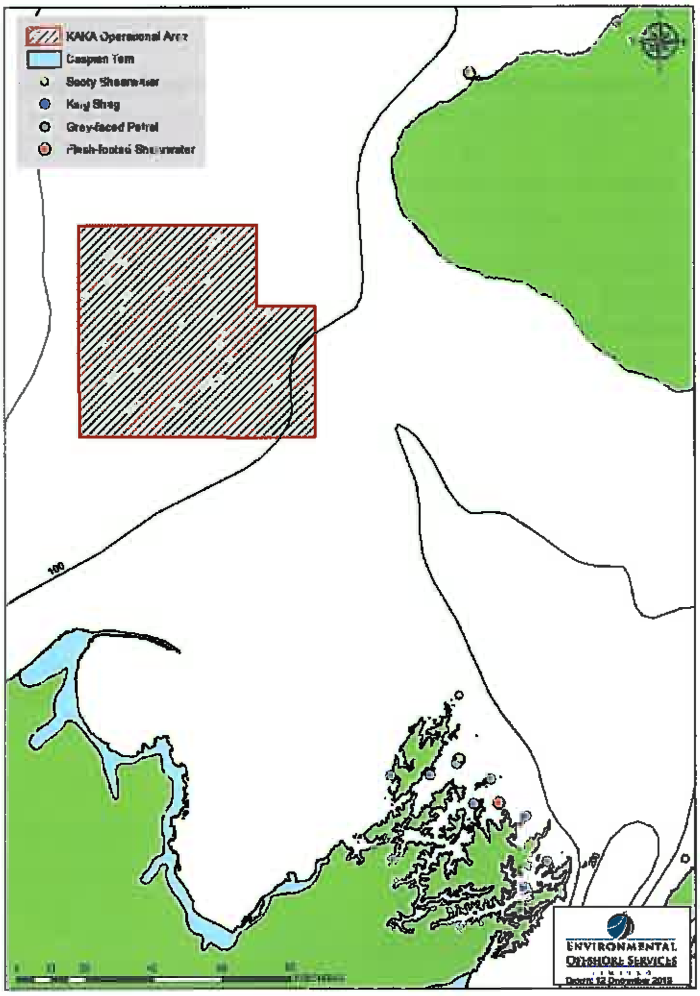

Figure 14: Breeding colonies of seabirds surrounding the KAKA Operational Area

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 airgun noise on corals is not well publicised due to a lack of literature. It has been suggested that sound emission from airguns 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 airgun 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 15) (MPI, 2013b). The KAKA Operational Area is located 50 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 15: Black coral distribution around the KAKA 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 KAKA Operational Area; the closest being Tapuae Marine Reserve and Westhaven (Te Tai Tapu) Marine Reserve (Figure 16).

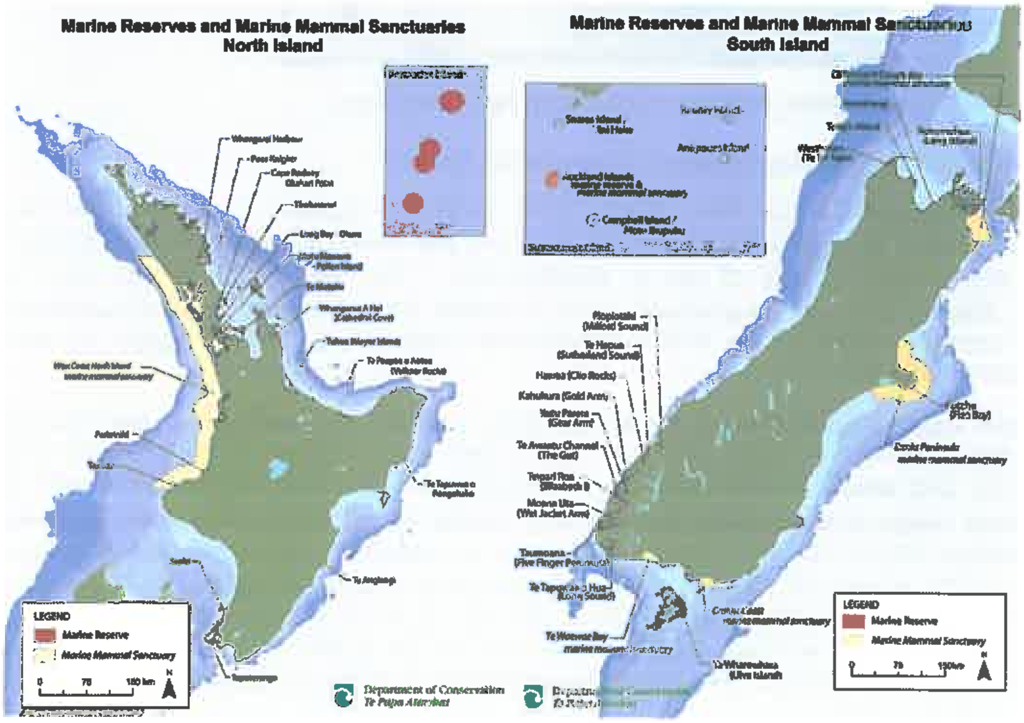

Figure 16: Protected Natural Areas and Marine Mammal Sanctuaries in New Zealand

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 km² of seabed was protected which equates to ~32% of the EEZ. The nearest BPA to the KAKA Operational Area is on the Challenger North Plateau, 175 km to the west (Figure 17).

Figure 17: Benthic Protected Areas in relation to the KAKA 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 KAKA Operational Area is located well offshore from these significant areas; however, the significant areas of relevance within the Taranaki region to the KAKA Operational Area are shown in Figure 18 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, 2013c). 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, 2013c). 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, 2013d). 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, 2013d). 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 where eroding stacks, caverns, tunnels and blowholes are present;
- **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.

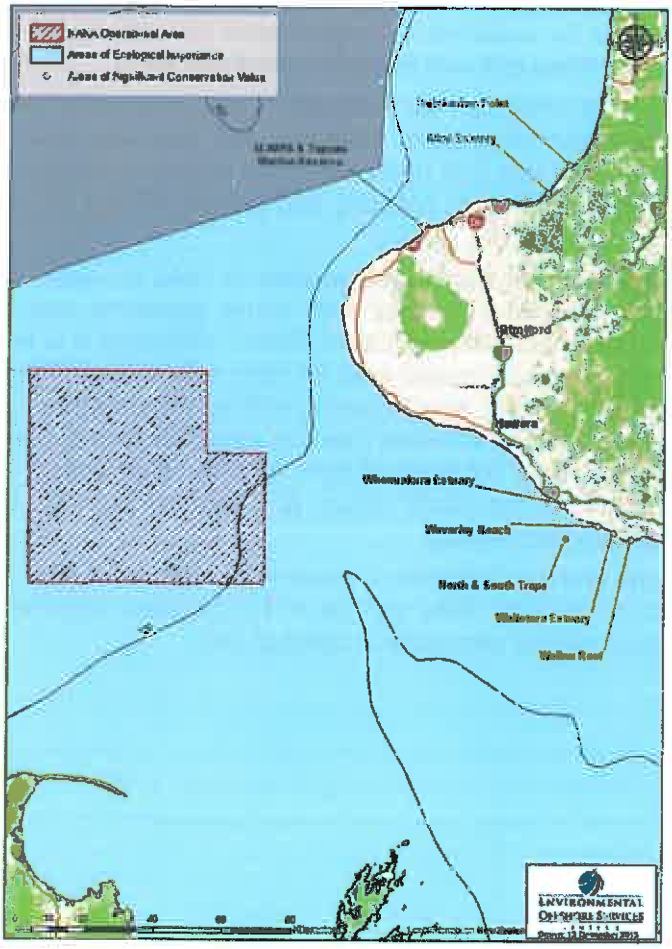

Figure 18: Taranaki Areas of significant conservation value and DOC Area of Ecological Importance

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 19.

- **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, 2013e), 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 in 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 19 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.

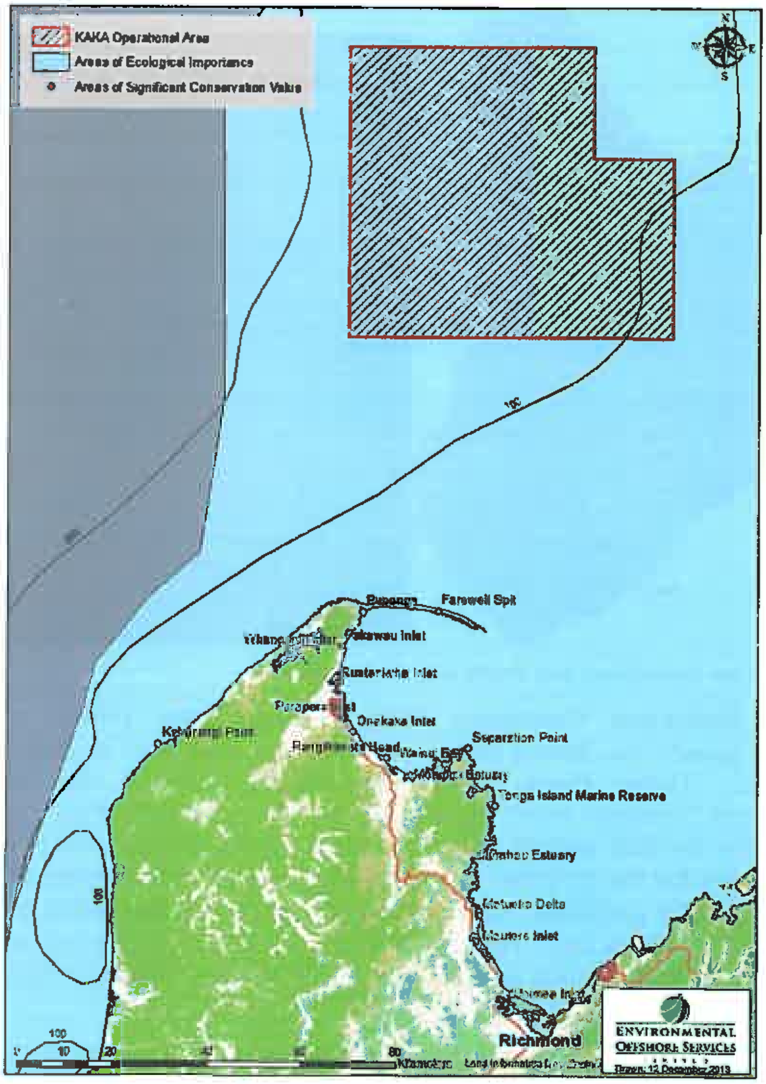

Figure 19: Tasman District Council areas of significant conservation value and DOC Area of Ecological Importance

4.3 Cultural Environment and Customary Fishing

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 20).

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).

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, 2013d).

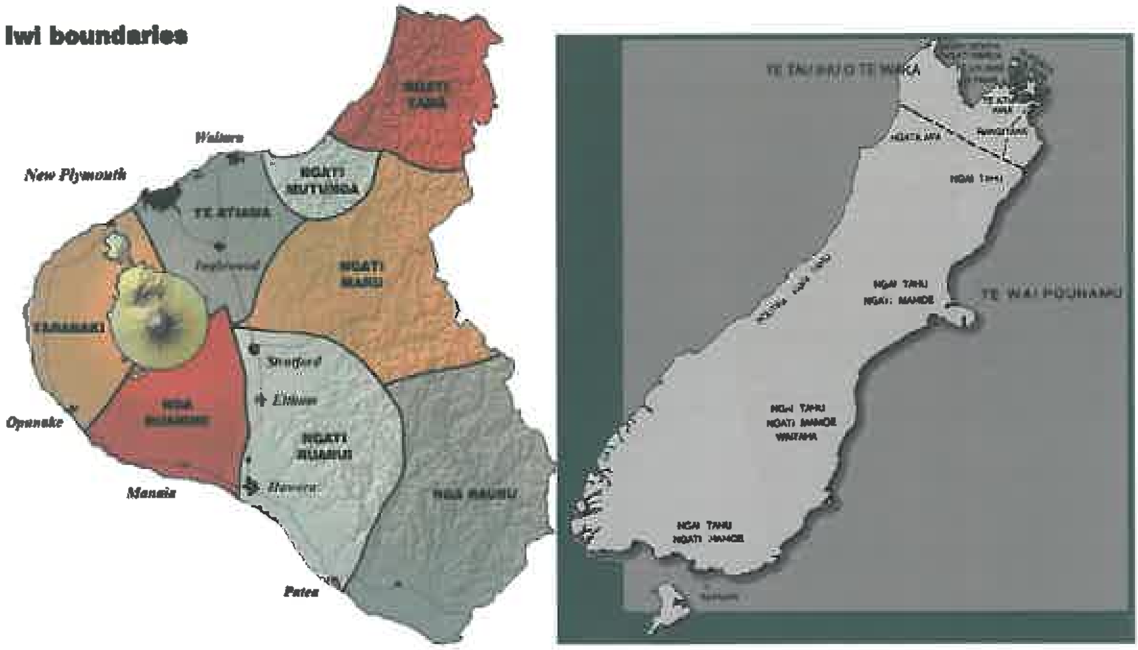

Figure 20: Taranaki Iwi boundaries and South Island Iwi map

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.

Within the KAKA Operational Area there are no established customary areas under the Fisheries Act or Kaimoana Customary Fishing Regulations (Figure 21). 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 KAKA 3D MSS scheduled for January 2014 and a summary of the engagement is provided in Appendix 2.

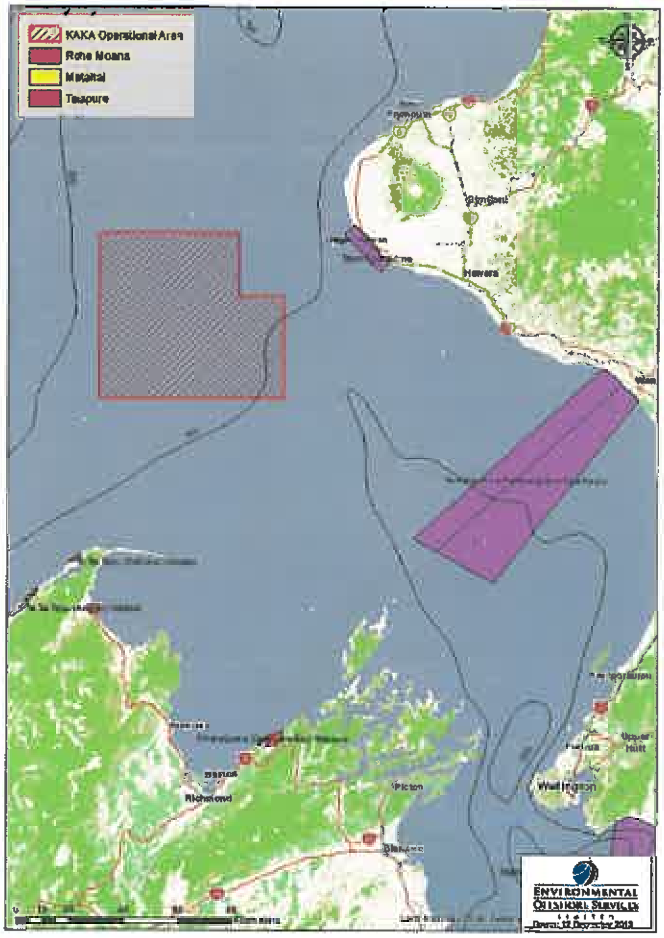

Figure 21: Culturally important areas surrounding the KAKA Operational Area
(**Note**: Rohe Moana boundaries may not be accurately representative of each particular hapu)

4.4 Anthropogenic Environment

This section focuses on the users of the environments surrounding the KAKA 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 KAKA 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 KAKA Operational Area is not often fished by recreational fishers due to its distance offshore and away from any local boat launching ramps. The seabed is also relatively flat with no significant reef structures identified (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 22). Over 1,000 fish species live in NZ waters (Te Ara, 2013b) of which the QMS provides for commercial utilisation of 96 species while ensuring sustainability (MPI, 2013e). These species are divided into separate stocks and each stock is managed independently to ensure the sustainable utilisation of that fishery.

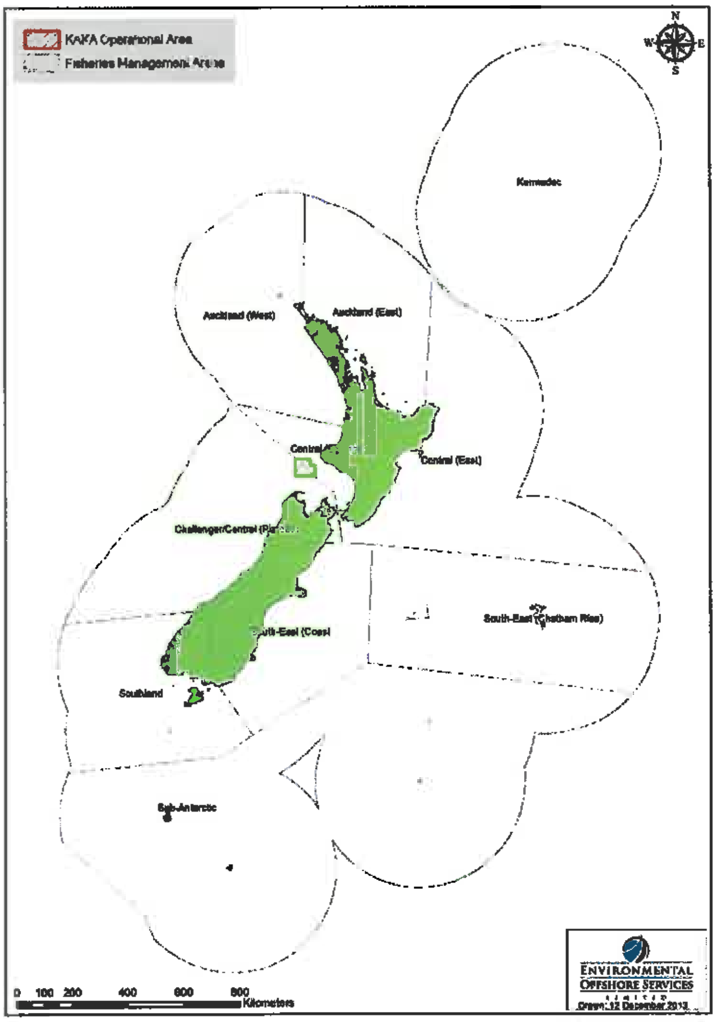

Figure 22: Fisheries management areas within NZ waters

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, 2013). 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 KAKA Operational Area and has been used within this MMIA to provide a summary of commercial fishing activities and what species are targeted (Figure 23).

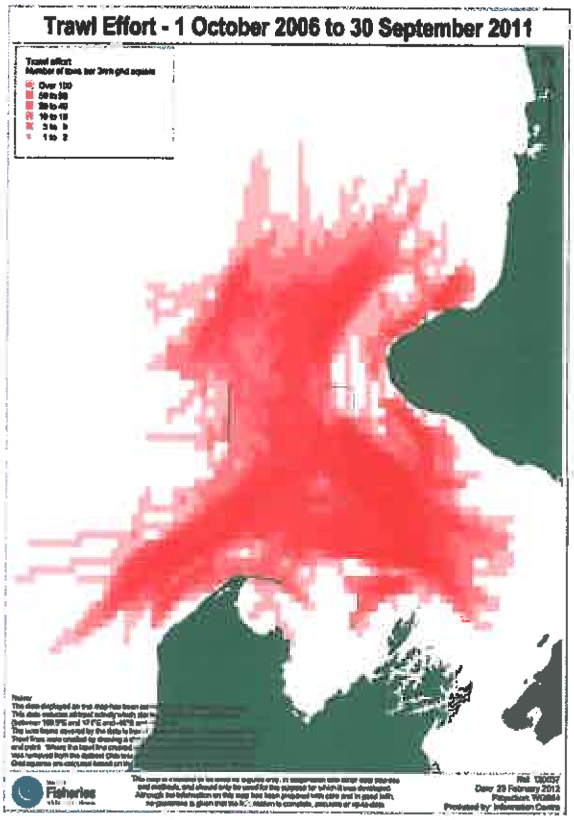

Figure 23: Trawl effort in the South Taranaki Bight

The fisheries assessment was undertaken for the period 1 October 2006 to 30 September 2011 within OMV's Area of Interest (AOI) for the 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 KAKA Operational Area and the potential commencement date of the KAKA 3D MSS.

Table 7: Trawl Catch History within OMVs 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 KAKA 3D MSS and the array of gear that will be behind the *Polarcus Alima*. A summary of the engagement is provided in Appendix 2. 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 KAKA 3D 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 KAKA 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 24. The KAKA Operational Area is located on the shipping route between Port Taranaki and Nelson, and Port Taranaki and the West Coast. During consultation the Port Taranaki harbour master has been advised of the proposed KAKA 3D 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 KAKA 3D MSS commencing and with adherence of all vessels to the COLREGS there should be no conflict between shipping vessels and the *Polarcus Alima*. The routes for foreign destinations from NZ ports is likely to vary and has not been included in Figure 24, although it is likely they will pass through or in close proximity to the KAKA 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 KAKA Operational Area is intersected through the middle along the western boundary of the precautionary Area (Figure 25).

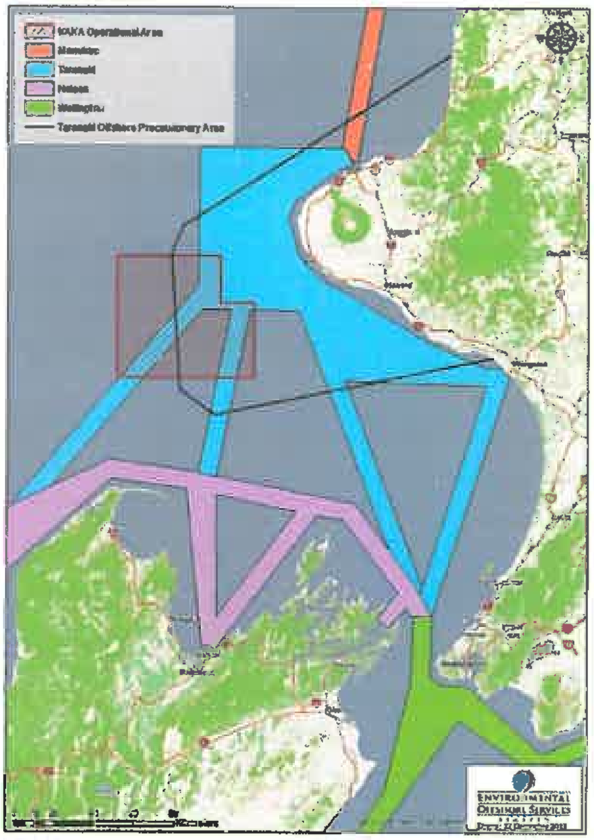

Figure 24: General shipping routes surrounding the KAKA Operational Area

Figure 25: 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 has 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. During these MSS there has been no recorded incident or harm come to any marine mammals or the marine environment. The current extent of the Taranaki offshore oil and gas production operations in the Taranaki Basin is shown in Figure 26.

Figure 26: 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 KAKA 3D 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 Ltd's knowledge of the environmental sensitivities within the South Taranaki Bight, to summarise the potential environmental effects which may result from the KAKA 3D MSS, from both planned and unplanned activities. Mitigation measures that will be implemented for the KAKA 3D 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 two mitigation zones within the Code of Conduct. No noticeable effects observed within the marine environment or on other marine fauna. The STLM also showed that beyond 1 km the SEL was above 171 dB re 1 $\mu Pa^2.s$ SEL which is the sound level for behavioural effects for marine mammals within the Code of Conduct. 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 1 km and 200 m from the acoustic source. This is based on the mitigation zone in the Code of Conduct which also correlated with the distance from the acoustic source where the SEL is below 171 dB re 1 $\mu Pa^2.s$ SEL. Behavioural effects to marine mammals are likely to occur and physical effects may develop closer to the source, but 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 186 dB re 1 $\mu Pa^2.s$ SEL within 200 m of the source (Duncan, 2013) 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.

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 KAKA 3D MSS to keep environmental effects to ALARP.

5.1 Planned Activities – Potential Effects & Mitigation Measures

5.1.1 Physical presence of *Polarcus Alima* and the Seismic Array

The *Polarcus Alima* and the associated seismic array towed behind the vessel, as well as the support vessels 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 KAKA 3D MSS to interfere with fishing activities due to the length of the seismic array that will be towed behind the *Polarcus Alima*. During the KAKA 3D MSS fishing vessels (mainly commercial) will be caused a temporary loss or reduction of access to any fishing grounds within the KAKA Operational Area; however, this would only occur for the duration of the KAKA 3D MSS (~21 days). Commercial fishers who use the KAKA Operational Area as part of their fishing grounds have been advised of the KAKA 3D 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 KAKA 3D MSS (Appendix 2). The acquisition of the KAKA 3D 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 KAKA Operational Area. As discussed in Section 3.1, tail buoys on the end of each streamer will mark the overall extent of the MSS array and avoid any uncertainty as to how far the streamers extend behind the *Polarcus Alima*.

To ensure that the potential environmental effects are minimised to ALARP, OMV will operate 24 hours a day, 7 days a week (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 KAKA 3D MSS and KAKA Operational Area; issue a Notice to Mariners and have tail buoys attached to the end of each streamer to mark the end of the seismic array.

With the mitigation measures in place, the relatively short survey duration (~21 days), the effects from the KAKA 3D 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 KAKA MSS will not come into contact with the seabed or coastline inshore of the KAKA Operational Area. The solid streamers used in the KAKA MSS have 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 they 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 KAKA 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 up in front of the seismic vessel.

- 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, 7 days a week (weather and marine mammal encounters permitting) the KAKA 3D MSS duration will be as short as possible (~21 days), and any potential effect on fish species within close proximity to the KAKA 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 KAKA 3D 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

KAKA 3D 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 KAKA 3D 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 *Polarcus Alima* was slipped in Singapore during October 2013 where the hull was cleaned and new antifoul paint was applied. This dry-docking in Singapore will help minimise the risk of any invasive species entering NZ waters on the *Polarcus Alima's* hull or seachests.

The support vessel *Ocean Pioneer* 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 KAKA 3D MSS is ***negligible***.

5.1.1.6 Interaction of Polarcus Alima with Marine Mammals

Within the KAKA 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 KAKA 3D MSS (Table 6). In NZ threat classification system 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 KAKA Operational Area and are listed as 'endangered' within the IUCN red list classification.

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 KAKA 3D MSS or entanglement with one of the streamers or 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 KAKA 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 *Polarcus Alima* 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 *Polarcus Alima'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 KAKA 3D 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 on marine mammals arising from the KAKA 3D MSS would be ***minor***.

5.1.2 Acoustic Source Sound Emissions

Sound emissions associated with the KAKA 3D 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 MSSs 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 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 and are not considered as being adversely affected from the sound emissions. During the WesternGeco survey 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 (T. Allen, pers. comm.; Schlumberger).

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 SELs from the KAKA 3D 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 μPa².s SEL (injury criteria) at a range greater than 200 m, and below 171dB re 1 μPa².s SEL (behaviour criteria) at a range of 1 km from the acoustic source (Duncan, 2013). 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 27 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 KAKA 3D MSS (2,380 in³) and was based on a depth of 100 m which is found in the southeast corner. Given the acoustic source used for the KAKA 3D MSS, which involves two arrays is operated alternatively in a flip-flop shooting mode, the operational capacity is 2,380 in³. The shallowest depth within the KAKA 3D Operational 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 100 m modelled (Duncan, 2013).

For the KAKA 3D MSS, survey lines will most likely be undertaken in an east – west direction. Figure 27 shows that the highest SEL is in the cross-line direction, typical of all airgun arrays due to the horizontal directionality of the array.

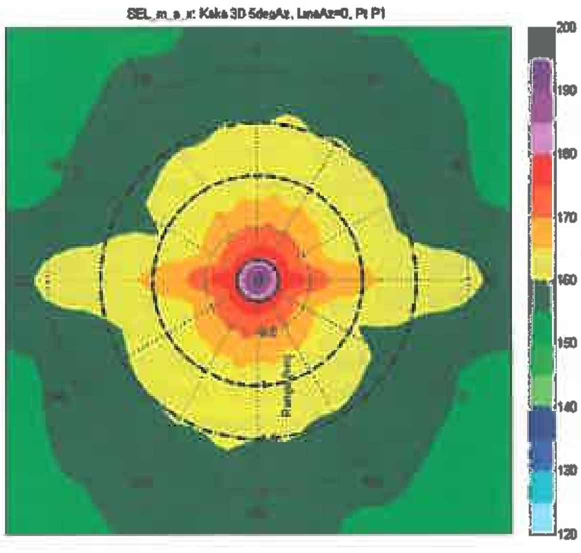

Figure 27: Maximum received SELs at any depth from the acoustic source within KAKA Operational Area

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.

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 KAKA 3D MSS STLM, these sound levels appear to be present within 1.5 km from the acoustic source (Figure 27).

5.1.2.2 Physiological Effects on Marine Mammals and Fauna

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, SELs need to be very high (Richardson *et al.*, 1995); and these are only found close to the acoustic source. The STLM showed that the SELs for injury criteria as identified in the Code of Conduct is likely to be at a range of less than 200 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; as marine mammals are a 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.

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 KAKA 3D MSS. Likewise, if a marine mammal approaches the seismic vessel or acoustic source and enters the relevant mitigation zone; then the trained and qualified MMOs onboard the vessel have the authority to shut down the acoustic source in accordance to the Code of Conduct.

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 SELs 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 SELs 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 KAKA 3D 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 KAKA 3D MSS will be below 1 kHz, and the sound emissions will only occur every 8 – 9 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 airgun found varying degrees of threshold shift, but recovery occurred within 24 hours of exposure (Popper *et al.*, 2005). For the KAKA 3D 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 KAKA 3D MSS on fish species would likely be ***negligible***.

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, 2013). The effects that have been observed generally occur in shallow water, and given the depth of the KAKA Operational Area (>100 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 airguns (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, these peak sound levels can be found within 1.5 km from the acoustic source used for the KAKA 3D MSS (Figure 27).

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 KAKA Operational Area. Squid are a pelagic species and can be found in Taranaki waters, where majority of the commercial squid fishing throughout NZ takes place in the summer months from January through to May (MPI, 2013f). The majority of commercially caught squid within NZ waters is caught off the South Island and the Auckland Islands. Squid are a very short lived but fast growing species where they only live for one year with spawning occurring between May and July (MPI, 2013g). Squid are caught in the Taranaki region during late summer when the warmer water is present (Section 4.1.2.5). The KAKA 3D MSS will be commencing at the start of the summer squid fishing season throughout southern NZ, so it is possible that squid could be present within the KAKA Operational Area, and if they were present and in close proximity (<1.5 km) to the operating acoustic source there is the potential for trauma to these species.

In summary, given that the frequencies and SEL generated during the KAKA 3D MSS is below what has been shown in the above studies; the acoustic sound wave is directed downwards from the source; the observed avoidance behaviour of marine mammals and other mobile fauna while the airguns are operating, adherence to the Code of Conduct, the effects of acoustic noise on marine mammals and other marine fauna is likely to be ***minor***.

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 air guns (> 5 kHz).

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).

A study on pink snapper held in captivity and exposed to airgun 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 KAKA Operational Area is in relatively deep water (>100 m) over a flat muddy seabed (no reef fish present) and given the relatively short duration of the KAKA 3D MSS (~21 days) and the likelihood that most pelagic fish or marine mammals would either avoid or move away from the acoustic source while it was operating, the KAKA 3D MSS would likely have ***minor*** effects on marine mammals and fish behaviour.

5.1.2.4 Disruption to Feeding, Mating, Breeding or Nursery Activities

The potential effects to marine species identified in this MMIA that could be present in the KAKA Operational Area include disturbance to feeding activities and displacement of habitat for the MSS duration. Any species that were in close proximity to the acoustic source are likely to move away from the immediate area while the source is operational. However, there is anecdotal evidence from other MSSs conducted around NZ that there is the potential for NZ fur seals to be attracted to the survey vessel.

Once the seismic vessel and acoustic array has passed through an area, or once the KAKA 3D MSS is complete, the sound source within the marine environment will have dissipated and there will be no further environmental effects on any species residing there. Therefore, the potential disruption and disturbance to the marine organisms basic life histories, that are likely to be encountered within or adjacent to the KAKA Operational Area is believed to be ***minor***.

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 Lorio & Clark, 2009).

If a MSS emits sound in the same frequency range as the sounds generated by cetaceans and interfered with or obscured 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
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

Toothed whales communication calls partially overlap with the high end of seismic airguns operational range, although most of the acoustic energy emitted from an airgun during deep-water surveys is between 0.01 – 0.3 kHz; well below the lower frequency limits of most toothed whales. Sperm whale, common dolphin and blue whales vocalise at a frequency (0.01 – 0.4 kHz) 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 SELs 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).

It is thought that the blue whale increases its calling to increase the probability that its signal will be successfully received by conspecifics. 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 are proposing to undertake a research voyage in January 2014 to study blue whales further and if any blue whales are observed during the KAKA 3D MSS, NIWA will be notified immediately to help with their study and increase the understanding of these marine mammals.

From the reviewed studies and literature available it is believed that the KAKA 3D MSS will have a ***minor*** effect on marine mammals use of naturally produced acoustic signals, and once the KAKA 3D MSS is complete there will be no more influence or interference with any mammals communication or echolocation frequencies.

5.1.3 Solid and Liquid Wastes

During the KAKA 3D 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 KAKA 3D MSS will include sewage and wastewater from toilets, washrooms, the galley and laundry. The *Polarcus Alima* and support vessels have onboard sewage treatment plants which ensures a high level of treatment before the waste is discharged. All vessels involved in the KAKA 3D MSS also have an International Sewage Pollution Prevention Certificate (ISPPC).

As a result of the sewage and greywater generated by the vessels involved in the KAKA 3D MSS and its high level of treatment, 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 *Polarcus Alima* 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 KAKA 3D 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 *Polarcus Alima'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 *Polarcus Alima* 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 KAKA 3D MSS, the distance offshore and exposed nature of the KAKA Operational Area and the anticipated low level of emissions, the environmental effects arising from the KAKA 3D 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 tangling during rough weather; snagging with floating debris; or potential rupture from abrasions, shark bites or other vessels crossing the streamers.

The streamers to be used in the KAKA 3D MSS are solid streamers so if they were to break or be severed there is little potential for an environmental effect on the marine environment. The solid streamers are also negatively buoyant and requires movement to maintain depth so if a streamer was to be severed it would start sinking. Although all streamers in the KAKA

3D MSS have Self Recovery Devices (SRD) which will deploy for retrieval once the streamer sinks below 55 m depth. This will prevent any potential for crushing of the benthic communities, even though the KAKA Operational Area has a flat muddy seabed with no reef communities present.

The KAKA 3D MSS will be undertaken by experienced personnel using international best practice and as a result of the streamer type to be used for the KAKA 3D MSS, if a 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 KAKA 3D 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 *Polarcus Alima's* fuel tank did occur, the maximum possible spill if the fuel tanks were full would be 1,925 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 *Polarcus Alima* is double skinned and has an Ice 1A1 Class rating. 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 KAKA 3D 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 *Polarcus Alima* as 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 KAKA 3D 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 *Polarcus Alima* 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 KAKA 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 KAKA 3D 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 MMOs 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 has just recently been updated following the 2012 – 2013 summer period where a number of MSSs 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 KAKA 3D MSS the requisite mitigation measures specific to a Level 1 MSS are identified in Section 2.2.1. However, due to the KAKA 3D MSS operating in an AEI and OMVs 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 KAKA 3D MSS

5.3.2.1 Sound Transmission Loss Modelling

As discussed in Section 5.1.2.1 STLM has been undertaken to predict SELs at various distances from the *Polarcus Alima*; with the modelling based on the specific configuration of the acoustic source to be used for the KAKA 3D MSS and the environmental conditions (i.e. bathymetry, substrate and underlying geology) of the KAKA 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 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 SEL has to provide the relative distances from the acoustic source which behavioural criteria (171 dB re 1μPa^2-s SEL) and injury criteria (186 dB re 1μPa^2-s SEL) could be expected.

The STLM showed that for the KAKA 3D MSS, compliance will be achieved with the Code of Conduct criteria (behaviour criteria < 1 km and injury criteria < 200 m). 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 KAKA 3D 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 Polarcus Chief Field Geologist and the lead MMO onboard the *Polarcus Alima*. To complete this validation, sound exposure levels (dB re 1μPa) will be recorded by receivers in the streamers located at four different offsets from the acoustic source; 200 m, 1,000 m, 1,500 m and 1,800m. These recordings will take place within the KAKA Operational Area, and although the KAKA Survey Area is relatively flat, the different depth measurements across the KAKA Survey Area will have sound exposure levels measured, as sound exposure levels are likely to decrease in the deeper waters (Duncan, 2013). 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.

The Polarcus team have recently completed this testing sequence for the Endurance MSS in the Canterbury Basin and the methodology worked well, so although this validation method is relatively new, the team that will be performing the KAKA 3D MSS STLM validation do have experience in the methodology.

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 KAKA 3D MSS or while the *Polarcus Alima* is mobilising to and from the KAKA 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 KAKA Operational Area, the chances that a Maui's dolphin is sighted is low.

5.3.2.3 Additional marine mammal observations outside KAKA Operational Area

The *Polarcus Alima* will travel to the KAKA Operational Area once the Endurance MSS is completed in the Canterbury Basin. It is likely that the *Polarcus Alima* will call into Port Nelson to resupply and have a crew change. On transit from Nelson to the KAKA 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 KAKA 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 Autopsy will be undertaken on any stranded marine mammals

If any marine mammals are stranded or washed ashore during the KAKA 3D MSS inshore of the KAKA Operational Area along the Taranaki, Wanganui, Manawatu, Kapiti/Wellington and top of the South Island coastline, OMV would engage Massey University to undertake a necroscopy (autopsy) 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 necroscopy and coordination with pathologists at Massey University; however OMV will cover the associated costs. OMV will meet these costs for any necroscopies required during the KAKA 3D MSS and for a period of two weeks after MSS completion.

5.3.2.5 Notification of large numbers of marine mammals

If during the KAKA 3D MSS that the MMOs onboard the *Polarcus Alima* 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.

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 Lorio & 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, there is not known to be any other MSS being conducted within the South Taranaki Bight at the same time as the KAKA 3D MSS other than the intermittent check-shot surveys undertaken off the Kan Tan IV (discussed below). As a result the cumulative effects from two concurrent MSS operating has not be considered as part of this assessment.

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 is a form of borehole seismic survey and is 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 in³) and fire approximately 150 shots at an operating capacity of 1,800 psi. In comparison to a 3D MSS, if the acoustic source for a check-shot was fired at the same rate as a 3D MSS (~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 KAKA 3D 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 KAKA 3D 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 KAKA 3D MSS is complete, any resonant noise within the KAKA 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.

The requirements and mitigation measures for a Level 1 MSS will be adhered to for the KAKA 3D MSS; the *Polarcus Alima* will use the minimum acoustic source required to achieve the objectives of the KAKA 3D 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 believed that only the KAKA 3D MSS will be operating in the South Taranaki Bight in January 2014, the short duration of the KAKA 3D MSS and the mitigation measures in place; the potential cumulative effects on marine mammals, marine fauna or the marine environment from the KAKA 3D MSS will be ***negligible***.

5.5 Summary of Environmental Effects and Mitigation Measures

The potential environmental effects and associated mitigation measures that will be implemented for the KAKA 3D MSS as identified in this MMIA are summarised in Table 9.

Table 9: KAKA 3D 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 *Polarcus Alima* 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 (~21 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 no streamers will come in contact with the seabed.	Best Practice. Solid streamers with SRD.	Negligible.
	Changes in abundance or behaviour of fish.	Low.	24/7 operations (weather 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. MMOs will record any seabird strikes that are witnessed.	Negligible.
	Introduction of marine pests or invasive species.	Low.	Recent dry-dock of *Polarcus Alima* (October 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 MMOs 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 due to mitigation measures in place.	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 below injury criteria at a range of 200 m, and below behaviour change at a range of 1 km from the acoustic source.	Minor.
	Behavioural effects on marine mammals and fauna.	Low.		Minor.
	Disruption to feeding, mating, breeding or nursery activities.	Low.		Minor.
	Interference with acoustic communication signals.	Low.		Minor.
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 streamers 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 KAKA Operational Area have been advised of the KAKA 3D 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 KAKA 3D MSS are detected and addressed.

The Environmental Management Plan (EMP) is essential for the successful implementation of the KAKA 3D 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 KAKA 3D MSS will be implemented to eliminate, offset, or reduce any identified environmental effects which could arise to ALARP.

The *Polarcus Alima* 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 KAKA 3D 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 KAKA 3D MSS have their own management systems that are consistent with the requirements of the KAKA 3D 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 *Polarcus Alima* 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 *Polarcus Alima* is operated with a high regard for environmental protection.

The KAKA 3D 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 *Polarcus Alima* have the authority to delay or shut down an active seismic array.

Table 10: KAKA 3D 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 (recently slipped in Singapore, October 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 MMOs 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 1A1 Class. Solid streamers used with SRDs 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 KAKA 3D MSS, OMV will comply with the Code of Conduct, NZ Maritime Rules, NZ Marine Protection rules, OMVs 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 KAKA 3D MSS in an AEI. The mitigation zones within the Code of Conduct for a Level 1 MSS were validated by STLM and ensures that if compliance with the mitigation zones is achieved, the KAKA 3D MSS should not result in any injury to marine mammals. OMV will have four independent and suitably qualified MMO's on board the *Polarcus Alima*, 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 MSSs 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 MMOs.

The *Polarcus Alima* is a state of the art specialist MSS vessel that has advanced seismic acquisition technology and environmentally sensitive 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 KAKA 3D 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 ***negligible*** or ***minor*** if the KAKA 3D 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	KAKA 3D MSS Information Sheet
2	Consultation Register with Key Stakeholders
3	Technical Details of the PAM system
4	Marine Mammal Mitigation Plan for the KAKA 3D MSS
5	Sound Transmission Loss Modelling

APPENDIX 1

KAKA 3D MSS Information Sheet

ENVIRONMENTAL OFFSHORE SERVICES LIMITED

OMV New Zealand Limited
KAKA 3D Marine Seismic Survey – South Taranaki Bight
Information Sheet

Environmental Offshore Services Limited (EOS Ltd) has been engaged by OMV New Zealand Limited (OMV) to prepare a Marine Mammal Impact Assessment (MMIA) for a 3D Marine Seismic Survey in the South Taranaki Bight (Figure 1).

The approximately 400 km^2 KAKA 3D Seismic Survey will be located largely within Petroleum Exploration Permit (PEP) 51906 and PEP 53537 to assess hydrocarbon prospectivity in the area. Figure 1 shows a large operational area within which surveying will occur. Exact survey details are yet to be determined, however it will be bound within the hatched polygon drawn (KAKA Operational Area).

The KAKA 3D Seismic Survey is scheduled to commence in January 2014 and will take approximately 21 days depending on weather constraints, marine mammal encounters and final survey size. OMV have contracted the *Polarcus Alima* to undertake the seismic survey; a state of the art specialised seismic vessel launched in 2010 (Figure 2). The 92 m *Polarcus Alima* will tow 10 streamers, up to 8 km long and 100 m apart resulting in a 900 m spread of gear towed just below the surface behind the vessel that will restrict its ability to manoeuvre. The end of each streamer is marked with a tail buoy that can be observed day and night due to flashing lights and radar reflectors. During seismic acquisition the vessel will be travelling at approximately 4.5 kts so the streamer tail buoys will be travelling one hour behind the vessel.

Two support vessels will accompany the *Polarcus Alima*; the 61 m vessel *Sealink* (Figure 3) and the 33 m *Ocean Pioneer* (Figure 4) 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.

Behind the *Polarcus Alima* an acoustic source is released using compressed air which travels down through the water column into the underlying rock. The ten streamers have hydrophones positioned along them 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.

OMV will operate the KAKA 3D 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 Exclusive Economic Zone (EEZ) Act which came into effect on 28 June 2013, seismic surveys are now classified as Permitted Activities as long as the operator complies with the Code of Conduct. This requires a MMIA to be prepared and to ensure that the mitigation measures (as well as some additional 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 KAKA 3D Seismic Survey can commence.

Contact Details

If you have any further questions or matters you would like to discuss or would like any further information in regards to the KAKA 3D Seismic Survey, please contact Dan Govier.

Dan Govier
Environmental Consultant
Environmental Offshore Services Ltd

Mobile: 0274 898 628
dan@eosltd.co.nz

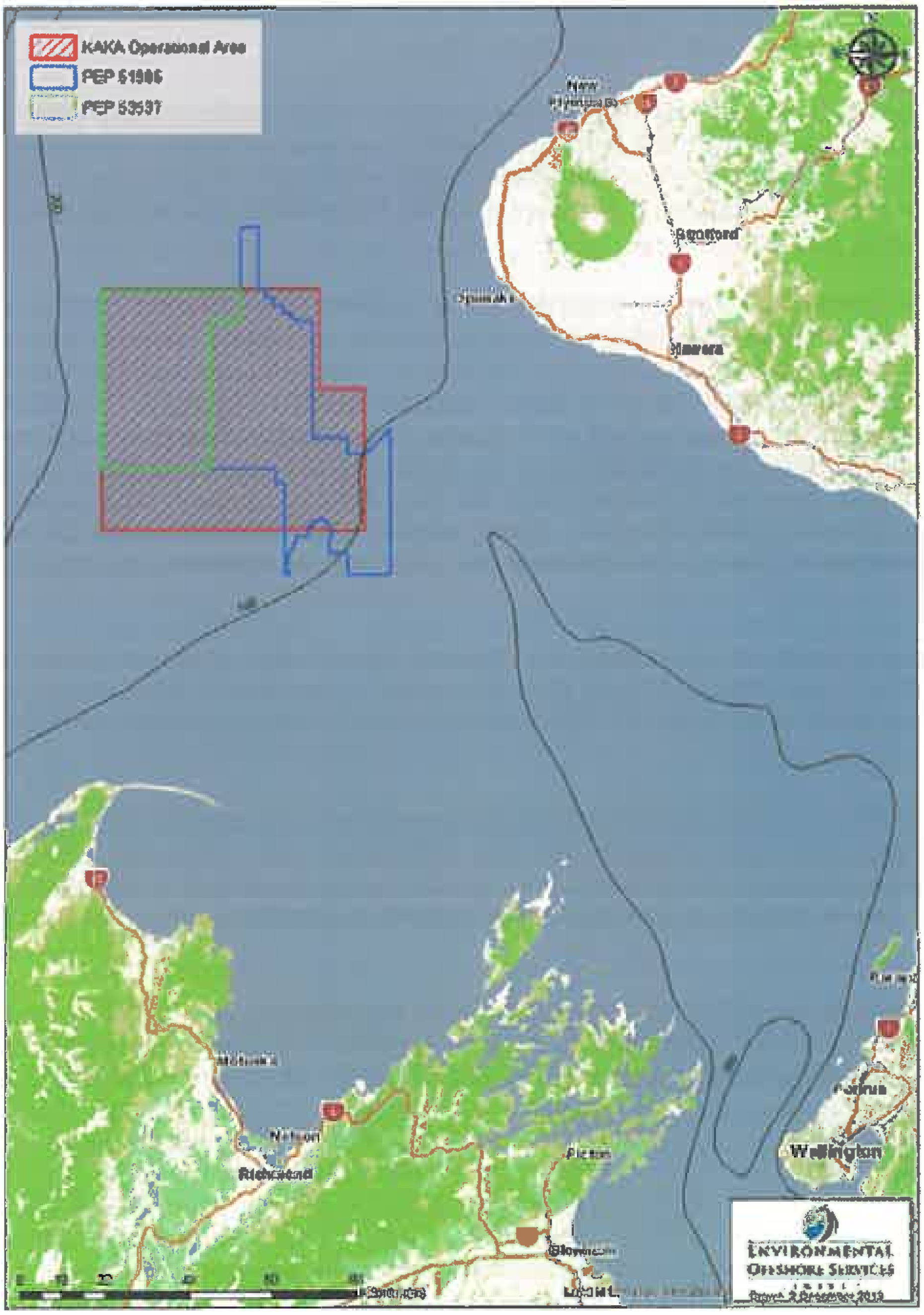


Figure 1: KAKA 3D Seismic Survey Operational Area

Figure 2: Seismic Survey Vessel – *Polarcus Alima*

Figure 3: Support Vessel – *Sealink*

Figure 4: Support Vessel – *Ocean Pioneer*

APPENDIX 2

Consultation Register with Key Stakeholders

Stakeholder	Consultation Summary
DOC	OMV and DOC met at the start of the MMIA process to introduce the KAKA 3D MSS and the proposed KAKA Operational Area. The intention was to discuss the mitigation measures that would be implemented, details of the updated 2013 Code of Conduct and the sensitivities in the area, as well as whether DOC were aware of any other MSS being proposed to be undertaken in the South Taranaki Bight at the same time.
NIWA	NIWA were appreciative of the update. They advised that they are trying to arrange field work for a blue whale survey in the South Taranaki Bight in January 2014. NIWA's research vessel '*Ikatere*' will be used to collect information on blue whales which will include: photo-id, tissue sampling for genetics and stable istotopes, CTDs and plankton tows. The aim of the research is to help address population and ecological knowledge gaps of blue whales in NZ. It was suggested that it would be good to be able to be in contact with the MMOs onboard the *Polarcus Alima* during the survey so they can be informed of any blue whale sightings.
Venture Taranaki	Venture Taranaki were appreciative of the information regarding the proposed KAKA 3D MSS.
Sealord	Sealord were updated with all details of the proposed KAKA 3D MSS. No questions were raised, Sealord were appreciative of the information and wished the survey well.
Egmont Seafoods	Egmont Seafoods were happy with the survey commencing and did not believe the proposed KAKA 3D MSS would impact on any of their fishers or fishing activities.
MPI	MPI were appreciative of the update for the proposed KAKA 3D MSS.
Port Taranaki	Port Taranaki were updated on the KAKA 3D MSS and were happy with the survey and appreciated being updated.
Taranaki Commercial Fishing Federation	Did not anticipate the KAKA 3D MSS would affect their fishing activities in any way.
Fishing Vessel Management Services Ltd - Nelson	Have forwarded the KAKA 3D MSS Information Sheet out to all of the deepwater vessels that will be working in the South Taranaki Bight in early 2014. They were also interested in the Code of Conduct and what it entailed so requested a copy. A copy was provided to them.
Taranaki Iwi Trust	Provided Taranaki Iwi Trust with an overview of OMV, seismic surveys, why they are done, the methodology used, Code of Conduct, EEZ Regulations and the requirements of a MMIA and what is involved within the process. OMV were asked how many maori are working within the industry, which is currently unknown due to the large number of supporting companies, but OMV will refer back at a later date. Taranaki Iwi Trust's main concerns are with the cumulative effects of the offshore industry, in regards to restriction of space, environmental aspects and cultural significance and want to investigate the balancing act of all of

	this. OMV will provide the MMO report to the Taranaki Iwi Trust after survey KAKA MSS is complete.
Ngati Ruanui	OMV have a good relationship with Ngati Ruanui which has been in place for several years. Ngati Ruanui were well informed in regards to the EEZ Regulations and Code of Conduct. OMV will provide a draft MMIA and the MMO report to Ngati Ruanui. If the *Polarcus Alima* is to visit Port Taranaki, Ngati Ruanui will be informed.
Nga Ruahine	Nga Ruahine were provided with an introduction to OMV and what their activities are within the Taranaki area. The EEZ Regulations, Code of Conduct and Seismic Surveys were introduced to provide Nga Ruahine with all the background information in regards to the proposed KAKA 3D MSS and the MMIA process. Nga Ruahine asked what proportion of OMV staff are maori and also raised that their main concerns are that no money that is generated from the oil and gas industry makes its way back to Nga Ruahine. OMV will undertake a follow up meeting with Nga Ruahine after the KAKA 3D MSS is complete to update them on the survey, how it went and what was observed in regards to marine mammals.

APPENDIX 3

Technical Details of the PAM System

Seiche Measurements Ltd
Bradworthy Industrial Estate
Langdon Road, Bradworthy
Holsworthy, Devon EX22 7SF
United Kingdom
Tel: +44 (0) 1409 404050
Fax: +44 (0) 1409 240276
Email: info@seiche.eu.com
Web: www.seiche.eu.com

Proposal No. SM13029

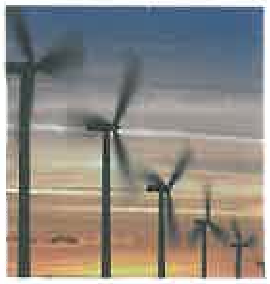
25 October 2013

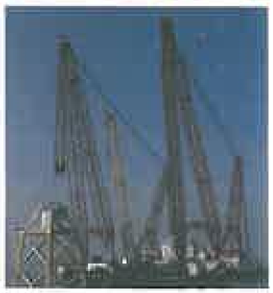
Passive Acoustic Monitoring Systems

Outline Specifications

Commercial in Confidence

Company Background





Seiche Measurements Limited (Seiche) specializes in the design development and manufacture of underwater measurement and acoustic systems.

Formed in 1996 to undertake underwater acoustics research projects, the company was involved in the early stages of Passive Acoustic Monitoring (PAM) development. Seiche Measurements Ltd is the leading worldwide supplier of passive acoustic monitoring equipment to the oil and gas and renewables industries.

The company has over 17 years of experience with passive acoustic systems and has been at the forefront of the design of systems for implementation in the oil exploration market. With over 70,000 days of deployments across all systems Seiche has a proven track record with the deployment and use of PAM.

Seiche provides a number of solutions for passive acoustic monitoring from simple single hydrophone systems through to state of the art low noise optical data transmission systems.

Facilities are in Devon UK and Houston Texas.

Industry User list includes:
Apache
BHP Billiton
BP
Capfish
CGG
Chevron
ConocoPhilips
DONG Energy
Exxon Mobil
Fugro
Gardline
Geomotive
Noble
PGS
RPS
RWE Innogy
Seabird
Shell
Tullow Oil
Western Geco

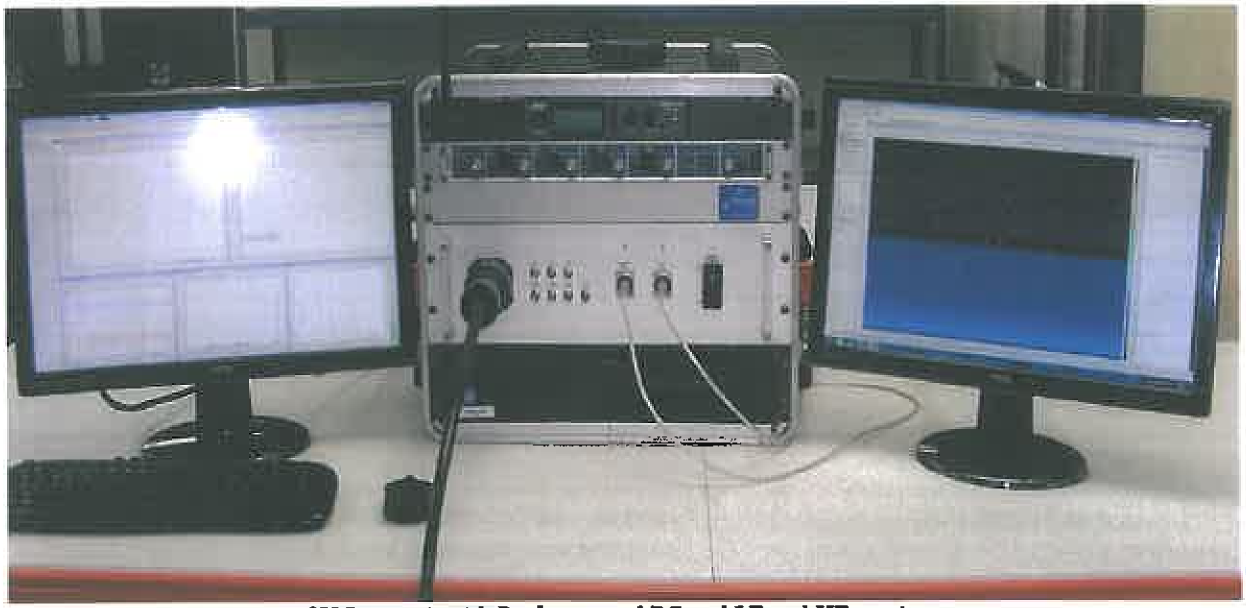
Academic and Government Research Users
Alfred Wegener Research Institute
Duke University
German Navy Research Inst *(through J. Bornhöft Industriegeräte).*
Imfremer
NOAA
St Andrews University
SMRU Ltd
Southampton University

System Outline – Conventional Deployment

The system is designed to give a flexible approach to the monitoring of marine noise from a towed hydrophone system. The system comprises an array cable, tow cable, deck cable, an electronics processing unit and laptops supporting Pamguard software.

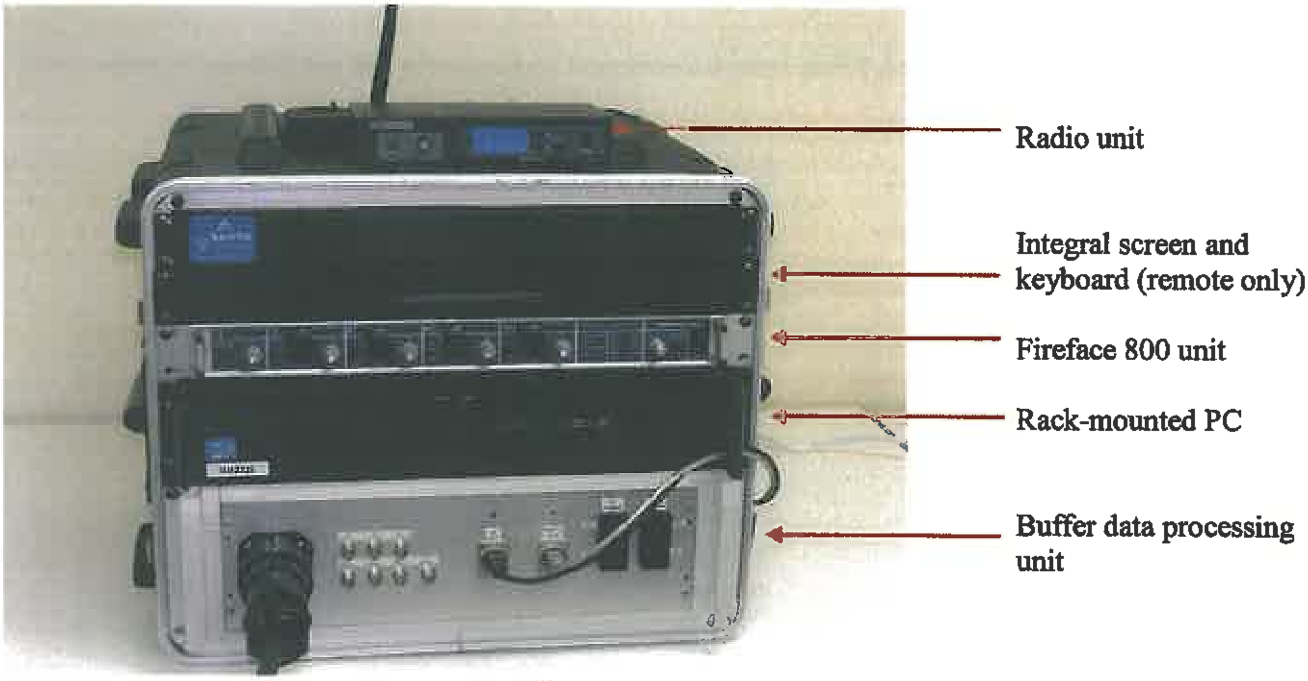
The electronic processing unit contains a buffer processing unit comprising of power supplies, buffer boards, national instrument card for high frequency signal and usb1208 for depth. There is also a radio transmission system that is used to process hydrophone signals for audio output to remote headphones.

There are a number of options for the base monitoring unit which enables a set up to be tailored to a particular vessel.



8U Base unit with Rack-mounted PC and LF and HF monitors

Electronics Processing Unit



Electronics system

Radio unit
The radio system provides a remote headphone output from the audio output system. (Note: it is limited in frequency to 16 kHz)

Integral screen and keyboard
The rack-mounted integral screen and keyboard can be used to run the rack-mounted PC for monitoring or for troubleshooting. It is contained in a 1U housing which slides out and flips up when in use.

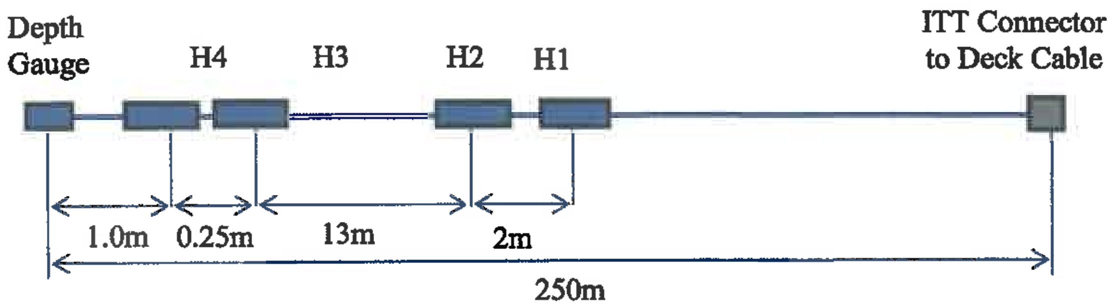
Fireface 800 unit
This unit is used for the low frequency signal. The analog signal from each hydrophone is sent from the back of the buffer data processing unit to the fireface unit. The detected signals are filtered and amplified then fed to the rack-mounted PC via the firewire cable.

Rack-mounted PC
The rack-mounted PC system has an Intel quad core i5 processor with 8 GB of RAM. This custom built PC system has enough power to run both high and low frequency audio data through Pamguard simultaneously from up to 4 hydrophones.

Buffer data processing unit
This unit connects the deck cable into the system and splits the analog signal from up to 4 hydrophones into high and low frequency acoustic data. The high frequency analog signal is converted into a digital signal and is fed via USB to the rack-mounted PC for real time analysis and display. The low frequency analog signal from 4 hydrophones is fed into the fireface unit which is connected to the PC via firewire. The high and low frequency signal can also be listened to using the BNC connectors for troubleshooting. There is a second USB that enables the depth sensor readings to be input to the PC.

Towed sensors

250m Towed Array
The sensor array comprises a 250m array with integral hydrophones and a depth sensor array.



Mechanical Information

Length:	250m
Depth Rating:	100m (not connector)
Diameter:	14mm over cable, 32mm over mouldings, 64mm over connectors
Weight:	60kg
Connector:	ITT 19 pin
BS	500 kg
Cable structure	Polyurethane jacket with steel braid beneath for tow portion of the cable (230m)

Hydrophone elements

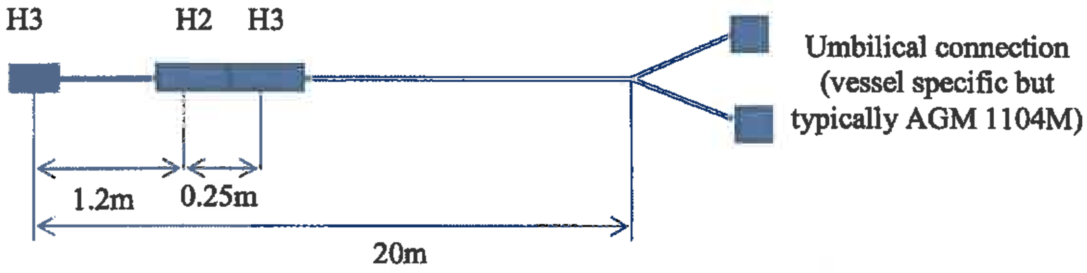
H1	Broadband	1 Hz to 200 kHz (3dB points)
H2	Broadband	1 Hz to 200 kHz (3dB points)
H3	Standard	2 kHz to 200 kHz (3dB points)
H4	Standard	2 kHz to 200 kHz (3dB points)

Spacing H1- H2 (HF detection)	2m	1.28mSecs
Spacing H2 - H3 (HF detection)	13m	8.32mSecs
Spacing H3 - H4 (LF detection)	0.25m	0.16mSecs

Interface unit Array 1 outputs

Broad band channel sensitivity	-166dB re 1V/µPa
Low frequency channel sensitivity	-157dB re 1V/µPa

20m Source Towed Three Channel Array
The source tow system enables the array to be deployed from the airguns making deployment and retrieval much more efficient and substantially reduces the risk of entanglement with the in water seismic gear.



Mechanical Information

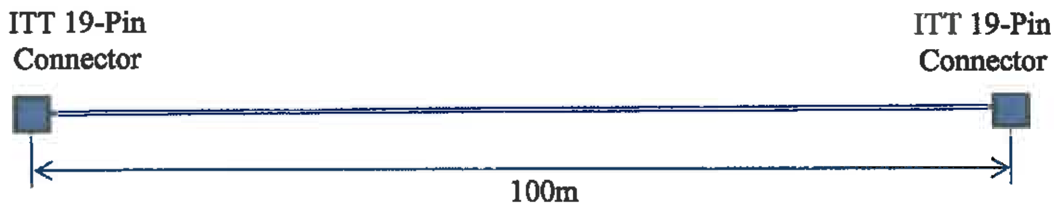
Cable Length:	20m		
Depth Rating:	100m (not connector)		
Diameter:	14mm over cable	32mm over mouldings	38mm over connectors
Weight:	10kg		
Connector:	AGM 1104M 4-way		

Hydrophone elements

H1	Wide-band	1 Hz to 150 kHz (3dB points)
H2	Wide-band	1 Hz to 150 kHz (3dB points)
H3	Wide-band	1 Hz to 150 kHz (3dB points)

Spacing H1- H2 (detection)	0.25m	0.16mSecs
Spacing H2- H3 (detection)	1.20m	0.80mSecs

100m Deck Cable
The deck cable is used for all array options



Mechanical Information

Cable Length:	100m
Diameter:	14mm
Connectors:	19 pin ITT (one male, one female)
Connector Diameter:	64mm
Weight:	25 kg
BS	500 kg

APPENDIX 4

Marine Mammal Mitigation Plan for the KAKA 3D MSS

APPENDIX 5

Sound Transmission Loss Modelling

Curtin University

Centre for Marine Science and Technology

Kaka 3D Seismic Survey Underwater Sound Level Modelling

Prepared for:

OMV New Zealand Ltd

Prepared by: Alec Duncan

PROJECT CMST 1271
REPORT 2013-58

11[h] December 2013

Abstract

This report describes acoustic propagation modelling that was carried out to predict received sound exposure levels from the Kaka 3D seismic survey southwest of Cape Egmont, New Zealand.

Modelling predicted that the Polarcus 2380 cui array operating within the Kaka 3D survey area would produce received sound exposure levels below 186 dB re 1 $\mu Pa^2.s$ at a range of 200m and below 171 dB re 1 $\mu Pa^2.s$ at a range of 1km. Lower received sound exposure levels would be expected if the source was in water deeper than the 100 m water depth modelled here. The survey is therefore expected to meet the requirements of the New Zealand Department of Conservation 2013 Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations.

Contents

List of Figures

1 Introduction

This report describes acoustic propagation modelling which was carried out to predict received sound exposure levels from the Kaka 3D 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 flat area with a small range of water depths.

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

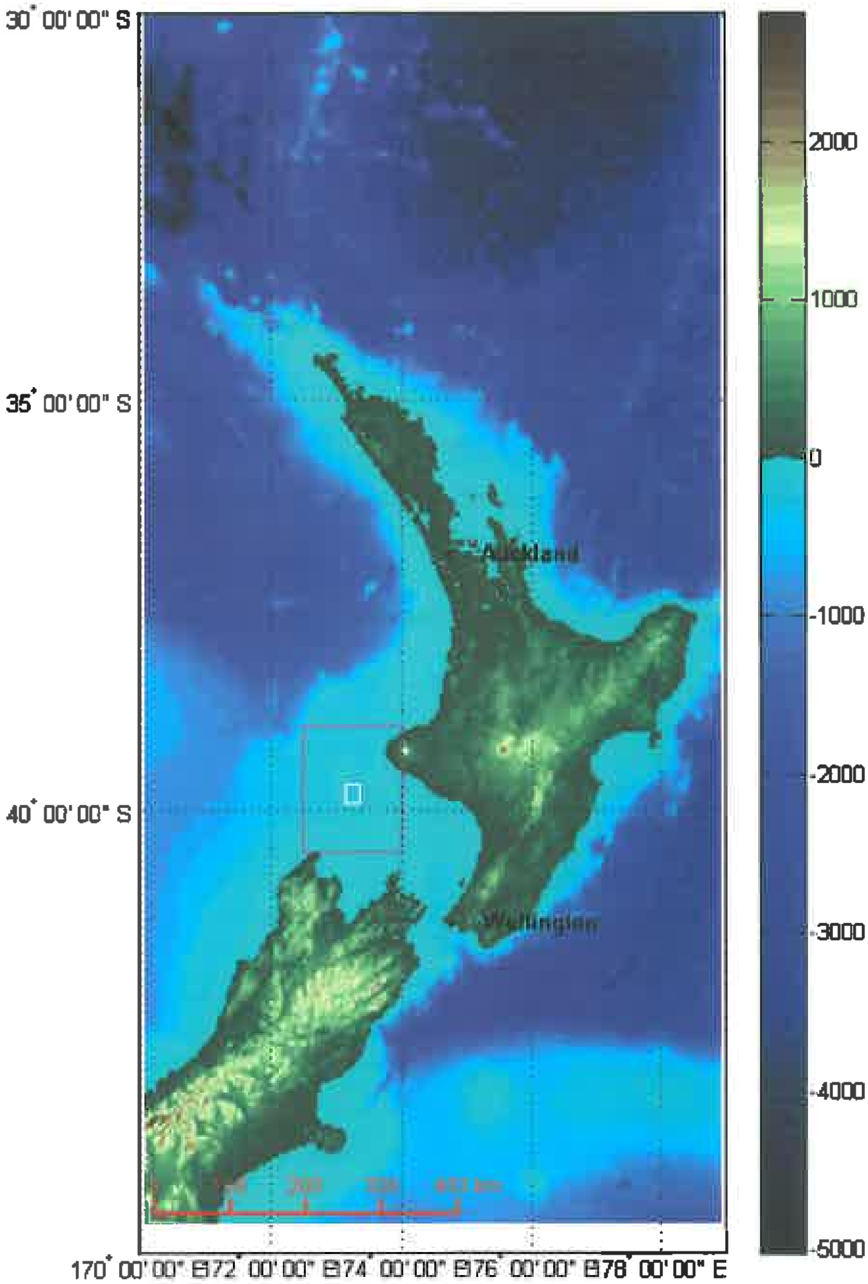


Figure 1. Map of New Zealand showing the survey area (white rectangle). The magenta rectangle shows the bounds of the survey region plotted in the next figure.

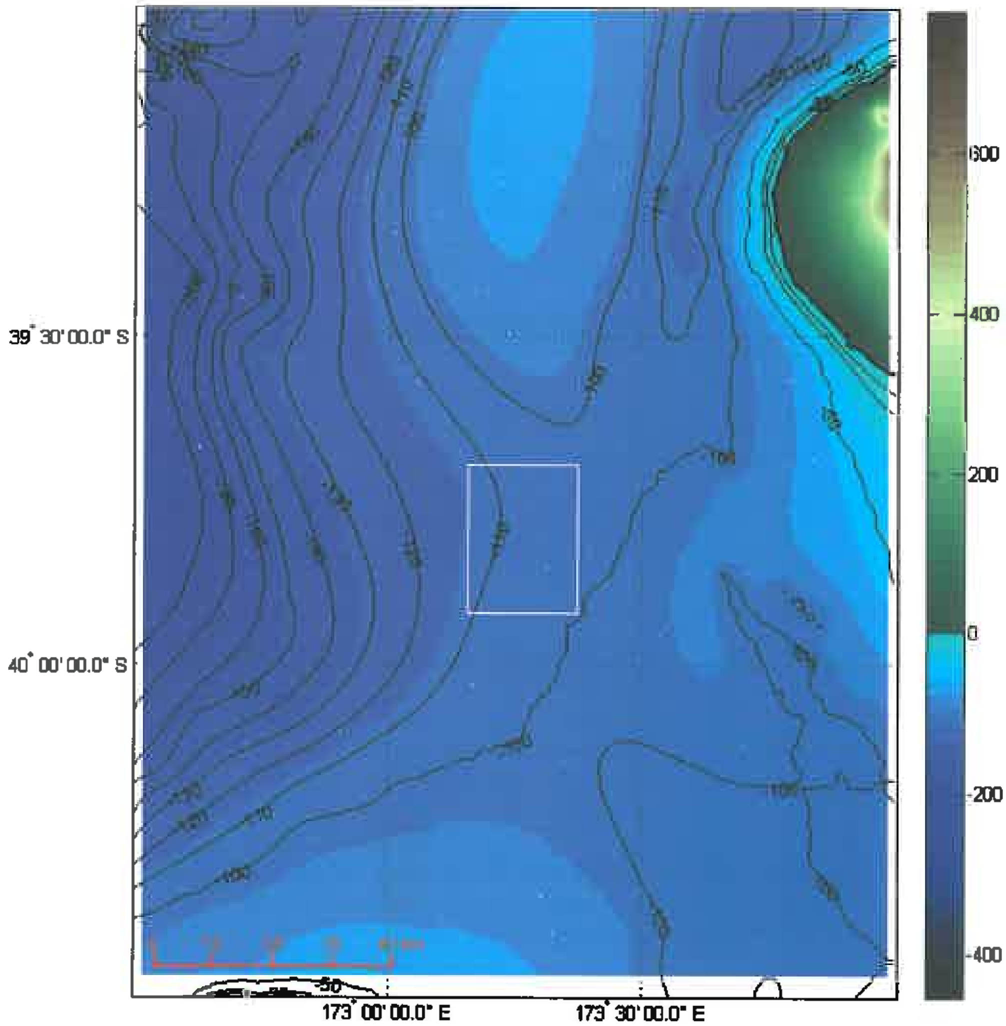


Figure 2. Survey bounding polygon (white) showing detailed bathymetry contours. Bathymetry is from the NIWA 250m elevation and bathymetry database (NIWA 2008)

2 Methods

2.1.1 Source modelling

The airgun array proposed for this survey is the Polarcus 2380 cubic inch array shown in Figure 3, and the proposed source depth is 8m.

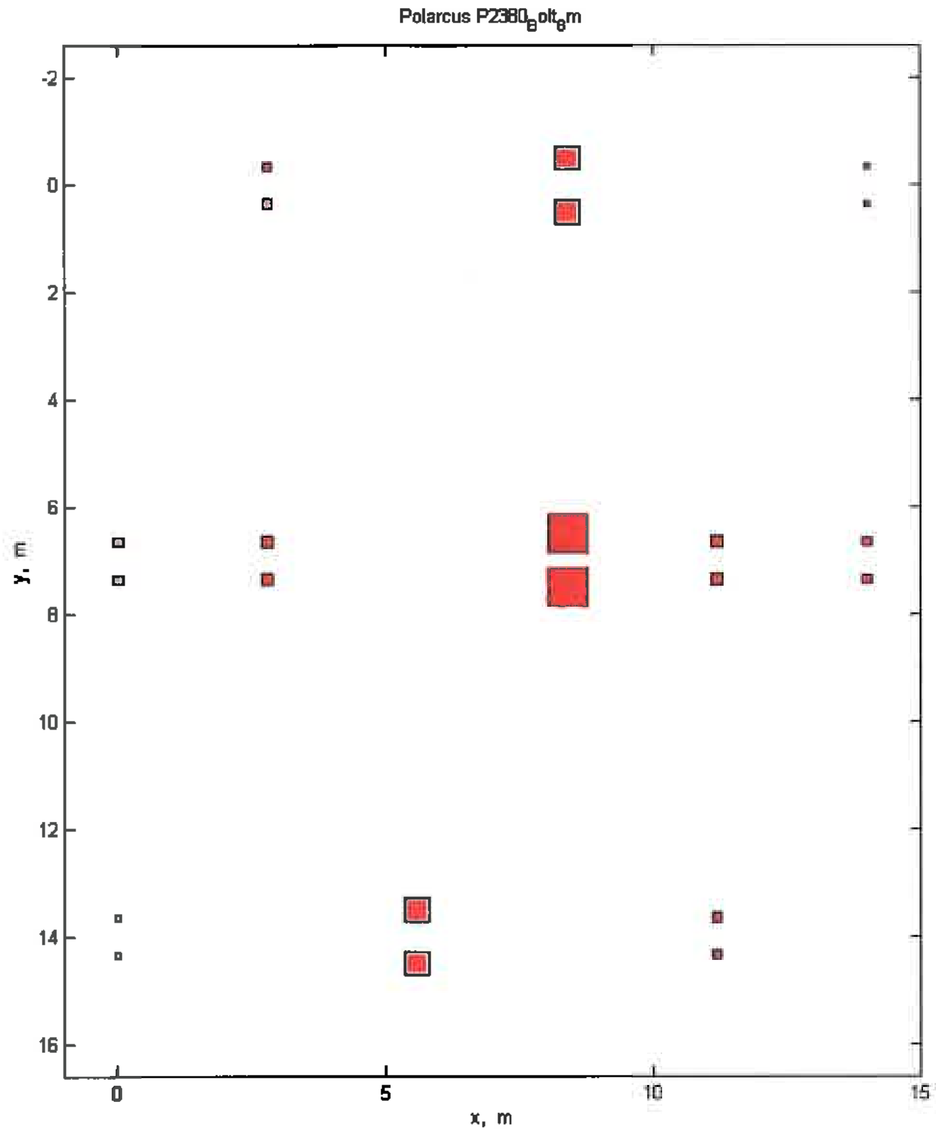


Figure 3. Plan view of the Polarcus 2380cui array. Array elements are shown much larger than actual size but are scaled proportional to the cube root of their volume.

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.

Beam patterns for the calibrated array 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 8 m, which is the intended source depth for this survey, so no correcton was required.

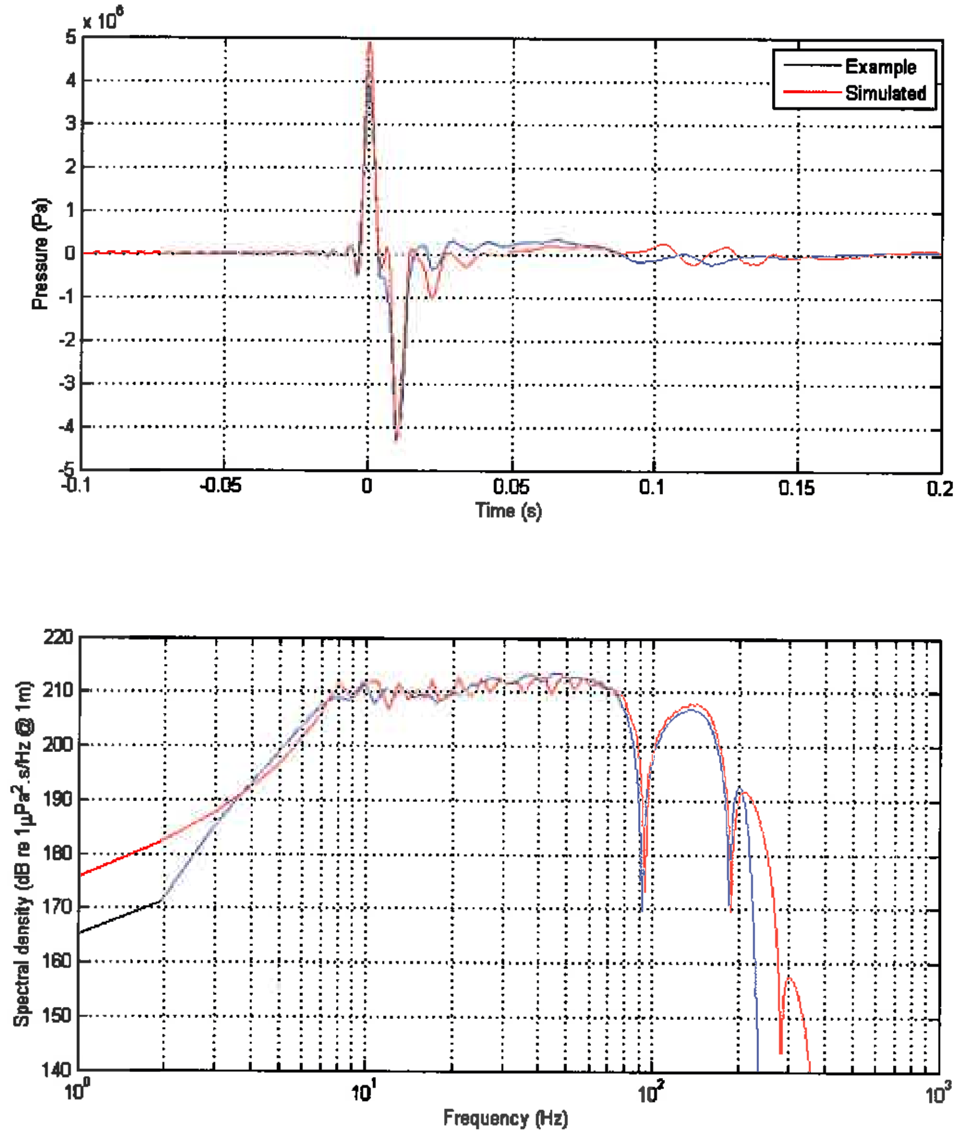


Figure 4. Comparison between the waveforms (top) and spectra (bottom) of the example signal for the vertically downward direction provided by the client (blue) and the signal produced by CMST's airgun array model (red).

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, as is typically the case with airgun arrays, in the horizontal plane the bulk of the high frequency energy is radiated in the cross-line direction.

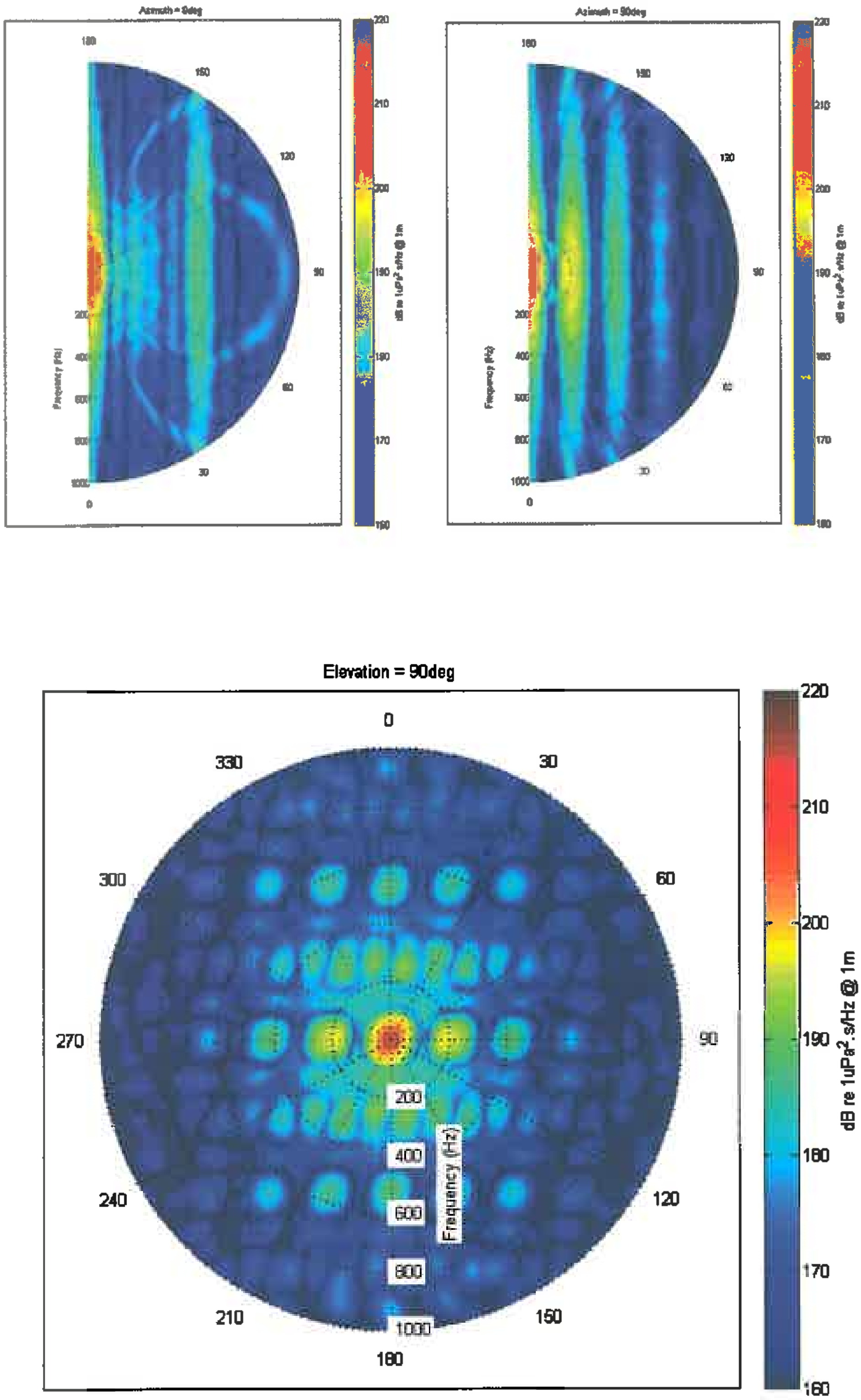


Figure 5. Array far-field beam patterns as a function of orientation and frequency (radial coordinate). The top two plots are for the vertical plane for the in-line direction (left) and cross-line direction (right). Zero elevation angle corresponds to vertically downwards. The bottom plot is for the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

2.1.4 Propagation modelling

2.1.4.1 Water-column properties

A representative sound velocity profile for the summer months of the southern hemisphere was used to obtain the best estimate of the environmental conditions at the time of the proposed survey. CMST's modelling procedure is to obtain a sound velocity profile from the the nearest grid point of the World Ocean Atlas (NOAA, 2005). The same profile is shown on two different vertical scales in the two panels of Figure 6. The profile shows a mixed layer of almost constant sound speed down to a depth of about 20m. Below 20m there is a rapid reduction of sound speed with increasing depth and below a depth of 100m the sound speed is approximately constant with only minor variations.

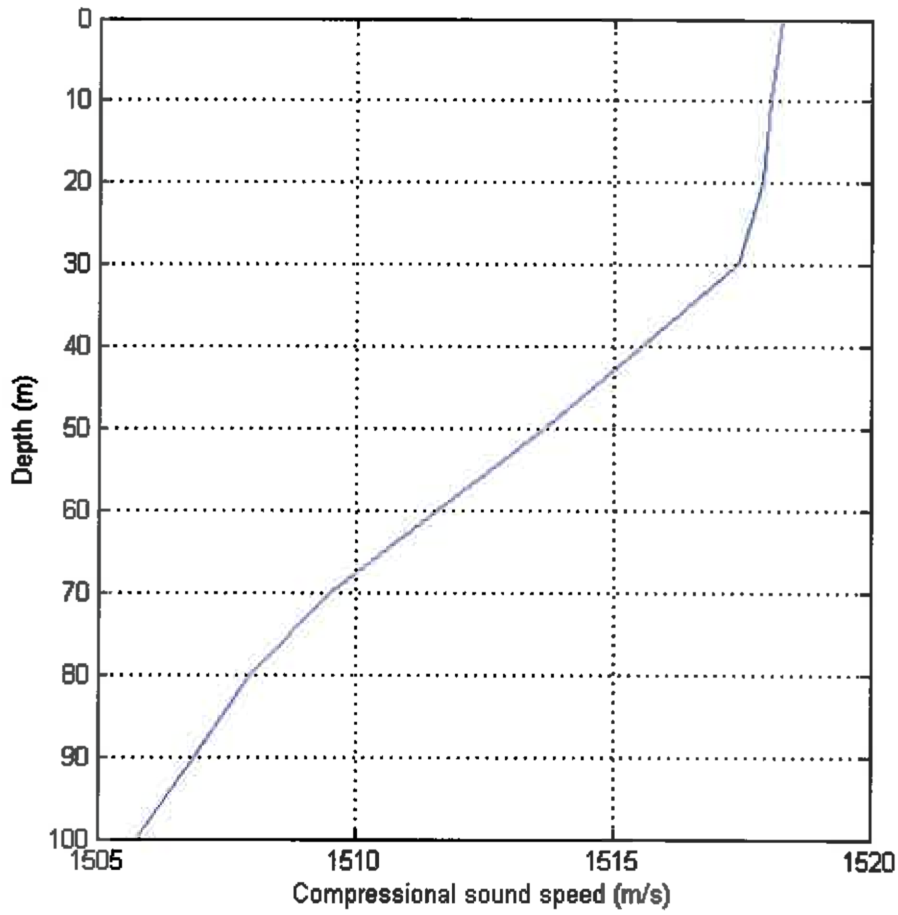


Figure 6. Sound velocity profile obtained from NOAA World Ocean Atlas (southern summer).

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/m^3)	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 the source location with the shallowest water depth in the survey area, which is in the southeast corner, and has a water depth of just over 100m.

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 (8 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 10 and Figure 11 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, ie. azimuths of 90° and 270°. The pronounced skew in these plots is due to the asymmetry of the layout of the guns in the array.

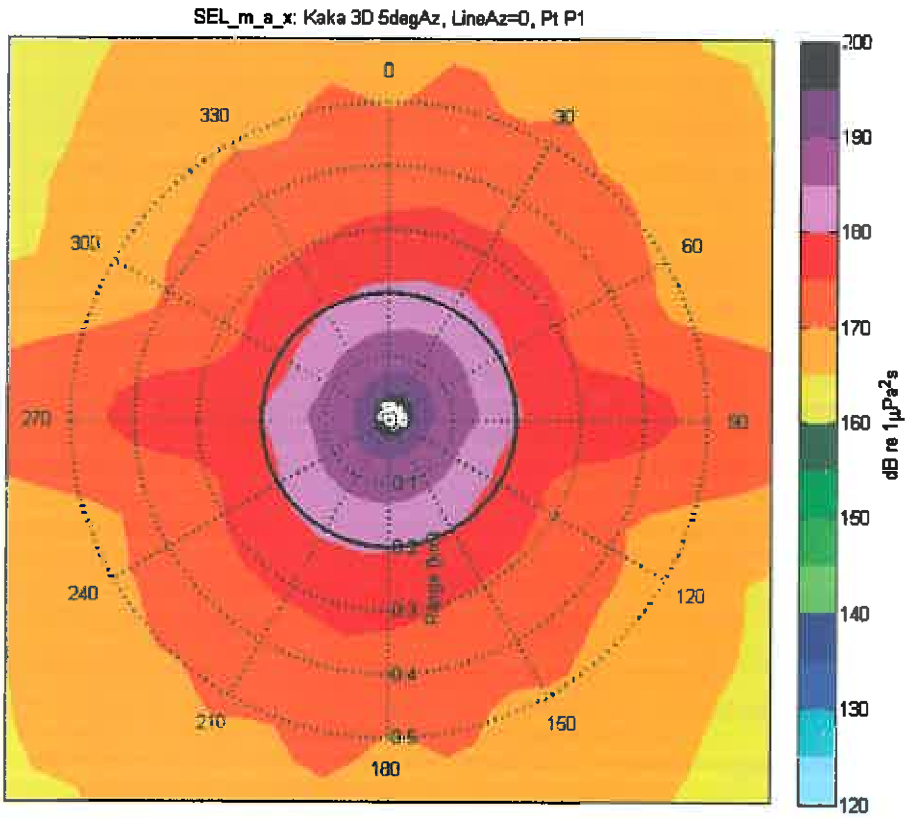


Figure 7. Predicted maximum received SEL at any depth as a function of azimuth and range from the source to a maximum range of 500m. An azimuth of 0° (up) corresponds to the in-line direction. The thick black circle corresponds to the 200m mitigation range.

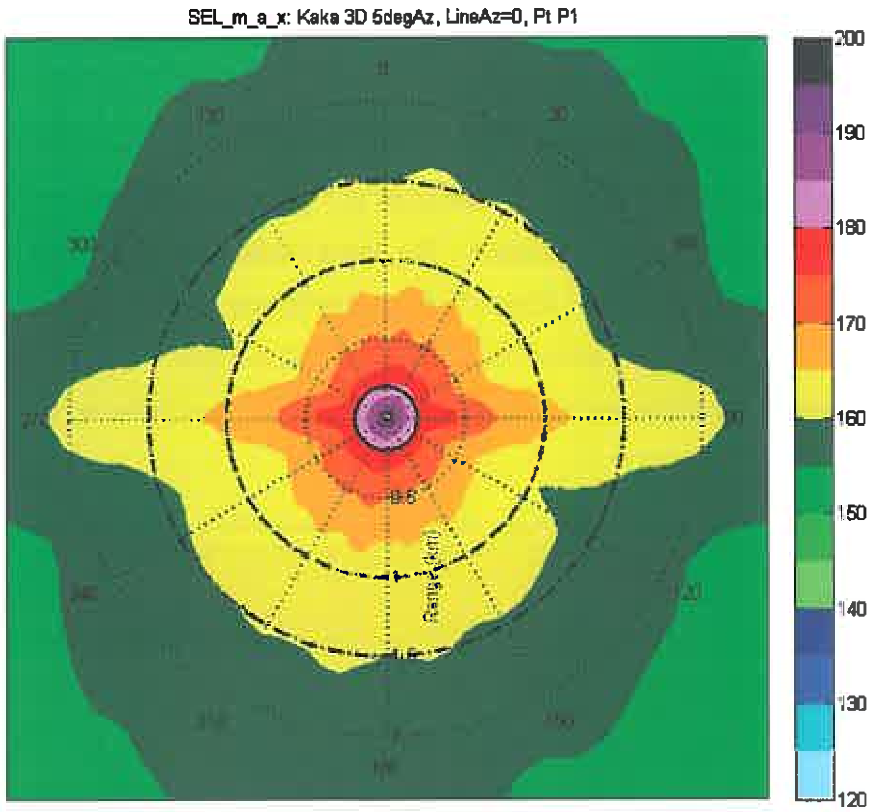


Figure 8. Predicted maximum received SEL at any depth as a function of azimuth and range from the source to a maximum range of 3km. An azimuth of 0° (up) corresponds to the in-line direction. The thick black circle corresponds to mitigation ranges of 200m (solid), 1km (dash), and 1.5km (dash-dot).

Figure 10 presents the modelling results in a concise form by plotting 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 μPa^2.s at a range of 200 m and below 171 dB re 1 μPa^2.s at a range of 1 km.

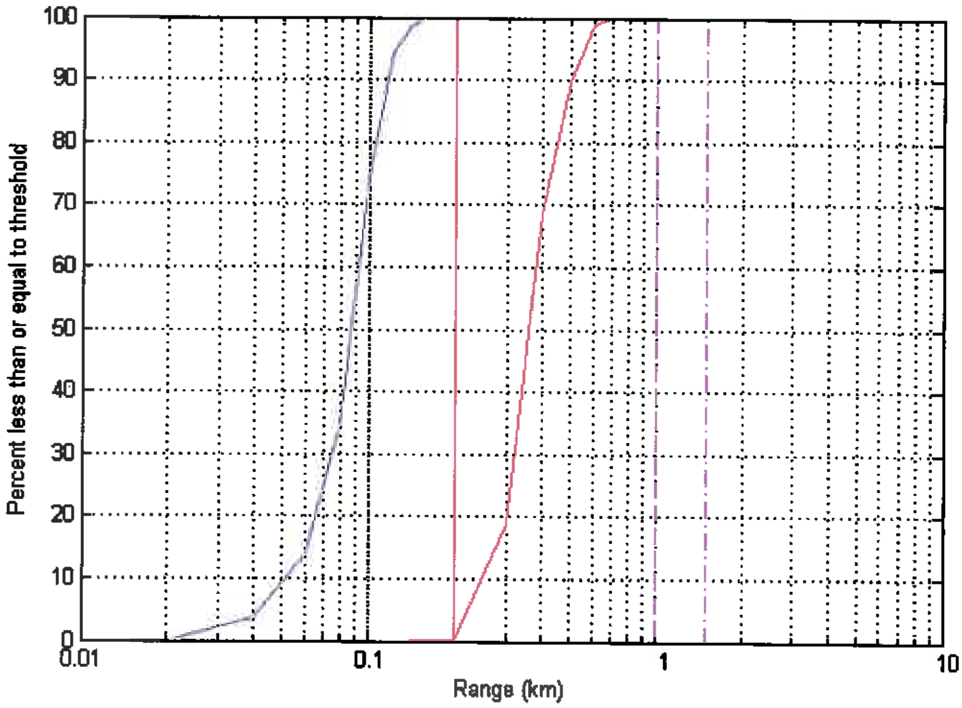


Figure 9. Percentage of received shots below thresholds of 186 dB re 1 μPa^2.s (blue) and 171 dB re 1 μPa^2.s (red) as a function of range. Percentages are calculated over all azimuths and depths.

Figure 14 shows predicted maximum received sound exposure levels in the water column as a function of range. Maximum levels are predicted to be 4.3 dB below186 dB re 1 μPa^2.s at 200 m and 4.7 dB below 171 dB re 1 μPa^2.s at 1 km.

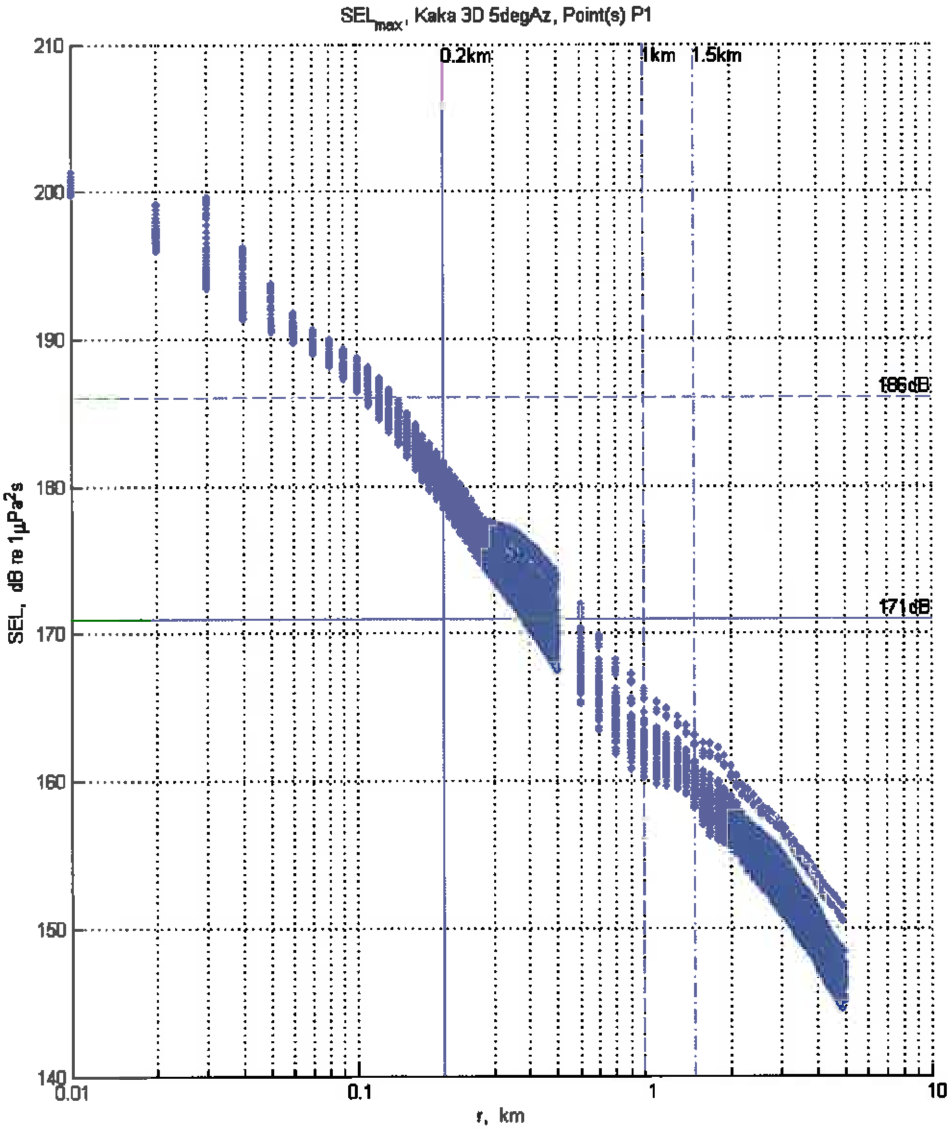


Figure 10. Predicted maximum received level over depth as a function of range for all modelled azimuths. Vertical magenta lines show mitigation ranges of 200m (solid), 1km (broken), and 1.5km (dash-dot). Horizontal green lines show mitigation thresholds of 171 dB re 1 $\mu Pa^2.s$ (solid) and 186 re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

4 Conclusions

Modelling predicted that the Polarcus 2380 cui array operating within the Kaka 3D survey area would produce received sound exposure levels below 186 dB re 1 $\mu Pa^2.s$ at a range of 200m and below 171 dB re 1 $\mu Pa^2.s$ at a range of 1km. Lower received sound exposure levels would be expected if the source was in water deeper than the 100 m water depth modelled here. The survey is therefore expected to meet the requirements of the New Zealand Department of Conservation 2013 Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations.

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Marine Mammal Mitigation Plan

Monitoring and Mitigation for the NZ Environment

Prepared For

OMV New Zealand Limited

RPS

Prepared by:

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DRAFT B	*For Client Review*	*LW*		*13.12.2013*		*13.12.2013*	*13.12.2013*
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Initials

LW: *Lisa Wozniak*

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APPENDICES

1.0 INTRODUCTION

RPS Energy Pty Ltd has been contracted by OMV New Zealand Limited (OMV) to provide independent mitigation services in relation to marine mammal monitoring during the acquisition of the KAKA 3D marine seismic survey (3D MSS) located within the Taranaki Basin, offshore of the southwest coast of the North Island, New Zealand (Figure 1), in Petroleum Exploration Permit (PEP) 51906 and 53537. The purpose built seismic vessel, *Polarcus Alima* will be utilised to acquire seismic data for the expressed purpose of determining hydrocarbon deposits. The estimated duration of the KAKA 3D MSS is approximately 21 days and scheduled to commence in January 2014.

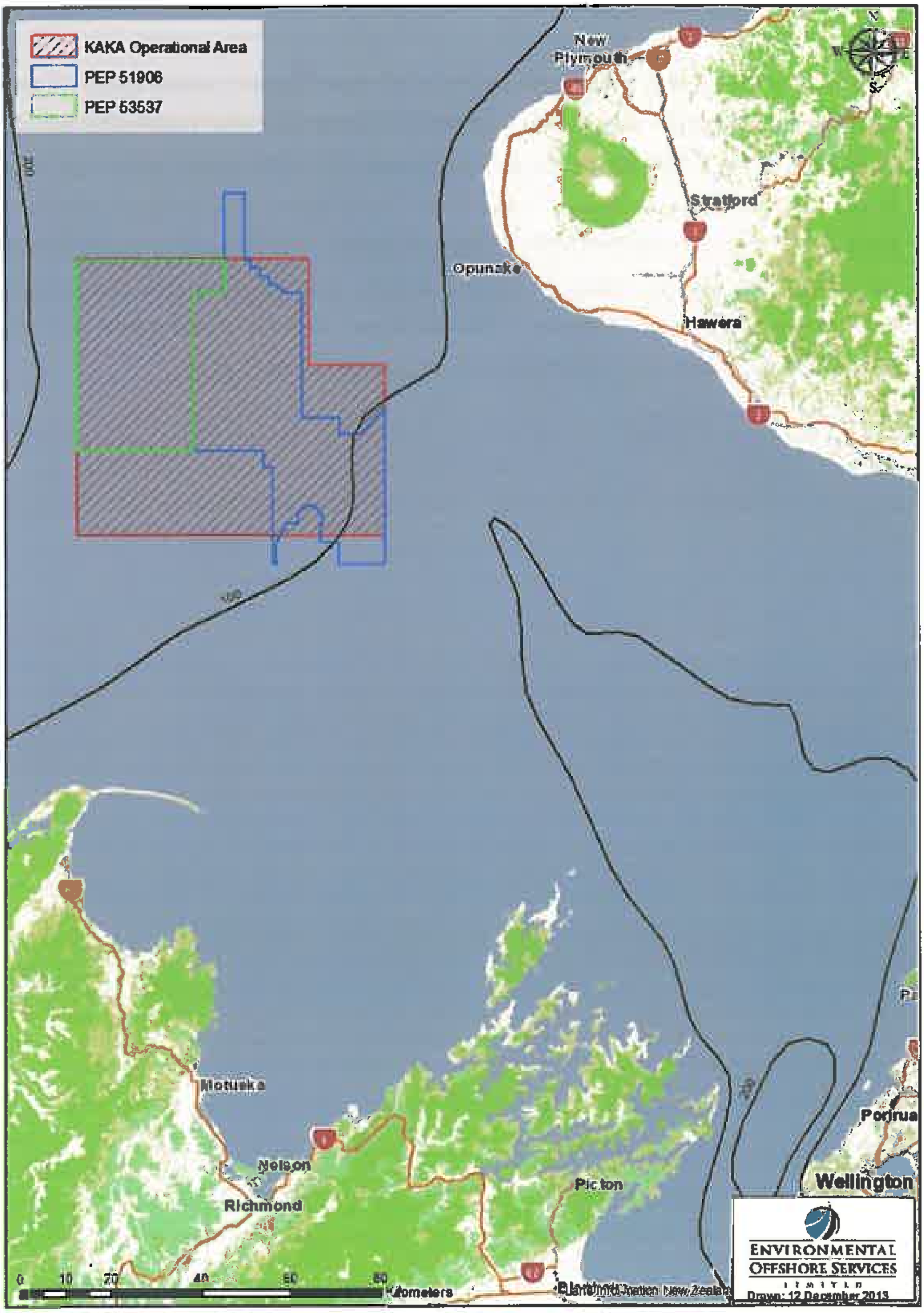


Figure 1: KAKA 3D MSS Operational Area within Taranaki Basin (EOS Ltd, 2013).

The use of a seismic source is required to collect seismic data and during operations introduces sound waves into the marine environment. With the introduction of sound into the marine environment, the potential exists wherein marine wildlife species may be negatively affected and/or disturbed. To reduce the risk of impact and/or disturbance, OMV is committed to implementing the highest level of protection for marine wildlife species during survey operations. OMV have developed additional mitigation measures above and beyond current requirements.

OMV will employ four independent third party observers contracted through RPS Energy Pty Ltd to remain onboard the survey vessel, *Polarcus Alima*, throughout the KAKA 3D MSS. The role of the independent observers is to ensure management measures for the protection of marine wildlife species are adhered to in accordance with the local regulatory requirements issued by the Department of Conservation (DOC) *Code of Conduct - Guidelines for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations* (DOC, 2013) (Appendix 1) and OMV's own company polices for environmental protection. OMV are fully committed to maintaining an exceptionally high level of stewardship and care while operating within the unique and diverse New Zealand marine environment. In demonstration of OMV's commitments to preserving the marine environment OMV shall implement additional mitigation measures above and beyond the *Code of Conduct* (DOC, 2013).

1.1 PURPOSE AND SCOPE: Marine Mammal Mitigation Plan (MMMP)

The purpose of this document is to itemise in detail current legislative requirements for the protection of marine species as related to the undertaking of a seismic survey in New Zealand waters in addition to a full description of management measures, protocols and procedures required for implementation to reduce any associated risks of disturbance to marine wildlife during survey operations.

1.2 OBJECTIVES: Marine Mammal Mitigation Plan (MMMP)

The objectives of the MMMP set forth below are designed to achieve compliance in accordance with local regulatory requirements, OMV's own environmental commitments and any additional mitigation measures required during the proposed project work. Four qualified observers meeting the *Code of Conduct* (DOC, 2013) requirements and approved by DOC to undertake designated roles during the survey include 2 X Marine Mammal Observers and 2 X PAM Operators who will:

- Support OMV in achieving compliance with environmental legislative obligations and OMV's own environmental commitments for marine mammal species protection during the KAKA 3D MSS;
- Provide concentrated monitoring both visually and acoustically for 'Species of Concern' stipulated in the *Code of Conduct* (DOC, 2013) on a 24 hour basis;
- Record all required observational, acoustic and survey data on a daily basis using required DOC customised Excel data forms (Appendix 2);
- Provide detailed reporting on a daily / weekly basis using standardised report forms which capture all pertinent project data (Appendix 3);
- Ensure Seismic Contractor's adherence to the Code of Conduct (2013) for operational compliance during the survey and adherence to this MMMP;
- Immediately reports any non-compliance event to the Director General under the Code of Conduct and this MMMP and provides resolution to prevent any re-occurrence;
- Immediately reports any Hector / Maui dolphin sighting to DOC National office (Ian Angus) and DOC Taranaki Area Office (Callum Lilley &/or Bryan Williams) via phone.
- Immediately notifies the Director General, if MMO or PAM Operator considers that higher numbers of cetaceans and/or Species of Concern than previously predicted in the MMIA are encountered at any time during the survey;
- Produce a comprehensive final report upon completion of the survey describing overall performance and conduct of the survey in accordance with DOC's requirements;
- Provide sound recommendations regarding interactions with marine mammal species and/or additional marine mega-fauna species to further reduce any potential impacts.

1.3 Role of RPS Energy Pty Ltd

RPS Energy Pty Ltd has been contracted by OMV to provide an independent assessment in relation to the overall performance and conduct of the KAKA 3D MSS, specifically for the purpose of compliance monitoring against the Code of Conduct (2013) and this MMMP.

RPS Energy Pty Ltd will deploy DOC 'qualified' and experienced offshore personnel to monitor and mitigate during survey operations in accordance with stipulated regulatory requirements for marine species and OMV's own environmental commitments, while also providing continuous onshore project management support.

2.0 MARINE MAMMAL MITIGATION PLAN – REQUIREMENTS

2.1 Relevant Legislation and Other Guiding Documents

Applicable national legislation for the preservation and protection of marine species and the marine environment during survey operations will include:

- Marine Mammal Protection Act 1978
- Marine Mammal Protection Regulations 1992
- Wildlife Act 1953
- Marine Mammal Impact Assessment (MMIA)
- The Exclusive Economic Zone and Continental Shelf (Environmental Effects-Permitted Activities) Act (EEZ Act 2013)
- *Code of Conduct - Guidelines for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations* (DOC, 2013)
- OMV's HSE Plan

2.2 Marine Mammal Protection Act 1978, Marine Mammal Protection Regulations 1992 and Wildlife Act 1953

The Marine Mammal Protection Act 1978 institutes protection for all whales, dolphins, porpoises and seals from injury, herding, harassment and disturbance. The Wildlife Act 1953 provides protection for all wildlife to include a small number of marine species such as whale sharks and manta rays pursuant to an amendment on 8 July 2010, schedule 7A, by the office of the Minister of Conservation (DOC, 2010). Both Acts are administered by the Department of Conservation (DOC).

An additional requirement under the Marine Mammal Protection Regulations 1992 mandates prompt reporting of any injured or entangled marine mammal species to the Department of Conservation (Appendix 4) and a specific code of practice for non-acoustic related vessel interactions with marine mammals to avoid collision (DOC, 2011).

In the event a marine mammal species is observed injured or entangled or vessel collision with a marine mammal has occurred, DOC shall be notified immediately and a separate report (Appendix 5) providing specific details of the event shall be completed.

EEZ Act 2013

The Exclusive Economic Zone (EEZ) and Continental Shelf (Environmental Effects-Permitted Activities) Act (EEZ Act) came into effect on 28 June 2013. Under the EEZ Act Marine Seismic Surveys are classified as permitted activities provided the activity complies with the *Code of Conduct* (2013).

2.3 Code of Conduct during Seismic Surveys

In accordance with the above legislative requirements, the Department of Conservation has produced the *Code of Conduct – 'Guidelines for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations'* (DOC, 2013) which details specific procedures and protocols designed to reduce any potential impacts to marine mammals during seismic operations which includes:

- 'Qualified' observers maintain continuous visual and acoustic surveillance for marine species, with specific emphasis placed upon "Species of Concern";

- Dedicated, 'qualified' observers will delay or halt seismic operations if any 'Species of Concern' or other marine mammal approaches within relevant mitigation zone(s) 0-1500m of the seismic source;

- Required data on observer effort, operations, sightings / acoustic detections and mitigating actions will be logged daily using DOC's standardised Excel data forms.

2.3.1 Additional Mitigation Measures Required by OMV

OMV have committed to additional mitigation measures above and beyond the *Code of Conduct* (DOC, 2013) in accordance with their internal company policies to ensure safeguard of marine species and the marine environment while undertaking the KAKA 3D MSS and to meet commitments within the Marine Mammal Impact Assessment (MMIA). These management measures include:

1. Qualified Observers will maintain observations for marine species during vessel transit periods to / from the survey area. Any animals observed will be recorded to the appropriate 'Off Survey' forms required by DOC;

2. At any stage during the KAKA 3D MSS whether while in transit or on survey site, if MMOs sight a Hector's / Maui's dolphin, DOC National Office (Ian Angus) and DOC Taranaki Area Office (Callum Lilley and/or Bryan Williams) will be notified immediately by phone. Should key contacts at DOC's National Office or Taranaki Area Office be unreachable; MMO contacts 0 800 DOC HOT (0 800 362 468) to report the sighting event. Critical sighting details to include time, position, number of animals and direction of travel;

3. During the timeframe 21 Jan – 4 Feb, IF MMOs sight a Blue whale NIWA key personnel will be contacted via VHF radio to advise and provide critical sighting details: time, position, number of animals and direction of travel;

4. During the KAKA 3D MSS, if MMOs or PAM Operators consider increased numbers of cetaceans and/or other Species of Concern are encountered than initially described as in the Marine Mammal Impact Assessment (MMIA), the Director-General shall be informed 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 the correct approach;

5. Should any marine mammals strand or wash ashore inshore of KAKA Operational Area along the Taranaki, Wanganui, Manawatu, Kapiti / Wellington and top of the South Island coastline during the KAKA 3D MSS or two weeks following completion, researchers at

Massey University will perform a necropsy in an attempt to determine cause of death.

2.3.2 Management of Additional Mitigation Measures

Numbered items listed in Section 2.3.1 will be the responsibility and monitored by the following personnel to ensure compliance with the requirements as follows:

MMO / PAM Personnel:
Numbered items: 1, 2 and 3.

OMV:
Number items: 3

2.3.3 Seismic Survey Power Levels and Use of Mitigation Source

As stipulated within the *Code of Conduct* (DOC, 2013) sound emissions during the survey should be kept to the minimum levels needed to acquire data while avoiding unnecessary or prolonged activation of the source at higher levels when not collecting data.

Moreover, the *Code of Conduct* (DOC, 2013) does not support nor encourage the use of a small, single airgun (mitigation or low power source) to act as a deterrent to marine species and thus should not be engaged. The combined monitoring effort of both visual and passive acoustic monitoring will provide 24 hours surveillance for species presence. Therefore the seismic source should be switched off entirely at the end of each survey line.

2.3.4 Species of Concern (SOC)

According to the *Code of Conduct* (DOC, 2013), all marine mammals are afforded protection under the Guidelines, however, certain marine mammal species are designated as 'Species of Concern' (Table 1) are afforded a higher level of protection due to the species type and/or species conservation status as follows:

- All whales as defined in the Marine Mammal Protection Regulations 1992:

'Whale means all species commonly known as whales and includes baleen whales, sperm whales, beaked whales, killer whales and pilot whales';

- Hector's and Maui dolphins – on the basis of specific national conservation concern for these species (critically endangered);
- Any additional species recommended for inclusion by the Department of Conservation on a case by case basis as specific concerns arise.

Table 1: SOCs and NZ threat classification (DOC, 2012; 2009).

Baleen whales	**Scientific Name**	**NZ Threat Classification**
Humpback whale	*Megaptera noveangliae*	Migrant
Blue whale	*Balaenoptera musculus*	Migrant
Pygmy blue whale	*Balaenoptera brevicauda*	Migrant
Antarctic minke whale	*Balaenoptera bonaerensis*	Migrant
Dwarf minke whale	*Balaenoptera acutorostrata*	Not Threatened
Sei whale	*Balaenoptera borealis*	Migrant
Fin whale	*Balaenoptera physalus*	Migrant
Southern right whale	*Eubalaena australis*	*Nationally Endangered*
Pygmy right whale	*Caperea marginata*	Data Deficient
Bryde's whale	*Balaenoptera edeni*	*Nationally Critical*
Toothed whales	**Scientific Name**	**NZ Threat Classification**
Sperm whale	*Physeter macrocephalus*	Migrant
Pygmy sperm whale	*Kogia breviceps*	Data Deficient
Dwarf sperm whale	*Kogia simus*	Vagrant
Gray's beaked whale	*Mesoplodon grayi*	Data Deficient
Arnoux's beaked whale	*Berardius arnouxi*	Data Deficient
Cuvier's Beaked whale	*Ziphius cavirostris*	Data Deficient
Strap-toothed beaked whale	*Mesoplodon layardii*	Data Deficient
Southern bottlenose whale	*Hyperoodon planifrons*	Data Deficient
Andrew's beaked whale	*Mesoplodon bowdoini*	Data Deficient
Dense-beaked (Blainsville's) whale	*Mesoplodon densirostris*	Data Deficient

True's beaked whale	*Mesoplodon mirus*	Data Deficient
Gingko-toothed whale	*Mesoplodon gingkodens*	Data Deficient
Hector's beaked whale	*Mesoplodon hectori*	Data Deficient
Pygmy beaked whale	*Mesoplodon peruvianus*	Data Deficient
Shepherd's beaked whale	*Tasmacetus shepherdi*	Data Deficient
Spade-tooth beaked whale	*Mesoplodon traversii*	Data Deficient
Southern right whale dolphin	*Lissodelphis peronii*	Not Threatened
Killer whale	*Orcinus orca*	*Nationally Critical*
False killer whale	*Pseudorca crassidens*	Not Threatened
Pygmy killer whale	*Feresa attenuata*	*Not listed*
Long-finned pilot whale	*Globicephala melas*	Not Threatened
Short-finned pilot whale	*Globicephala macrorhynchus*	Not Threatened
Bottlenose dolphin	*Tursiops truncatus*	*Nationally Endangered*
Hector's dolphin	*Cephalorynchus hectori*	*Nationally Endangered*
Maui's dolphin	*Cephalorynchus hectori maui*	*Nationally Critical*
Pinnipeds	**Scientific Name**	**NZ Threat Classification**
New Zealand sea lion	*Phocarctos hookeri*	*Nationally Critical*

2.3.5 Areas of Ecological Importance

Within the *Code of Conduct* (DOC, 2013) specific areas for marine species are described as Areas of Ecological Importance (AEI) (Figure 2) which includes Marine Mammal Sanctuaries. These areas support a diversity of marine species either on a permanent or seasonal basis and are ecologically important for marine species survival. A list of specific area locations and associated marine species are depicted within Table 2.

The proposed survey area for the KAKA 3D MSS is located within an area of ecological importance. Table 3 outlines the species that have been identified as potentially being present in this area.

Other important areas directly related to marine mammal species are the marine mammal sanctuary zones of which a total of 6 exist throughout New Zealand waters. The North Island maintains one marine mammal sanctuary zone for marine species (Figure 3). The West Coast North Island Marine Mammal Sanctuary provides critical habitat for the critically endangered Maui's dolphin and other marine species. Given the dangerously low population level for the Maui's dolphin estimated at approximately 55 individuals (MPI and DOC, 2013), minimising any impacts to this species are paramount.

Specific activities have had serious impacts upon the survival of the Maui's / Hector's dolphin. Currently restrictions for set net fishing practices (recreational or commercial) have been mandated to provide the highest level of protection for this species (Figure 5) given the Maui's dolphin range and distribution within the shallow coastal / inshore waters of generally < 20 m deep(Figure 6).

Implementation of mitigation measures for 'Species of Concern' within the *Code of Conduct* (DOC, 2013) to reduce any further disturbance impacts will be strictly adhered to and additional mitigation measures to report in the immediate any Maui's dolphin sighting at any stage during the KAKA 3D MSS to both DOC's National Office and DOC Taranaki Area Office. If key personnel at both DOC's office are non-contactable; MMO reports the sighting to 0 800 DOC HOT (0 800 362 468).

Table 2: Areas of permanent and seasonal ecological importance (DOC, 2006).

Permanent Ecological Importance Description of Area	**Latitude Range**	**Species of Concern**
Kaipara Harbour – New Plymouth	36°30' S- 39°4' S	Maui's dolphins
Kahurangi Point – Jackson Head Oamaru – Port Underwood Long Point – Chaslands Mistake	40°46'S - 43°58'S 41°21'S - 45°07'S 46°15'S - 46°38'S	Hector's dolphins
Kaikoura	42°210'S - 42°50S	Sperm and Beaked Whales
Hauraki Gulf	36°00'S - 37°00'S	Bryde's whales
Bay of Plenty East Coast Northland Chatham Rise	36°45'S - 37°45'S 34°40'S - 35°50S 43°00'S - 52°40'S	Beaked whales
Southern New Zealand	45°45'S - 52°40'S	New Zealand sea lion and southern right whales
Seasonal Ecological Importance Description of Area	**Latitude Range**	**Species of Concern & Season**
East coast / Hawkes Bay	37°30'S - 39°40S	Southern right whales

Cook Strait Otago Southland / Stewart Island	41°00'S - 41°35'S 45°20'S - 46°05'S 46°40'S - 47°15'S	(May – Oct for all areas identified)
Central New Zealand East & West Coasts North Island	40°50'S - 42°45'S 35°00'S - 38°00'S	Humpback whale (May - Oct) Humpback whale (Sept – Dec)

Table 3: Species of concern* and other marine mammals which may potentially occur within the survey area.

BALEEN WHALES	TOOTHED WHALES	PINNIPEDS	SCIENTIFIC NAME
Humpback whale*			*Megaptera noveangliae*
Blue whale*			*Balaenoptera musculus*
Minke whale*			*Balaenoptera acutorostrata & Balaenoptera bonaerensis*
Sei whale*			*Balaenoptera borealis*
Southern right whale*			*Eubalaena australis*
Fin whale*			*Balaenoptera physalus*
	Sperm whale*		*Physeter macrocephalus*
	Gray's Beaked whale*		*Mesoplodon grayi*
	Arnoux'sBeaked whale*		*Berardius arnouxi*
	Curvier's Beaked whale*		*Ziphius cavirostris*
	Strap-toothed beaked whale*		*Mesoplodon layardii*
	Southern bottlenose whale*		*Hyperoodon planifrons*
	Andrew's beaked whale*		*Mesoplodon bowdoini*
	Blainsville's beaked whale*		*Mesoplodon densirostris*
	Gingko-toothed whale*		*Mesoplodon gingkodens*
	Hector's beaked whale*		*Mesoplodon hectori*
	Pygmy beaked whale*		*Mesoplodon peruvianus*
	Shepherd's beaked whale*		*Tasmacetus shepherdi*
	True's beaked whale*		*Mesoplodon mirus*
	Hector's dolphin*		*Cephalorhynchus hectori*
	Maui dolphin*		*Cephalorhynchus hectori maui*
	Common dolphin		*Delphinus delphis*
	Killer whale*		*Orcinus orca*
	Long-finned Pilot whale*		*Globicephala melas*

	Short-finned Pilot whale*		*Globicephala macrorphynchus*
	Bottlenose dolphin*		*Tursiops truncates*
	Dusky dolphin		*Lagenorhynchus obscurus*
		New Zealand Fur Seal	*Arctocephalus forsteri*

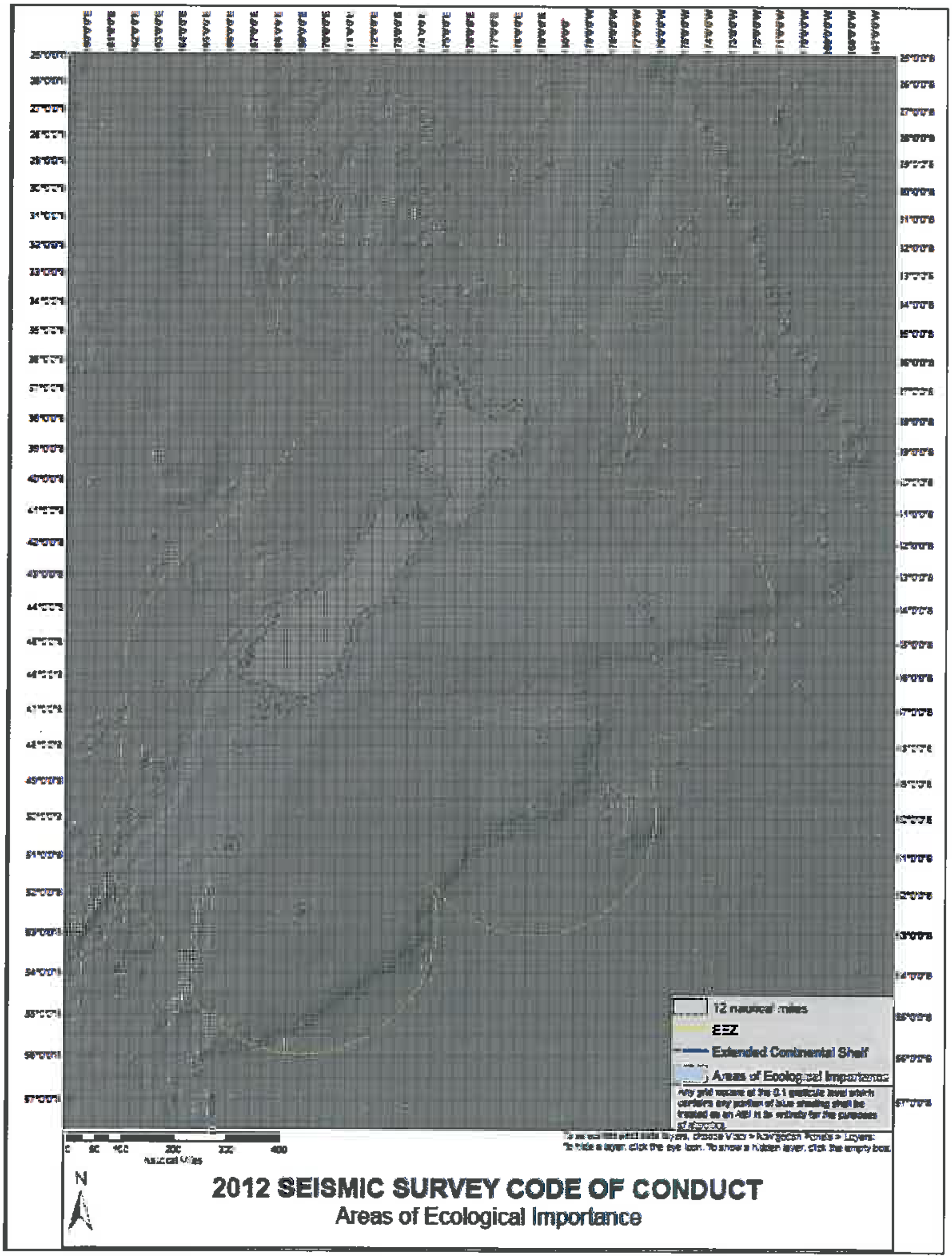


Figure 2: Areas of Ecological Importance (DOC, 2013a)

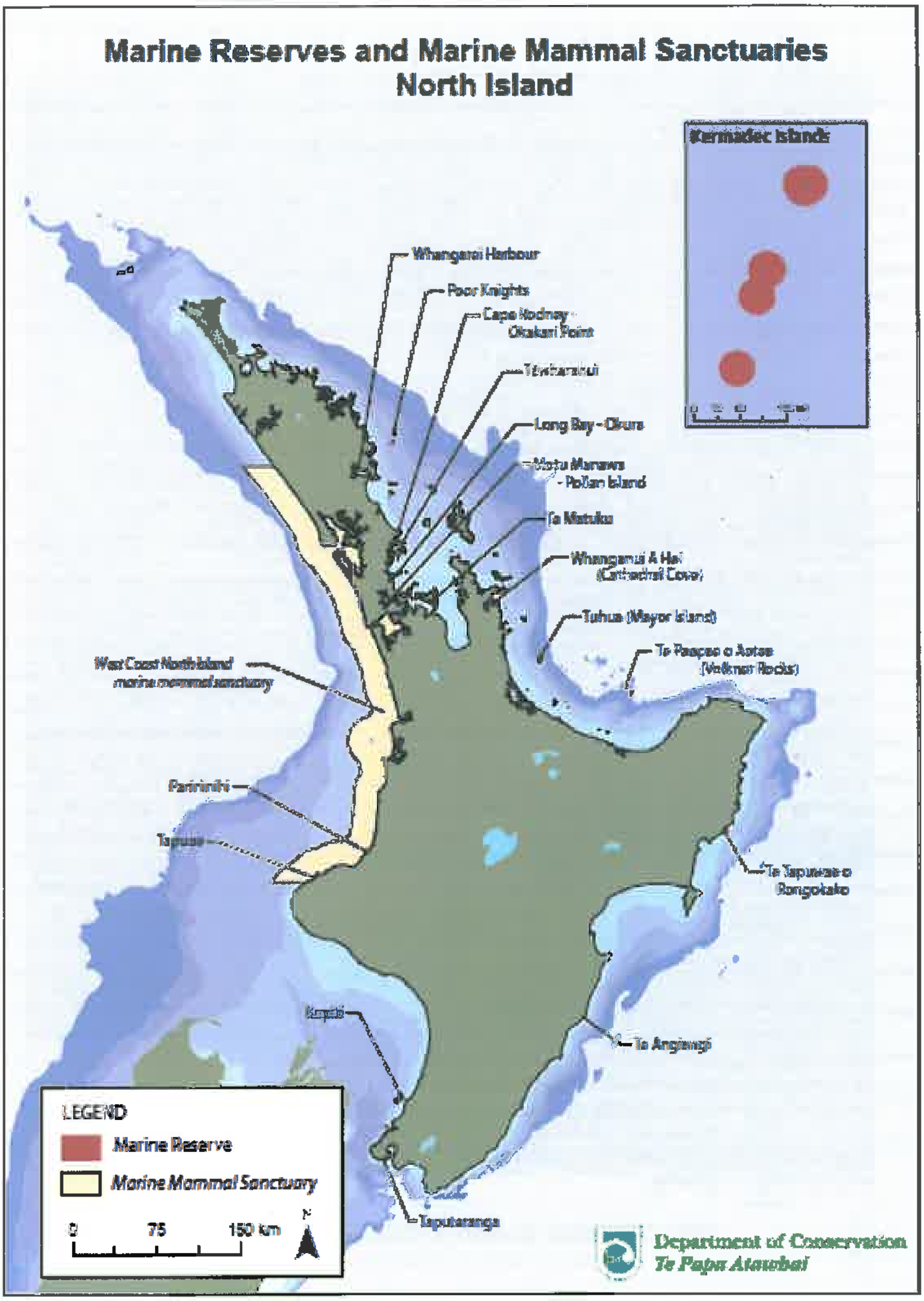


Figure 3: Marine Mammal Sanctuaries and Marine Reserves - North Island (DOC, 2013b)

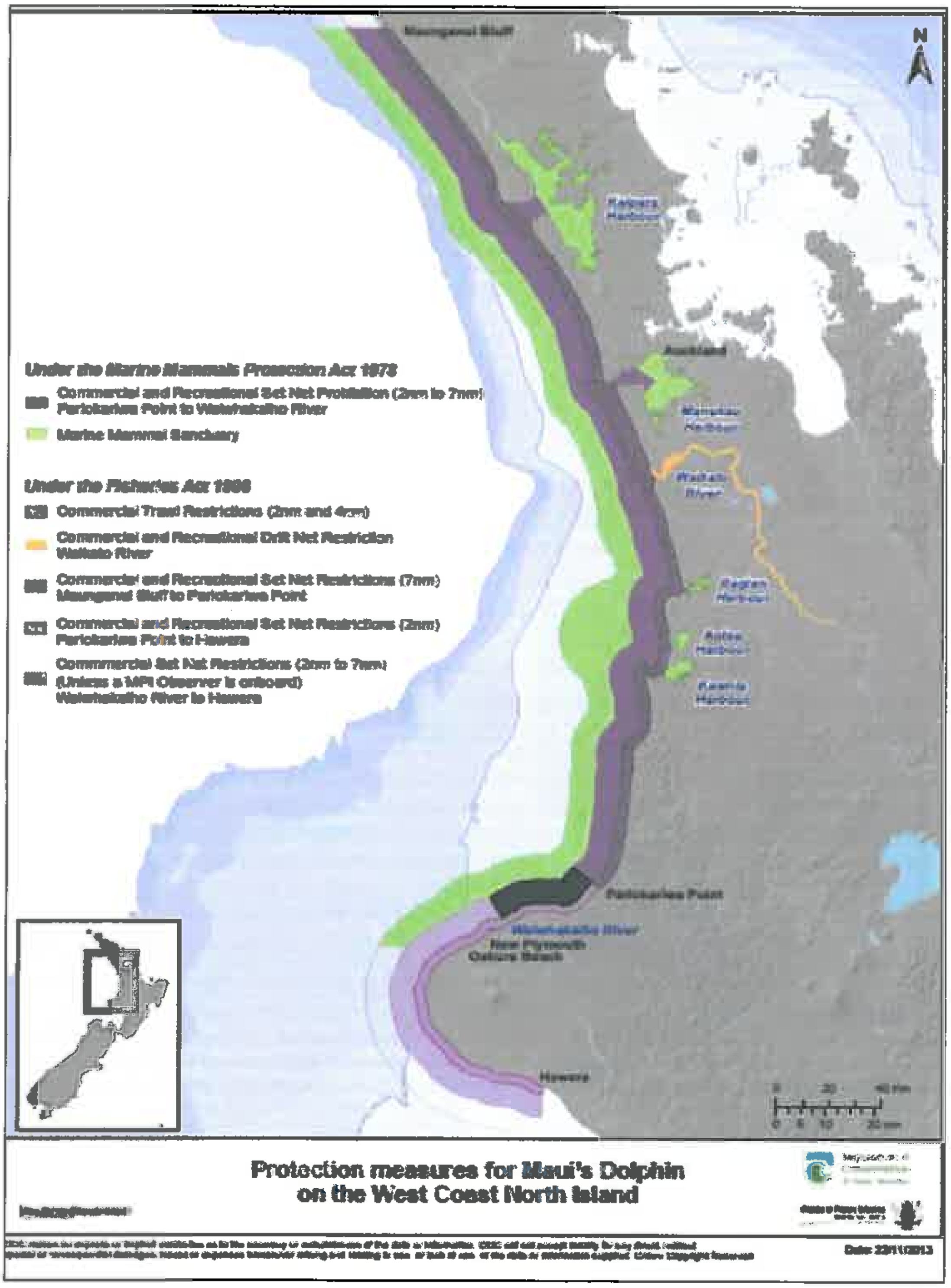


Figure 4: Restrictions of Fishing Activities within the West Coast Island Marine Mammal Sanctuary (DOC, 2013c)

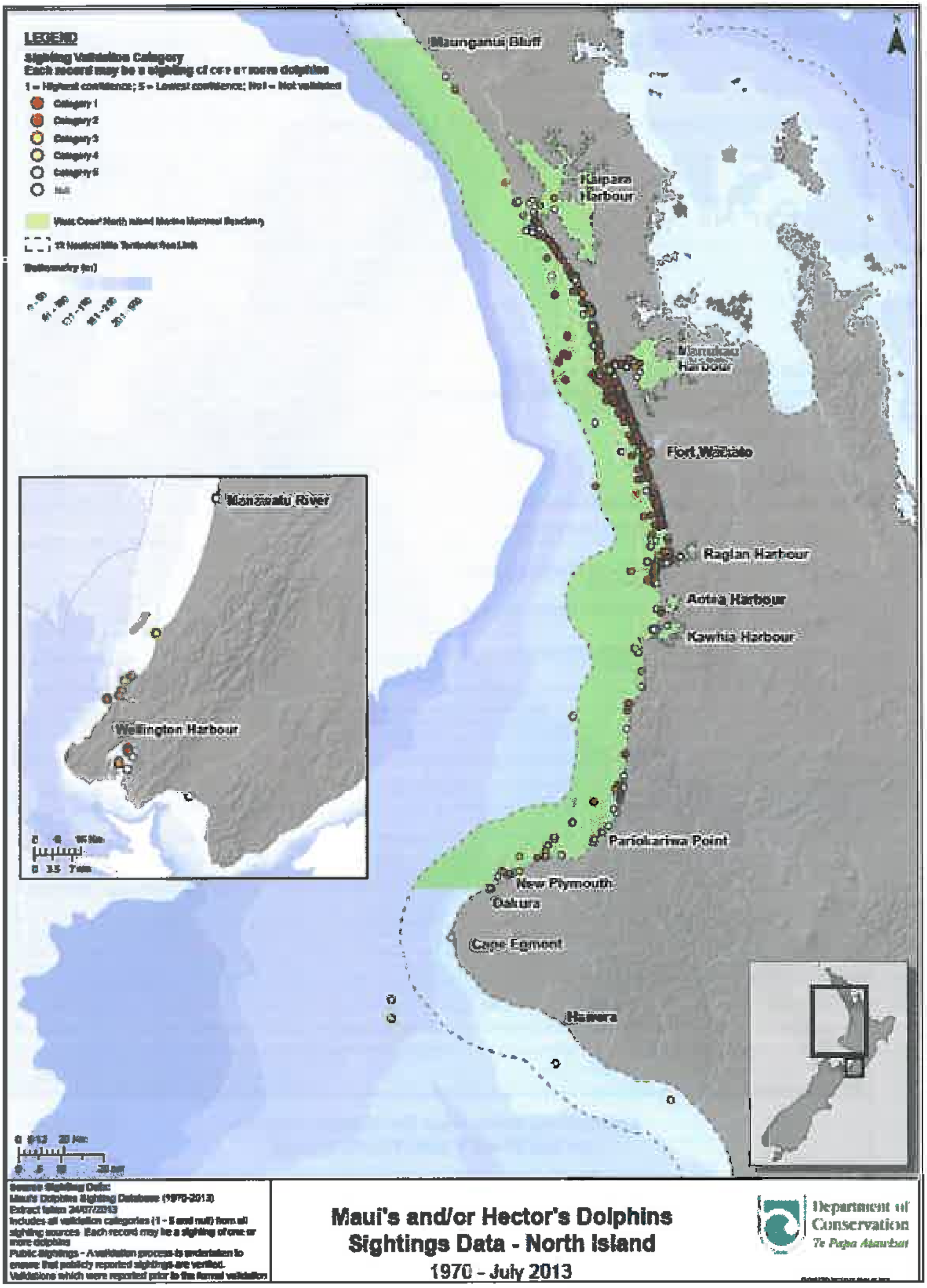


Figure 5: Maui's and/or Hector's dolphin sightings 1970 - July 2013 (DOC, 2013d)

Plate 1: Hector's / Maui's dolphin

3.0 STRUCTURE AND ROLES

3.1 Role of RPS Energy Pty Ltd

RPS has been contracted by OMV to provide qualified and experienced offshore personnel throughout the survey period. The offshore team will consist of the following personnel:

- Qualified MMO – Team Leader
- Qualified MMO
- Qualified Lead PAM Operator
- Qualified PAM Operator

The MMOs and PAM Operators (MMO / PAM Team) will support and advise OMV by providing 24 hour surveillance for marine species detection (visual and acoustic), recording and reporting duties and monitor for compliance in accordance to the *Code of Conduct* (DOC, 2013) and OMV's additional mitigation requirements. The MMO / PAM Team will be supported by the RPS Marine Fauna Operations Manager and RPS administrative support staff for logistics.

The role of the Team Leader will be to supervise the MMO / PAM Team and liaise with the Vessel's Party Chief and OMV Client Representative. The Team Leader will ensure the requirements of this MMMP are maintained throughout the survey. Should deviations occur, it will be the responsibility of the Team Leader to notify key personnel immediately, rectify the situation in communications with the Vessel's Party Chief and OMV's Client Representative.

An organogram depicting lines of communication is shown in Figure 6.

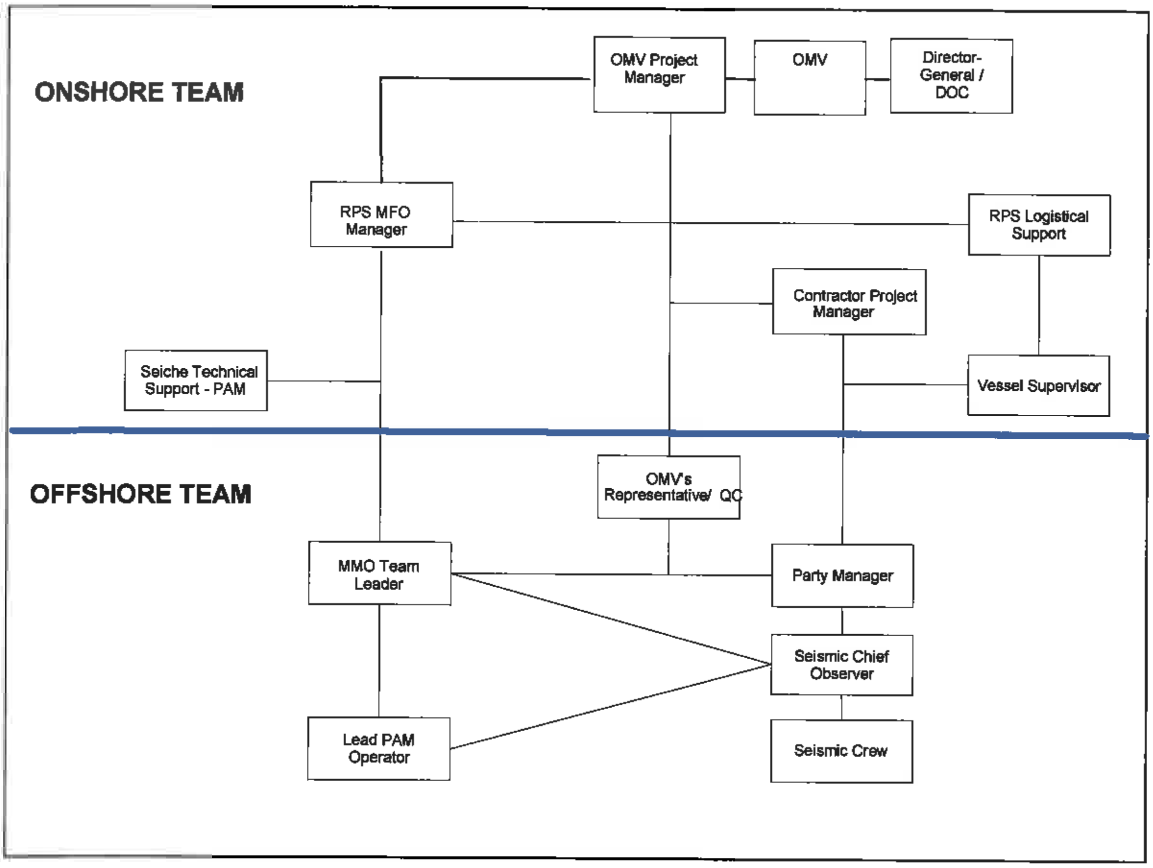


Figure 6: Communications Organisational Chart

3.2 Key Personnel Roles and Responsibilities

For the purpose of marine mammal mitigation and management, staff associated with the survey have the following roles and responsibilities shown in Table 4.

Table 4: Key personnel roles and responsibilities for implementation of this MMMP.

Position	Role / Responsibility
OMV Project Manager	• Ensure all HSE documents are compliant with OMV and the subcontractor HSE processes • Ensure the HSE documents are available for all RPS personnel involved with the survey • Review and endorse this MMMP • Coordinate project resources to achieve compliance with the MMMP • Provide copies of this MMMP to the Client Representative and Party Chief and ensure all roles are known and understood • Ensure compliance with this MMMP following advice and support from RPS Marine Fauna Operations Manager, MMO Team Leader, OMV Client Representative • Ensure all OMV and subcontractor personnel are aware of and support the roles of the MMO / PAM team during the survey. • Assurance of 'in country' back-up PAM system in the event the primary system malfunctions and cannot resume monitoring.
OMV Client Representative	• Ensure the contracting company procedures and operations are consistent with the endorsed MMMP for the project by: • Ensuring that electronic and hard copies of the HSE Plan are available for all RPS personnel • Ensure compliance with the HSE Plan • Implementing and ensuring compliance with this MMMP and Code of Conduct (2013) • Maintaining clear communications between OMV, the RPS Marine Fauna Operations Manager, RPS MMO / PAM Team and the vessel contractor • Monitoring performance against the requirements of this MMMP • Ensure that a suitable observation position is allocated for the MMOs • Ensure that a suitable workstation is available for the PAM Operators • Working with the RPS MMO / PAM Team to receive daily and weekly reports and undertake reviews/audits against this MMMP when required • Communicating the requirements of this MMMP with the appropriate personnel to ensure clear understanding of roles and responsibilities and supply personnel with electronic and hard copy versions • Supporting RPS personnel during undertaking of their responsibilities

	during the survey.
RPS Marine Fauna Operations Manager	• Develop the MMMP for endorsement by the OMV and DOC • Provide qualified and experienced MMO / PAM Team to implement the MMMP during the survey • Provide the necessary resources to allow the MMO / PAM Team to implement the requirements of this MMMP • Liaise with the OMV Project Manager to ensure compliance with the procedures and commitments of this MMMP are met and maintained • Communicate deficiencies identified to the implementation of this MMMP to the OMV Project Manager and OMV Client Representative and ensure corrective actions are implemented wherever necessary • Provide advice and support to the MMO / PAM Team wherever required • Provide a first draft and final report to OMV within two months of survey completion.
RPS Team Leader	• Coordinate the implementation of this MMMP on the seismic survey vessel • Liaise with the OMV Project Manager, OMV Client Representative and Polarcus Party Chief • Provide direction and advice to MMO / PAM Team and key personnel onboard the seismic vessel with respect to implementation of this MMMP • Provide daily and weekly reports collating all required MMO & PAM data to OMV for forward to DOC • Liaise with the seismic survey personnel to identify environmental issues and manage them efficiently and effectively to achieve compliance with this MMMP • Undertake monitoring of the seismic contractor's adherence to the Code of Conduct (2013) ensuring operational compliance and OMV's additional mitigation measures within this MMMP • Communicate deficiencies identified in the implementation of this MMMP to the RPS Marine Fauna Operations Manager, OMV Project Manager and OMV Client Representative and ensure corrective actions are implemented and maintained • Provide and coordinate advice to the OMV Client Representative, Party Chief, Vessel Master and any other contracted personnel as required. • Notifies NIWA via VHF if Blue whale sighted and provides critical sighting details • *Immediately reports any non-compliance event to Director General under the Code of Conduct and this MMMP* • *Immediately reports any Hector / Maui dolphin sighting to DOC National office (Ian Angus) and DOC Taranaki Area Office (Callum Lilley &/or Bryan Williams) via phone. If unavailable; reports sighting to 0 800 DOC HOT (0 800 362 468)*

	• *Immediately notifies the Director General, if MMOs consider that higher numbers of cetaceans and/or Species of Concern than previously predicted in the MMIA are encountered at any time during the survey*
RPS MMOs and PAM Operators	• Provide dedicated visual monitoring duties during daylight hours and during vessel transit periods to / from the survey site • Record all sightings of marine mammals using DOC standardised Excel data forms • Provide dedicated PAM monitoring 24 hour per day throughout seismic operations (PAM) • Record all acoustic recordings of marine mammals (PAM) using DOC Excel data forms • MMOs and/or PAM Operators have the full authority under the Code of Conduct to DELAY or SHUT DOWN operations if marine mammal species are present within the relevant mitigation zone(s); • MMOs and PAM Operators ensure compliance of the survey operations in accordance with the Code of Conduct (2013); • MMOs and PAM Operators to liaise with each other to calibrate range finding of PAM system • Liaise with the Party Chief and seismic crew in communicating start of operations at night (no MMOs on watch) and recording seismic operations • Provide advice to the OMV Client Representative, Party Chief, Vessel Master and any other contracted personnel as required. • Notifies NIWA via VHF if Blue whale sighted and provides critical sighting details • *Immediately reports any failure of PAM to DOC via email as outlined in the Code of Conduct, Section 4.1.2 and this MMMP Section 4.8.* • *Immediately reports any non-compliance event to Director – General under the Code of Conduct (2013) and this MMMP.* • *Immediately notifies the Director General, if PAM Operators consider that higher numbers cetaceans and/or Species of Concern than previously predicted in the MMIA are encountered at any time during the survey.*
Polarcus Vessel Master	• Responsible for the safe operation of the vessel • Comply with statutory regulations and project-specific requirements regarding protection of marine mammal and other marine fauna
Polarcus Vessel Manager	• Confirm the seismic contractor's environmental procedures meet project requirements identified for the survey • Ensures overall compliance with the environmental procedures, including this MMMP required as part of this survey.
Polarcus Party Chief	• Ensure the seismic contractor's procedures and systems comply with OMV's standards as outlined within OMV's HSE Plan and any supporting documents for the survey

	• *Immediately notifies RPS Team Leader, OMV Client Rep and OMV Project Manager IF the seismic source has exceeded stated operational capacity at any stage* • Ensure all contract personnel understand the responsibilities and roles of the RPS MMO / PAM Team • Ensure that all seismic contractor personnel understand their own responsibilities in implementing this MMMP • Ensure a suitable PAM workstation is available for the PAM Operator • Ensure clear and open lines of communications are maintained between the RPS MMO / PAM Team and the seismic crew • Discuss any deficiencies identified by the RPS Team Leader and the OMV Client Representative and assist to maintain corrective actions
Seismic Chief Observer	• Help identify and provide the optimum lines of communication between the seismic crew and MMO / PAM Team • Ensure communications are maintained with the MMO / PAM Team throughout each seismic shift. • Ensure the on shift MMO and PAM Operator are contacted 45 minutes prior to starting the seismic source for any reason • Ensure the on shift MMO and PAM Operator are contacted just prior to initiation of soft start • Ensure the on shift MMO and PAM Operator are notified when the source has reached full operational power • Ensure the on shift MMO and PAM Operator are contacted at any time the status of the seismic source has changed • Ensure shift operations are conducted in line with the Code of Conduct (2013) • *Immediately notifies Vessel Party Chief IF the seismic source has exceeded stated operational capacity at any stage* • Immediately initiate shutdown procedures as requested by the on shift MMO or PAM Operator for marine mammal presence within relevant mitigation zone(s) • Delay soft start procedure as requested by on shift MMO or PAM Operator for marine species presence within relevant mitigation zones • Provide a copy of the Daily Shot Log listing all operational activity of the seismic source for compliance purposes.
Seismic / Navigation Crew	• *Immediately notifies Seismic Chief Observer IF the seismic source has exceeded stated operational capacity at any stage* • Apply the requirements of this MMMP to their respective work areas throughout seismic operations • Attend inductions as directed to meet the requirements of this MMMP

	• Take all reasonable care to ensure their own actions do not cause adverse impacts on marine fauna • Report any sighting of marine mammals to the on shift RPS MMO and immediate supervisor.
Bridge Crew	• Apply the requirements of this MMMP to their respective work areas throughout seismic operations • Attend inductions as directed to meet the requirements of this MMMP • Report any sighting of marine mammals to the on shift RPS MMO.
Ship's Crew	• Attend inductions as directed to meet the requirements of this MMMP.
Chase Vessel Master and Crews	• Attend inductions as directed to maintain an understanding of this MMMP • Report any sightings of marine mammals to the on shift RPS MMO • Comply with statutory regulations and project-specific requirements regarding protection of marine mammal and other marine fauna, particularly best practice procedures to avoid vessel related interactions with marine species.

3.3 Key Personnel Contact Details

Simon Lange – OMV Exploration Manager (Onshore)

Mick Lord – OMV Project Manager (Onshore):

Stan Mikhaylov - Polarcus Vessel Manager: (Onshore)

Lisa Wozniak - RPS Marine Fauna Operations Manager (Onshore):

Duncan MacQueen – OMV Client Representative (Offshore):

Polarcus Vessel Party Chief: (Offshore)

Polarcus Seismic Chief Observer: (Offshore)

Ian Angus - Department of Conservation, National Office Wellington
Iangus@doc.govt.nz
(04) 471 3081 - office

Callum Lilley & Bryan Williams - Department of Conservation, Taranaki Area Office

clilley@doc.govt.nz	bwilliams@doc.govt.nz
(06) 759 7169 - office	(06) 759 7174 - office

Marine Conservation Unit, Department of Conservation NZ
EMERGENCY HOTLINE
0 800 DOC HOT (0 800 362 468)

Director-General, Department of Conservation
P.O. Box 10420, Wellington NZ 6143
Marinemammals@doc.govt.nz

4.0 MARINE MAMMAL MANAGEMENT PROCEDURES

4.1 Project- Specific Inductions

In accordance with this MMMP all participating contractors, OMV personnel and vessel crews will attend a project-specific induction that provides background and objectives to the project and identifies safety concerns associated with the seismic survey. This induction should be carried out by the Seismic Contractor and OMV project management personnel prior to departing the port.

4.2 Pre-Mobilisation Requirements

4.2.1 Staff Training and Offshore Certificates

All MMO and PAM Operator personnel undertaking marine mammal detections, (visual or acoustic), have met requirements and are recognised as 'qualified'. All MMOs have a minimum of three years professional experience and > 12 weeks sea-time in NZ waters; PAM Operators have a minimum of three years professional experience and > 12 weeks international sea-time as required under the *Code of Conduct* (DOC, 2013). All MMO and PAM Operators maintain appropriate certificates for their designated roles, in addition to holding current Basic Offshore Safety Induction and Emergency Training (BOSIET) or Further Offshore Safety Emergency Training Certificate (FOET) and current OGUK or equivalent medicals.

Furthermore, all client representatives maintain same current offshore certificates, Basic Offshore Safety Induction and Emergency Training (BOSIET) or Further Offshore Safety Emergency Training Certificate (FOET) and current OGUK or equivalent medicals.

All RPS Energy Pty Ltd personnel also maintain the required and appropriate offshore personal protective equipment (PPE) to undertake their respective roles.

4.2.2 Preparation of Workstations

The MMO viewing platform will be located on the vessel bridge with access to fly-bridges if required. The viewing platform should be at least 10 m above the sea level (i.e. height of bridge floor plus observer eye height) to optimise viewer capacity. The viewing workstation should include a viewing chair, laptop computer space with immediate access to range-finding binoculars, GPS and camera.

4.3 Communication Protocols

Compulsory communication protocols are to be followed to ensure the effectiveness of implementing this MMMP during the seismic survey. The following protocols describe the timing, personnel required and agendas for dedicated meetings during the survey period:

1. At Start Up and/or Crew Change
   OMV Client Representative, MMO Team Leader and relevant onboard personnel (i.e. Vessel Party Manager) to discuss the implementation of this MMMP and senior contact person to whom all recommended marine mammal related seismic interruptions are to be reported will be identified. Procedures for soft start, start-up delays, and shut-downs should be pre-determined before commencing the survey. A nominated distribution list for receipt of the MMO / PAM daily and weekly reports shall also be compiled.

2. Onboard Daily Operational Meetings
   At a pre-determined time and in accordance with watch schedules, the MMO Team Leader, should be present at the daily operational meetings with the OMV Client Representative and relevant personnel to discuss the previous and future 24 hour operations.

4.4 Operational Procedures and Mitigation

4.4.1 Standard Mitigation and Code of Conduct (DOC, 2013).

The standard requirements for marine mammal monitoring and mitigation in accordance with the *Code of Conduct* (DOC, 2013), shall be implemented as follows:

Upon arrival on survey site:

The standard requirements for monitoring and mitigating shall be implemented by the MMOs and PAM Operators in accordance with the *Code of Conduct* (DOC, 2013) as follows:

1. 30 minutes monitoring visually and acoustically performed prior to the commencement of a soft start; where possible 2 X MMOs to monitor soft start provided this does not result in a health and safety issue

2. Dedicated monitoring with 1 X MMO and 1 X PAM Operator remains continuous at all times source is actively engaged and/or in water (not engaged);

3. During all shift scheduled monitoring periods, MMOs and PAM Operators will not engage in any activities or duties, save for data recording

4. Monitoring for marine species detection (visual and acoustic) focusing on the relevant mitigation zones 0-1500m;

5. Following a Delay and Shut Down Event, both MMOs and PAM Operators must continue monitoring until the species type (i.e. SOC + Calf, SOC or other marine mammal) has:

   4a. been visually observed to exist the relevant mitigation zone OR;

   4b. 30minutes has elapsed since the last sighting within the relevant mitigation zone OR;

4c. 10minutes has elapsed since the last fur seal sighting within the 200m zone.

5. MMOs may stand down from active watch duties during extended periods of poor weather in accordance with procedures outlined in the Code of Conduct Section 3.8.1.

6. No MMO or PAM Operator may exceed a work shift of 12hrs per day at any time during the survey period

7. Specific requirements apply for start up at a new location in poor sighting conditions which include:

6a. MMOs have undertaken observations within 20 nautical miles (nm) of the planned start up position for a minimum of 2.0 hours in good sighting conditions proceeding operations and no marine mammal have been detected;

6b. Where there have been less than 2.0 hours of good sighting conditions within 20 nautical miles of the planned start up position proceeding operations, the source may be activated **IF:**

- PAM monitoring has been conducted for 2.0 hours immediately prior to proposed operations;
- Two MMOs have conducted observations in the 2.0 hours immediately prior to proposed operations;
- No Species of Concern have been detected, visually or acoustically, during the 2.0 hour period immediately prior to the start of operations within the relevant mitigation zone(s);
- No other marine mammals have been detected, visually or acoustically, within the relevant mitigation zone in the 30minutes immediately prior to proposed operations;
- No fur seals have been sighted in the relevant mitigation zone in the 10minutes immediately prior to the proposed operations.

4.4.2 Additional Mitigation OMV's Commitments

As part of OMV's commitments within the Marine Mammal Impact Assessment (MMIA), additional mitigation measures beyond standard measures within the *Code of Conduct* (DOC, 2013) shall be implemented for the duration of the KAKA 3D MSS. The additional mitigation measures encompass the following:

Prior to arrival on survey site:

- MMOs will undertake dedicated monitoring during vessel transit periods to and from the survey site. All observations of marine mammal species will be recorded to the appropriate "Off Survey" DOC data form.

- MMOs will immediately notify DOC National Office and DOC Taranaki Area Office by phone, if a Hector's / Maui's dolphin is sighted and provide critical details to include time, position, number of animals and direction of travel. If key personnel at both DOC offices are not reachable; MMO reports sighting to 0 800 DOC HOT (8 800 362 468)

On survey site:

- MMOs will immediately notify DOC National Office and DOC Taranaki Area Office by phone, if a Hector's / Maui's dolphin is sighted and provide critical details to include time, position, number of animals and direction of travel. If key personnel at both DOC offices are not reachable; MMO reports sighting to 0 800 DOC HOT (8 800 362 468)

- MMOs or PAM Operators will immediately notify the Director General, if the PAM Operator considers that higher numbers cetaceans and/or Species of Concern than previously predicted in the MMIA are encountered at any time during the survey. 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 the correct approach.

4.4.3 Seiche PAM System and Software

The Seiche PAM system is an integrated unit comprising an electronics processing unit, a National Instruments DAQ sound card sampling at 500000 Hz, a ASIO RME Fireface 800 sampling at 48000 Hz and a desktop PC running Intel Core i5 3.30 GHz CPU on Windows 7 OS (Figure 7). The hardware is interfaced with PAMGuard (v1.12.05 BETA) software and displayed on a desktop monitor, while the raw or vetoed acoustic signals are be monitored through a Sennheiser HD 215 pro headset.

A PAMGuard configuration file is created to include a data model comprising low and high frequency sound acquisition from the National Instruments and ASIO Fireface sound cards. NMEA data collection is acquired through the vessels navigation system to provide real time GPS coordinates. An ODBC database logged and stored time stamped positional data for cross reference against sounds heard. Sound processing modules are configured to detect low and high frequency click events and a whistle and moan detector for low frequency delphinid whistles. A real-time scrolling Spectrogram displayed raw acoustic signals and noise from the 0-24 kHz range from 2 hydrophone channels with configured FFT engine parameters (sample rate 48 kHz, FFT length 2048, Frequency resolution 23.44 Hz, time resolution 42.67 ms, time step size 21.33 ms). A bearing radar display indicates positions of whistles relative to the vessel heading. A seismic veto filter is applied to process and remove the noise of full power shot points from the sound output, allowing continuous aural monitoring during source full volume operations.

The four hydrophone elements (Figure 8) have broadband frequency sweep of 1kHz – 200kHz, these raw signals are processed by the low and high frequency sound cards at the appropriate sampling range of 48kHz (LF) and 200 kHz(HF). Further filters are applied via the PAMGuard software to return a detection range of 0-24kHz and 110-150kHz respectively.

The low frequency click detector module is configured to optimise detection of received echolocation clicks transmitting within the 24 kHz range. This contained a two channel trigger threshold function of 11 dB above ambient noise from the raw input data from sound acquisition, a high pass butterworth digital pre-filter of 4000 Hz (order 4) and a digital trigger filter of 6000 Hz butterworth filter (order 6).

The high frequency click detector module is configured to optimise detection of echolocation clicks of ultrasonic vocalising species such as hector's dolphin within the 110 – 150 kHz range. This contained a two channel trigger threshold of 10 dB above ambient noise, a butterworth high pass digital pre-filter of 40 kHz order (6) and a butterworth band pass digital trigger filter set to 110 – 150 kHz (order 6).

Figure 7: Seiche PAM Equipment – Monitoring Set Up with Electronics Stack

The combined suite of modules included in the PAMGuard configuration file ensures a broad range of frequencies (low and high), incorporating a wide range of vocalisations (clicks, whistles, moans, buzzes) can be monitored simultaneously by the PAM operator. Binary data files are collected at regular intervals, and low and high frequency sound recorders allows any acoustic detection to be backed up and stored for post processing and analysis. A map module is configured to display the survey pre-plots within a general bathymetry map with vessel tracking, airgun display, PAM hydrophone array positioning and mitigation exclusion zone with display functions of click trains and click events for localisation using target motion theory.

4.4.4 PAM System – Installation, Deployment and Redudancy

4.4.4.1 Installation

The terminal end of the PAM tow cable is connected to a 100m deck cable which is fed from the starboard auxiliary winch no.1 through cable trays on the gun deck and into the instrument room where it is connected to the PAM monitoring stations electronics processing unit. The PAM receiver unit houses an analogue to digital signal processing unit which receives and converts acoustic signals from the 4 hydrophone elements. The processed signals are then channelled through two sound cards which sample at low (48000 Hz) and high (500000 Hz) frequencies and interfaced through a desktop PC running integrated Pamguard software version 1.12.05 BETA. An additional backup IFAW software suite is available as a back-up which includes Logger 2000, Rainbow Click, whistle Detector, Porpoise Detector and NMEA server. A full system spare including cables and hardware is available as a redundancy to ensure full monitoring capacity throughout the duration of the survey.

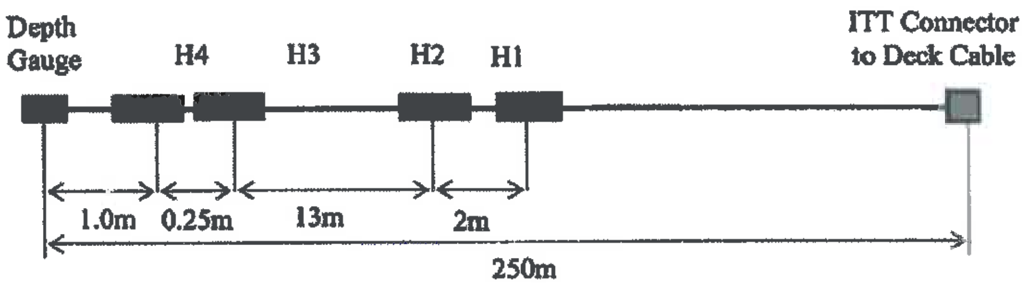
4.4.4.2 Deployment

The Seiche PAM cable is 250m in length and includes a 15.25m four hydrophone element array plus depth sensor at the fishtail end of the cable. The cable is deployed from starboard auxiliary winch no. 1 to a total length of 245.25m and tows at a depth of 20m. The in-water section of the PAM cable is threaded through the spacing between lead-in no. 3 and lead-in no.4. The excess 4.75m of PAM cable is attached to a winch rope by 'chinese finger' and spooled onto auxiliary winch no.1 (Figure 8).

Full deployment/recovery of the hydrophone cable is achieved in less than 10 minutes. A buddy system under full PPE is employed during each instance of cable deployment or retrieval ensuring safe working conditions.

4.4.4.3 Redundancy

Seiche PAM kit are packaged and shipped as fully redundant systems. Thus a full system installed and deployed serves as the 'operational' system whiel a second system identical to the operational systems including deck and tow cables and hardware to give 100 spares for redundancy is available ensuring full monitoring capacity throughout the duration of the survey.



Hydrophone elements

H1	Broadband	1 Hz to 200 kHz (3dB points)
H2	Broadband	1 Hz to 200 kHz (3dB points)
H3	Standard	2 kHz to 200 kHz (3dB points)
H4	Standard	2 kHz to 200 kHz (3dB points)

Figure 8: Sensor positions on the tow cable and raw signal frequency ranges of the four sensors (Seiche, 2013).

Figure 9: Seiche PAM deployment.

4.4.5 PAM Operations

Prior to the start of and during the seismic operations, dedicated PAM Operators will monitor 24 hours covering both day and night time periods. During daylight hours if cetaceans are detected, the PAM Operator will notify the on shift MMO of the detection. The on shift MMO will immediately attempt to locate the animal(s) (if not submerged) and provide estimated distance and bearing to the animal to achieve concurrent visual and acoustic detections.

The PAM Operators will use headphones to listen for sperm whales, baleen whales and other odontocete echolocations and monitor the spectrogram software to confirm sounds at the appropriate frequency. All cetaceans detected will be classified into broad groups and where possible to species based on their unique acoustic characteristics. Some cetaceans, such as Sperm whales, can easily be identified and tracked acoustically due to their unique and frequent echolocations. *Cephalorhynchus* spp dolphins also produce distinct vocalisations including ultrasonic, narrow-banded echolocation clicks at approximately 129 kHz (Kyhn *et al.*, 2009) and have an obvious waveform and power spectrum. The PAM system uses a high frequency National Instruments sound card, which samples up to 500,000 samples/second and is suitable for detecting a large range of sounds.

Based on echolocation detection, PAMGUARD modules will be used to track and determine location (range, bearing and error) of whales. If the PAMGUARD data indicates with high confidence that the animal is approaching or within the relevant mitigation zone(s), the PAM Operator will request a Delay or Shutdown in accordance with this MMMP and the *Code of Conduct* (DOC, 2013).

The PAM Operator will attempt to determine whether the acoustic detection is a Species of Concern, however, if there is reasonable doubt that the animal is not a Species of Concern and the animal is within the relevant mitigation zone(s), the PAM Operator will seek confirmation with the on shift MMO. A precautionary approach should be applied when determining appropriate mitigation protocols and consider factors such as recent sighting frequency of Species of Concern.

Screen grabs and acoustic recordings (.wav files) will be saved and backed up on external hard drives during the seismic survey. All relevant data including acoustic detections, movement patterns and mitigating actions will be entered into the standardised DOC Excel data forms.

4.4.6 PAM Operations and System Failure

The *Code of Conduct* (2013), Section 4.1.2 mandates specific requirements and timeframes for trouble-shooting or the repair of PAM in relation to seismic operations:

If the PAM system should malfunction or becomes damaged operations may continue for 20 minutes without PAM, while the PAM Operator diagnoses the issue. If the diagnosis indicates the PAM gear must be repaired to resolve the issue, operations may continue for 2.0 hours without PAM monitoring provided 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 within the previous 2.0 hours;
- Two MMOs maintain watch at all times during operations when PAM in 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 4.0 hours in any 24 hour period.

4.4.7 Pre-Start Observations

MMOs, PAM Operators and seismic crews will follow defined protocols for start of operations following completion of the required 30minute monitoring period (Appendix 6).

All pre-start observations required by the MMO and PAM Operator will follow in accordance to the standard mitigation requirements outlined within Section 4.1.3 of the *Code of Conduct* (DOC, 2013) for Level 1 surveys which includes:

Visual and acoustic monitoring will be undertaken simultaneously 30 minutes prior to soft start procedure to ensure no cetaceans are present within the relevant mitigation zone(s) and to ensure no fur seals are present 10 minutes prior to soft start within the relevant mitigation zone.

Soft start procedure can only commence once both the on shift MMO and on shift PAM Operator confirm to the seismic operator, that no Species of Concern or other marine mammals are present within the relevant mitigation zone(s), ensuring it is safe to commence a soft start procedure.

4.5 Soft Start Procedure and Seismic Operations

A soft start procedure is aimed to provide sufficient time for marine mammals which may be in the area time to move away from source before the source reaches full operational output. The soft-start procedure involves gradually increasing the emitted sound levels of the seismic source by systematically activating the source array from lowest volume level to full operational volume over a specific period of 20 - 40 minutes. All soft start procedures will follow in accordance to the *Code of Conduct* (DOC, 2013) as outlined within Section 3.8.10 for Level 1 survey as follows:

1. Soft start should occur between 20 - 40 minutes to reach full operational capacity. If there is a problem during the soft-start (e.g. technical issue with airguns) and the 40 minute period is exceeded, it is preferable to extend the soft-start period rather than shut down. However, if the problem is severe and cannot be readily rectified the source should be shutdown to minimise excessive input of sound into the marine environment;

2. Visual and acoustic monitoring will be maintained continuously during soft-start and all seismic source operations to detect marine mammals;

3. Once seismic operations are underway, if a Species of Concern is visually or acoustically detected within the relevant mitigation zone(s), the on shift MMO or on shift PAM Operator will notify immediately the seismic crew to shutdown the source;

4. Both the on shift MMO and PAM Operator will continue to monitor / track marine mammals during the shutdown period;

5. Either the on shift MMO or PAM Operator will notify seismic crews providing an "All Clear" indicating it is safe to re-commence operations with a soft start procedure.

6. MMOs or PAM Operators will continually monitor all source operations, ensuring compliance to the Code of Conduct and stated operational capacity of the source is not exceeded at any stage.

7. MMOs and PAM Operators shall record during monitoring periods, time soft start begins and time array reaches full power, time Start of Line (SOL) and time End of Line (EOL) to allow cross referencing of source operations to the Daily Shot Log provided by Seismic Observers

8. MMOs and PAM Operators will ensure any break in source firing of ≥ 10minutes, shall required a full soft start procedure and no marine mammals in the relevant mitigation zone(s) in order to resume survey operations.

4.6 Source Testing

In accordance with the *Code of Conduct* (DOC, 2013), Section 3.8.8, all testing of the seismic source will follow a soft start procedure, though, the 20 minute minimum duration shall not apply. However, where possible, testing of the source shall include a gradual build up of the source output to the required test level but not be conducted at a faster rate than a normal soft start procedure.

The required 30 minute Pre-Start of Observation period (visual and acoustic) shall apply prior to all seismic source testing. If a marine mammal (includes Fur seals) is detected within the relevant mitigation zone(s) during the pre-start observational period or during testing, the required Delay and Shutdown procedures applicable to species type (i.e. SOC + Calf, SOC and other marine mammal) will be immediately implemented by the on shift MMO or on shift PAM Operator.

4.7 Line Turns and the Mitigation Source

In accordance with the *Code of Conduct* (DOC, 2013), the use of a small, single airgun during line turns for Level 1 surveys is not supported nor recommended and thus should not be undertaken. TAB

4.8 Recording and Reporting

Both the MMO and PAM Operators will log all required observational / acoustic data outlined within Appendix 2 of the *Code of Conduct* (DOC, 2013) using the standardised DOC Excel data forms (Appendix 2), including inclusion of true sighting plots for cetaceans inserted within the DOC Marine Mammal Detection Form. Differentiation is required for sighting and/or acoustical detections occurring either on or off the survey site. Thus the use of both the ON SURVEY and OFF SURVEY DOC Excel data forms will be strictly followed. The OFF SURVEY forms will be used during vessel transit periods to / from the project survey area and/or during any other periods when outside the operational survey area. The ON Survey forms will be used when inside the operational survey area.

The DOC datasheets must always have macros enabled to function properly and cut and paste should never be used with these spreadsheets. Additionally, it is recommended to not use the DOC Excel data forms on any Apple computers.

The MMO Team Leader will provide Daily and Weekly reports respectively to OMV for forward to Department of Conservation (Appendix 3). The distribution list for other key personnel on the project to receive reports shall be nominated by OMV at project start up.

Upon completion of the Kaka 3D MSS and within the required two week period, the standardised raw DOC Excel data forms (Off Survey & On Survey) shall be submitted to the Director General in accordance with Section 3.5 in the *Code of Conduct* (DOC, 2013).

Moreover, upon completion of the survey a comprehensive final MMO and PAM trip report collating all required project data as outlined within Appendix 2 of the *Code of Conduct* (DOC, 2013) will be submitted. The final report shall be delivered to OMV for forward to the Director General within the required two month period.

4.9 Compliance Reporting to the Department of Conservation

Any non-compliance event in relation to this MMMP and/or the *Code of Conduct* (DOC, 2013) shall be reported without delay to the Director General / Department of Conservation (DOC). Additional items which require immediate reporting under the Code of Conduct and in respect of OMV's additional mitigation measures include:

- If MMOs or PAM Operators consider that a higher number of cetaceans and/or Species of Concern than predicted in the MMIA are encountered at any time during the survey, shall be immediately reported to the Director General;

- If failure of the PAM system occurs, DOC is notified via email as soon as practicable with the time and location in which operations continued without an active PAM system;

- Immediately report if a Hector's / Maui's dolphin is sighted at any time to Department of Conservation National Office (Ian Angus) and Taranaki Area Office (Callum Lilley and/or Bryan Williams) by phone. If key personnel at both DOC offices are not reachable; MMO reports the sighting to 0 800 DOC HOT (0 800 362 468).

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