Todd Energy Limited

Trestles 3D Seismic Survey

Marine Mammal Impact Assessment

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List of Definitions and Abbreviations

AEI	Areas of Ecological Importance
Acoustic Array	An acoustic source system in which airgun elements are arranged to produce desired directional characteristics
Acoustic Source	A source of acoustic pressure waves used, or intended to be used, for the purpose of an acoustic seismic survey, and in relation to a source vessel, means an acoustic source on or controlled from the vessel.
The Code	The 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 re 1 μPa^2-s	The typical measure for sound intensity (loudness) in water: decibels referenced to the accepted reference pressure of sound in water (1 micropascal)
DOC	Department of Conservation
EEZ	Exclusive Economic Zone
EEZ Act	Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012
Energetic costs	The metabolic costs of various forms of biological activity
EPA	Environmental Protection Authority
Flip-Flop	Alternating activation of two parallel seismic source arrays
Full-fold	Full power operations to achieve maximum offset acquisition data
Good sighting conditions	In daylight hours, during visibility of more than 1.5 km, and in a sea state of less than or equal to Beaufort 3.
Level 1 survey	Any marine seismic survey using an acoustic source with a total combined operational capacity exceeding 7 litres/427 cubic inches.
MARPOL	International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978
MMIA	Marine Mammal Impact Assessment
MMO	Marine Mammal Observer
MMS	Marine Mammal Sanctuary
MPI	Ministry for Primary Industries
MSL	MetOcean Solutions Limited
NABIS	National Aquatic Biodiversity Information System
NIWA	National Institute of Water and Atmospheric Research
NZ	New Zealand
Operational Area	The entire geographical area potentially used for acoustic source activation throughout the marine seismic survey, including seismic data acquisition lines, acoustic source testing and soft start initiation
Pa	Pascal (Pa) is the SI unit used for measuring pressure, sound waves are pressure fluctuations through the medium in which they propagate

PAM	Passive Acoustic Monitoring
PEP	Petroleum Exploration Permit
PML	Petroleum Mining Licence
PSI	Pounds per square inch, a non-SI unit of pressure measurement
RMA	Resource Management Act 1991
REM	Resource and Environmental Management
SEL	Sound Exposure Level
Shutdown	Stopping an active marine seismic survey by immediately turning off power to the acoustic source.
SLIMPA	Sugar Loaf Island Marine Protected Area
Soft Starts	The gradual increase in the source's power to the operational power requirement over a period of at least 20 minutes and no more than 40 minutes, starting with the lowest capacity/power acoustic source.
Sound exposure level (SEL)	A measure of the received energy in the sound source pulse and represents the sound pressure level that would be measured if the pulse energy were spread evenly across a 1 second period.
Sound transmission loss modelling	The process carried out during the environmental impact assessment stage, in advance of a marine seismic survey in an Area of Ecological Importance, where acoustic propagation is modelled to predict the received sound levels at various distances, based on the specific configuration of the acoustic source and environmental conditions in the Operational Area.

1 Non-Technical Summary

Todd Energy proposes to undertake a marine seismic survey, the 'Trestles 3D Seismic Survey', in the Taranaki Basin. The primary objective of this survey is to provide quality, modern 3D seismic coverage over the area north of the Maui Field in order to establish the key characteristics of the petroleum system in that area, particularly those related to the Miocene "Vulcan" Prospect and deeper targets in Eocene and Paleocene aged rocks. The planned seismic survey will record data with sufficient offsets to allow for Quantitative Interpretation of the prospectivity in the area'.

It is anticipated that to complete the survey a timeframe of 3 – 4 weeks will be required; with the start of the survey planned for mid-February 2015. The seismic Operational Area is located off Cape Egmont and in waters to the southwest. All seismic operations will be restricted to waters beyond 7 km from shore (primarily in water depths greater than 100 m). No seismic operations will occur within 1.5 km of the boundary to the West Coast North Island Marine Mammal Sanctuary. The nearest major settlement to the Operational Area is the coastal city of New Plymouth, located approximately 30 km to the northeast.

The seismic survey would be undertaken using the *MV Polar Duke*, a designated 3D seismic survey vessel which will tow 12 streamers, each measuring 7 km in length and separated by 100 m increments. The acoustic source will also be towed by the 3D seismic vessel and will consist of a 3460 in^3 array located at 7 m water depth, which will be activated at an operating pressure of 2,000 psi. The airguns which comprise this source are typically set off so that the shot-point interval is 18.75 m apart, and with an average vessel speed of 4 knots, this equates to a shot every 9 seconds. Two support vessels, the *MV Sanco Sky* and *MV Guru* will accompany the 3D seismic vessel to provide supplies and scout the area ahead for obstructions.

The Department of Conservation's 2013 *Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations* (the 'Code') defines three levels of marine seismic surveys based on acoustic source capacity. Based on this classification, the Trestles 3D Seismic Survey is considered a 'Level 1' seismic survey and requires a Marine Mammal Impact Assessment (MMIA) to be approved by the Department of Conservation before the survey commences.

An important part of the MMIA development is consultation with interested parties and technical experts, and in preparation for the Trestles 3D Seismic Survey, Todd Energy is undertaking consultation with a wide range of stakeholders whose concerns will be taken into account.

In assessing the potential impacts of the seismic survey on marine mammals the following steps were undertaken:

- all potential environmental sensitivities which could be vulnerable to seismic operations were identified;
- all potential environmental effects of the seismic operations were identified;
- mitigation actions were developed to avoid, remedy or mitigate each potential effect; and
- an assessment of the significance of each potential effect (based on likelihood, magnitude, geographical scale, and mitigation actions) was conducted.

A thorough understanding of the existing environmental sensitivities in the offshore Taranaki region provides a fundamental basis for this MMIA. Environmental sensitivities include marine mammals, sea birds, fish species, benthic marine fauna and plankton.

The MMIA process has identified that up to six species of marine mammal that are classified as 'threatened' by the New Zealand Threat Classification Scheme (Baker *et al.* 2010) could be present in the Operational Area; killer whales, bottlenose dolphins and southern right whales have a high probability of occurring in the Operational Area, whereas Bryde's whales, Hector's dolphins and Māui dolphins have a low probability of being present. Other non-threatened species of marine mammals could also be utilising habitat in the vicinity, including a number of 'species of concern' as defined by the Code. However, despite the presence of marine mammals, the Trestles 3D Seismic Survey will not overlap spatially or temporally with any known critical habitat for marine mammals.

Numerous sea bird species are likely to be present in the survey area; however Gibson's albatross, antipodean albatross, Salvin's mollymawk, black-billed gulls, black-fronted terns, red billed gulls, pied shags, black petrels, flesh-footed shearwater, northern New Zealand dotterel and caspian terns have a Department of Conservation (DOC) threat listing of nationally vulnerable or greater so are of greatest significance. The most commonly caught commercial fish species in this area are jack mackerel and barracouta accounting for about 95% of the total catch in offshore Taranaki waters.

As part of this MMIA, a range of potential effects on the environment have been assessed. To address these potential effects Todd Energy will implement mitigation measures which aim to eliminate or minimise any negative environmental consequences as far as practicable.

The introduction of sound into the marine environment is considered to be the most significant potential impact from the Trestles 3D Seismic Survey. The primary mitigation tool to address this impact is compliance with the Code which Todd Energy commits to do for the duration of the survey. The Code is highly regarded internationally, alongside similar guidelines issued by the United Kingdom, California (U.S.A.), Australia, Brazil, Sakhalin (Russia), Gulf of Mexico (Mexico) and Canada (Weir and Dolman, 2007).

In accordance with the Code, the standard measures that will be employed include:

- The use of pre-start observations to detect marine mammals (both visually and acoustically) prior to the commencement of seismic operations;
- The delay of operations in the event that marine mammals are detected within the mitigation zones defined in the Code;
- The use of 'soft starts' whereby the acoustic power is gradually increased over 20–40 minutes prior to the use of the source array at full capacity at the start of, and during the survey to give any marine mammals the opportunity to leave the survey area before full power is reached; and
- The shutdown of the acoustic source if 'species of concern' enter the mitigation zones defined in the Code.

Sound Transmission Loss Modelling was conducted as part of this MMIA whereby acoustic propagation is modelled to predict the received sound levels at various underwater distances from the acoustic source. This modelling predicts that the mitigation zones defined in the Code will sufficiently protect marine mammals from physiological and behavioural changes.

In addition to those mitigations stipulated by the Code, Todd Energy commits to the following mitigations over and above those required:

- Whilst transiting to and from the Operational Area, and during daylight hours and good sighting conditions, a MMO will be on watch and recording marine mammal sightings;
- Weekly MMO reports will be provided to DOC and the Environmental Protection Authority;
- DOC will be notified immediately of any sightings of Māui or Hector's dolphins; and
- If any strandings occur in the North and South Taranaki Bights that result in mortality during the Trestles 3D Seismic Survey or within 14 days of the survey completion

date, Todd Energy will, on a case-by-case basis, consider covering the costs of undertaking a necropsy in an attempt to determine the cause of death.

With regard to strandings, it is important to note that no marine mammal strandings have to date been linked to marine seismic surveys.

Other potential environmental effects (outside those directly relating to marine mammals and noise) are addressed by adherence to the Marine Mammal Protection Regulations 1994, the International Convention for the Prevention of Pollution From Ships 1978 (MARPOL), and the International Regulations for the Prevention of Collisions at Sea 1972 (COLREGS).

In summary, the environmental effects associated with the Trestles 3D Seismic Survey, when assessed in light of the proposed mitigation measures, are considered to be negligible or minor for virtually all operations. Moderate effects could potentially occur for other marine mammal species (i.e. those not considered to be species of concern) that approach the acoustic source to within 200 m during full capacity operations. These conclusions are largely driven by the commitment from Todd Energy to comply with the Code which will reduce the risk of any potential environmental impacts. However, those mitigation actions over and above the requirements of the Code that Todd Energy will include in their operational protocols will also assist with reducing adverse effects.

2 Introduction

2.1 Background

Resource and Environmental Management Limited (REM) has been engaged by Todd Energy to prepare a Marine Mammal Impact Assessment (MMIA) for the Trestles 3D Seismic Survey within the Taranaki Basin.

The 'Survey Area' for which full-fold seismic data will be acquired (Figure 1) lies primarily within Petroleum Exploration Permit (PEP) 53374 with extensions into Petroleum Mining Licence (PML) 381012 and PEP 38158. Surrounding the Survey Area is a larger Operational Area which is all encompassing and provides a buffer (4 – 20 km) for run in/out, line turns, acoustic source testing and soft start source initiation. The majority of the Survey Area lies within the territorial sea, with seismic operations extending into the Exclusive Economic Zone (EEZ) in the western reach.

The Exclusive Economic Zone and Continental Shelf (Environmental Effects – Permitted Activities) Regulations 2013 (Permitted Activities Regulations) under the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 (EEZ Act) classify seismic surveys in the EEZ as 'Permitted Activities' as long as they comply with the '2013 Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations' (the 'Code') (DOC, 2013). Compliance with the Code is voluntary in the territorial sea.

Todd Energy has adopted and will adhere to the Code for the entire duration and geographical scope of the survey, regardless of the legislative differences outlined above.

This MMIA has been prepared in accordance with the Code to:

1. Describe baseline environmental sensitivities in relation to the seismic survey;
2. Identify potential environmental impacts on marine species and the surrounding environment; and
3. Describe measures to avoid or minimise any adverse impacts to the surrounding environment and marine mammals.

The survey is proposed to commence in mid-February 2015 and will take 3 - 4 weeks to complete.

Todd Energy holds and exclusively operates PEP 53374. Seismic operations beyond the scope of this PEP will occur under ingress agreements with neighbouring operators.

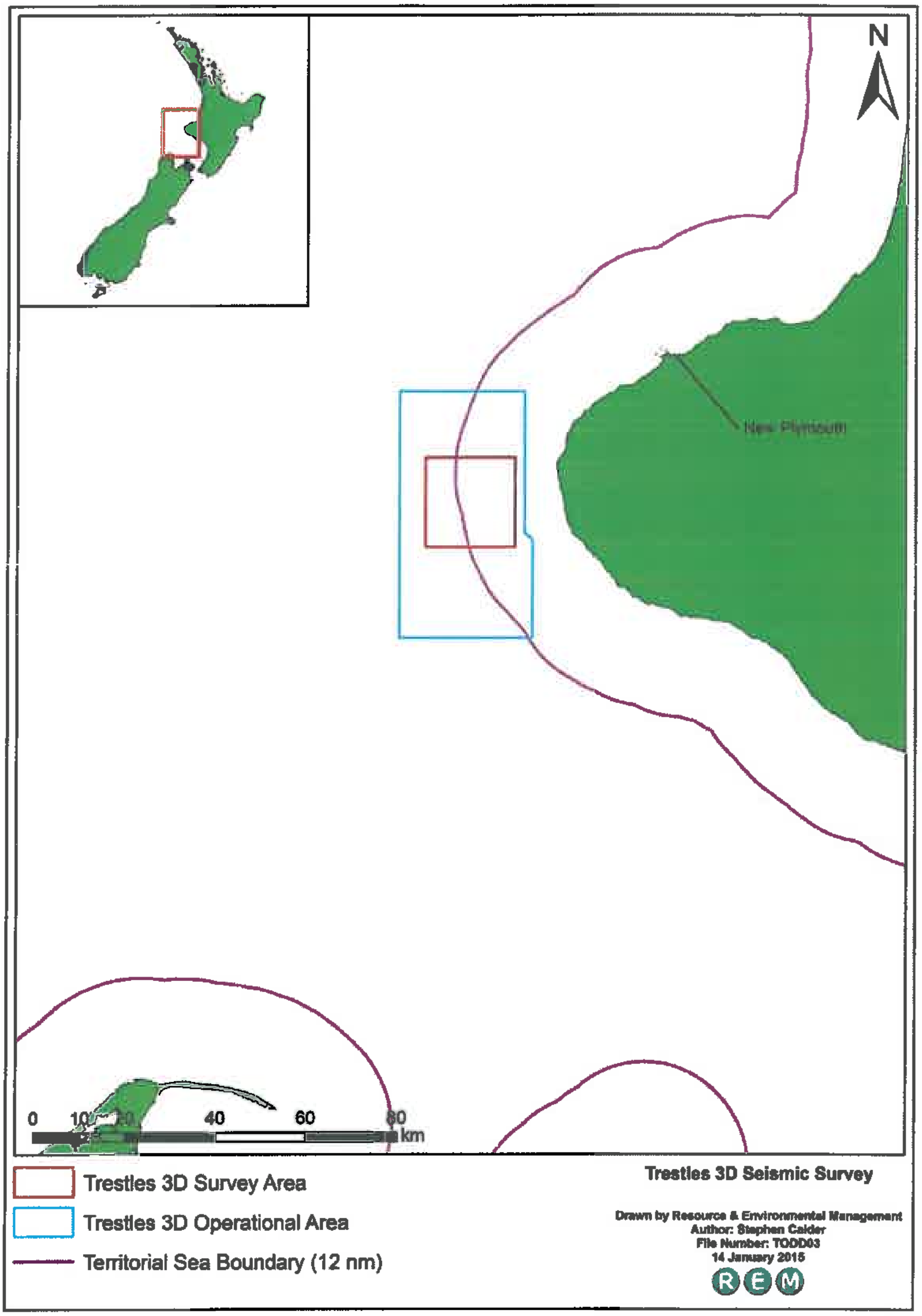

Figure 1: Location Map of the Survey Areas and Operational Area

2.2 New Zealand Legislation

Activities associated with the offshore oil & gas sector; including maritime activities, environmental protection, biosecurity, industrial safety, and cultural and archaeological heritage is covered under a range of different statutes.

The jurisdiction of each statute can vary, for example, the Resource Management Act 1991 (RMA) and the Biosecurity Act 1993 only apply within NZs territorial sea (12 Nm from the statutory baseline), whereas the EEZ Act applies within the NZ EEZ (12 - 200 Nm from shore) and Continental Shelf, and the Marine Mammals Protection Act 1978 applies to NZ's 'fisheries waters' (including inshore waters, the territorial sea, and the EEZ).

The Operational Area of the Trestles 3D Seismic Survey occurs both in the EEZ and the territorial sea (Figure 1). Hence the legislation, with which Todd Energy will comply for the upcoming seismic survey, is the RMA which relates to waters inside the 12 Nm territorial sea, and the EEZ Act (including the Code) which relates to waters beyond 12 Nm from shore. The seismic survey will also comply with the Marine Mammals Protection Act 1978.

2.2.1 Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012

The EEZ Act came into force on 28 June 2013, when the first regulations (Permitted Activities) were promulgated. The EEZ Act is considered as landmark legislation as it establishes the first comprehensive environmental consenting regime for activities in NZ's EEZ and Continental Shelf. The purpose of the EEZ Act is to manage and protect the natural resources of the EEZ whilst concurrently enabling use of resources on or within the seabed and sub-surface.

The EEZ Act allows the Minister for the Environment to classify activities with the EEZ and Continental Shelf, depending on the considerations outlined in s33 of the EEZ Act. These considerations include; environmental effects of the activity, the importance of protecting rare and vulnerable ecosystems and the economic benefit to NZ of the activity. The classifications for activities within the EEZ Act are either:

- **Permitted** – the activity can be undertaken provided the operator meets the conditions specified within the regulations. Seismic surveys fall within this classification and the conditions state that the person undertaking the activity must comply with the Code;
- **Non-notified discretionary** – where 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 EPA must assess the consent application, although the EPA has discretion to extend the timeframes by up to double;
- **Discretionary** – activities may be undertaken if applicants obtain a marine consent from the EPA. The consent application will be 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 consent application; and
- **Prohibited** – the activity may not be undertaken.

2.2.2 2013 Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations

The Code was developed to establish a comprehensive regime to manage the potential impacts of seismic survey activities. Under the EEZ Act – *Permitted Activities*, seismic surveys within the EEZ must now comply with the Code.

The Code aims to:

- Minimise disturbance to marine mammals from seismic survey activities;
- Minimise noise in the marine environment arising from seismic survey activities;
- Contribute to the body of scientific knowledge on the physical and behavioural impacts of seismic surveys on marine mammals through improved, standardised observation and reporting;
- Provide for the conduct of seismic surveys in NZ continental waters in an environmentally responsible and sustainable manner; and
- Build effective working relationships between government, industry and research stakeholders.

Under the Code, three levels of seismic survey are defined based on the power level of the acoustic array. Level 1 surveys (>427 cubic inches) are typically large scale geophysical investigations, Level 2 surveys (151 – 426 cubic inches) are lower scale seismic investigations often associated with scientific research, and Level 3 surveys (<150 cubic inches) include all small scale, low impact surveys. The Trestles 3D Seismic Survey is classified as a Level 1 survey which features the most stringent requirements for marine mammal protection (see Section 3.3.1).

The notification requirements of the Code have been adhered to and followed with the formulation of this MMIA. A letter was submitted to the Director-General of Conservation on 30 October 2014 notifying DOC of the initial intentions for this survey (which was originally part of a proposed Shell Todd Oil Services (STOS) Māui 2015 3D/4D Seismic Survey which has subsequently been postponed), and a follow up letter was submitted to DOC on 6 January 2015 to describe the changes in relation to operating parties (whereby the survey became an entirely separate Todd Energy operated survey, known as the 'Trestles' 3D Seismic Survey in January 2015).

2.2.3 Resource Management Act 1991

The purpose of the RMA is to promote the sustainable management of natural and physical resources in NZ. The RMA applies to all terrestrial land, all lakes and rivers, and the territorial sea. Territorial Authorities are responsible for implementing the RMA: which in the case of the Trestles 3D Seismic Survey is the Taranaki Regional Council.

Section 16 of the RMA states that "every occupier of land (including any premises and any coastal marine area), and every person carrying out an activity in, on or under a body of water or the coastal marine area, shall adopt the best practicable option to ensure that the emission of noise from that land or water does not exceed a reasonable level". In the territorial sea (coastal marine area), compliance with the Code is voluntary. Todd Energy will voluntarily comply with the Code within the territorial sea for the Trestles 3D Seismic Survey. Compliance with the Code is met through managing operational noise to acceptable pre-defined levels; which presumably also satisfies s16 of the RMA.

In addition to this and under the Taranaki Regional Coastal Plan, seismic surveys for the 'purpose of petroleum prospecting' are a 'Permitted Activity' provided the following conditions are met:

- The survey does not involve placement of explosives or does not otherwise directly involve disturbance of the foreshore or seabed; and

- The survey is not conducted in an area that is used by marine wildlife for breeding purposes during the time that those animals are breeding.

The Trestles 3D Seismic Survey will not directly disturb the seabed and does not involve the use of explosives. With regard to assessing any potential overlap between the seismic survey operations and breeding habitat for marine wildlife. The following points of consideration have been made:

- Southern right whales calve in shallow coastal waters around the NZ mainland during winter months. Cow/calf pairs have been seen in Taranaki coastal waters in winter. The Trestles 3D Seismic Survey is planned for late summer/early autumn 2015; hence no temporal overlap is predicted between the survey operations and southern right whale breeding activities (also see Section 5.3.5);
- Māui dolphins calve from November to mid-February in shallow coastal waters (less than 100 m). The population concentration for this species is north of the Survey Area with very low densities of dolphins occurring south of New Plymouth (Currey *et al.* 2012; see Figure 18, Section 5.3.5). Therefore, no significant spatial overlap is predicted between the survey operations and Māui dolphin breeding activities (also see Section 5.3.5);
- NZ fur seals breed on the Sugar Loaf Islands, which represent the closest breeding colony to the Operational Area (approximately 30 km to the northeast). This species gives birth ashore with peak pupping occurring in mid-December. Pups remain at the breeding colony from birth until weaning which occurs when pups are 8 – 12 months old (Baird 2011). Therefore, no significant spatial overlap is predicted between the survey operations and NZ fur seal breeding activities (also see Section 5.3.5); and
- There is no information to suggest that Taranaki waters are breeding habitat for any other marine mammal species.

The Taranaki Regional Council has been notified of the proposed survey and will be supplied with a copy of this MMIA prior to survey commencement.

2.3 International Conventions

The following international regulations and conventions will be adhered to during the Trestles 3D Seismic Survey.

International Regulations for the Prevention of Collisions at Sea 1972

These regulations are commonly referred to as the COLREGS and provide an international set of operational expectations and navigation procedures to prevent collisions at sea. NZ ratified the convention in 1972, and the COLREGS are implemented in NZ under the Maritime Transport Act 1994.

The International Convention for the Prevention of Pollution from Ships 1973

This convention is commonly referred to as the MARPOL Convention and addresses the prevention of ship-based marine pollution from both operational and accidental causes. The original MARPOL Convention has been updated through time by a number of amendments and associated protocol. Specific provisions of relevance relate to the discharge of oily water from machinery spaces, sewage and garbage. Discharge requirements and allowances vary with proximity to the shore and are further discussed in Section 6.3.4.

2.4 MMIA Objectives

This MMIA forms part of the overall planning process for the Trestles 3D Seismic Survey. In accordance with the Code the objectives of this MMIA are to:

- Describe the activities related to the proposed marine seismic survey (Section 3);
- Describe the state of the local environment in relation to marine species and habitats, with particular focus on marine mammals, prior to the activities being undertaken (Section 5.3);
- Identify the actual and potential effects of the activities on the environment and existing interests, including any conflicts with existing interests (Section 5.4);
- Identify the significance (in terms of risk and consequence) of any potential negative impacts and define the criteria used in making each determination (Section 6);
- Identify persons, organisations or tangata whenua with specific interests or expertise relevant to the potential impacts on the environment (Section 8);
- Describe any consultation undertaken with persons described above and specify those who have provided written submissions on the proposed activities (Section 8);
- Include copies of any written submissions from the consultation process (Appendix 1);
- Specify any possible alternative methods for undertaking the activities to avoid, remedy, or mitigate any adverse effects (Section 4);
- Specify the measures that the operator intends to take to avoid, remedy, or mitigate the potential adverse effects identified (Section 6);
- Specify a monitoring and reporting plan (Section 7); and
- Specify means of coordinating research opportunities, plans, and activities relating to reducing and evaluating environment effects (Section 7).

3 Project Description

3.1 Seismic Survey Overview

Marine seismic surveys are used to identify geological features below the seafloor, by relying on the differing reflective properties of sound waves to various subsurface rock strata. During a survey the sound wave energy source (airgun array), which is towed behind the seismic vessel, transmits a downward pulse of sound generated by the release of compressed air from an airgun source array. This pulse travels through the water column and into the earth. At each point where different geological strata exist, different densities and velocity discontinuities cause a portion of the energy to be reflected back to the sea surface. The reflected sound waves are picked up by a series of acoustic receivers (hydrophones) which are located along the 'streamers' towed behind the vessel. Data received by the hydrophones are amplified and digitised to facilitate interpretation. The seismic data profiles provide an 'image' of the rocks beneath the seafloor, commonly to depths of 10 km (McCauley *et al.* 2000). The configuration of a marine seismic survey is illustrated in Figure 2.

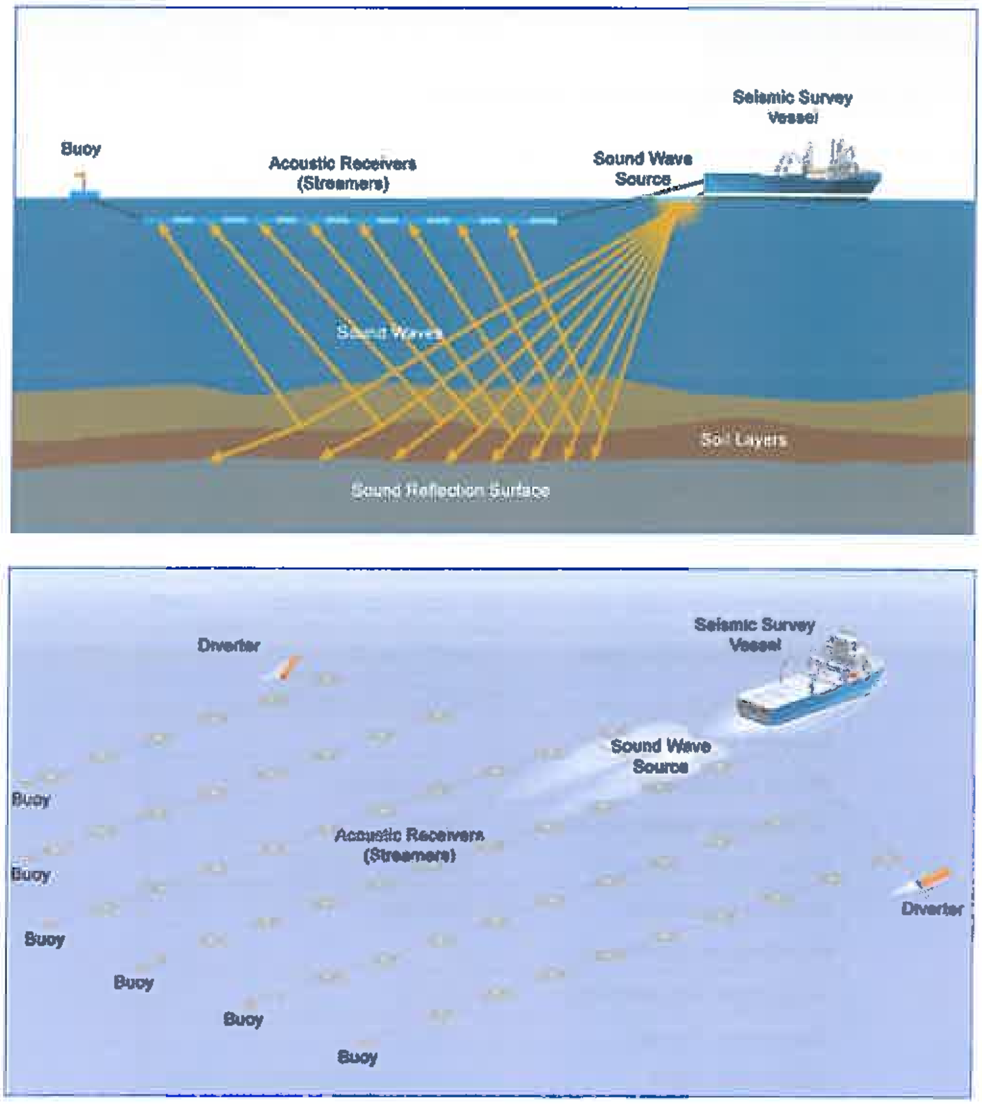

Figure 2: Schematic of an Operational Marine Seismic Survey

(Source: www.fishsafe.eu)

Streamers consist of neutrally buoyant tubular sections containing the hydrophones and electrical conductors which transmit seismic data to the vessel. Streamers commonly consist of two types, either fluid-filled or solid streamers. The fluid used in fluid-filled streamers is typically an oil-based fluid; whereas solid streamers are typically filled with a water-based gel. In recent years the industry has moved towards to use of solid streamers for the following reasons:

- They produce lower secondary noise profiles, hence higher quality seismic data;
- They are relatively fast to deploy and steerable once deployed;
- They are more resistant to shark damage;
- They require less frequent repairs which in turn reduces operational risk; and
- When damaged there is no hydrocarbon pollutant emitted.

Marine seismic surveys can be 2-dimensional (2D), 3-dimensional (3D) or 4-dimensional (4D). 2D surveys tow only one streamer (with acquired data representing a 2D slice of the subsurface structure), 3D surveys tow multiple streamers (with acquired data representing a 3D image of the subsurface structure), and 4D surveys (also known as time-lapse surveys) which involve repeated 3D seismic surveys through time in order to introduce a fourth dimension (time).

3.2 Trestles 3D Seismic Survey

The proposed Trestles 3D Seismic Survey is being undertaken by Todd Energy in order to provide quality, modern 3D seismic coverage over the area north of the Maui Field in order to establish the key characteristics of the petroleum system in that area, particularly those related to the Miocene "Vulcan" Prospect and deeper targets in Eocene and Paleocene aged rocks. The planned seismic survey will record data with sufficient offsets to allow for Quantitative Interpretation of the prospectivity in the area.

The survey has a defined 'Survey Area' in which full-fold data acquisition will occur (Figure 1). Surrounding the Survey Areas is a larger Operational Area which provides for run in/out, line turns, acoustic source testing and soft start initiation.

3.2.1 Survey Parameters

The acoustic parameters and configuration of the proposed Trestles 3D Seismic Survey are outlined in Table 1.

Table 1: Survey Parameters for the Trestles 3D Seismic Survey

Survey line direction	north-south
Source size	3460 cubic inches
Source depth	7 m
Array configuration	3 sub-arrays
Sub-array separation	10 m
Shot point interval	18.75 m flip flop
Source pressure	2000 psi
Number of streamers	12
Streamer separation	100 m
Streamer length	7050 m
Streamer type	Solid Sercel Sentinel SSAS
Streamer depth	18-25 m slanted

The array will be activated with a shot point interval of 18.75 m. At a typical vessel speed of 4 knots (2.06 $m.s^{-1}$), this relates to a shot every 9 seconds. The acoustic output for marine seismic surveys is typically broad band, with most energy concentrated in the 5 – 200 Hz frequency range (OGP & IAGC, 2004).

Airgun arrays are designed to direct the majority of energy vertically towards the seabed. However, some energy is also lost horizontally into the water column, and can be detected at different distances from the source (see Section 6.3.2).

3.2.2 Location and Timing of Survey

The Survey Area is located mostly within PEP 53374 with minor ingresses into PML 381012 and PMP 38158. As specified in the Code, the Operational Area encompasses all possible seismic operations (i.e. run-ins and run-outs from each survey line, soft starts, line turns, and acoustic source testing). For the most part the source will only be operating at full power within the Survey Areas and up to 3.5 km beyond the Survey Areas (half the streamer length); however full power may be required within the Operational Area at times for the purposes of testing after maintenance.

Todd Energy is planning to undertake the Trestles 3D Seismic Survey from mid-February to mid-March 2015. Seismic operations will be conducted 24 hours per day, 7 days per week, subject to suitable weather conditions and marine mammal encounter protocols (see Section 3.2), and it is envisaged that the survey duration will be 3 – 4 weeks in total.

3.2.3 Survey Vessels

Todd Energy will conduct the seismic survey using a specialist 3D seismic vessel. The survey vessel to be used in this instance is the *MV Polar Duke* which is 106.8 m in length. The survey will include two full time support vessels: *MV Sanco Sky* (72.4 m) and *MV Guru* (24 m). Detailed specifications for the *MV Polar Duke* can be found in Appendix 2.

All survey vessels will be mobilised to the Survey Area directly from the previous survey for Woodside Exploration Limited, in PEP 55793. Crew changes during the survey will occur from New Plymouth either by helicopter or port call. Port calls will be required during adverse weather conditions. Refuelling of the survey vessel will be preferentially conducted at sea from a support vessel; however refuelling in port may also occur. At-sea refuelling is routine during seismic surveys and will take place in daylight hours within permissible weather conditions. The support vessels will refuel at Port Taranaki.

At the outset of the survey the towed gear (streamers and air gun arrays) will be deployed. This gear will remain in the water for the duration of the survey, except when on-board repairs are necessary or inclement weather dictates the need to bring gear aboard.

During data acquisition, the 3D seismic vessel will follow predetermined survey lines in the Survey Area.

3.3 Operational Protocols

3.3.1 Mitigations: Level 1 Marine Seismic Survey

Todd Energy will adhere to the operational protocols outlined below which are in accordance with the requirements of the Code.

A Level 1 survey requires at least two qualified Marine Mammal Observers (MMOs) and two qualified[1] Passive Acoustic Monitoring (PAM) operators onboard for the duration of the survey.

The minimum observer requirements for a Level 1 survey are that:

- The qualified observers will be dedicated in that their roles on the vessel are 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 while the acoustic source is in the water, at least one qualified MMO (during daylight hours) and one qualified PAM operator will maintain a watch for marine mammals.

Todd Energy has contracted a third party consultancy company to provide two MMOs and two PAM operators to oversee operations in relation to the Code for the Trestles 3D Seismic Survey. The MMOs and PAM operators will be qualified and trained in accordance with the code. Todd and Woodside Exploration Limited will be employing a trainee Iwi MMO on the survey through Blue Planet Marine as well, to provide much needed experience required for qualification.

MMO observations are made during daylight hours whereas PAM is operational on a 24 hour basis. Details of the PAM specifications are provided in Appendix 3.

Pre-Start Observations

The normal requirements for pre-start observations are as follows:

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

The Level 1 source cannot be activated during daylight hours unless:

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

The source cannot be activated during night-time hours or poor sighting conditions (visibility of 1.5 km or less or in a sea state greater than or equal to Beaufort 4) 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

[1] Under the 3-year interim measure PAM operators for this seismic survey will be DOC approved.

- The qualified observer has not detected vocalising cetaceans in the relevant mitigation zones.

In addition to the normal pre-start observation requirements outlined above, when arriving at a new location in the survey programme for the first time, or when returning to the Operational Area following a port call, the initial acoustic source activation must not be undertaken at night or during poor sighting conditions unless either:

- MMOs have undertaken observations within 20 Nm of the planned start up position for at least the last two hours of good sighting conditions preceding proposed operations, and no marine mammals have been detected; or
- Where there have been less than two hours of good sighting conditions preceding proposed operations (within 20 Nm of the planned start up position), the source may be activated if:
  - PAM monitoring has been conducted for two hours immediately preceding proposed operations; and
  - Two MMOs have conducted visual monitoring in the two hours immediately preceding proposed operations; and
  - No Species of Concern have been sighted during visual monitoring or detected during acoustic monitoring in the relevant mitigation zones in the two hours immediately preceding proposed operations; and
  - No fur seals have been sighted during visual monitoring in the relevant mitigation zone in the 10 minutes immediately preceding proposed operations; and
  - No other marine mammals have been sighted during visual monitoring or detected during acoustic monitoring in the relevant mitigation zones in the 30 minutes immediately preceding proposed operations.

Delayed Starts & Shut-downs

If, during pre-start observations or while a Level 1 acoustic source is activated (which includes soft starts), a qualified observer detects at least one cetacean with a calf within 1.5 km of the source, start-up will be delayed or the source will be shut down and not be 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.

If during pre-start observations or while a Level 1 acoustic source is activated (which includes soft starts), 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.

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

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

last detection of any other marine mammal within 200 m of the source, and the mitigation zone remains clear.

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

Soft Start Protocol

Typically Level 1 acoustic sources will not be activated at any time except by soft start, unless the source is being reactivated after a single break in firing (not in response to a marine mammal observation within a mitigation zone) of less than 10 minutes immediately following normal operations at full power, and the qualified observers have not detected marine mammals in the relevant mitigation zones. Soft start means a gradual increase of the source's power, starting with the lowest capacity gun, over a period of at least 20 minutes and no more than 40 minutes (unless the source is being reactivated after a break in firing less than 10 minutes before that time).

4 Survey Design – Mitigations and Alternatives

This section of the MMIA outlines considerations that were given to the survey design in order to minimise adverse impacts on the environment. In particular, the survey design was developed with an awareness of the need to minimise potential impacts in the coastal zone and the West Coast North Island Marine Mammal Sanctuary (Māui dolphin habitat). This awareness has guided survey design outcomes as described below.

4.1 Survey Location

Careful consideration has been given to the location of the survey area. Initial designs for the survey area encompassed a significant area of waters within the 100 m bathymetry contour (Figure 3). An initial environmental assessment identified that operations within the proposed area could have increased the potential for adverse effects on Māui dolphins or potential Māui dolphin habitat. On this basis the survey area was refined to reduce the eastward extension in order to avoid potential impacts on this threatened species as much as possible.

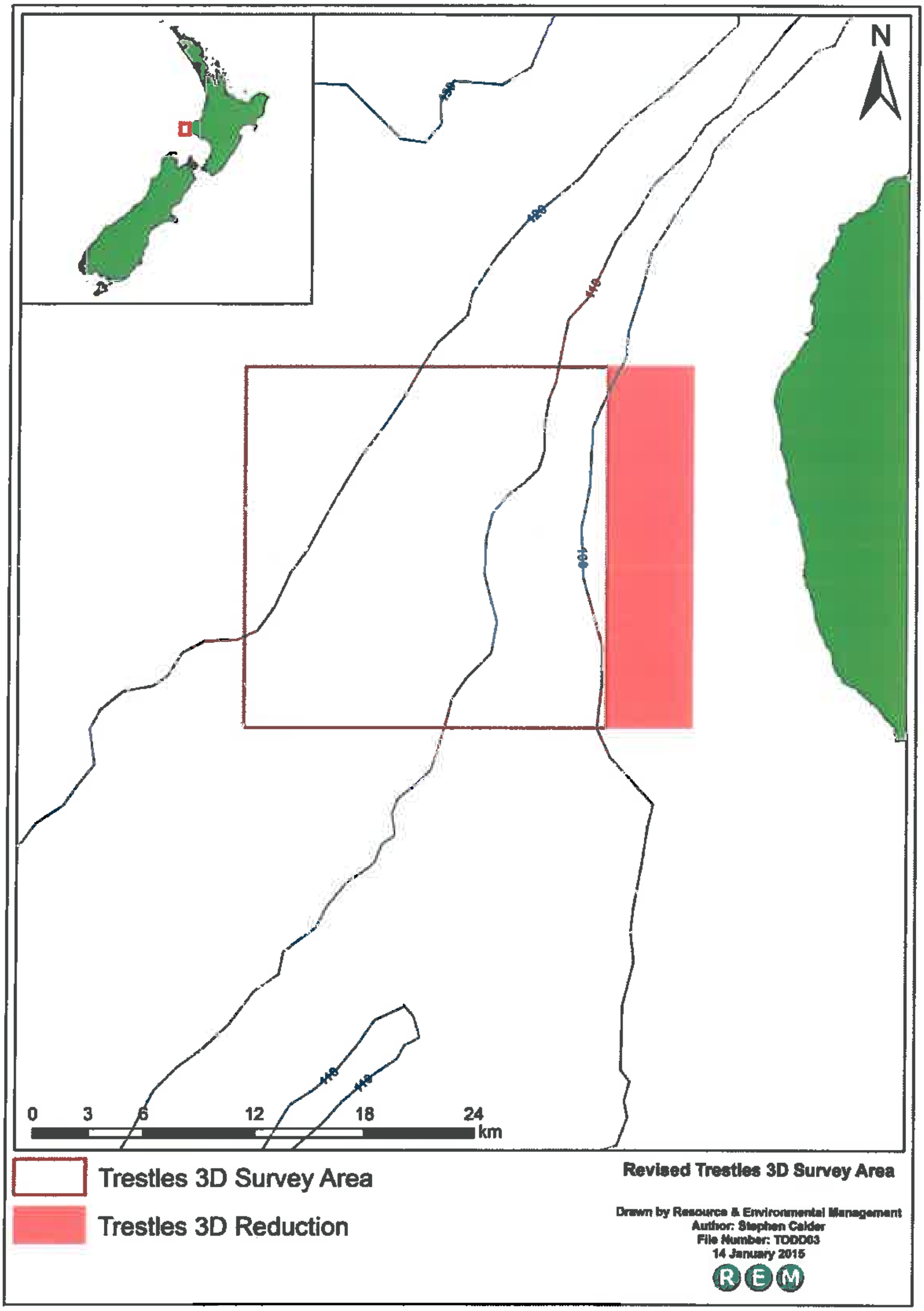

Figure 3: Initial and Revised Survey Area

The Operational Area has also been reduced in extent during the planning process to ensure that operations in the coastal zone are minimised and that a buffer of at least 1,500 m is maintained between the northern boundary of the Operational Area and the West Coast North Island Marine Mammal Sanctuary (Figure 4). Based on the Sound Transmission Loss Modelling (see Section 6.3.2), it is concluded that marine mammals within the sanctuary will suffer no behavioural or physiological effects from the Trestles 3D Seismic Survey.

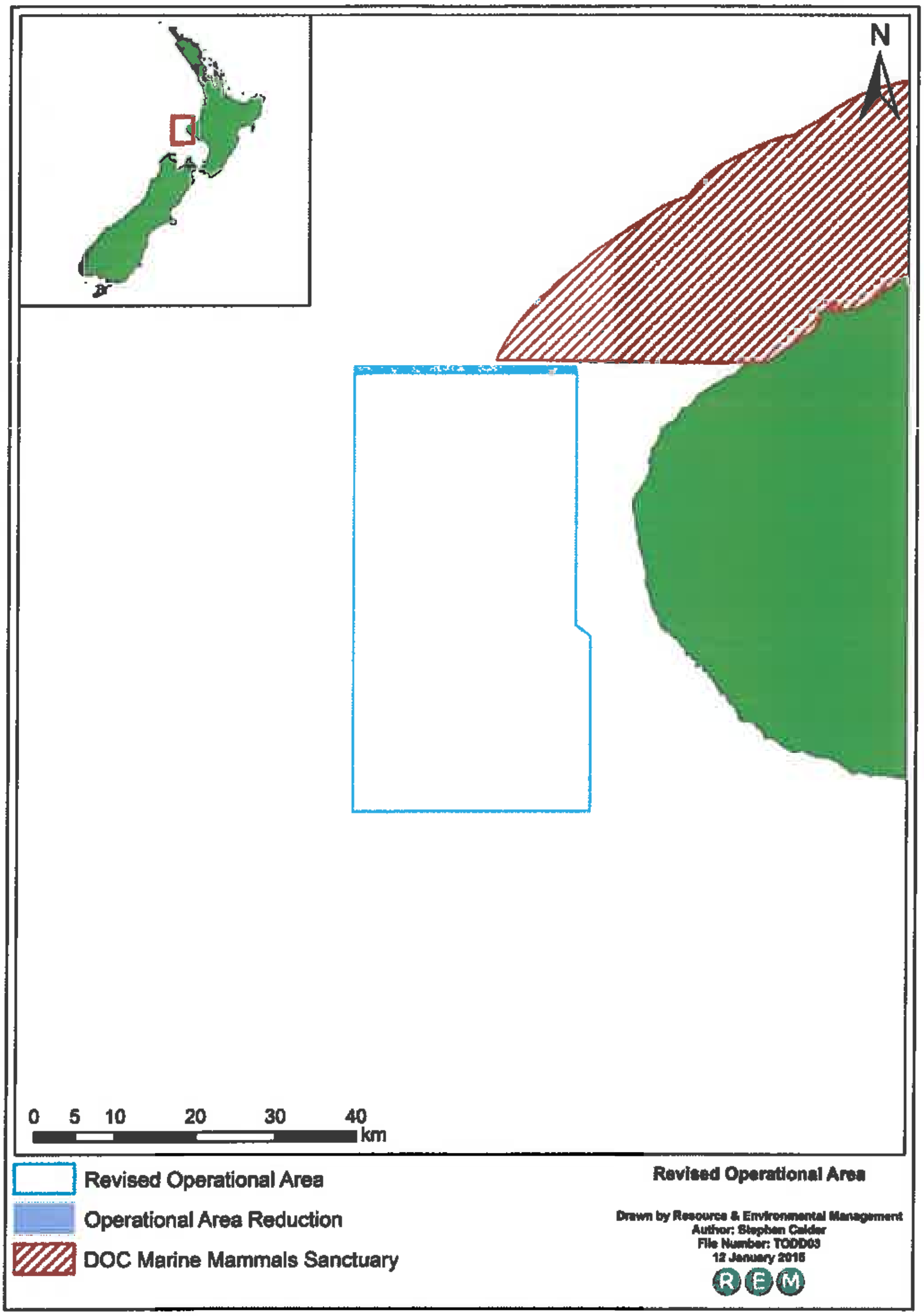

Figure 4: Initial and Revised Operational Area

4.2 Acoustic Parameters

A variety of seismic sources are available for marine applications, including water guns (20-1500 Hz), air guns (100 – 1500 Hz), sparkers (50-4000 Hz), boomers (300-3000 Hz), and chirp systems (500 Hz – 200 kHz). The greatest resolution of near surface structure is generally obtained from the higher frequency sources such as the chirp systems, while the lower frequencies characterise structure at depth.

The source size to be used is dependent on the source design offered by the seismic contractor. However, the source in the case of the Trestles 3D Seismic Survey will be 3460 cubic inches and will emit power levels similar to previous seismic surveys in the Taranaki Basin. This source level represents the lowest source level possible in order to minimise acoustic disturbance whilst still allowing the geophysical objectives of the survey to be met.

5 Baseline Environment

5.1 Methodology

The aim of this section is to describe the state of the local environment in relation to marine species, habitats and existing users. In keeping with the requirements of the Code, emphasis has been placed on marine mammals.

A review of information from regional, national and international sources was undertaken in order to thoroughly describe the following environmental receptors:

- Physical environment;
- Biological environment; and
- Existing interests.

This MMIA was prepared on the basis of existing information sources held within the public domain or from Todd Energy or STOS file records (with STOS permission). There is a large amount of baseline data available for Taranaki waters and this information is considered sufficient for the purposes of this MMIA, hence baseline field studies were not completed by REM as part of this work. The following sources are considered to be of primary importance; however a complete bibliography can be found in Section 10:

- Summaries of MetOcean conditions as produced by MetOcean Solutions Limited (MSL)[2];
- Various research reports from the National Institute of Water and Atmospheric Research (NIWA);
- The National Aquatic Biodiversity Information System (NABIS) as hosted by The Ministry for Primary Industries (MPI);
- Past benthic monitoring reports from Cawthron Institute;
- DOC sightings and stranding records for marine mammals;
- The DOC Threat Classification System;
- The International Union for the Conservation of Nature (IUCN) Red List of Threatened species;
- The Taranaki Regional Coastal Plan and Regional Oil Spill Contingency Plan;
- Fisheries effort reports from MPI; and
- STOS PML 381012 Exploration Wells Impact Assessment.

Baseline environment information has been provided based on the best information sources possible. In some instances abundance data, precise distributions and seasonal variations are relatively unknown as pelagic communities are inherently difficult to study due to their typically large distributional ranges, observational limitations at sea and the high costs of conducting systematic marine surveys.

[2] Note that data associated with Maui-8 locations have been used to represent the Operational Area

5.2 Physical Environment

5.2.1 Climate

The NZ climate is underpinned by a succession of eastward migrating anticyclones, which pass through on a 6 - 7 day cycle. The centres of these anticyclones generally track across the North Island, with more northerly paths being followed in spring, and southerly paths in autumn and winter. Anticyclones are high pressure systems comprised of descending air. These bring settled weather, with clear skies or low cloud/fog and little or no rain.

Troughs of low pressure are present between the anticyclones. These troughs, often contain cold fronts (northwest to southeast orientated), which initially bring cloudy skies and north-westerly winds followed by a period of rain before a change to cold showery south-westerly winds.

The South Taranaki Bight is directly exposed to intense weather systems from the Tasman Sea and is subject to high winds and seas. The strongest and most frequent winds and swells are generally from the west to southwest. Weather in the South Taranaki Bight can be extremely changeable but climatic extremes are infrequent.

In New Plymouth, the closest city to the proposed seismic survey, summer daytime temperatures range from 19 °C to 24 °C but seldom exceed 30 °C. Winters are relatively mild and are the most unsettled time of the year, with daytime maximum temperatures ranging from 10 °C to 14 °C (NIWA, 2013). Table 2 outlines basic weather parameters at New Plymouth.

Table 2: 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
Humidity (%)	79	78	78	80	83	83	82	82	83	82	80	81
Temperature – average daytime (°C)	21	22	20	18	16	14	13	13	14	16	17	19
Temperature – average night time (°C)	14	14	13	11	10	8	7	7	8	10	10	13
Wind speed average (kts)	9	9	9	9	10	10	10	10	11	12	11	10
Wind speed – max (kts)	30	38	30	33	35	37	36	31	47	58	31	37

(Source: Weather2, 2014)

Oceanographic and meteorological conditions from a central location in PML 381012 and considered to be representative of the Trestles survey area, have been used in this MMIA to provide background information on the environmental conditions likely to be found during the seismic survey.

5.2.2 Geology

The Taranaki Basin is located along the western side of the North Island; covering an area of about 330,000 km^2 and occupying the site of a late Mesozoic extension of the landward side of the Gondwana margin. This basin lies at the southern end of a rift which now separates Australia and NZ, and movement along the Taranaki, Cape Egmont and Turi fault zones have influenced the structure of the basin over time (Figure 5).

The Taranaki Basin is a sedimentary basin with Jurassic and earliest Cretaceous Murihiku rocks generally being regarded as basement or early basin-fill. Exploration for oil and gas reserves within the offshore area of the basin has occurred since the early 1900's, and it is currently the only oil and gas producing basin in NZ.

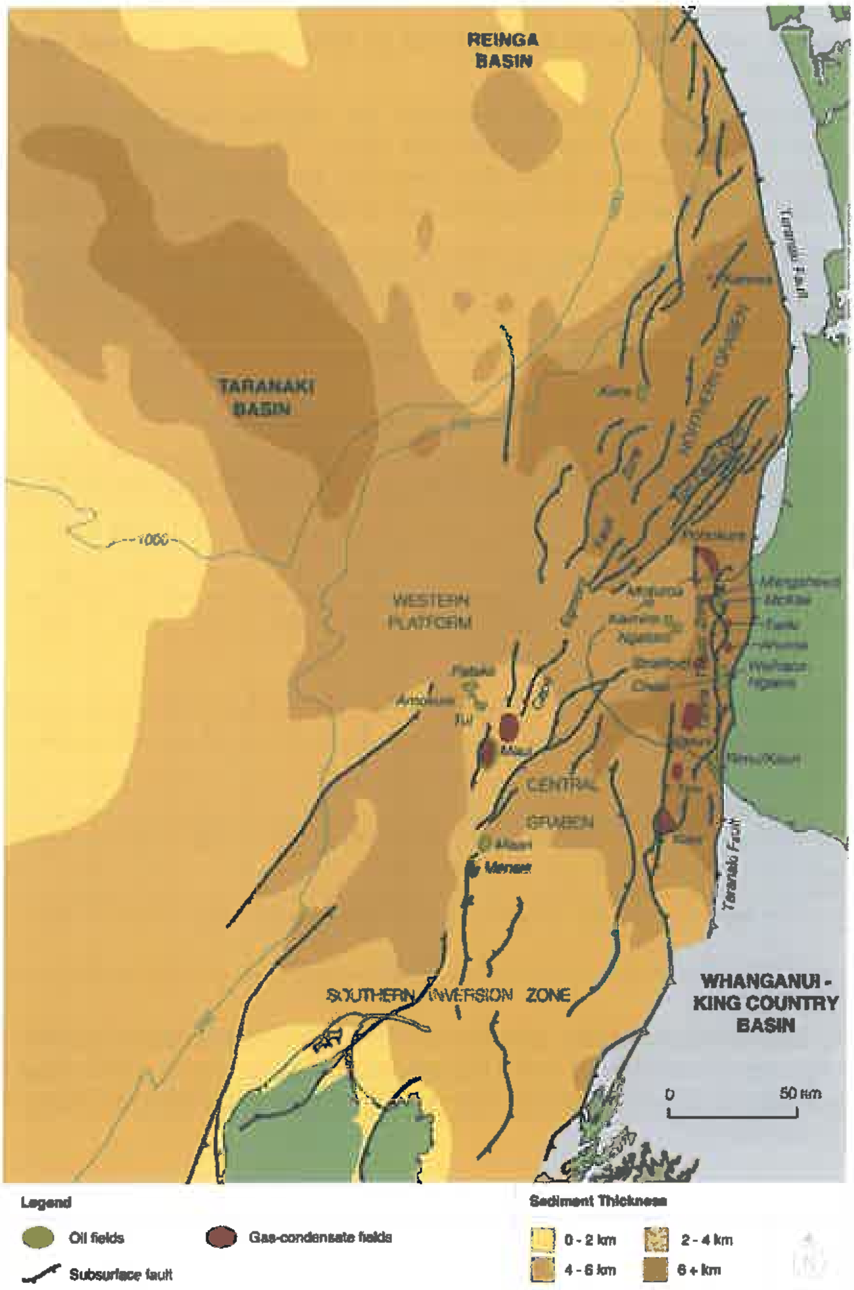

Figure 5: Taranaki Basin Map

(Source: NZP&M, 2012)

Surficial marine sediment across the Taranaki shelf follows a gradient from the coastal zone to the continental shelf, with fine to medium sand typical of coastal sediments and silt and muds prevailing further offshore. Mechanisms for sediment transportation in the region are the waves and currents generated by prevailing southwest – westerly storms.

The seabed in the Operational Area is mainly composed of silt, clay and fine sand fractions (Johnston, 2011; Johnston & Forrest, 2012; Johnston et al., 2012; Elvines et al, 2014).

5.2.3 Oceanography

Wave Height

The Operational Area is situated in a high energy wave climate on account of its exposure to long period swells originating from the Southern Ocean, and locally generated waves. The majority of the wave energy originates from the southwest for the central Māui Field area (Figure 6). However, energetic wave conditions can arrive suddenly from other directions.

Wave height data from MSL, based on numerical hind-casting and validated with wave buoy data from offshore Taranaki are summarised in Figure 6. The largest significant wave height over the period 1979 – 2011 was 9.10 m for the central Māui Field area. The mean wave height was 2.60 m.

The most energetic month in the Māui area is September (mean wave height 2.89 m) while the calmest month is February (mean wave height 2.20 m).

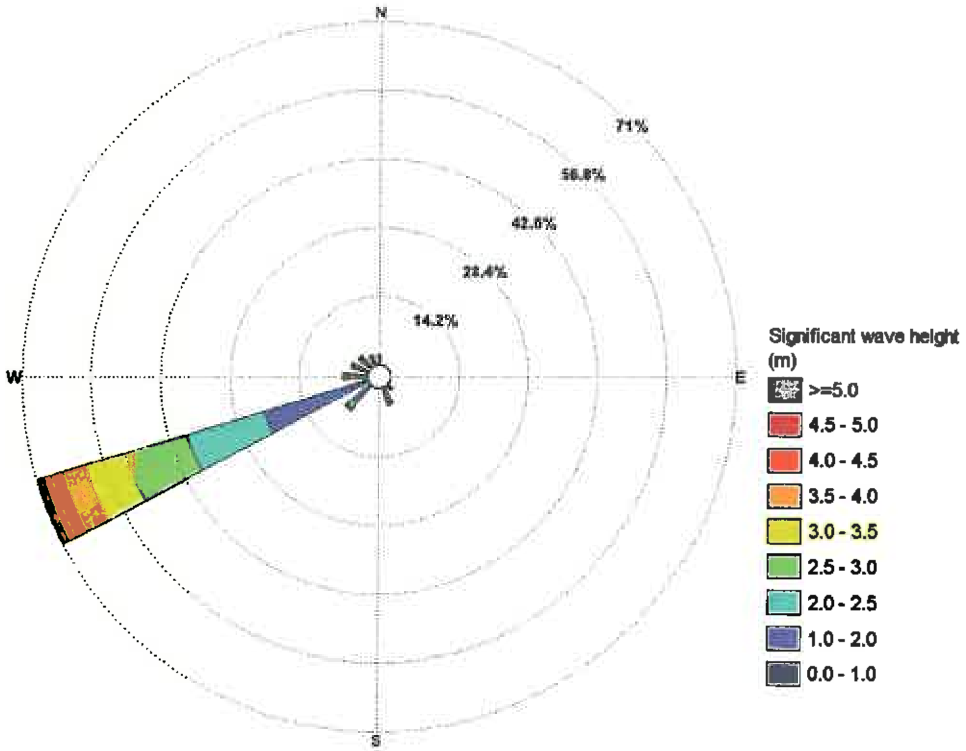

Figure 6: Annual Wave Rose for the central Māui Field area

(Source: MSL data supplied by STOS)

Wind Climate

Wind climate modelling in the central Māui Field area, indicates that the windiest month is June (9.14 $m.s^{-1}$), while the month with the least wind is February (7.52 $m.s^{-1}$).

The predominant wind in the central Māui Field area is from the westerly to south-westerly sectors, however strong winds are also possible from all quarters (Figure 7).

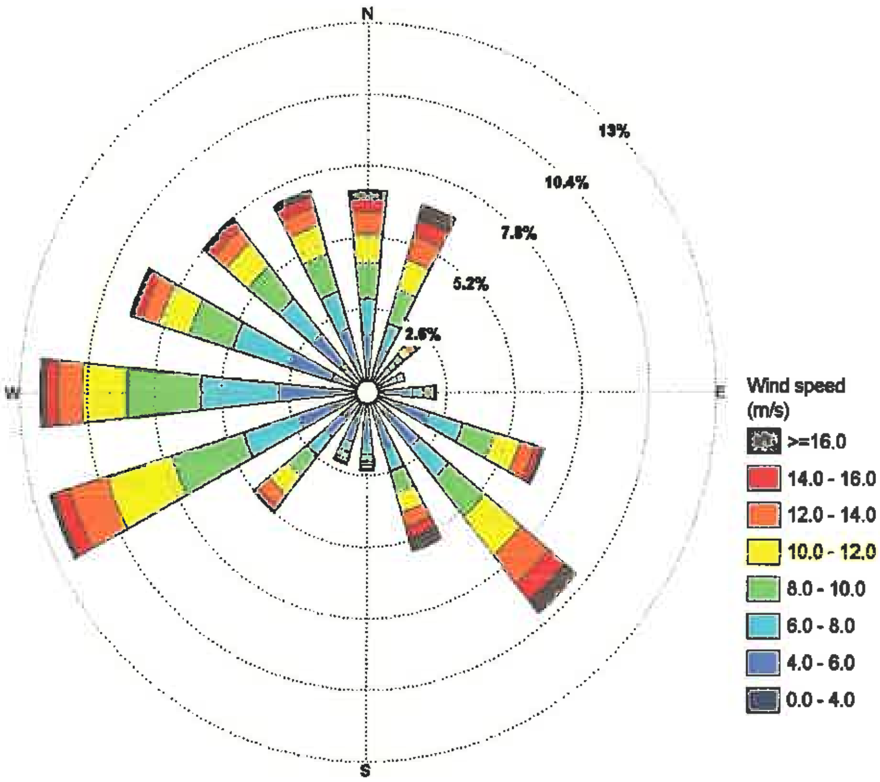

Figure 7: Annual Wind Rose for the central Māui Field area

(Source: MSL data supplied by STOS)

Bathymetry

The continental shelf is broad in the Taranaki region and occupies approximately 30,000 km^2. The shelf slopes gently towards the west with an overall gradient of less than 0.1° and locally less than 0.5° (Nodder, 1995).

A gridded bathymetry for the Operational Area was provided by STOS for the purpose of this project based on actual sounding data for locations where this was available and using the LINZ sounding data from hydrographic charts for the remainder of the Operational Area. Through the Operational Area the seabed slopes towards the west: from 60-100 m water depths on the eastern boundary to depths of 120-130 m on the western boundary, with the steepest gradient occurring in the northern portion of the Operational Area (Figure 8).

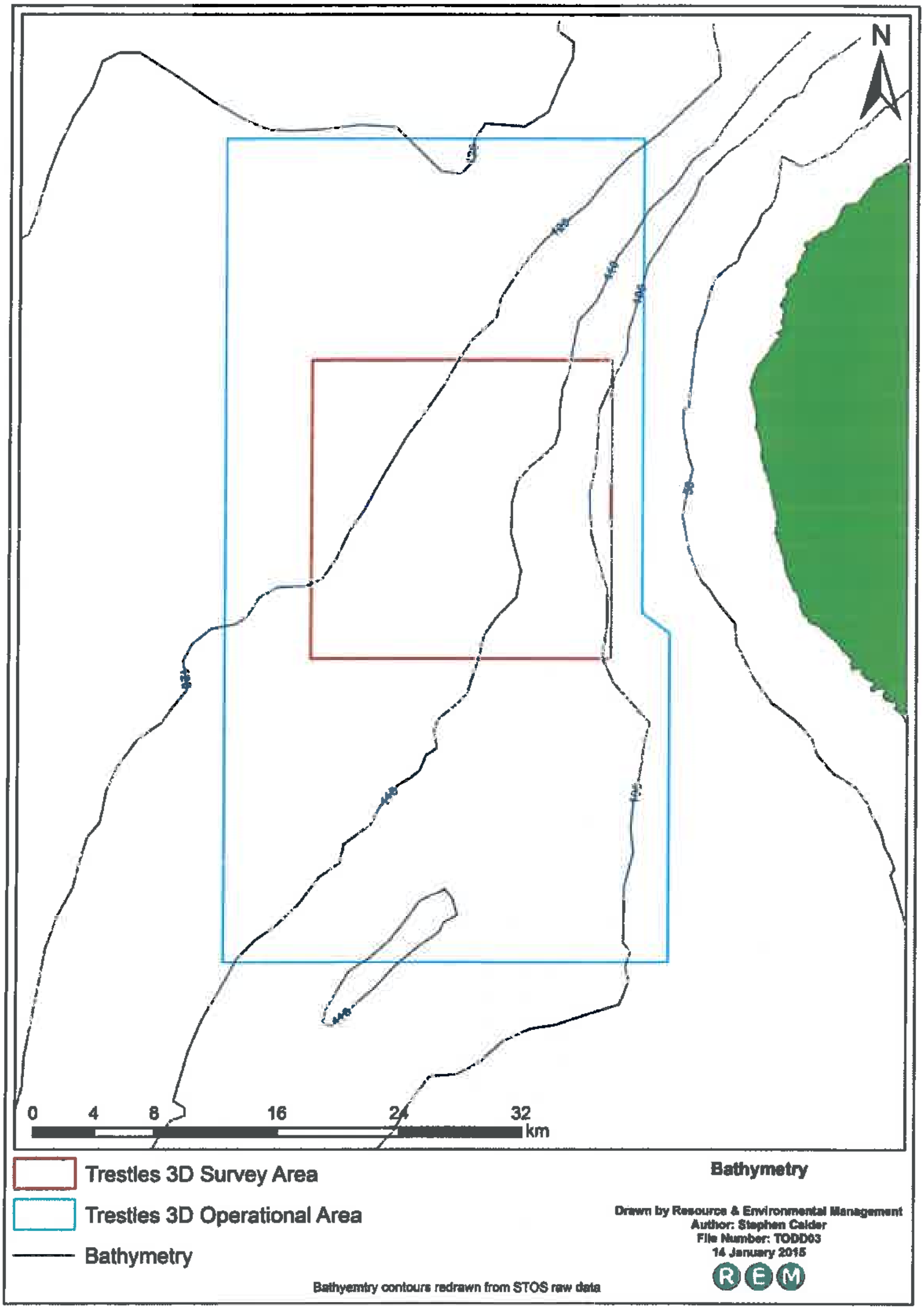

Figure 8: Bathymetry of the Survey Area

Currents

NZ sits in the eastward-forward southern branch of the South Pacific subtropical gyre. This gyre is driven by winds – the southeast trade winds to the north, and the Roaring Forties westerly winds to the south. Together these winds set up the anti-clockwise circulation within the gyre, which is then modified by the spin of the earth (Coriolis Effect).

Currents on the west coast of NZ are generally weaker and more variable than those along the east coast. The West Auckland Current flows southwards along the west coast of the North Island from North Cape to Raglan and is met by north-flowing currents in the North Taranaki Bight (Figure 10). These currents are both sub-tropical in origin with sea temperatures generally ranging from 13° to 22°.

The Westland Current flows in a northerly direction along the west coast of the South Island before merging with the D'Urville Current and moving into the South Taranaki Bight. The D'Urville Current sweeps into Cook Strait from the northwest, mixing with water from the Southland and East Cape currents before moving eastwards across Cook Strait. The D'Urville Current is warm, saline and well stratified water from the Tasman Sea, pushed into Cook Strait by westerly and northerly winds.

The current regime around NZ is dominated by three main processes; wind-driven flows, low frequency flows and tidal currents (MSL, 2014). The net flows are a combination of all three of these processes, and can be further influenced by bathymetric effects.

In the central Māui Field area, the depth-averaged currents showed a bimodal distribution with a clear north – south orientation and a slight predominance directed towards the north (Figure 9). At this site there is very little seasonal variation in flow patterns (MSL, 2014a).

There are few direct measurements of currents around NZ, and long-term current measurements are even rarer. Tides around NZ are moderate compared to world standards, with a tidal range of 1–2 m and tidal currents which travel about 2 km/hour (~1 knot). The exception is Cook Strait where the tidal currents can be much stronger.

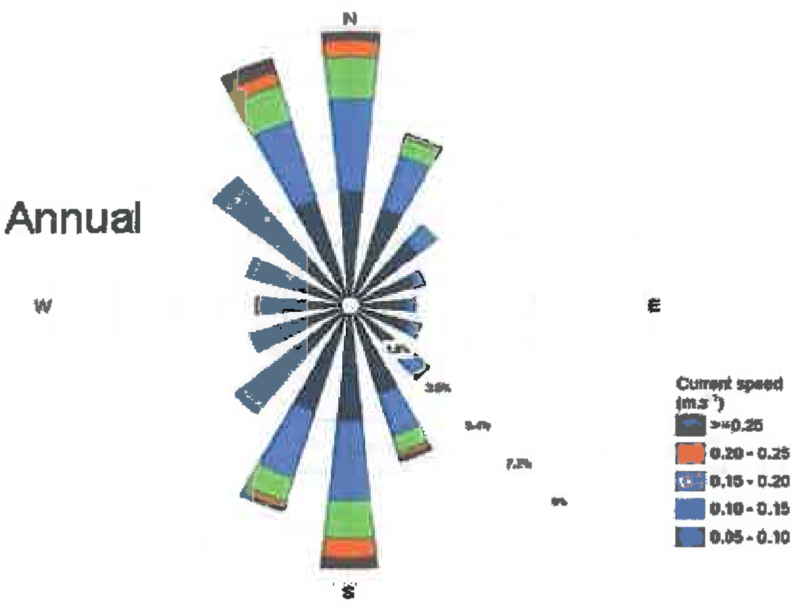

Figure 9: Annual Current Rose the central Māui Field Area

Note: Currents are shown in the 'going to' direction

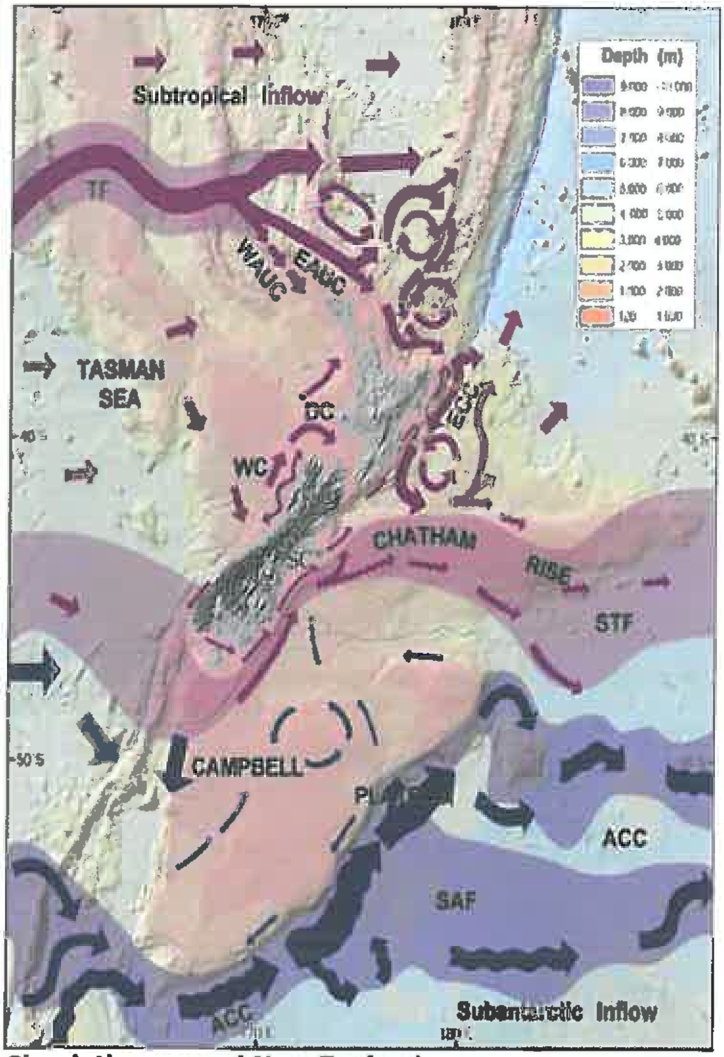

Figure 10: Ocean Circulation around New Zealand

(Source: The Encyclopaedia of New Zealand)

Water Column

During spring and summer months, thermal stratification of the water column occurs over a large portion of the Greater Cook Strait and the offshore Taranaki region. This seasonal stratification is a result of the solar heating of the upper water column. During late autumn this stratification usually breaks down due to mixing of the water column and reduced levels of solar radiation. The degree of stratification is strongly influenced by weather conditions, where rough weather in summer can quickly cause vertical mixing; hence, the summer thermocline is not a consistently present.

The water column properties within the Taranaki Bight are largely driven by the upwelling plumes originating from the Kahurangi Shoal off the west coast of the South Island. This upwelling leads to the formation of cyclonic plumes that are episodically shed off Cape Farewell (Figure 11). These intermittent upwelling events generate cold, nutrient rich water that move to the northeast towards the Taranaki coast, promoting high nutrient concentrations and associated biological activity on a temporally variable basis (ASR, 2003).

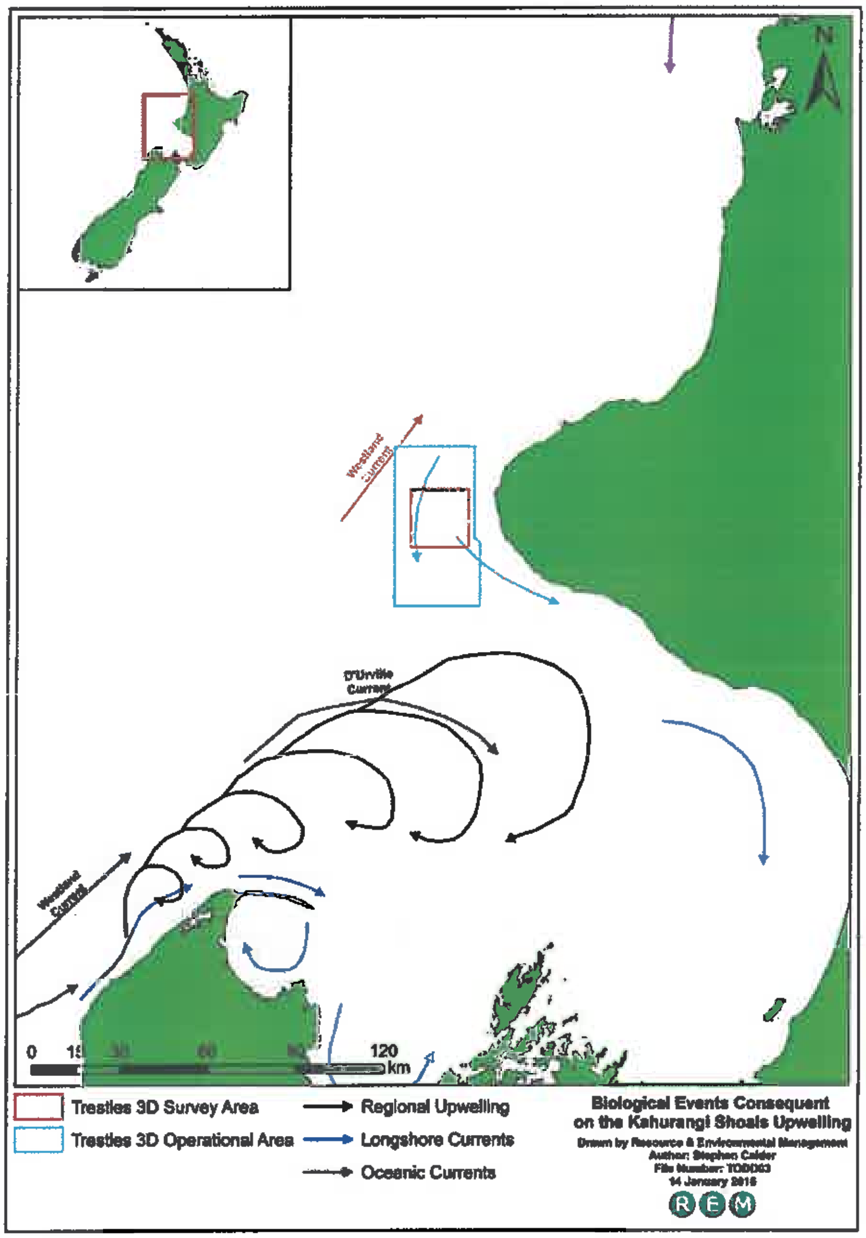

Figure 11: Biological events consequent on the Kahurangi Shoals upwelling

(Source: Adapted from Bowman *et al.* 1982)

Water Temperature

Satellite records from 1999 – 2009 provide information on monthly average sea surface water temperatures in the Māui Field area (MSL, 2013). The seasonal average temperatures were:

- Summer – 17.3 °C;
- Autumn – 18.0 °C;
- Winter – 15.0 °C; and
- Spring – 14.0 °C.

5.3 Biological Environment

5.3.1 Overview of Marine Ecosystem

NZ is home to approximately 16,000 marine species. Of which, the NZ threat classification system lists about 3% as being under conservation threat on account of small population size, restricted range and/or declining populations. The NZ Threat Classification Database can be accessed via the following link:

http://www.doc.govt.nz/publications/conservation/nz-threat-classification-system/nz-threat-classification-system-lists-2012-14/

The list of threatened marine species includes 38 seaweeds (Hitchmough *et al.* 2005), 33 marine invertebrates (Freeman *et al.* 2010), 36 seabirds (Miskelly *et al.* 2008), 82 species of marine fish, and 8 marine mammals (Baker *et al.* 2010).

New Zealand Marine Environmental Classification

The Marine Environmental Classification was developed to provide a spatial framework for the systematic management or marine biogeographic regions (NZMEC, 2005). This classification system uses physical (depth, solar radiation, sea surface temperatures, waves, tidal current, sediment type, and seabed slope and curvature) and biological parameters to map marine areas that have a similar environmental character. The classification system is accessible via the following link:

https://www.mfe.govt.nz/publications/ser/marine-environment-classification-jun05/

The vast majority of the Operational Area falls within 'class 60' representing the moderately shallow waters on the continental shelf (Figure 12). The characteristics of areas classified as Class 60 are described below (NZMEC, 2005).

- **Class 60**: occupies moderately shallow waters (mean = 112 m) on the continental shelf. It experiences moderate annular solar radiation and wintertime sea surface temperatures and has moderately high average chlorophyll-*a* concentrations. Some of the most commonly occurring fish species are jack mackerel, 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 tusk shells (Dentaliidae), cockles (Cardiidae), clams (Carditidae, Veneridae and Nuculanidae), brittle stars (Amphiuridae) and scallops (Pectinidae).

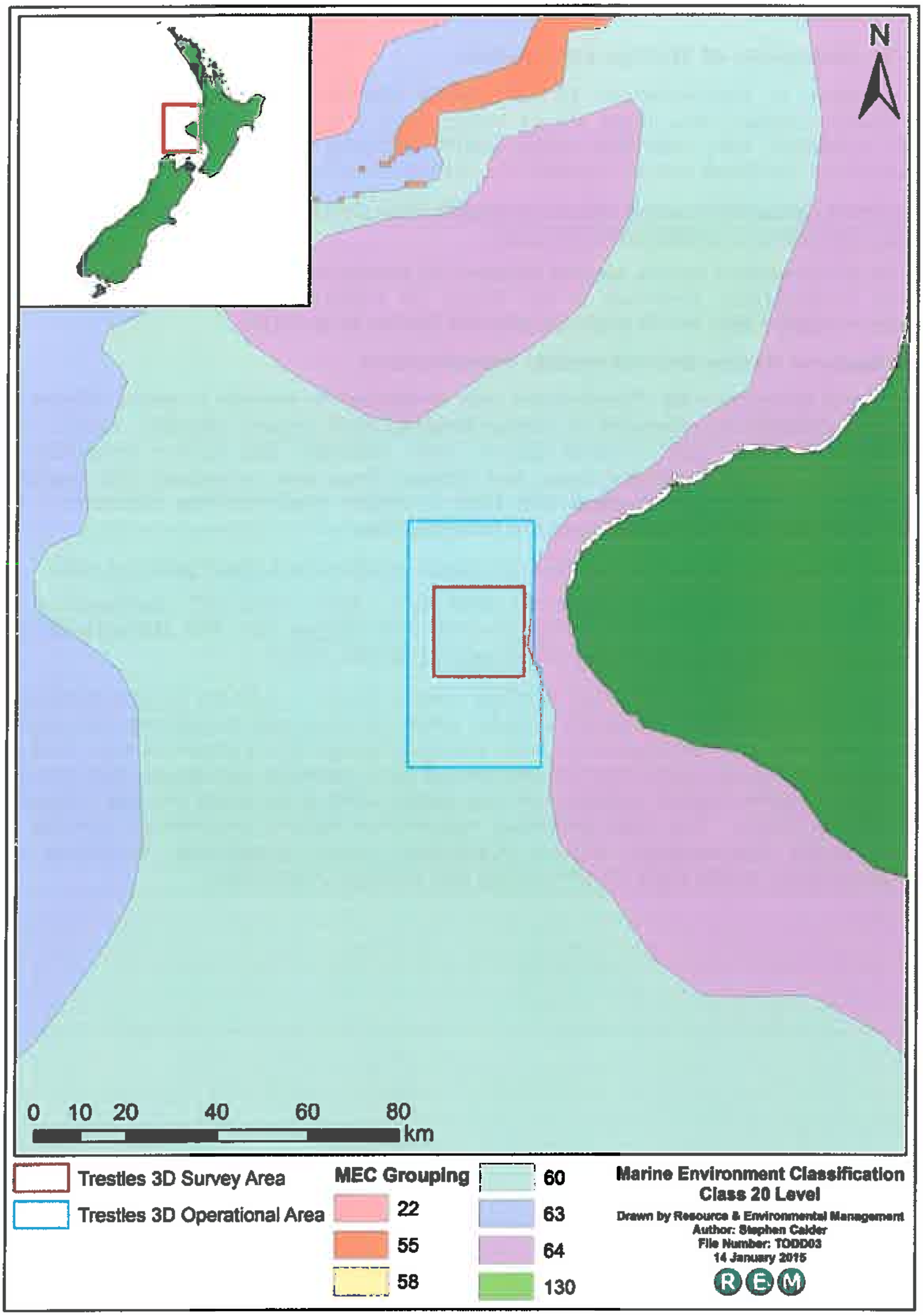

Figure 12: The Marine Environmental Classification at the 20-Class Level.

5.3.2 Sensitive Sites

Sensitive sites are locations that receive special mention due to their recognised natural ecological values, and/or established protection regimes.

Marine Mammal Sanctuaries

There are six gazetted Marine Mammal Sanctuaries (MMS) around NZ established under the Marine Mammal Protection Act 1978. Two additional sanctuaries for whales and fur seals have recently been established under the Kaikoura Marine Management Act 2014; bringing the total number of MMS in New Zealand to eight.

The only MMS of relevance to this MMIA is the West Coast North Island Marine Mammal Sanctuary, of which, its northern boundary extends from Maunganui Bluff in Northland to its southern boundary at Oakura Beach, with its offshore boundary 12 Nm from the shore. The MMS was established in 2008 for the protection of the Māui dolphin (Figure 13). The Operational Area of the Trestles 3D seismic survey lies outside, to the south and west of this sanctuary, separated by 1.5 km from the southern boundary of the sanctuary (see Figure 4).

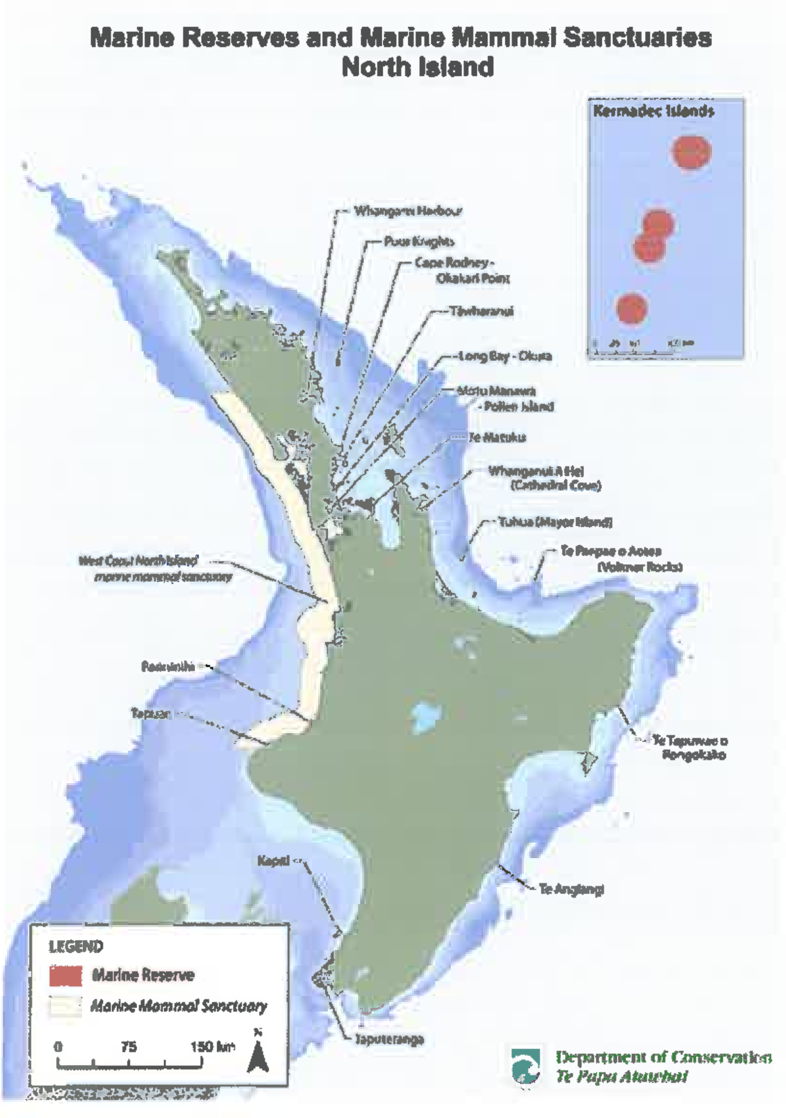

Figure 13: North Island Marine Reserves and Marine Mammal Sanctuary

(Source: www.doc.govt.nz)

Areas of Ecological Importance

The Code identifies Areas of Ecological Importance (AEI) as illustrated in Figure 14. The locations and extent of AEI in NZ continental waters have been determined from DOC marine mammal sighting and stranding records, fisheries related data from the Ministry for Primary Industries and species distributional information from a range of data sources.

When seismic surveys are operating within these AEIs, as is the case with the Trestles 3D Seismic Survey, the Code states that additional measures to avoid, remedy or mitigate adverse effects on marine mammals may be required and that increased planning is therefore necessary for such surveys.

In addition MMIAs for seismic surveys occurring within the AEI must incorporate sound transmission loss modelling, ground-truthing of modelled results and additional mitigation measures over and above those required in the Code. These requirements have been incorporated into this MMIA (Sections 6.3.2, Appendix 7, and 6.3.3) and all associated actions will occur as part of the Trestles 3D Seismic Survey.

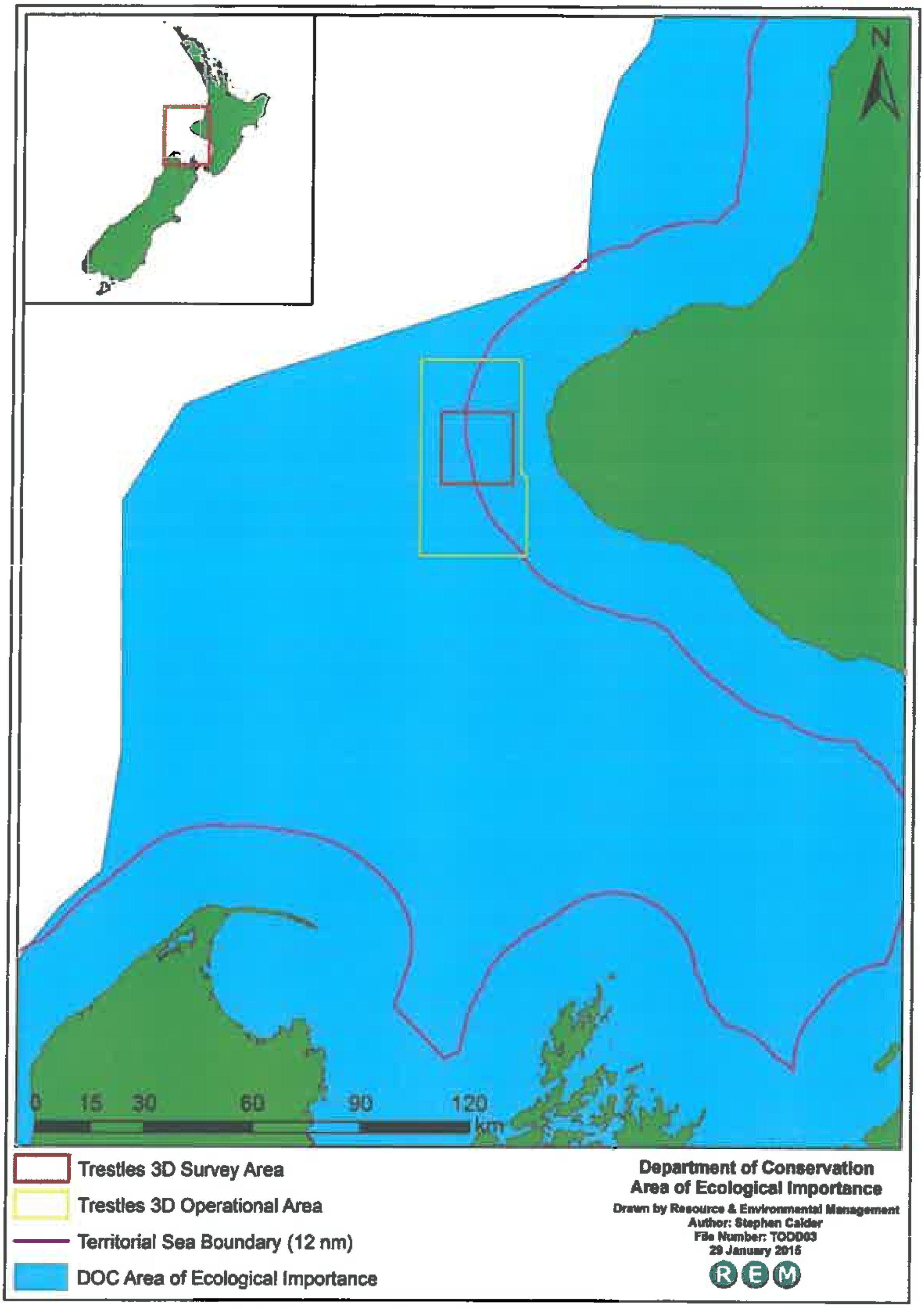

Figure 14: Areas of Ecological Importance

(Redrawn from http://www.doc.govt.nz)

Marine Reserves and Marine Protected Areas

Tapuae Marine Reserve is the second closest protected area to the Operational Area (Figure 13). The Tapuae Marine Reserve covers 1,404 ha and has a diverse range of habitats from canyons to boulder fields (DOC, 2014). It adjoins the Sugar Loaf Islands Marine Protected Area in the north, and extends south of New Plymouth to Tapuae Stream. The northwest part of the reserve is sheltered and characterised by islands, caves, canyons, and boulder fields, while the south-western part of the reserve is more exposed (DOC, 2014). Within the reserve, the waters contain a diverse range of fish, invertebrate and algal species. Tapuae Reserve is an important breeding and haul out site for NZ fur seals. Within this area other marine mammals have also been observed such as common dolphins, pilot whales, orca, humpback whales and southern right whales.

Sugar Loaf Islands Marine Protected Area (SLIMPA) is the eroded remnants of a volcano that is characterised by low sea stacks and seven small islands. The predator free islands within SLIMPA are the only offshore islands in the Taranaki Region and are afforded the status of wildlife sanctuary (entry by permit only). Nineteen species of seabird are associated with the islands, which provide important nesting habitat for upwards of 10,000 seabirds per year. A breeding colony of NZ fur seals also occurs here. SLIMPA provides a unique semi-sheltered subtidal environment along an otherwise exposed coastline (DOC, 2014a). SLIMPA supports a diverse range of subtidal marine habitats with 89 species of fish, 33 species of encrusting sponges, 28 species of bryozoans and 9 nudibranchs being present (DOC, 2014a).

Taranaki Areas of Outstanding Coastal Value

Within the Taranaki Regional Coastal Plan (TRC, 1997) there are several coastal areas which are identified as having significant conservation value and are protected by regional policy from disturbance and development. No spatial overlap will occur between these areas and the Operational Area (Figure 15); however, they included here for completeness. Note that SLIMPA, as described above, is also considered an Area of Outstanding Coastal Value.

Pariokariwa Point to Waihi Stream

This section of coastline contains a diverse range of nationally and locally significant features. The area includes fur seal haul-out and seabird roosting areas on Opourapa Island, offshore reefs containing abundant marine life, outstanding natural landscape at White Cliffs, a shipwreck, and important breeding habitat for fluttering shearwaters, grey-faced petrels and little blue penguins. The Mohakatino Estuary to the north is considered nationally significant; supporting whitebait, flounder and shellfish, and the adjacent sand flats and wetlands are habitat for threatened species such as Australasian bitterns and caspian terns. The large Tongaporutu Estuary to the south is an important nesting area for little blue penguins and grey-faced petrels. The variable oystercatcher has also been recorded there. The estuary includes whitebait spawning habitat and an abundance of shellfish with high species diversity. A large reef supporting a range of marine life and sponges extends 8 km offshore.

Mimi Estuary

This area includes tidal mudflat, saltmarsh and sand dune habitat which are uncommon in north Taranaki. It provides habitat for migratory and wading birds, whitebait spawning habitat in the upper estuary, feeding grounds for snapper and trevally, nursery areas for juvenile marine species including flounder, and a periodic breeding site for little blue penguins.

__Whenuakura Estuary__

This is a relatively unmodified estuary which provides habitat for the threatened caspian tern and variable oystercatcher. The estuary provides feeding habitat for migratory birds and an important whitebait spawning habitat.

__North and South Traps__

These subtidal rocky outcrops host extensive kelp forests (*Ecklonia radiata*) with diverse and abundant marine life. This rocky habitat is an unusual feature on an otherwise sandy coast.

__Waverley Beach__

This is an outstanding natural landscape with eroding sandstone stacks, caverns, tunnels, and blowholes, which produces unique landforms at the land/sea interface.

__Waitotara Estuary__

This is an unmodified estuary adjacent to an existing conservation area which provides important habitat for wetland birds (Australasian bittern, NZ shoveller and black swan). It is also a stopover for migratory wading birds. Sub-fossil totara stumps are present in the estuary and it is an important whitebait spawning area.

__Waiinu Reef__

The area has limestone rock outcrops from mean high water to 500 m offshore. The hard rock platforms contain many well-preserved fossils and an abundance of marine life.

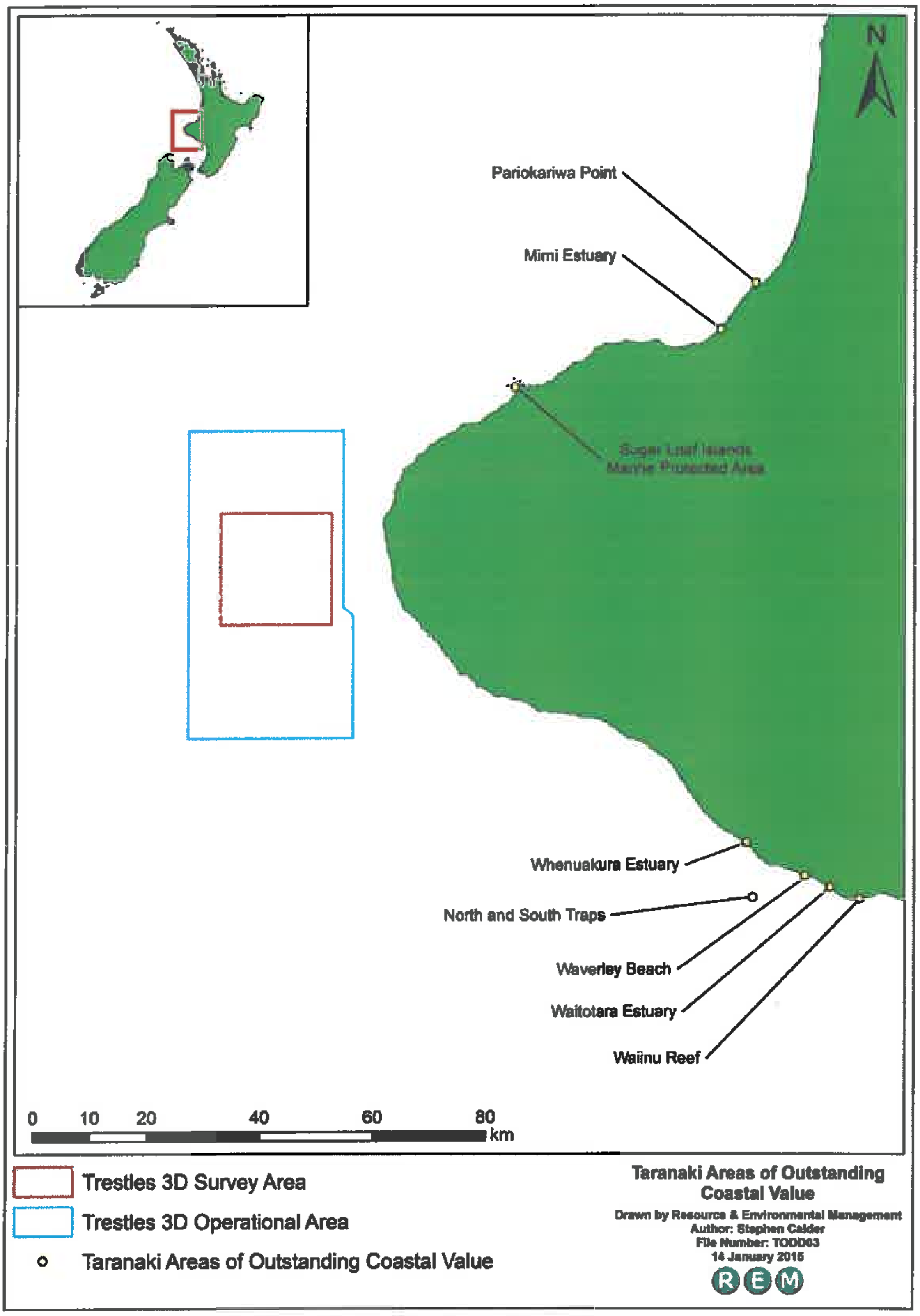

Figure 15: Taranaki Areas of Outstanding Coastal Value

5.3.3 Benthic Ecosystem

The benthic ecosystems in the offshore Taranaki Region are generally characterised by soft sand/mud substrates that supports a range of faunal species; mainly polychaete worms, cumaceans and amphipods (small crustaceans), and bivalves. The habitat is considered to be relatively homogenous (low habitat diversity).

Deep Sea Corals

A rich and diverse range of corals are recorded in NZ waters from the intertidal region out to depths of c. 5,000 m (Consalvey *et al.* 2006). Within the phylum Cnidaria, all corals belong to the class of Anthozoa or hydrozoa. These typically long-lived organisms exist either as individuals or in colonies, and form external skeletons which provide habitat for other organisms. Of the protected marine invertebrate species, the deep sea corals are the most relevant to this MMIA.

Within NZ's EEZ, black coral and stylasterid hydrocoral (formerly known as red coral) are protected under the Wildlife Act 1953. The NABIS database provides a distribution map for black corals only and indicates that a discrete patch of coral is located to the southeast of the Operational Area[3] and more extensive black coral habitat is found along the continental shelf break to the northeast (Figure 16). Within NZ waters there have been 58 species of black coral identified, and although their depth and geographical distributions have not been analysed in detail, it appears most tend to live in deep water on seamounts or other hard substrate in depths ranging from 200 to 1,000 m deep.

[3] The Taranaki Bight record of black coral is based upon fisheries observer data which was collected in December 2009 while the vessel was trawling for jack mackerel (at 40.15667, 174.075). This was a one-off record, and black coral has not subsequently been reported for this area (NABIS, 2012).

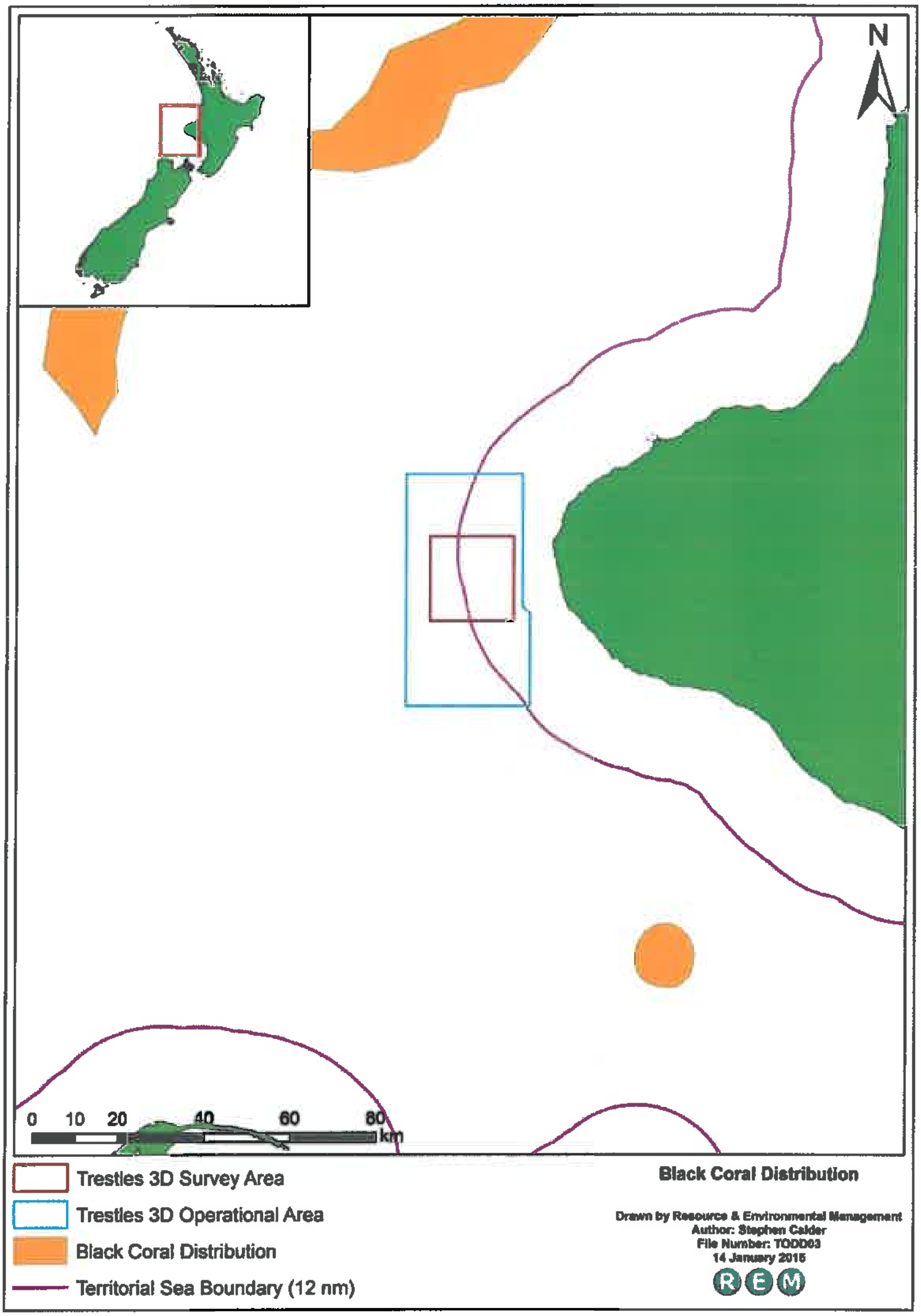

Figure 16: Black coral distribution relative to the Operational Area

5.3.4 Pelagic Ecosystem

Plankton

Plankton is the collective term for drifting organisms that inhabit the pelagic zone (water column) of the world's oceans. Plankton fills the role of primary producers of the ocean and forms the basis of the marine food web. Plankton travel with the ocean currents, and although some plankton can move vertically within the water column their horizontal distribution is primarily determined by the surrounding currents.

Plankton can be divided into three main groups:

- Phytoplankton: free-floating plants (capable of photosynthesis);
- Zooplankton: free-floating animals (includes larval stages of larger animals); and
- Bacterioplankton: free-floating bacteria (important in nutrient cycling).

The upwelling of cold, nutrient-rich waters from Kahurangi Shoals off the West Coast of the South Island influences primary productivity in the Taranaki Bight. Phytoplankton proliferates in this nutrient rich water which moves in plumes across the South Taranaki Bight. Zooplankton (in particular *Nyctiphanes australis*) in turn feed on the phytoplankton and increase in abundance as the plumes mature. This prevalence in zooplankton is thought to provide a food supply for blue whales (see Section 5.3.5).

Fish Species

Fish populations around the Operational Area are comprised of various demersal and pelagic species, most of which are widely distributed from north to south and from shallow water to beyond the shelf edge.

Over the summer months when warmer currents move down from the north, a number of pelagic species visit the Taranaki coastline following the abundance of food. The most common species are sunfish, flying fish, marlin, albacore tuna, skipjack tuna, mako sharks and blue sharks.

A general summary of fish species in Taranaki waters is presented in Table 3.

Table 3: General Distribution of Fish Species in the Taranaki Region

(Source: [1] Hurst *et al*. 2000; [2] O'Driscoll *et al*. 2003; [3] IUCN, 2014)

Coastal[1]		**Deepwater**[2]
Kahawai	Gemfish	Redbait
Red gurnard	Sand flounder	Ling
School shark	Blue mackerel	Frostfish
Sea perch	Kingfish	Hoki
Giant stargazer	Blue warehou	Silver warehou
Rig	John dory	Hake
Tarahiki	Murphy's mackerel	Northern spiny dogfish
Gould's arrow squid	Jack mackerel	
Sloan's arrow squid	Horse mackerel	**Pelagic**[3]
Snapper	Barracouta	Albacore tuna
Blue cod	Elephant fish	Skipjack tuna
Lemon sole	NZ sole	Southern bluefin tuna
Hapuku	Spiny dogfish	Great white shark
Trevally	Silverside	Basking shark
Red cod	Silver dory	Mako shark
Scaly gurnard	Porcupine fish	Blue shark
Cucumber fish	Carpet shark	Marlin
Witch	Leather jacket	

Great white sharks, basking sharks, deepwater nurse sharks and oceanic whitetip sharks are at risk of extinction and are classified as being vulnerable (IUCN, 2014). Of these species great white sharks and basking sharks have the potential to occur in Taranaki waters and both are fully protected in NZ under the Wildlife Act 1953 and are further protected on the high seas from fishing by NZ flagged vessel under the Fisheries Act 1996.

5.3.5 Marine Mammals

NZ waters support a diverse community of marine mammals. There are forty-one species of cetaceans (whales and dolphins) and nine species of pinnipeds (seals and sea lions) known to inhabit NZ waters (Suisted & Neale, 2004). Understanding the distribution of these species is fundamental with regard to understanding the potential impacts that seismic surveys may have on them. The information contained in this section therefore largely focusses on species distribution with the aim of identifying any spatial overlap between marine mammal distributions and the Operational Area. The key information sources which underpin this section are:

- Published literature on individual species (individually referenced);
- DOC marine mammal sighting (opportunistic) and stranding records (DOC, 2014b; as provided to REM in March 2014); and
- Torres, L. (2012). Marine mammal distribution patterns off Taranaki, New Zealand, with reference to the OMV NZ Ltd petroleum extraction in the Matuku and Maari permit areas. Report prepared by NIWA for OMV NZ Ltd. March 2012. Report number WLG2012-15.

These information sources contain opportunistic presence-only data, and it is important to recognise that observer effort is not consistent across space and time.

A summary of the marine mammal species which could be present in the Operational Area are provided in Table 4. Based on the distributional information available and in accordance with the New Zealand Threat Classification System (as summarised in Appendix 4), up to six threatened species (Bryde's whale, killer whale, Hector's dolphin, Māui dolphin, southern right whale, and bottlenose dolphin) could be present within the Operational Area. However, three of these species (South Island Hector's dolphins, Māui dolphins and Bryde's whales) have a low likelihood of occurring here (Table 4). Other species, in addition to those classified as threatened and mentioned above, may occur in the Operational Area, and a full list of marine mammal species are provided in Table 4.

Table 4: Marine mammal species which may be present in the Operational Area

	Species	Scientific name	IUCN Status (www.redlist.org)	NZ Threat Status (Baker *et al.* 2010) (see Appendix 4)	Listed as a 'Species of Concern' in the Code	Likelihood of presence in Operational Area	Season most likely present
Baleen Whales	*Humpback whale	*Megaptera novaeangliae*	Least concern	Migrant	Yes	✓	winter/spring
	*Blue whale	*Balaenoptera musculus* and *B. musculus brevicauda*	Endangered	Migrant	Yes	✓	spring/summer
	*Bryde's whale	*Balaenoptera edeni*	Data Deficient	**Nationally Critical**	Yes	✓ low [1]	-
	*Fin whale	*Balaenoptera physalus*	Endangered	Migrant	Yes	✓	-
	*Minke whale	*Balaenoptera acutorostrata* and *B. bonaerensis*	Data Deficient	Not Threatened	Yes	✓	Autumn/winter/spring
	Sei whale	*Balaenoptera borealis*	Endangered	Migrant	Yes	✓	-
	Southern Right whale	*Eubalaena australis*	Least Concern	**Nationally Endangered**	Yes	✓	winter/spring
	*Pygmy right whale	*Caperea marginata*	Data Deficient	Data Deficient	Yes	✓	-
Toothed whales and dolphins	*Arnoux's beaked whale	*Berardius arnouxi*	Data Deficient	Vagrant	Yes	✓	-
	*Andrew's beaked whale	*Mesoplodon bowdoini*	Data Deficient	Data Deficient	Yes	✓	-
	*Ginko-toothed whale	*Mesoplodon ginkodens*	Data Deficient	Vagrant	Yes	✓	-
	*Gray's beaked whale	*Mesoplodon grayi*	Data Deficient	Data Deficient	Yes	✓	-
	*Strap-toothed whale	*Mesoplodon layardii*	Data Deficient	Data Deficient	Yes	✓	-
	*Shepherd's beaked whale	*Tasmacetus shepherdi*	Data Deficient	Data Deficient	Yes	✓	-
	*Cuvier's beaked whale	*Ziphius cavirostris*	Data Deficient	Data Deficient	Yes	✓	-
	*Sperm whale	*Physeter macrocephalus*	Vulnerable	Not Threatened	Yes	✓	summer
	*Pygmy sperm whale	*Kogia Breviceps*	Data Deficient	Data Deficient	Yes	✓	-
	*Long-finned Pilot whale	*Globicephala melas*	Data Deficient	Not Threatened	Yes	✓	summer
	*Short-finned Pilot whales	*Globicephala macrorhynchus*	Data Deficient	Migrant	Yes	✓	summer
	*Killer whale – Type A	*Orcinus orca*	Data Deficient	**Nationally Critical**	Yes	✓	-
	*False killer whales	*Pseudorca crassidens*	Data Deficient	Not Threatened	Yes	✓	-
	*Bottlenose dolphin	*Tursiops truncatus*	Least Concern	**Nationally Endangered**	Yes	✓	-
	*Common dolphin	*Delphinus delphis*	Least Concern	Not Threatened	No	✓	-
	*Dusky dolphin	*Lagenorhynchus obscurus*	Data Deficient	Not Threatened	No	✓	-
	* Māui dolphin	*Cephalorhynchus hectori maui*	Critically Endangered	**Nationally Critical**	Yes	✓ low [2]	winter

	*South Island Hector's dolphin	*Cephalorhynchus hectori hectori*	Endangered	**Nationally Endangered**	Yes	✓ low [2]	winter
	*Striped dolphin	*Stenella coeruleoalba*	Least Concern	Vagrant	No	✓ low [3]	-
	Risso' s dolphin	*Grampus griseus*	Least Concern	Vagrant	No	✓ low [3]	-
	* NZ fur seal	*Arctophoca australis forsteri*	Least Concern	Not Threatened	No	✓	year round

** These species are represented in the stranding record for Taranaki 1960 – 2013 (Source DOC 2014b); [1]distribution is largely limited to waters further north; [2] largely coastal distribution; [3] vagrant status*

Whale migration routes

Each spring most of the large whales living in the Southern Hemisphere undertake extensive migrations: from the Pacific Islands to the Antarctic Ocean to feed, and return each Autumn-Winter back to the Pacific Islands for the breeding season (May – July) (DOC, 2007).

Figure 17 shows the distribution and migratory patterns of humpback, sperm, Bryde's and southern right whales around NZ throughout the year. These species are each discussed individually below. Whilst the northwards migration routes are well known, the southwards routes are not so well understood.

Figure 17: Whale Distribution in NZ Waters

(Source: Te Ara, 2014)

Humpback Whale

Humpbacks have well-established migration routes between summer feeding grounds in Antarctic waters to winter breeding grounds in tropical waters. This migration route passes through NZ waters (Berkenbusch *et al.* 2013), whereby whales move northwards up the east coast of the South Island and through Cook Strait from May to August. Animals on their southern migration move down both coasts of the North Island from September to December (Gibbs and Childerhouse, 2000). The majority of humpback sightings in the South Taranaki Bight occur between June and November, a period which corresponds with the migration period (Torres, 2012). Lactating females and yearlings are often seen early in the season, followed by immature whales, then mature males and females, with pregnant females being the last cohort to travel (Gibbs and Childerhouse, 2000).

It is likely that the South Taranaki Bight is regularly used as a migratory corridor for humpback whales from May to December.

Blue Whales

Two subspecies of blue whale may be present in NZ waters; the pygmy blue whale (*Balaenoptera brevicauda*) and the Antarctic blue whale (*B. musculus intermedia*). Due to difficulties in distinguishing the two subspecies apart, they are generally reported collectively as 'blue whales'.

There is a significant presence of blue whales in the South Taranaki Bight and Greater Cook Strait area (Torres, 2013; Torres *et al.* 2014). Observations by Torres *et al.* (2014) support the hypothesis that the region is a blue whale foraging ground. Sightings peak in June and November; however, blue whales have been sighted in the South Taranaki Bight in most months of the year (Torres, 2012). However, to date no information is available on the residency of individual blue whales within the South Taranaki Bight.

The distribution and movements of these whales is typically driven by prey availability (De Vos *et al.* 2014); therefore, the presence of prey in large aggregations is important. Blue whales are filter feeders that target large zooplankton, particularly euphausiids (Fiedler *et al.* 1998). The South Taranaki Bight and Greater Cook Strait areas have been shown to have the most extensive zooplankton biomass of all the NZ coastal regions (Shirtcliffe *et al.* 1990), a possible explanation for the high number of sightings in this area. Therefore this species could be encountered in the Operational Area.

Bryde's Whale

Little is known about seasonal latitudinal movements of Bryde's whales in NZ. Numbers appear to be concentrated in the warmer waters around the Hauraki Gulf; however, they are occasionally seen in Taranaki. Only two stranding events have been reported in the region; one in Manawatu at Foxton Beach and the other in North Taranaki at Mohakataino River Mouth (DOC, 2014b). Sightings at sea are also rare; one sighting was reported approximately 25 km to the west of OMV's Maari WHP, and two were reported northwest of Cape Farewell (Torres, 2012).

The South Taranaki Bight area is outside of the regional population concentration for Bryde's whales; hence, this species if not commonly seen in the area and if occasionally present would be expected to be found in very low numbers.

Fin Whale

Fin whales are rarely observed in NZ coastal waters (Dawson, 1985); however, stranding incidents and sightings have been recorded for the Taranaki region, with two stranding occurrences (at Ohawe Beach, South Taranaki Bight; and New Plymouth foreshore, North Taranaki Bight) and only a small number of live sightings (<10) recorded for this region (DOC, 2014b). These records indicate that fin whales may, at times, be present in the Operational Area.

Minke Whales

There are two species of minke whale known to occur in NZ waters; the Antarctic minke (*Balaenoptera bonaerensis*) and the dwarf minke (*B. acutorostrata subsp.*). Minke whales have been observed around the NZ coast, but are reported to be most common south of NZ where they feed in Antarctic waters. DOC sighting records indicate minke whales utilise the Taranaki region, with observations recorded close to shore off Cape Egmont (DOC, 2014b).

It is possible that this species could be encountered in the Operational Area.

Sei Whale

Throughout February and March, Sei whales migrate to Antarctic feeding grounds, returning back to NZ waters between the South Island and Chatham Islands for calving. Although there are no records of Sei whales stranding in the Taranaki region (DOC, 2014b); sightings of this species have been made in the South Taranaki Bight. All observations correlated to the summer months (Torres, 2012).

It is possible that this species could be encountered in the Operational Area.

Southern Right Whale

Southern right whales are the only species of baleen whale known to breed in NZ waters. In winter months they move into coastal waters at lower latitudes to calve, particularly around the subantarctic Auckland Islands (Rayment *et al.* 2012). Summer months are usually spent in latitudes 40 - 50°S (Oshumi and Kasamatsu, 1986; as cited by Reilly *et al.* 2013), where the whales take advantage of the seasonal proliferation of planktonic prey (Tormosov *et al.* 1998; as cited by Reilly *et al.* 2013; Rowantree *et al.* 2008).

Southern right whales are frequently observed in sheltered coastal waters. A number of sighting records exist for the Taranaki region. A stranding incident has also occurred in the Taranaki region. For the most part, sightings of southern right whales are typical only in coastal waters during the winter months (coinciding with their migration cycle). However, it is possible that individuals will move through the Operational Area further offshore outside of the winter months as they travel towards higher latitude feeding areas.

Pygmy Right Whale

The majority of knowledge of this species is from stranded specimens as sightings at sea are rare. Pygmy right whales are well represented in the stranding record for the Taranaki region, but no live sightings have been reported (DOC, 2014b). As a result of the stranding record, there is a possibility that this species could be present within the Operational Area.

Beaked Whale

Eleven species of beaked whales are known from NZ waters; and are typically associated with deep water. They are generally elusive at sea so few live sighting records have been reported, however a number of stranding records exist and many species are known primarily from these stranding events (DOC, 2014b).

Seven species of beaked whale have been recorded in the stranding record for Taranaki (Table 4) (DOC, 2014b), with a particularly high representation of Gray's beaked whales. For this reason it is believed that the South Taranaki Bight may provide an important habitat for this species. Other species of beaked whales that have stranded here are: Arnoux's beaked whale, Cuvier's beaked whale, strap-toothed whale, Andrew's beaked whale, ginko-toothed whale and Shepherd's beaked whale (DOC, 2014b). These species may also use this area to an unknown extent.

Sperm Whale

Sperm whales feed on squid and fish and live in open ocean environments or areas on the seaward edge of the continental shelf in the vicinity of deep productive canyons, with their distribution being strongly related to bathymetry. As a result of this, a resident population of sperm whales exists in Kaikoura.

Torres (2012) reported that sperm whale sightings in the South Taranaki Bight typically occurred in deep offshore water and were limited to summer months. Despite this it is possible that sperm whales could occasionally be present in the Operational Area.

Pygmy Sperm Whale

Pygmy sperm whales are difficult to observe at sea on account of their small size, timid behaviour, lack of a visible blow, and their low profile in the water. A small number of pygmy sperm whales have stranded in recent years around the Wanganui and South Taranaki coastlines, the most recent of which was on Waiinu Beach in South Taranaki in May 2011 (DOC, 2014b). This stranding incident indicates that this species is present in the general Taranaki area and as a result it is assumed that pygmy sperm whales may be present in the Operational Area.

Pilot Whales

Two species of pilot whale occur in NZ waters; the long-finned pilot whale (*Globicephala melas*) and the short-finned pilot whale (*G. macrorhynchus*). Although the two species are loosely separated by water temperature preferences; short-finned pilot whales prefer warm temperate and tropical waters, while long-finned pilot whales are typically found in colder temperate waters (Olson, 2009, as cited in Berkenbusch *et al.* 2013), they are difficult to distinguish at sea therefore most sighting information does not differentiate between species.

There are both sighting and stranding records of pilot whales in the South Taranaki Bight. Torres (2012) reported sightings of pilot whales within the South Taranaki Bight were more frequent during summer months, and mass stranding events of pilot whales is a common occurrence in Golden Bay during summer (DOC, 2014b).

Pilot whales utilise the waters of the South Taranaki Bight. Based on their preference for colder water temperatures it is likely that the species most often encountered here is the long-finned pilot whale and that they have a greater presence during summer months.

Killer Whale

It is recognised that this species is in need of a taxonomic review as evidence suggests there are several morphological forms (Taylor *et al.* 2013) which have provisionally been designated Types A – D (Baker *et al.* 2010). The majority of killer whale sightings in NZ coastal waters are believed to be Type A, with Types B – D occurring mostly in Antarctic waters. Type A killer whales have been seen in all coastal regions of NZ, including the South Taranaki Bight (Visser, 2000). Although it has been suggested that killer whales are more likely to be present within the region from November through to February (Visser, 2000), Torres (2012) reported that sightings are relatively evenly distributed through time.

Given the species' wide ranging and highly mobile nature, it is likely that killer whales frequently pass through the Taranaki region and therefore may be present within the Operational Area.

False Killer Whale

False killer whales are commonly observed in deep, warm/temperate oceanic waters (Dawson, 1985). They are present in the stranding record from Taranaki and therefore could be observed in the Operational Area.

Bottlenose Dolphin

Bottlenose dolphins are widely distributed throughout the world in cold temperate and tropical seas, with NZ representing their southernmost range. Three distinct coastal sub-populations occur around NZ and make up the 'inshore' population. This inshore population occurs in the Bay of Islands, Marlborough Sounds and Fiordland (Baker *et al.* 2010). In addition to the inshore population, bottlenose dolphin sightings are common in offshore waters. These offshore dolphins are typically seen in larger groups than the inshore dolphins (Torres, 2012).

Few sightings or standings have occurred in Taranaki or the Manawatu/Wanganui regions, with the majority of records in Nelson, Tasman, Marlborough and off Wellington's south coast (Berkenbusch *et al.* 2013; Torres, 2012).

Offshore bottlenose dolphins may on occasion utilise the waters within the Operational Area; however, only one stranding and a small number of sightings (<5) of this species have been recorded for the Taranaki region (DOC, 2014b); indicating that this area is probably not of particular ecological importance to this species.

Common Dolphin

The common dolphin has a wide cosmopolitan distribution and is known to occur in all regions of NZ (Berkenbusch *et al.* 2013). Torres (2012) reported that the common dolphin is the cetacean species most frequently encountered in the South Taranaki Bight, with sightings recorded in all months of the year. Sightings of common dolphins in the South Taranaki Bight are typically in water depths between 0 and 100 m; however, this species has also been observed throughout more oceanic waters. In some locations a degree of off-shore/on-shore movement may be common based on prey distribution and availability (Neumann, 2011; Meynier *et al.* 2008).

This species is common around the Taranaki coastline and it is likely to be observed within the Operational Area.

Dusky Dolphin

Dusky dolphins are primarily a coastal dolphin found in water depths less than 2,000 m. They prefer cool, upwelling waters and are more commonly seen around the South Island and lower North Island (Wursig *et al.* 2007). Dusky dolphins are present in NZ waters year round (Berkenbusch *et al.* 2013); however, evidence suggests that they spend more time in offshore waters during the winter months (Wursig *et al.* 2007).

Torres (2012) found that small numbers of dusky dolphins were present in Taranaki waters throughout the year. Therefore, is appears that dusky dolphins may be regularly present in the South Taranaki Bight, albeit in low numbers.

Hector's Dolphins

There are two subspecies of endemic Hector's dolphins; the South Island Hector's dolphin (*Cephalorhynchus hectori hectori*) and the Māui dolphin (*C. hectori maui*).

Although morphologically and genetically distinct (Baker *et al.* 2002), the two subspecies cannot be readily differentiated by visual observations. Interpretation of sighting records can therefore become confused as in most circumstances genetic verification (the most reliable way to distinguish between the two subspecies) is not possible. There is also no evidence to suggest the ecology of the two is substantially different (Torres, 2012).

The South Island Hector's dolphin population is comprised of three geographically and genetically distinct subpopulations; the east coast South Island subpopulation estimated at 9,130 individuals (Mackenzie and Clement, 2014), the west coast South Island subpopulation estimated at 5,388 individuals (Slooten *et al.* 2004), and the south coast South Island subpopulation estimated at 628 (Clement *et al.* 2011 as cited in Du Fresne *et al.* 2012). Although the South Island Hector's dolphin is typically found in South

Island coastal waters, occasional sightings of what are presumed to be South Island Hector's dolphins occur around the lower North Island (i.e. Wellington Harbour, Kapiti Coast; DOC, 2011) and in two instances South Island Hector's dolphins have been genetically identified off Raglan and South Manukau (Hamner *et al.* 2012), areas which overlap with the distribution of Māui dolphins.

Māui dolphins occur strictly on the west coast of the North Island with the population concentration occurring between Manukau Harbour and Port Waikato (Slooten *et al.* 2005). Their total distribution extends from Maunganui Bluff to Taranaki (Figure 18). The most recent population estimate for Māui dolphins is 55 individuals aged 1 year and over (95% CI = 48 – 69) (Hamner *et al.* 2014).

The majority of sightings of Māui dolphins occur in water depths less than 20 m and within 4 Nm of the coast (Du Fresne, 2010); however, during an aerial survey in 2006 a reliable sighting of a Māui dolphin was made 7 Nm off shore in the Muriwai area (Scali, 2006, as cited in Du Fresne, 2010). Two further offshore sightings have been made from Taranaki oil platforms approximately 17 and 24 Nm offshore; however, these sightings are unverified (Torres, 2012). The frequency of offshore sightings increases in winter, suggesting a slight seasonal shift in habitat preference (Slooten *et al.* 2006; Du Fresne, 2010). The Māui and South Island Hector's dolphins appear to prefer water depths of 1 – 100 m.

A Marine Mammal Sanctuary covering 2,164 km of coastline is in place to protect the Māui dolphin. The Government has recently extended the set net fishing ban off the coast of Taranaki (Figure 19).

Although the distribution of the Māui and South Island Hector's is unclear, data does not suggest that either sub-species is consistently present in the Operational Area, rather that both subspecies are sporadic visitors to the area, and that they typically occur in shallower coastal waters.

If a Māui or Hector's dolphin sighting is made during the Trestles 3D Seismic Survey (either during data acquisition or during transit to and from the Operational Area), an immediate notification will be made to DOC via Ian Angus (DOC National Office and Callum Lilley (Taranaki Area Office,

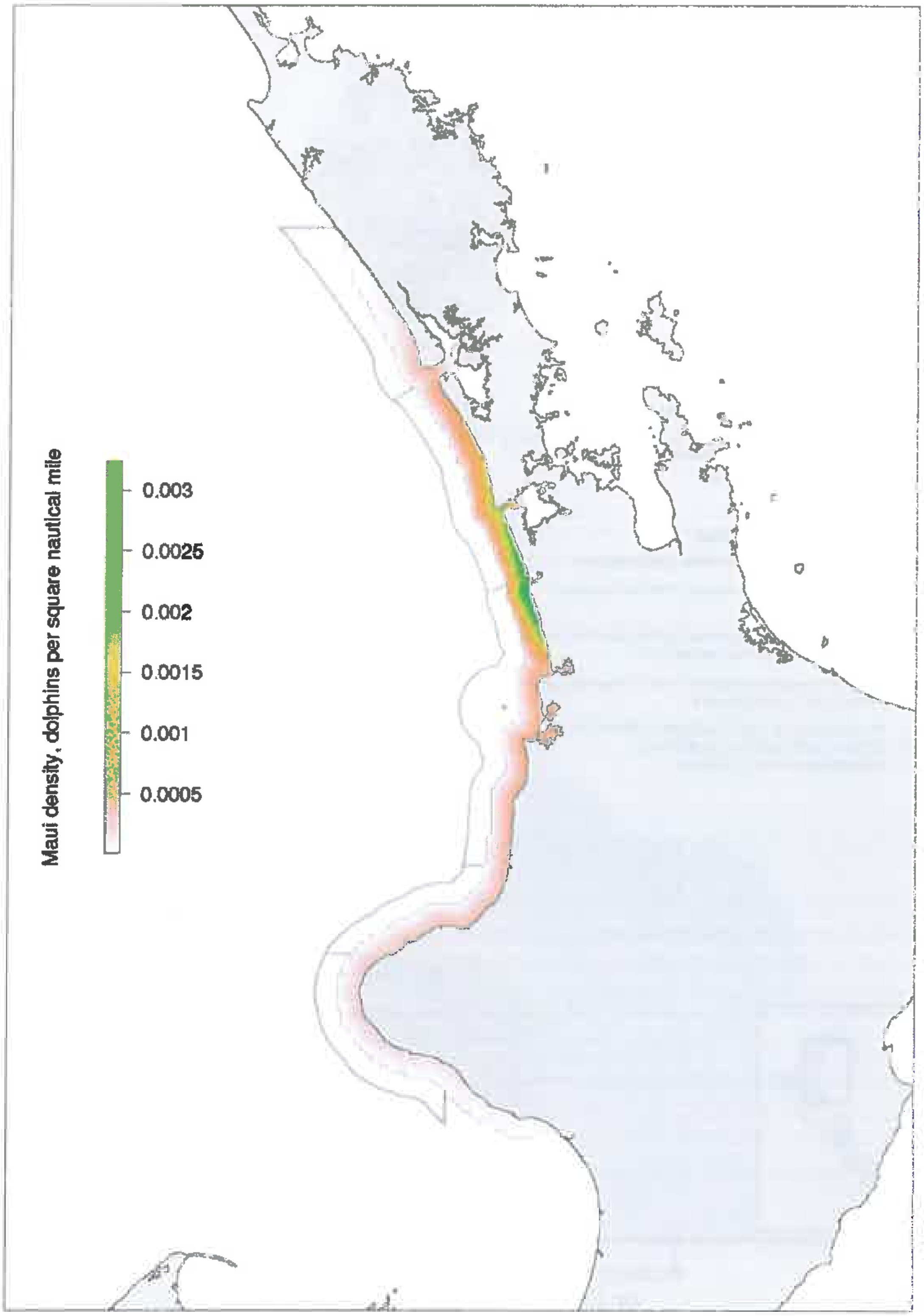

Figure 18: Māui dolphin density

(Based on nine aerial and genetic surveys conducted between 2000 and 2012)

(Source: Currey *et al.* 2012)

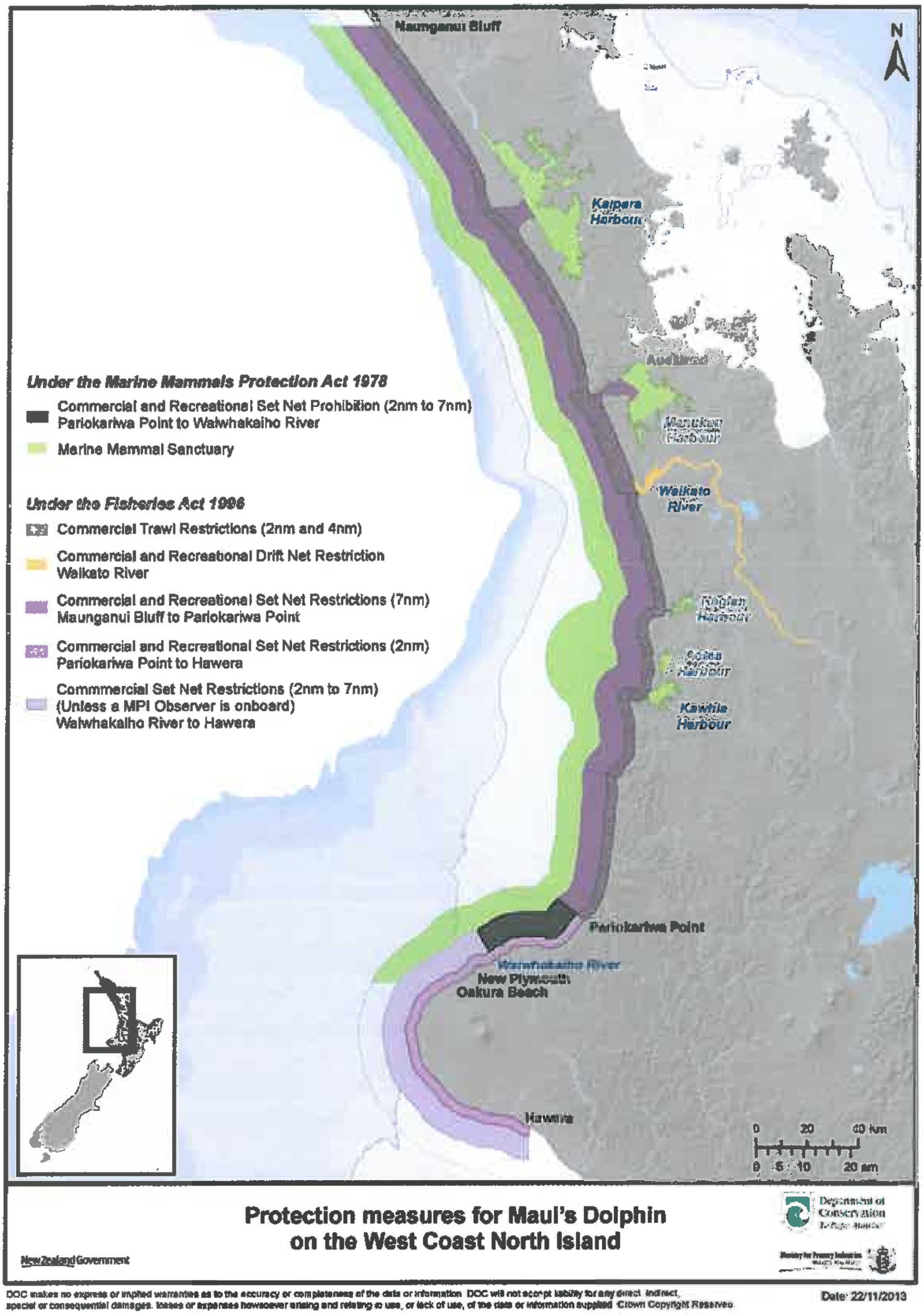

Figure 19: Māui dolphin protection measures

(Source: www.doc.govt.nz)

Striped Dolphin

Striped dolphins typically inhabit warmer ocean waters north of NZ and are rarely seen in NZ coastal waters (Dawson, 1985). However, this species has stranded on Taranaki coastlines in the past and for completeness is included here. They are unlikely to be seen in the Operational Area.

Risso's Dolphin

Striped dolphins typically inhabit warmer ocean waters north of NZ and are rarely seen in NZ coastal waters (Dawson, 1985). However, this species has stranded on Taranaki coastlines in the past and for completeness is included here. They are unlikely to be seen in the Operational Area.

New Zealand Fur Seal

The New Zealand fur seal is the most common seal in NZ waters. This species has a wide distribution around mainland NZ and its offshore islands, and are also naturally present along the coasts of South Australia, Victoria and Tasmania. Breeding colonies on mainland NZ are mostly located in the South Island.

New Zealand fur seals are present year round in offshore Taranaki waters where they have a continual presence at the offshore oil and gas production platforms. These platforms act as artificial reefs and attract large schools of fish, which in turn attract seals. Seals also haul-out on platforms and other industry related infrastructure.

The closest New Zealand fur seal breeding location to the Operational Area is at the Sugar Loaf Islands. The breeding season is from mid-November to mid-January. At the breeding colonies adult males arrive first from late October followed by females in late November. Pups are generally born in January and weaned in July - August when females return to sea (Baird, 2011).

It is clear that New Zealand fur seals will be consistently present in the Operational Area. In February/March however, pups will still be too young to forage at sea, and instead will be restricted to the terrestrial breeding colonies to which their lactating mothers return every few days to nurse them. It is likely however that these lactating female fur seals will forage in areas that overlap with the Operational Area.

5.3.6 Seabirds

Due to the diversity of seabirds in NZ waters, NZ is often considered to be the seabird capital of the world. There are 86 species of sea birds found in the marine waters off NZ which include albatrosses, cormorants and shags, fulmars, petrels, prions, shearwaters, terns, gulls, penguins, and skuas (DOC, 2013a). The greatest variety of albatrosses and petrels in the world are found within NZ waters, with NZ considered as an important breeding ground.

Information on seabirds within the Taranaki area was obtained from DOC records, Ministry for Primary Industries records, the NABIS database and the Taranaki Regional Oil Spill Contingency Plan.

Table 5 summarises the information from these data sources into an indicative list of the seabirds which could be present in the Operational Area. Note that some species might only be present as individuals while others could be present in flocks of thousands (e.g. fairy prions).

Table 5: Seabird species which could be present in Taranaki

Common Name	Scientific Name	NZ Threat Status (Robertson *et al.* 2013) (see Appendix 4)
Gibson's albatross	*Diomedea antipodensis gibsoni*	Nationally critical
Antipodean albatross	*Diomedea antipodensis antipodensis*	Nationally Critical
Salvin's mollymawk	*Thalassarche salvini*	Nationally critical
Black-billed gull	*Larus bulleri*	Nationally critical
Black-fronted tern	*Chlidonias albostriatus*	Nationally endangered
*Red billed gull	*Larus novaehollandiae scopulinus*	Nationally vulnerable
Pied shag	*Phalacrocorax varius varius*	Nationally vulnerable
*Northern NZ dotterel	*Charadrius obscurus aquilonius*	Nationally vulnerable
Black petrel	*Procellaria parkinsoni*	Nationally vulnerable
*Flesh-footed shearwater	*Puffinus carneipes*	Nationally vulnerable
*Caspian tern	*Hydroprogne caspia*	Nationally vulnerable
Hutton's shearwater	*Puffinus huttoni*	Declining
*Northern little blue penguin	*Eudyptula minor iredalei*	Declining
White-chinned petrel	*Procellaria aequinoctialis*	Declining
*Sooty shearwater	*Puffinus griseus*	Declining
White-fronted tern	*Sterna striata striata*	Declining
*Northern diving petrel	*Pelecanoides urinatrix urinatrix*	Relict
*Fluttering shearwater	*Puffinus gavia*	Relict
Broad-billed prion	*Pachyptla vittata*	Relict
Cook's petrel	*Pterodroma cookii*	Relict
Mottled petrel	*Pterodroma inexpectata*	Relict
Grey-backed storm petrel	*Garrodia nereis*	Relict
White-faced storm petrel	*Pelagodroma marina maoriana*	Relict
*Fairy prion	*Pachyptila turtur*	Relict
Northern royal albatross	*Diomedea epomophora Sanfordi*	Naturally uncommon
Southern royal albatross	*Diomedea epomophora epomophora*	Naturally uncommon
Buller's mollymawk	*Thalassarche bulleri bulleri*	Naturally Uncommon
Campbell Island mollymawk	*Thalassarche impavida*	Naturally uncommon
Chatham Island mollymawk	*Thalassarche eremita*	Naturally uncommon
Northern giant petrel	*Macronectes halli*	Naturally uncommon
Grey petrel	*Procellaria cinerea*	Naturally Uncommon
Snare's cape petrel	*Daption capense australe*	Naturally Uncommon
Black shag	*Phalacrocorax carbo novaehollandiae*	Naturally uncommon
Little black shag	*Phalacrocorax sulcirostris*	Naturally uncommon
Westland Petrel	*Procellaria westlandica*	Naturally uncommon
Buller's shearwater	*Puffinus bulleri*	Naturally uncommon
Brown skua	*Catharacta antarctica lonnbergi*	Naturally uncommon
Arctic tern	*Sterna paradisaea*	Migrant
White winged black tern	*Chlidonias leucopterus*	Migrant
Wandering/Snowy albatross	*Diomedea exulans*	Migrant
Short-tailed shearwater	*Puffinus tenuirostris*	Migrant
Southern giant petrel	*Macronectes giganteus*	Migrant
Wilson's storm petrel	*Oceanites oceanicus*	Migrant
Cape pigeon	*Daption capense capense*	Migrant
Eastern little tern	*Sternula albifrons sinensis*	Migrant

Black browed mollymawk	*Thalassarche melanophris*	Coloniser
Indian ocean yellow-nosed mollymawk	*Thalassarche carteri*	Coloniser
*Southern black-backed gull	*Larus dominicanus dominicanus*	Not threatened
*Australasian gannet	*Morus serrator*	Not threatened
Little shag	*Phalacrocorax melanoleucos brevirostris*	Not threatened
White-headed petrel	*Pterodroma lessonii*	Not Threatened
*Grey faced petrel	*Pterodroma macroptera gouldi*	Not threatened

** indicates a coastal breeding presence in Taranaki Bight/Greater Cook Strait (see Figure 20)*

Breeding Colonies

No seabird breeding occurs in the Operational Area; however there are thirteen species of seabirds that seasonally occupy coastal breeding locations in the Taranaki Bight/Greater Cook Strait region (Figure 20).

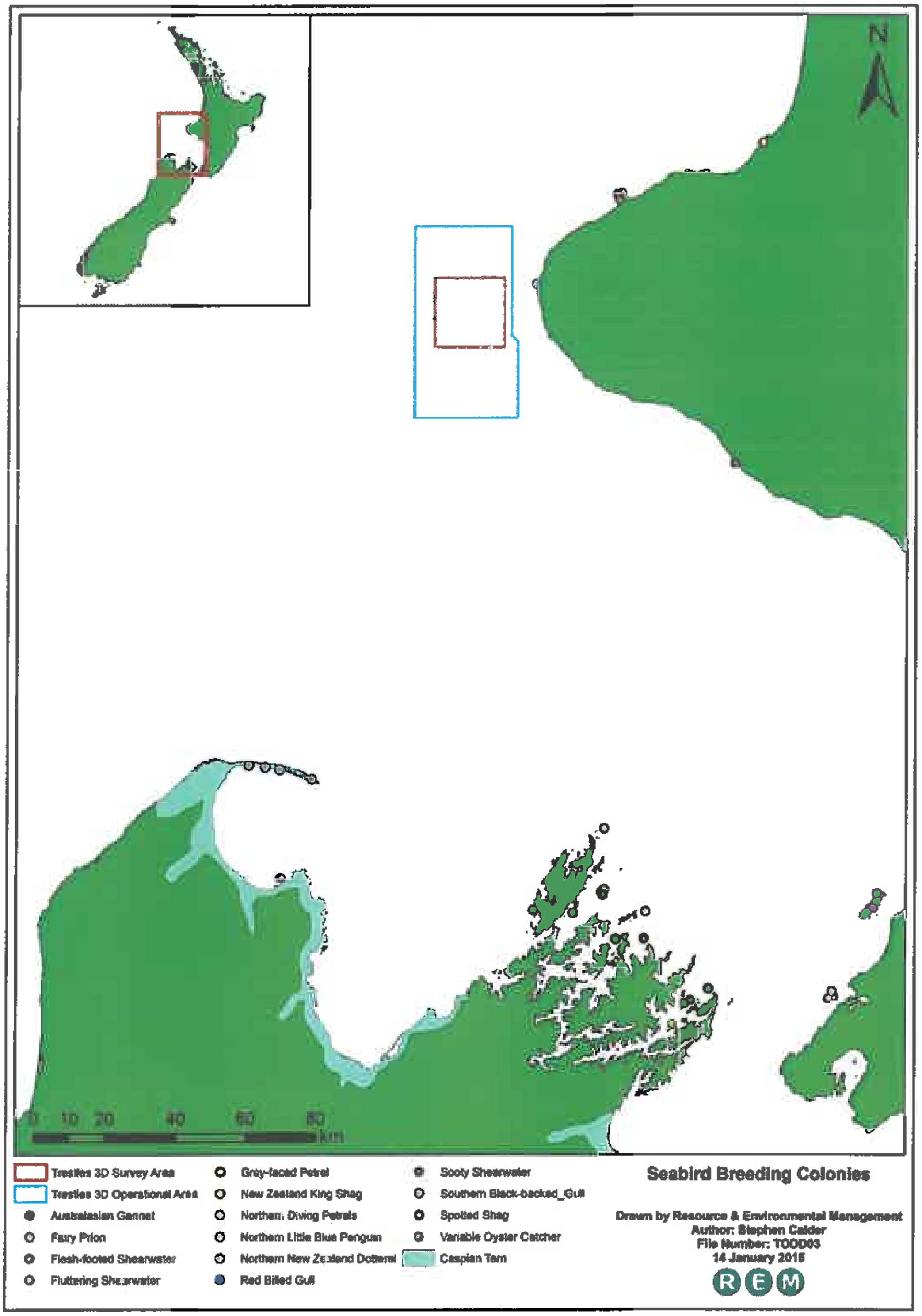

Figure 20: Breeding Colonies of Seabirds in Surrounding Coastal Areas

(Data source: primarily NABIS, with updates from various Regional Coastal Plans)

5.3.7 Marine Reptiles

There are seven species of marine reptiles known to occur off the coast of NZ: the loggerhead turtle (*Caretta caretta)*, the green turtle (*Chelonia mydas)*, the hawksbill turtle (*Eretmochelys imbricate)*, the olive Ridley turtle (*Lepidochelys olivacea)*, the leatherback turtle (*Dermochelys coriacea*) the yellow-bellied sea snake (*Pelamis platurus)*, and the banded sea snake (*Laticauda colubrine)*. Apart from the leatherback sea turtle, marine reptiles are generally found in warm temperate waters and as a result most of NZ's marine reptiles are found off the northeast coast of the North Island in the warmer water (WWF, 2013).

Marine reptiles do occasionally visit the Taranaki coastline, although mainly during summer months when the warmer currents push down the western side of NZ. Leatherback turtles and yellow bellied sea snakes have been observed within Taranaki waters (DOC, 2013b); however, they are only rarely seen in this region.

5.4 Existing Interests

5.4.1 Cultural Values

Spiritual Significance of Area to Iwi

The earliest accounts associated with Taranaki Iwi ancestors precede the arrival of Taranaki Maunga to the western seaboard. They were known as the Kāhui Ao, Kāhui Rangi, Kāhui Pō and Kāhui Atua, collectively called Te Kāhui Maunga. They occupied Mimi Maunganui (the mountain preceding Taranaki), Ruatupua (Pouakai), and Ruatawhito (Kaitake) ranges. Their principle village was Karakatonga, situated high up in the heart of the Waiwhakaiho River valley. When the new mountain surfaced the people temporarily evacuated the site with many also perishing.

The journey of Taranaki Maunga from the central plateau has been recounted for centuries. It is an account that describes cataclysmic volcanic activity.

Taranaki Maunga was formerly known as Pukeonaki and Pukehaupapa and stood in the area around Lake Rotoaira near Tūrangi, with Ruapehu, Tongariro, and Pihanga. Pukeonaki and Tongariro both loved Pihanga and fought over her. Following the conflict Pukeonaki, bearing the scars of battle, withdrew underground and down the Whanganui River valley. Led by his companions Te Rauuhiuhi, Wheoi and the guide stone Rauhoto they entered the sea. When Taranaki surfaced he saw Pouakai Mountain standing inland. Pukeonaki then followed Rauhoto up the Hangatahua River and resurfaced beside Pouākai. Rauhoto continued her flight on the North eastern side of Pouākai where she then turned westward at the gap between Pouākai and Kaitake. Her flight path went through the sweeping saddle between Kaitake and Pouākai and ended near the mouth of the Hangatahua River by the sea. Pukeonaki remained there with Pouākai and their offspring became the trees, plants, birds and rivers that flow from their slopes. The reef systems and pinnacles borne from the movement of the mountains become an on-going source of food for on-going generations

Consequently, it is a deeply held belief by Taranaki iwi that the seabed (part of Taranaki's journey) is sacred territory and should be left undisturbed.

Iwi within Wider Taranaki Region

The 2013 Census identified that Māori comprise 17.4% of the population in Taranaki. *Te Kāhui Māngai*, a directory of iwi and Māori organizations developed by *Te Puni Kokiri* (the Ministry of Maori Development), highlights twelve iwi in the Hauauru (Western North Island) region and eight of those are located in the Taranaki region (Figure 21).

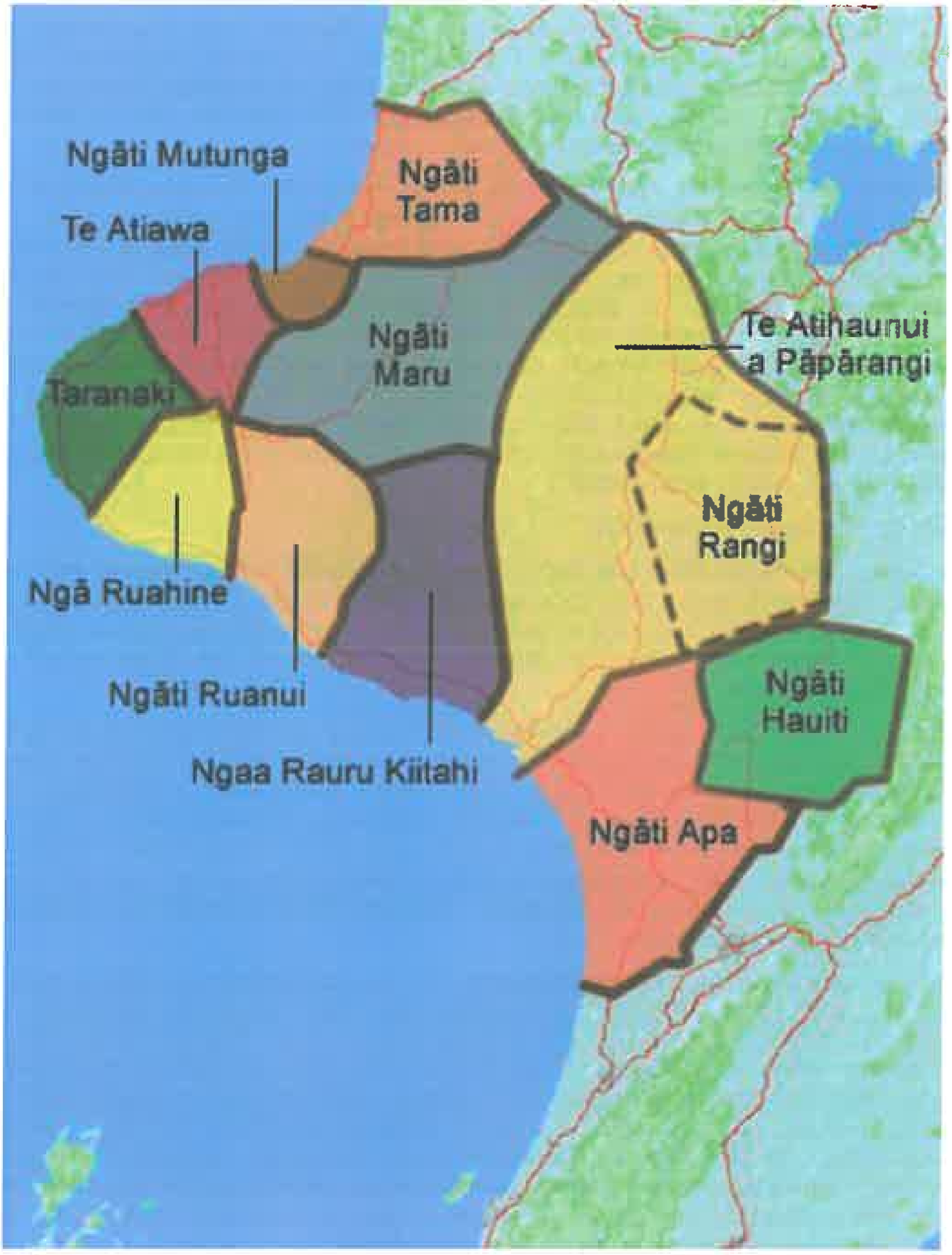

Figure 21: Taranaki Iwi Boundaries

(Source: Te Puni Kokiri)

Taranaki Iwi - Fisheries Interests

Under the Māori Fisheries Act (2004) Taranaki Iwi, and 56 other recognised iwi across the country, were allocated fisheries assets including fishing quota. The fishing quota allocated to Taranaki Iwi falls within the Fisheries Management Area (FM8) (see *Section 5.5.4*) which it then leases to commercial fishery operators. In addition to the fishing quota held by individual iwi, each recognised iwi, including Taranaki Iwi, is allocated income shares in Aotearoa Fisheries Limited which is managed and overseen by Te Ohu Kai Moana (Māori Fisheries Commission).

In addition to the commercial fisheries interests provided for under the Māori Fisheries Act (2004), Taranaki Iwi, and other iwi within New Zealand, have Customary Fishing Rights which are provided for under the Fisheries (Kaimoana Customary Fishing) Regulations 1998. These regulations stem from the Treaty of Waitangi (Fisheries Claims) Settlement Act 1992. These customary fishing rights are separate, and in addition to, the commercial fisheries assets described above.

The allocation of customary fishing rights is undertaken by Tangata Kaitiaki/Tiaki in accordance with tikanga Maori. Tangata Kaitiaki/Tiaki are individuals or groups appointed by the local Tangata Whenua and confirmed by the Minister of Fisheries who can authorise customary fishing within their rohe moana. Under the regulations customary fishing rights can be caught by commercial fishing vessels on behalf of the holder of the customary fishing right and Taranki Iwi generally use local commercial fishers operating out of New Plymouth for this purpose. Fish caught under a customary fishing authorisation can only be used for customary purposes (e.g. tangi) and cannot be commercially traded. Customary fishing rights are in addition to recreational fishing rights and do not remove the right of Tangata Whenua to catch their recreational limits under the amateur fishing regulations.

Taranaki Iwi – Coastal Interests

The coastal environment within the Taranaki Iwi rohe contains a number of features and resources of value to Taranaki Iwi. Taranaki Iwi exercise mana whenua and mana moana from Paritūtū in the north around the western coast of Taranaki Maunga to Rāwa o Turi stream in the south and from these boundary points out to the outer extent of the exclusive economic zone.

The seas that bound the Coastal Marine Area are known by Taranaki Iwi as Ngā Tai a Kupe (the shores and tides of Kupe). The coastal lands that incline into the sea are of high importance to Taranaki Iwi and contain kāinga (villages), pā (fortified villages), pūkawa (reefs) for the gathering of mātaitai (seafood), tauranga waka or awa waka (boat channels), tauranga ika (fishing grounds) and mouri kōhatu (stone imbued with spiritual significance). The importance of these areas reinforces the Taranaki Iwi tribal identity and provides a continuous connection between those Taranaki Iwi ancestors that occupied and utilised these areas.

Prior to the proclamation and enforcement of the confiscation of lands within the Taranaki Iwi rohe (area of interest), Taranaki Iwi hapū occupied, cultivated, fished, harvested and gathered mātaitai in the Coastal Marine Area. The entire shoreline from Paritūtū to the Rāwa o Turi was critical to daily life such as fishing, food gathering, cultivations and ceremonies. The sea and coastal reefs provided a staple food source with fertile volcanic soils providing excellent growing conditions for large community cultivations. Food preparation and harvesting was ultimately dependant on the lunar calendar that controlled tides and other environmental conditions, but the best times for gathering and harvesting are known by Taranaki Iwi as Ngā Tai o Mākiri (the tides of Mākiri). These generally occur in March and September.

The small boulder reefs are possibly one of the most unique features of the Taranaki Iwi coastline providing special habitat for all matters of marine life. Resources found along the extent of the coastline of Ngā Tai a Kupe provide Taranaki Iwi with a constant supply of food. The reefs provide pāua (abalone), kina (sea urchin), kōura (crayfish), kūkū (mussels), pūpū (mollusc), ngākihi (limpets), pāpaka (crab), toretore (sea anemone), and many other reef species, while tāmure (snapper), kahawai, pātiki (flounder), mako (shark) and other fish are also caught along the coastline in nets and on fishing lines.

Also evident in the reefs are the monolithic tauranga waka or awa waka where large boulders were moved aside by hand to create channels in the reef. These provided access to offshore fishing grounds and prevented boats from being smashed onto rocks by the heavy surf. Large kāinga were also built around the tauranga waka providing Taranaki Iwi hapū with the infrastructure for efficient fishing operations. Whenever possible, fishing nets were also set in the tauranga waka. Fishing also took the form of separate, smaller pool like structures, or tauranga ika. They were baited and had a small opening on the seaward end of the structure to attract fish. On an incoming tide fish would enter the pools to feed and would then be chased out to be caught by a net placed over the small entranceway.

Taranaki Iwi oral traditions recount that in former times, the extent of large boulder reefs in the central part of Taranaki Iwi was much larger than those seen today. The large sandy areas in the central part of the Taranaki Iwi rohe is an occurrence attributed to Mangohuruhuru. Mangohuruhuru was from the South Island and was bought here by Taranaki Iwi rangatira Pōtikiroa and his wife Puna-te-rito, who was Mangohuruhuru's daughter. Mangohuruhuru settled on the coastal strip between Tipoka and Wairua and built a house there called Te Tapere o Tūtahi. However, the large rocky Taranaki coastline was foreign to him and he longed for the widespread sandy beaches of his homeland. He warned Taranaki Iwi and told them he was calling the sands of Tangaroa. This phenomenon came as a large tsunami and totally buried Mangohuruhuru and his kainga.

The sands bought by Mangohuruhuru continue to provide excellent growing conditions for many of the low lying seaside kāinga within the central part of the Taranaki Iwi rohe.

The Coastal Marine Area was also the main highway for many Taranaki Iwi uri (descendants) when travelling between communities, as most of the coastal lands were free of the thick bush found a little higher towards the mountain. Coastal boundary stones and mouri kōhatu are another unique cultural feature within the Taranaki Iwi rohe and they form a highly distinctive group, not commonly found elsewhere in the country. Many of these were invariably carved with petroglyphs in spiral form and were often located in accessible areas, within pā earthworks and open country. However, most of them were nestled in the reef on the seashore alongside tauranga waka, tauranga ika, pūkāwa, pūaha (river mouths) and below or adjacent to well-known pā sites.

Tahu and Turi the twin kaitiaki (guardians) mark the mouth of the Tapuae River[4], Te Pou o Tamaahua in Ōākura, Te Toka a Rauhoto (originally located a little inland on the south side Hangatāhua River mouth) Opu Opu [Hopuhopu] (also a tauranga waka and tauranga ika) in the bay off Te Whanganui Reserve, Kaimaora, Tuha, Tokaroa and Omanu in the reefs at Rahotū and Matirawhati the stone boundary marker between Ngāti Haua (a hapū of Ngāruahine) and Taranaki Iwi on the reef of the Rāwa o Turi river mouth. These mouri kōhatu continue to be revered by Taranaki Iwi hapū.

Taranaki Iwi have continued to exercise custodianship over those areas accessible to Taranaki Iwi. Many Taranaki Iwi hapū have imposed rāhui (temporary restrictions) over sites, restricting the taking of kūkū, kina, pāua and other mātaitai. Proper and sustainable management of the Coastal Marine Area has always been at the heart of the relationship between Taranaki Iwi and the Taranaki Iwi coastline.

Two Rohe Moana (customary food gathering areas as notified under Regulation 9 of the Fisheries (Kaimoana Customary Fishing) Regulations 1998) occur just inshore of the Operational Area (<u>Figure 22</u>).

[4] George, Simon. 2012, *Sites and Rohe of Historical Significance to Taranaki Iwi.* Unpublished paper

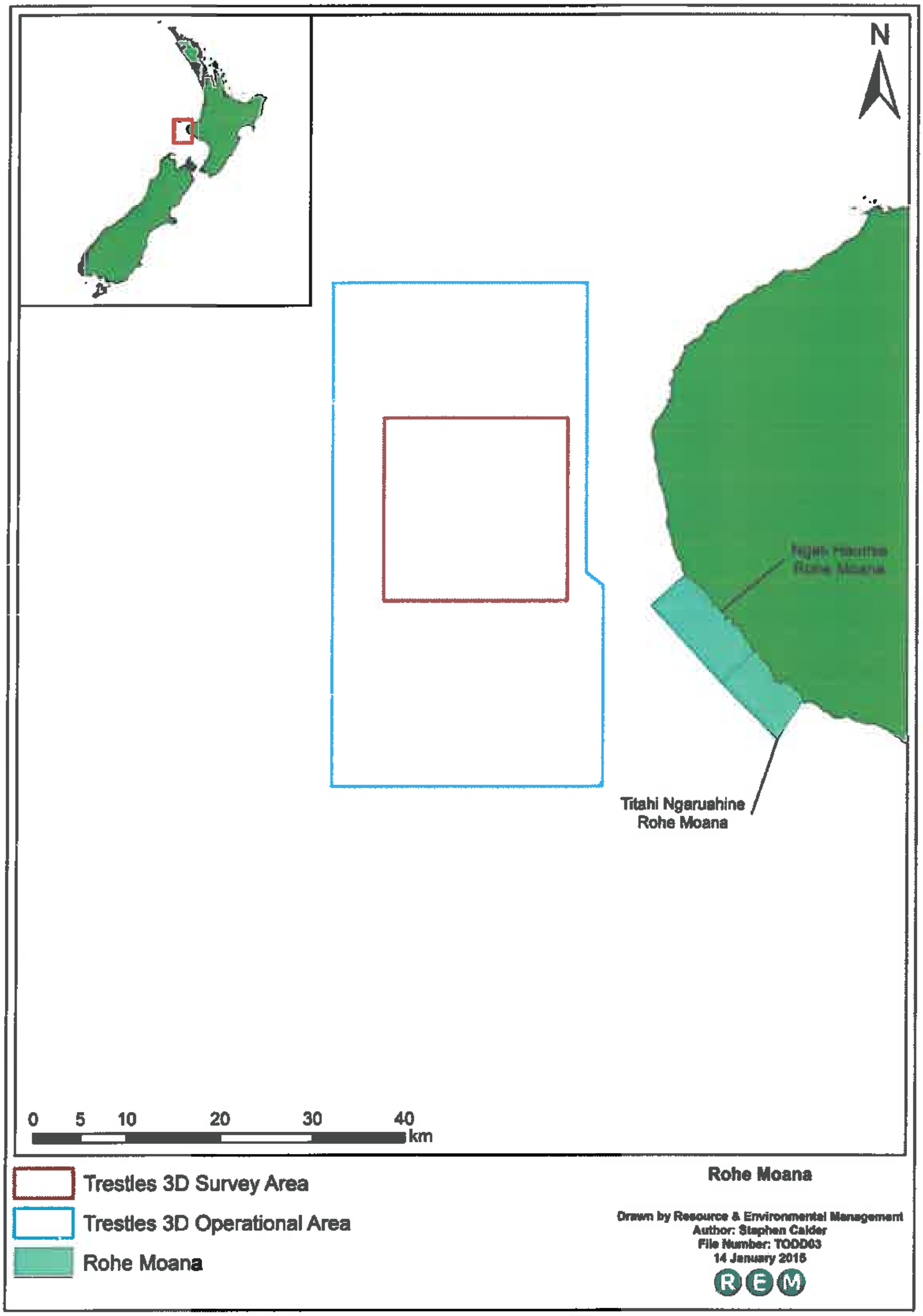

Figure 22: Rohe Moana in the vicinity of the Operational Area

5.4.2 Commercial Values

Commercial Fisheries

The Quota Management System is the primary fisheries management tool to provide for commercial utilisation of NZ fish resources in a sustainable manner. NZ waters have been split into ten Fisheries Management Areas (Figure 23).

MPI undertook a fisheries assessment for the area west of Cape Egmont within Fisheries Management Areas 7 and 8 (Challenger/Central (Plateau) and Central (Egmont)) (Figure 23). The assessment area is shown in Figure 24.

Five years' worth of fishing data was used in this assessment (1 October 2006 to 30 September 2011) from completed catch effort returns from commercial fishers. Data was included in the assessment if the fishing event started, ended or passed through the assessment area. The total catch that this data was based upon was 17,818 tonnes. The vast majority of the total catch was jack mackerel and barracouta (74.4% and 20.4% respectively). The remainder of the top five species caught (including barracouta, frostfish, blue mackerel and redbait) were caught as bycatch from jack mackerel trawls.

As jack mackerel and barracouta made up nearly 95% of the total landings within the assessment area, MPI only considered these two dominant species in order to investigate what time of year they are targeted. The catch peaks of the jack mackerel fishery occurred during October, December, January and June. The least amount of fishing effort occurs during the months of March through to May.

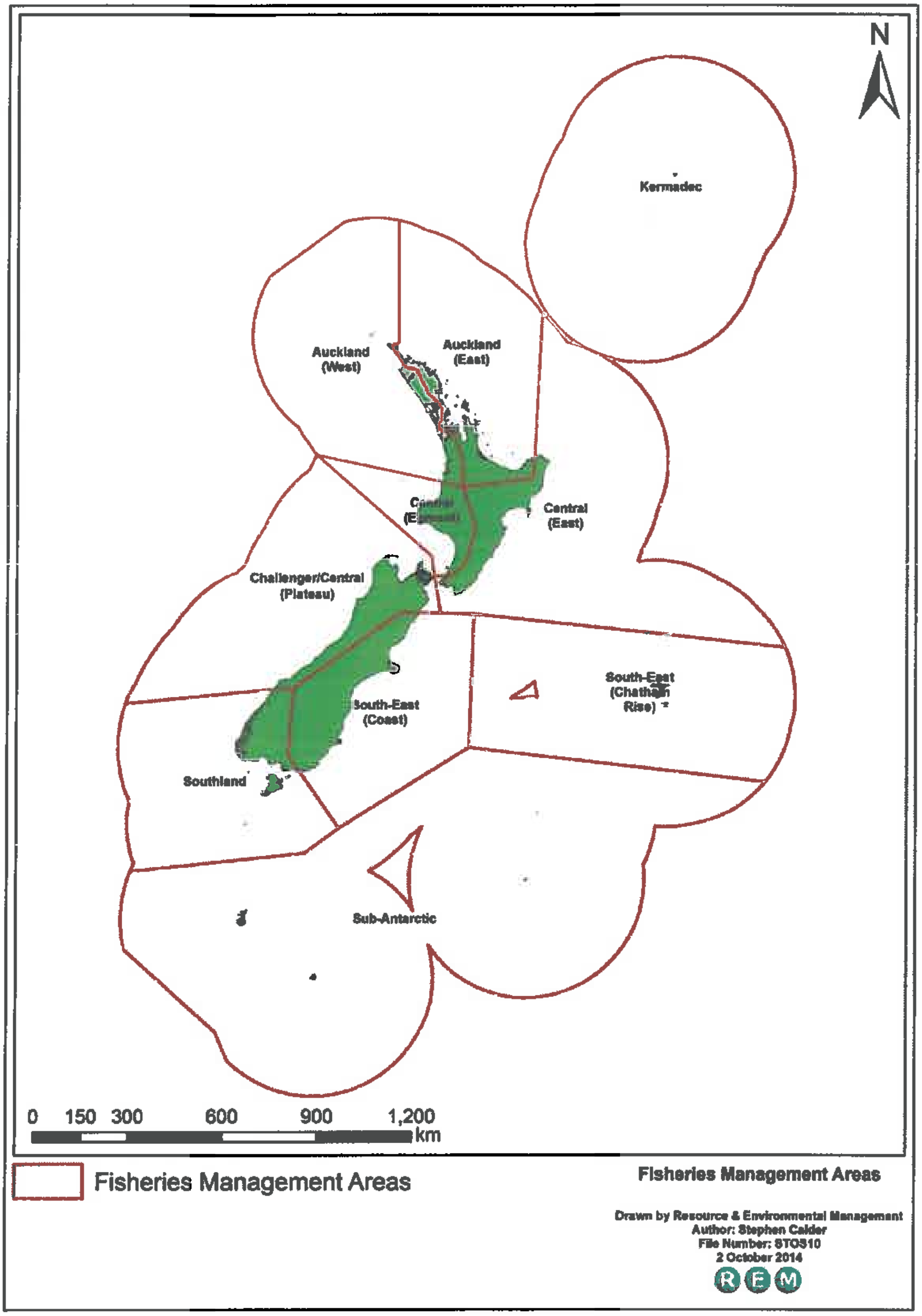

Figure 23: Fisheries Management Areas

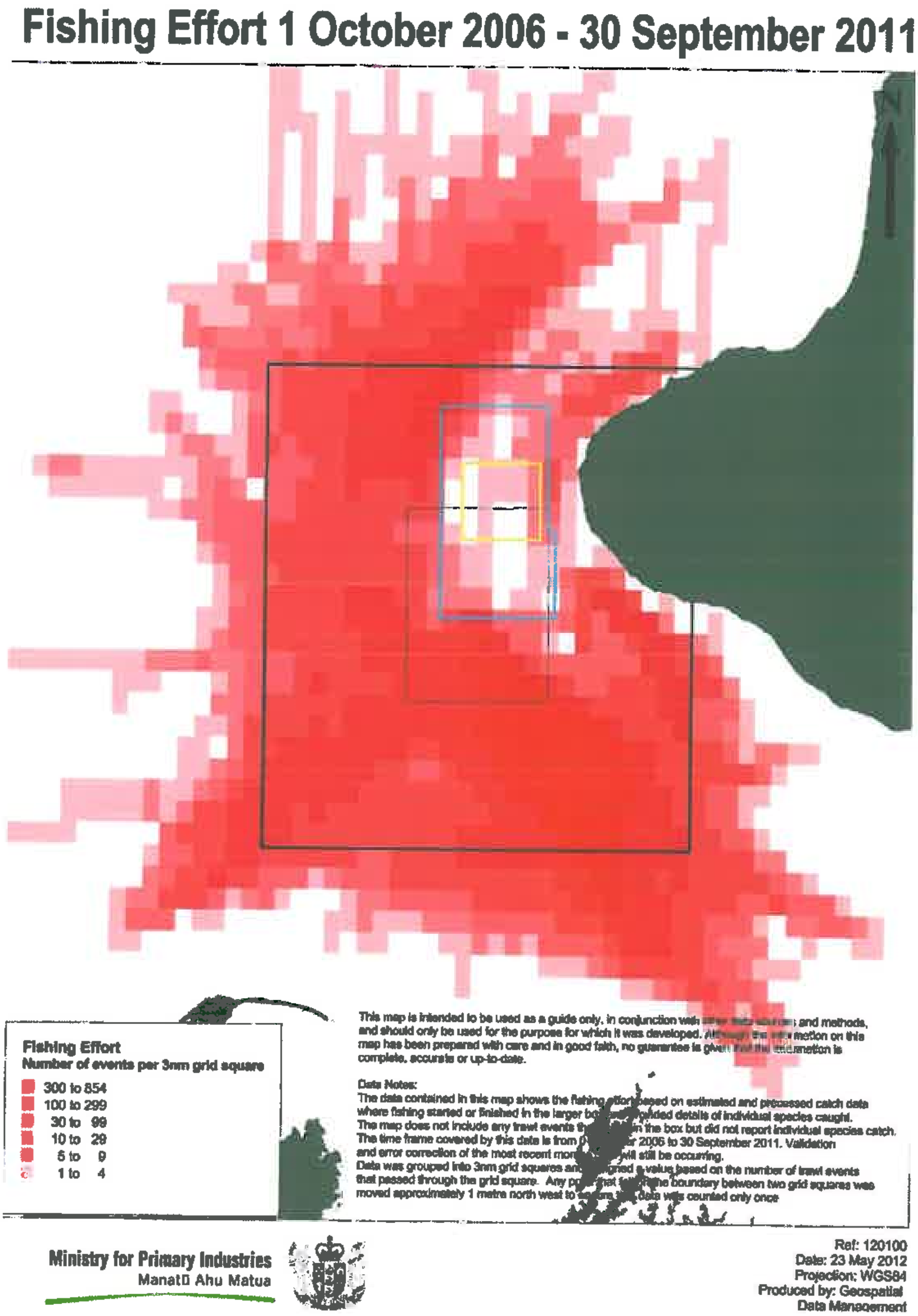

Figure 24: Fishing Effort west of Cape Egmont from October 2006 – September 2011

Trestles 3D Operational Area and Survey Area (fold coverage) are shown as blue and yellow polygons.
(Source: MPI report)

Ports and Harbours

Port Taranaki is the closest port to the Operational Area and is situated to the northeast of the seismic operations. Port Taranaki is the only deep water seaport on NZs west coast with a maximum port draft of 12.5 m. It is a modern port, offering nine fully serviced berths which cater to a wide variety of cargo requirements; however, cargo transiting Port Taranaki typically relates to the farming, engineering and petrochemical industries. The port also offers a full range of support services: providoring, stevedoring, ship agency and government border protection services (Port Taranaki, 2014).

Shipping Routes

In general, Maritime New Zealand (MNZ) recommends commercial vessels stay a minimum of 5 Nm from the mainland, any charted danger or offshore islands. For the movement of cargo, commercial vessels typically use the most direct path between two ports. This is well illustrated by the regionally recognised shipping routes presented in Figure 25.

The NZ Nautical Almanac provides guidance for vessels operating in the vicinity of production platforms and exploration rigs. The guidance recommends that an adequate safe margin of distance should be maintained, and where there is sufficient sea room, vessels should keep at least 5 Nm clear of the installations.

A precautionary area was established in offshore Taranaki by the International Maritime Organisation in 2007. All ships traversing this area must navigate with particular caution in order to reduce the risk of a maritime casualty and resulting marine pollution.

This precautionary area is a standing notice in the annual Notice to Mariners that is issued each year in the NZ Nautical Almanac. The Almanac lists the navigation hazards within this precautionary area, including the Pohokura, Māui, Maari, Tui and Kupe fields.

The navigational hazards of particular relevance to this MMIA are the Maui A and B platforms and associated pipelines which are protected by the:

- Continental Shelf (Māui A Safety Zone) Regulations 1975;
- Continental Shelf (Māui B Safety Zone) Regulations 1991; and
- Submarine Cables and Pipelines Protection Order 2009.

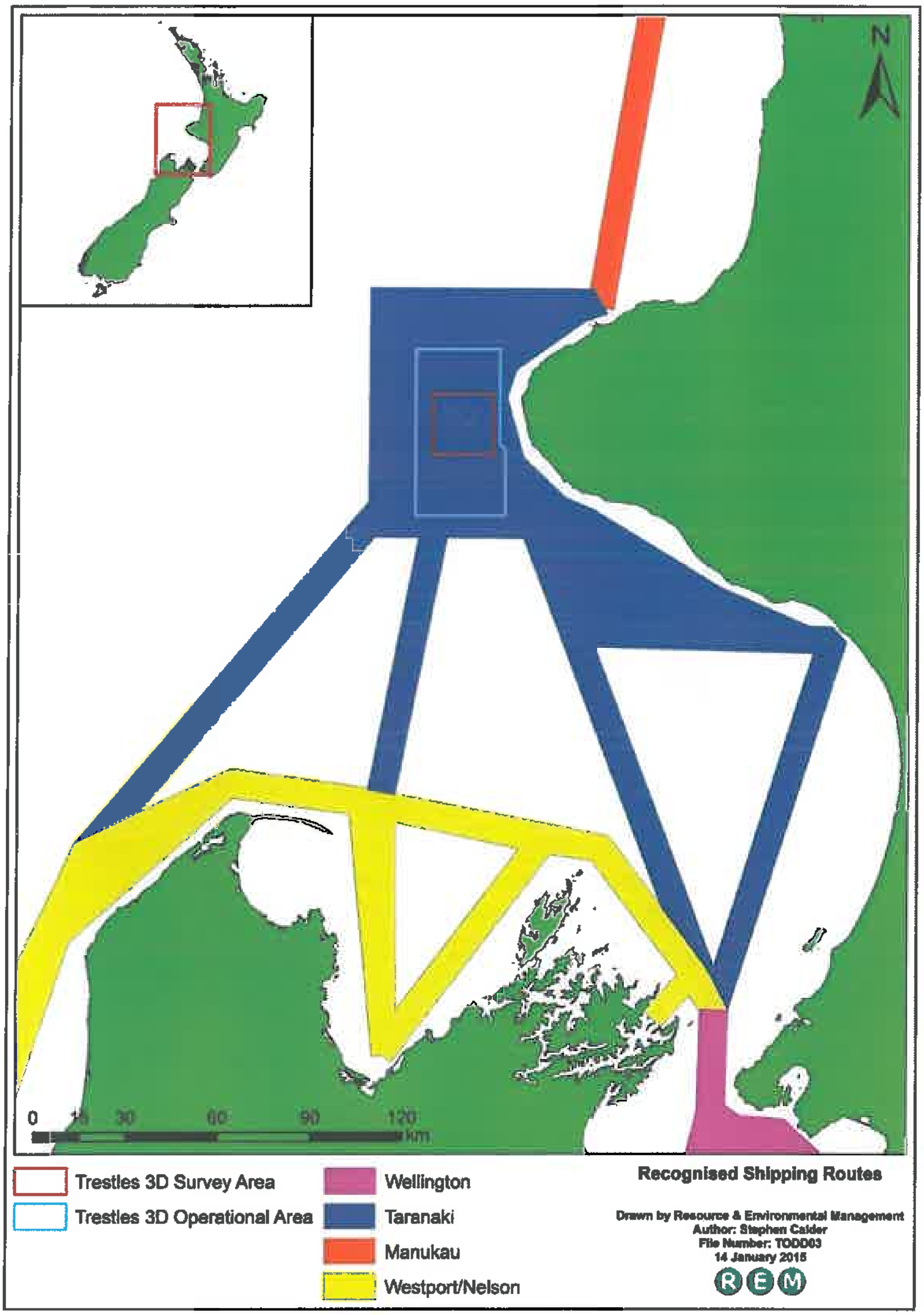

Figure 25: Recognised Shipping Routes around Taranaki

(Source: MNZ data) (Routes for foreign destinations are highly variable and not shown)

Oil and Gas Activity

Hydrocarbon exploration and production activities in Taranaki have been ongoing for the last 100 years, and offshore more than 50 years. Producing offshore fields include: Maari, Māui, Kupe, Pohokura, and Tui. Figure 26 shows the current extent of offshore oil and gas production within the Taranaki Basin. With regard to exploration, seismic surveys have been commonplace off the Taranaki coastline since the 1950s. To date there have been no recorded incidents of harm to marine mammals as a result of these seismic operations.

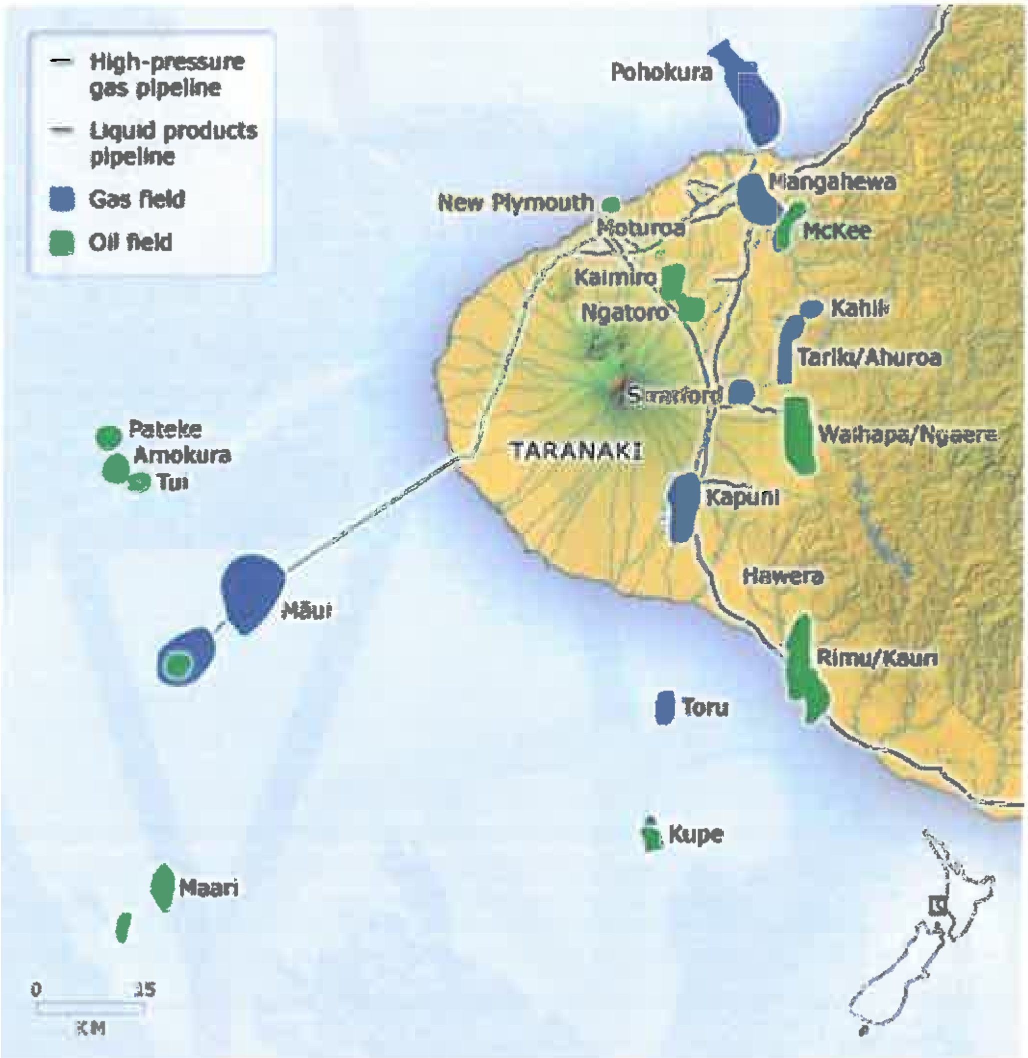

Figure 26: Taranaki Oil and Gas Fields

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

Tourism Industry

Land-based tourism is a significant contributor to the economy in the Taranaki region. However, on-water tourism is limited on account of the exposed coastline and the frequently rough seas. Despite this a small number (5 – 10) of commercial tourism operators have businesses based around maritime activities (surfing, fishing, and kayaking).

5.4.3 Social Values

Recreational Fisheries

Taranaki coastal waters support significant recreational fisheries for snapper, kingfish, hapuku/bass, trevally, kahawai, tarakihi and gurnard. During summer, warm currents from the north bring tuna, sharks, billfish, and other valuable recreational pelagic species into the region. However, waters within the Operational Area are not fished often by recreational fishers, on account of the distance from Port Taranaki and the relative lack of rocky substrate (i.e. reefs around which fish congregate).

Ecological Research

Various organisations conduct research within or near the Operational Area (e.g. NIWA, DOC, MPI, various oil and gas companies etc.). Ecological monitoring at marine reserves, marine protected areas, and at locations associated with oil and gas activities (e.g. production platforms and drilling programmes) form the primary basis for marine research in the region. Māui dolphin population surveys also occur periodically within the West Coast North Island Marine Mammal Sanctuary and in coastal areas beyond the sanctuary boundaries.

The Trestles 3D Seismic Survey will also contribute to the knowledge of marine mammals and other mega-fauna in the Operational Area through the reporting of wildlife observations by the dedicated MMOs onboard the survey vessel.

6 Potential Effects and Mitigations

This section considers the potential effects of the Trestles 3D Seismic Survey on the environment and existing interests; and measures which will be employed by Todd Energy to avoid, remedy or mitigate the potential adverse effects.

As part of the Trestles 3D Seismic Survey a number of planned activities will be undertaken in accordance with industry best practice. The potential effects of these planned activities and associated mitigation measures are outlined in Section 6.3.

In addition to the planned activities, it is theoretically possible that unplanned events could occur under accidental circumstances. These events and their associated mitigation measures are considered in Section 6.4.

6.1 Methodology

The following steps were followed in order to assess the significance of potential effects from the Trestles 3D Seismic Survey:

- Identification of the sources of potential impacts (both positive and negative);
- Description of potential impacts;
- Identification of the key potential environmental receptors and their sensitivity to potential impacts;
- Description of mitigation measures that will be employed to minimise potential impacts; and
- Assessment of the significance of any residual impact. This assessment considers the likelihood and magnitude of any residual impact in relation to the sensitivity of each environmental receptor. The 'Assessment of Significance' criteria used for residual impacts are provided in Table 6.

Table 6: Assessing significance of residual impacts on marine mammals

Negligible Impact
• No residual impacts are predicted, or • The risk of residual impacts occurring is extremely low, and • The effect is predicted to be of small enough magnitude that it does not require further consideration, and no recovery period is required.
Minor Impact
• The risk of residual impacts occurring is low, and/or • The residual impact is predicted to disappear rapidly (within hours) after cessation of the causative activity. • No further management measures are required for the return to the original situation or behaviour. • For acoustic impacts on marine mammals, this impact is likely to occur when exposed to sound levels less than 171 dB re 1 $\mu Pa^2.s$.
Moderate Impact
• The risk of residual impacts occurring is moderate, and/or • The residual impact is predicted to occur at a level which requires only a short period of recovery (up to 24 hours) following cessation of the activity. • No further management measures are required for the return to the original situation or behaviour. • For acoustic impacts on marine mammals, this impact is likely to occur when exposed to sound levels between 171 – 186 dB re 1 $\mu Pa^2.s$; behavioural changes are likely to occur.
Severe Impact
• The risk of residual impacts occurring is high, and/or • The residual impact is predicted to occur at a level which requires a long period of recovery (greater than 24 hours) following cessation of the activity. • For acoustic impacts on marine mammals this impact is likely to occur when exposed to sound levels greater than 186 - 218 dB re 1 $\mu Pa^2.s$ and Temporary Threshold Shift is likely to occur.
Critical Impact
• The risk of residual impacts occurring is very high, and/or • The residual impact is predicted to occur at a level whereby no recovery is expected following cessation of the activity. • For acoustic impacts on marine mammals this impact is likely to occur when exposed to sound levels greater than 218 dB re 1 $\mu Pa^2.s$; Permanent Threshold Shift or other physiological damage is likely to occur.

6.2 Sources of Impact – Planned Activities

The first step of the assessment process is to identify potential sources of environmental impact or impact on existing interests.

Table 7 outlines the planned activities associated with the Trestles 3D Seismic Survey that have the potential to impact the baseline environment.

Table 7: Sources of impact and associated potential impacts – planned activities

Physical presence of the seismic vessel, towed gear and support vessels
Potential Impacts: • Ship strike - marine mammals • Collision – sea birds • Displacement of marine fauna or existing interests from important habitat • Indirect effects, such as changes in the availability of target species by fisheries or marine predators
Acoustic disturbance
Potential Physical Impacts: • Injury – including permanent and temporary threshold shift Potential Perceptual Impacts: • Auditory 'Masking' of important biological sounds (reduced ability of marine fauna to perceive natural acoustic signals used by conspecifics for communication, navigation, predator avoidance, foraging etc.) Potential Behavioural Impacts: • Interruption of behavioural patterns and/or displacement from important habitat (feeding, breeding, migrating or resting) • Indirect effects such as changes in the availability of target species by fisheries or marine predators
The discharge of approved waste from survey vessels
Potential Impacts: • Reduced habitat quality on account of waste discharge (sewage, greywater, galley waste etc.)

6.3 Potential Impacts and Mitigation Measures – Planned Activities

6.3.1 Physical Presence of Seismic Vessel, Towed Gear and Support Vessels

Ship Strike - Marine Mammals

'Ship strike' - the collision between a vessel and marine fauna - has been recognised as an increasing conservation concern for marine mammals globally (IWC, 2014). In areas where whales and marine traffic overlap, the potential for ship strike is present for all vessel types and sizes. As described in Section 5.3.5, a number of marine mammal species may be present in the Operational Area during the Trestles 3D Seismic Survey; and the nature of marine seismic surveys require the presence of a primary seismic survey vessel and at least one support vessel. Hence, an overlap between marine mammal habitat and seismic survey vessels will clearly be present during the Trestles 3D Seismic Survey.

A number of factors influence the likelihood of ship strikes, these are:

- Vessel size – larger vessels (> 80 m) are more frequently involved in ship strike incidents than smaller vessels (Laist *et al.* 2001; Jensen and Silber 2003);
- Vessel speed – most lethal ship strike incidents involve vessels travelling at faster speeds (> 12 knots) (Laist *et al.* 2001; Vanderlaan and Taggart 2007);
- Species – large whales are the most common victims of ship strike (e.g. fin whales, right whales, humpback whales, and sperm whales) (Laist *et al.* 2001; Van Waerebeek *et al.* 2007); and
- Behaviour - species that remain at or near the sea surface for extended periods are particularly vulnerable to ship strike (Constantine *et al.* 2012); as are species that are attracted to vessels (Bejder *et al.* 1999, Wursig *et al* 1998).

All cetacean species potentially present in the Operational Area are ship strike candidates. However, data indicates that in open ocean habitat, large whales are at greater risk than smaller marine mammal species (Laist *et al.* 2001; Jensen and Silber, 2003). The size and agility of dolphins and seals probably means that these groups are more successful at avoiding potential collisions.

DOC staff are unaware of any ship strike reports for the Taranaki region (*pers. comm.* D. Lundquist, L. Boren, C. Lilley, DOC), and no ship strikes have been reported by seismic survey vessels in New Zealand waters (http://iwc.int/scprogress). In addition to this, interrogation of the last five years of data on anthropogenic related mortality for large cetaceans as submitted via 'New Zealand Progress Reports on Cetacean Research' to the Scientific Committee of the International Whaling Commission confirmed no reported ship strike mortality or injury for large whales in the Operational Area.

Mitigations:

- The 3D seismic vessel will have a total overall length of 106.8 m. A vessel of this size is capable of causing trauma during a ship strike. However, seismic data acquisition requires a very slow vessel speed (4 - 5 knots) relative to most other marine traffic (10 – 20 knots). This reduction in speed dramatically reduces the likelihood of ship strike during the Trestles 3D Seismic Survey;
- The likelihood of ship strike during the Trestles 3D Seismic Survey will be further reduced by compliance with the Marine Mammal Protection Regulations 1992 (which dictate vessel behaviour around marine mammals);
- Observations for marine mammals during transit increase the chances of their detection and allow any fine scale changes of vessel route in order to avoid them; and

- The seismic source, when active, should provide marine megafauna with warning of the seismic survey vessels approach.

With these mitigation measures in place, it is considered that the potential for ship strike impacts with marine mammals are sufficiently managed and no residual impact is predicted. Therefore, the significance of this potential impact is deemed to be **negligible**.

Collision - Seabirds

The presence and movement of the survey vessels during the Trestles 3D Seismic Survey have the potential to affect seabirds, as do any other large seagoing vessels.

Potential adverse effects are largely limited to collisions between flying seabirds and the survey vessel. Collisions during daylight hours are unlikely as most seabirds are agile flyers with keen eyesight and should be able to avoid collisions with structures.

The seismic vessels will be illuminated at night for safety, navigational and operational purposes. A number of birds navigate by starlight at night (Black, 2005) and some species also feed on bioluminescent prey (Telfer *et al*, 1987); therefore, the presence of any artificial lighting at sea can potentially disorientate and/or attract seabirds; this in turn increases the probability of collisions.

Diving petrels, albatrosses, shearwaters and storm petrels are particularly sensitive to artificial lighting (Black, 2005; Poot *et al.* 2008), as are fledglings and inexperienced fliers (Telfer *et al.* 1987). Poor weather and reduced visibility conditions (such as from rain and fog) further increases the potential for lighting to affect navigating seabirds (Merkel and Johansen, 2011). DOC New Plymouth has confirmed that from the offshore oil and gas industry in Taranaki only one or two collision casualties are reported per year, with no reports received in many years (*pers. comm.* C. Lilley, DOC). For this reason the Trestles 3D Seismic Survey is not expected to have any significant adverse effect on seabirds.

Potential positive interaction is that the slow moving survey vessels could provide loafing or perching opportunities that would not otherwise be available to seabirds.

Mitigations:

No specific mitigation actions are in place to minimise the likelihood of collisions between seabirds and the seismic vessels; however, the short term duration of the Trestles 3D Seismic Survey and the slow operational speed of the seismic vessel will reduce the potential for any long-term residual impacts on seabirds.

The significance of the residual impact associated with collision of seabirds is considered to be **negligible**.

Displacement of Marine Fauna from Operational Area

The constant physical presence of the seismic survey vessels and the span of towed gear in the Operational Area during the Trestles 3D Seismic Survey may cause some species of marine mammal, seabird, or pelagic fish to avoid the area. Constant disruptions to normal behaviours (feeding, socialising, breeding etc.) from the survey assets and infrastructure could cause some mobile species to seek alternative habitat elsewhere. This displacement is likely to persist only for the survey duration.

It is likely that the Operational Area provides important habitat for some marine species, but it does not encompass any recognised unique habitat (Section 5.3). Hence, alternative habitat at similar water depths is accessible to both the north and south of the Operational Area for those species exhibiting avoidance behaviour.

Mitigations:

No specific mitigation actions are in place to minimise this potential impacts; however, the following points have been considered in the determination of significance for this potential effect:

- The information presented in Section 5.3, suggests that no single species or population relies entirely on the Operational Area for critical habitat;
- Marine mammals, seabirds and pelagic fish are typically wide ranging and have the ability to move away from a constant source of disruption if necessary; and
- The short term duration of the Trestles 3D Seismic Survey will reduce the potential for any long-term displacement impacts on marine fauna.

Therefore, the significance of the residual impact is considered to be **minor**.

Displacement of Existing Interests from Operational Area

The constant physical presence of the seismic survey vessel and the span (1,100 m) and extent (7,000 m) of towed gear during the Trestles 3D Seismic Survey will certainly displace fishing operations and marine traffic within the Operational Area for the survey duration.

With regard to fishing, this displacement could cause a temporary reduction of access to fishing grounds, and/or the requirement for alternative fishing equipment to be used. Marine traffic (including fishing vessels) may need to take a less direct route to their destination in order to safely avoid the Trestles 3D Seismic Survey operations; this could have measurable effects in relation to time and fuel consumption.

Mitigations:

- Commercial fishers, recreational fishing clubs and boating clubs who use the Operational Area have been notified of the upcoming seismic survey; and
- Seismic survey operations will occur 24 hours a day, 7 days a week (weather permitting) to minimise the overall duration of the survey.

With these mitigation measures in place, it is considered that the potential for displacement impacts on existing interests are sufficiently managed. Therefore, the significance of this potential impact is deemed to be **minor**.

Indirect Effects

Displacement of marine fauna could result in changes in the abundance, distribution or behaviour of pelagic fish species targeted by either fisheries or marine predators.

Mitigations:

- Seismic survey operations will occur 24 hours a day, 7 days a week (weather permitting) to minimise the overall duration of the survey. This will reduce the potential for any long-term indirect impacts on fisheries or marine predators.

Therefore, the significance of residual impact associated with indirect effects is considered to be **minor**.

6.3.2 Acoustic Disturbance – Potential Effects

Air gun arrays used for marine seismic surveys generally produce sound at frequencies between 50 and 100,000 Hz (McGregor *et al.* 2013). These low-frequency sounds propagate efficiently through water.

The pulses associated with seismic surveys produce 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). There is an instantaneous rise in maximum pressure followed by an exponential pressure decrease and drop in energy.

The physics of underwater sound mean that there is potential for seismic survey operations to have an adverse effect on most marine fauna.

In deeper waters, spherical spreading loss (the reduction in intensity (or power) caused by the spreading of waves into an ever increasing space) from an air gun array results in a loss of around 6 dB per doubling of distance. The majority of the sound energy from an air gun array travels vertically downwards, however some is radiated horizontally and at shallow angles. This sound energy can travel significant distances (a few tens of kilometres to over 100 km) depending on the propagation conditions (McCauley, 1994).

Sound waves travel until they meet an object or they attenuate by normal exponential signal decay. Low frequency sounds attenuate slowly, hence travel long distances in the marine environment. High frequency sounds, on the other hand, attenuate rapidly to levels similar to those produced from natural sources.

Exposure of marine fauna to acoustic disturbance is determined by:

- The acoustic source size and pressure;
- The frequency of the emitted sound;
- The firing sequence and tow speed;
- The duration of exposure;
- The propagation conditions (bathymetry, substrate, physical water properties); and
- The distance between the organism and the acoustic source.

In order to assess the potential exposure of marine fauna to underwater noise from the Trestles 3D Survey, and in accordance with the Code, sound transmission loss modelling was commissioned. This modelling was undertaken by Curtin University in order to predict sound propagation from the acoustic parameters specific to the Trestles 3D Seismic Survey and the local bathymetry.

Note that all mitigations regarding potential acoustic disturbance are presented collectively at the end of this section; in order to minimise repetition throughout sub-sections.

Sound Transmission Loss Modelling

The Trestles 3D Seismic Survey Operational Area is located within an AEI, and in accordance with the Code, a sound transmission loss modelling report was commissioned from Curtin University (Appendix 4). In order to predict worst case scenario received Sound Exposure Levels (SEL), the modelling was undertaken in two parts

- Short range modelling: to assess maximum predicted sound propagation at the boundary of each mitigation zone (as defined by the Code); and
- Long range modelling: to evaluate maximum sound propagation into the West Coast North Island Marine Mammal Sanctuary (MMS).

The input parameters for the models were:

- Acoustic specifications - as described in Section 3.2.1;
- Water depth - Bathymetry used was a merged bathymetry grid using STOS and LINZ data and is considered to be the most accurate bathymetry for the Operational Area. A 94 m source location was used for the short-range modelling in alignment with the shallowest water depth within the Survey Area (Figure 27); and a 103 m water depth was used for the long-range modelling in line with the location predicted to produce the highest sound exposure levels in the MMS (Figure 28); and
- Sea floor substrate type – Sandy mud (sand content 10-50%) was used to inform the model based on this substrate type being the most reflective substrate known from Operational Area (occurring in the northeast corner).

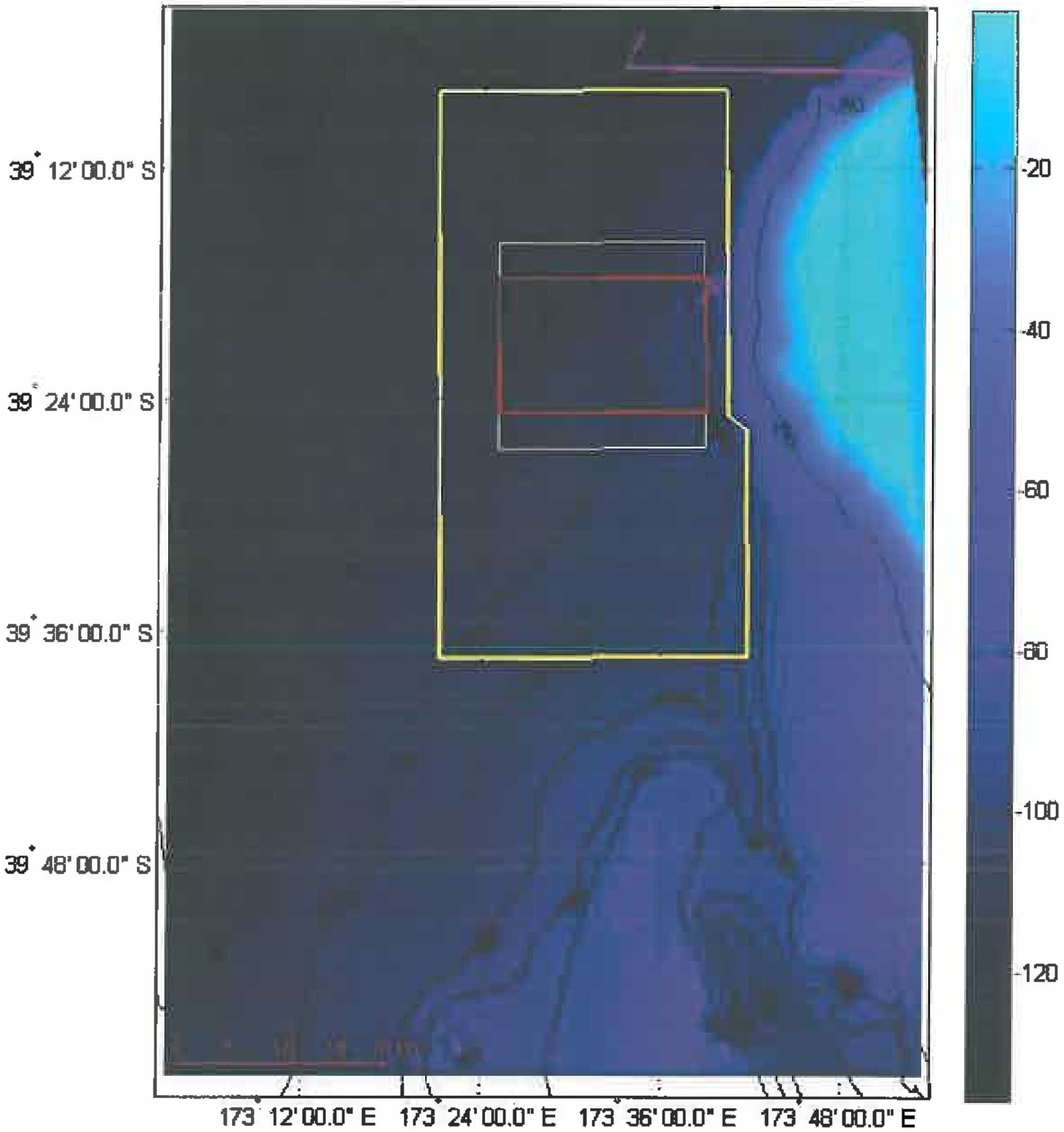

Figure 27: Source location for short-range modelling (indicated by 'S1')

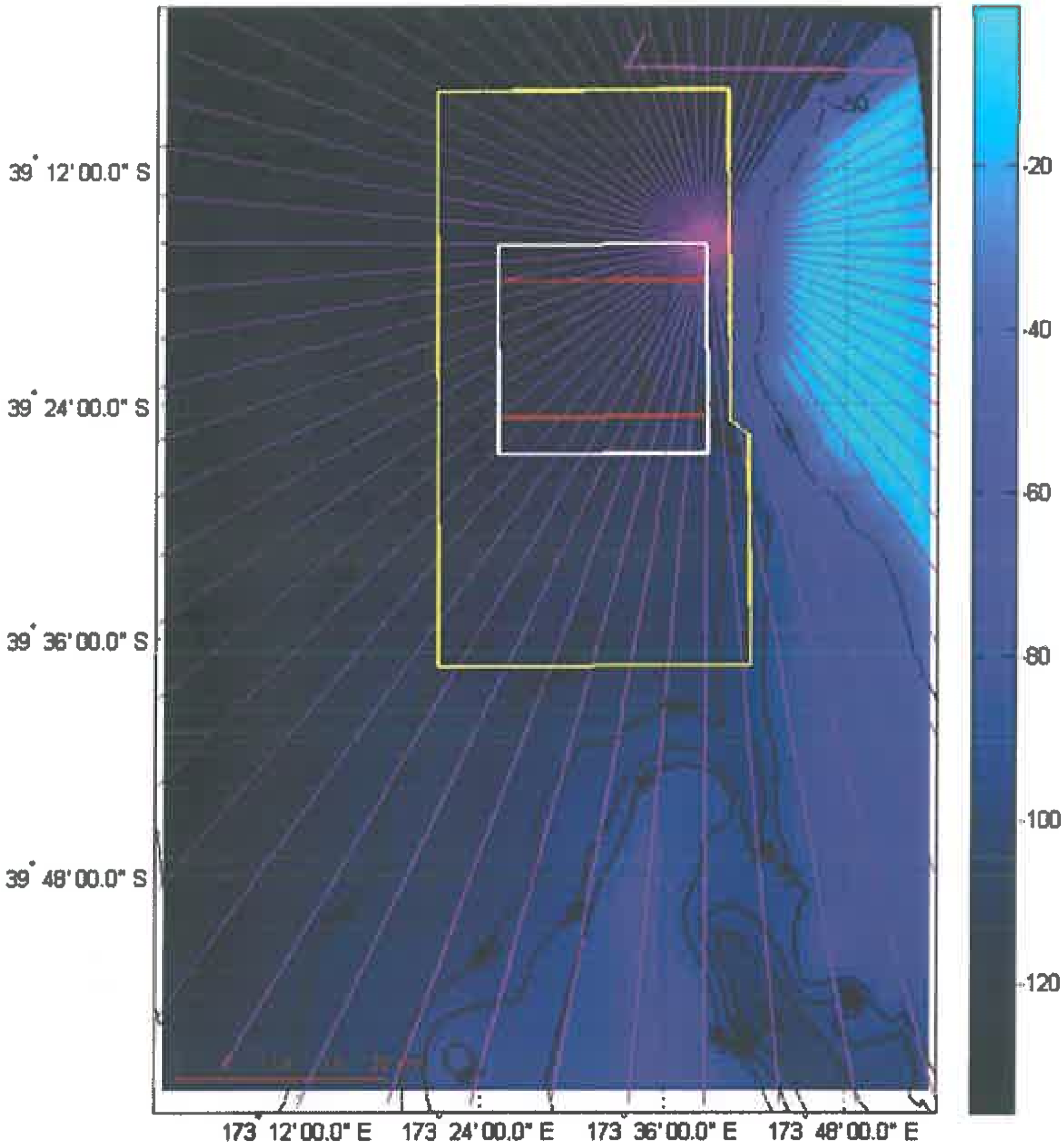

Figure 28: Source location for long-range modelling (indicated by 'S2')

Short range modelling results:

Short range modelling allows for predictions to be made about the likelihood of compliance with the Code of Conduct mitigation zones. The model results predicted that the maximum SELs would be below the threshold for physiological disturbance as defined by the Code (186 dB re 1 μPa^2.s) at 200 m from the source; and that the maximum SELs would be below the threshold for behavioural disturbance (171dB re 1 μPa^2.s) at 1 and 1.5 km from the source (Figure 29, Figure 30) and Table 8).

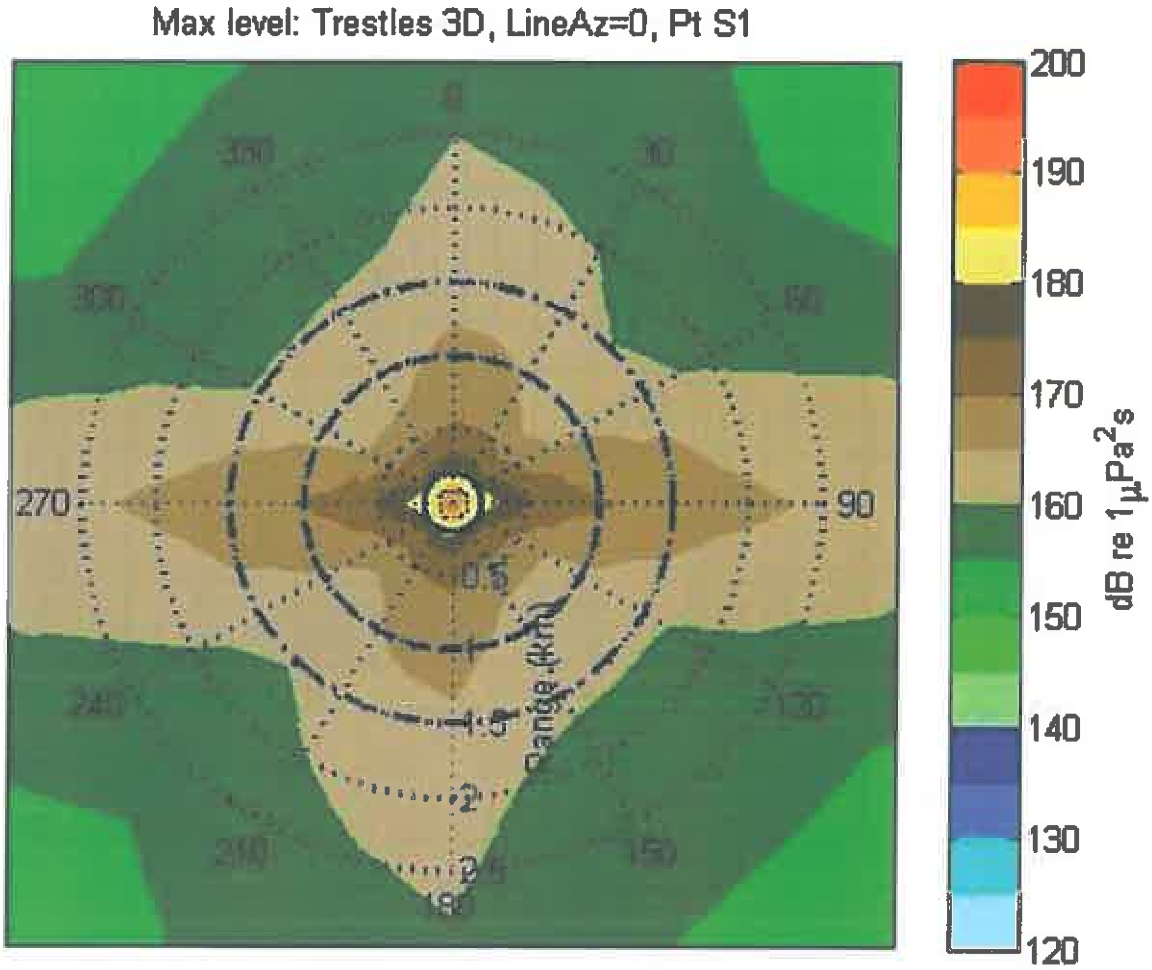

Figure 29: Predicted maximum received SEL at any depth

(as a function of azimuth and range from the source. The 0° azimuth corresponds to the in-line direction. The thick black circle denotes the mitigation zones, 200 m (solid), 1 km (dashed), 1.5 km (dash-dot)

Table 8: Maximum sound exposure levels as a function of range from source location S1

Range	Maximum Sound Exposure Level (dB re 1 μPa².s)
200 m	182.7
1.0 km	170.5
1.5 km	168.3

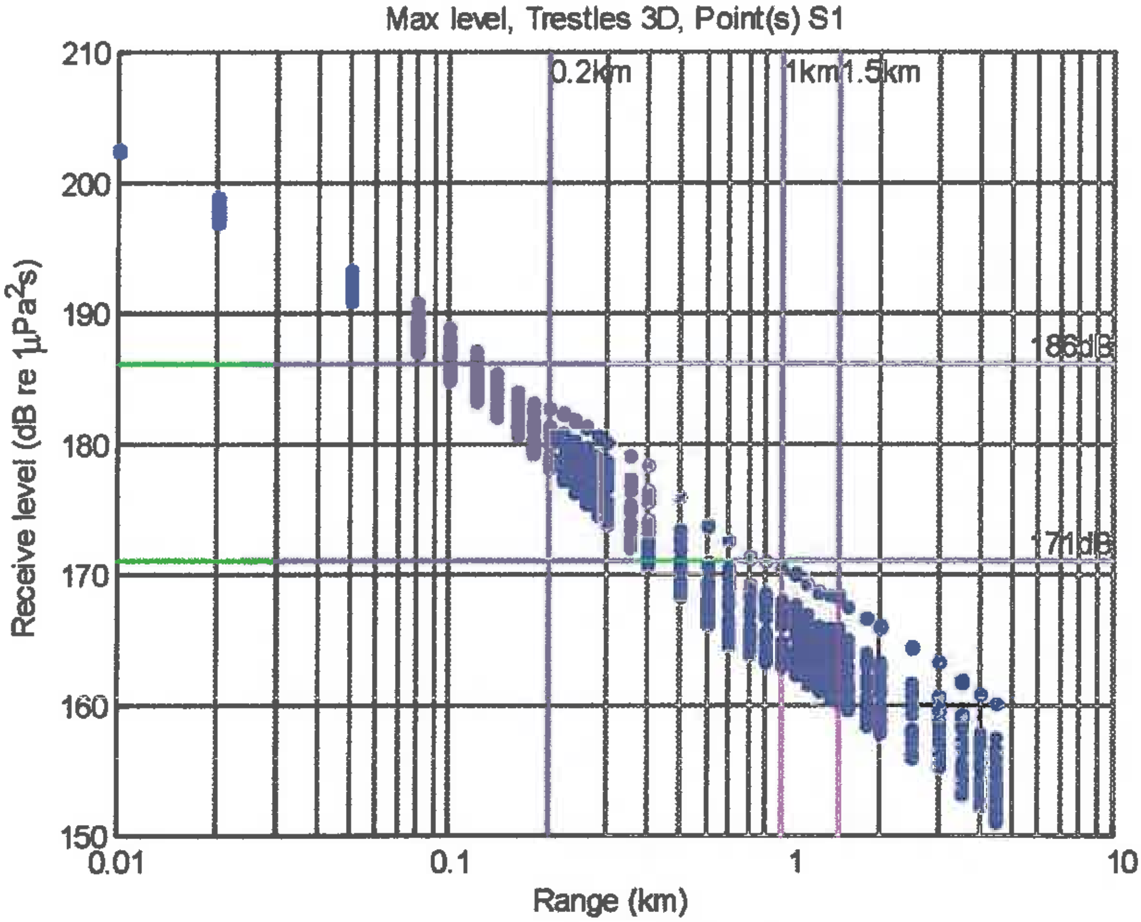

Figure 30: Scatter plot of maximum SEL at source location S1

Long range modelling:

Long range modelling was undertaken to investigate the geographical distribution of sound energy from the seismic source within the Survey Area in relation to the marine mammal sanctuary nearby. The model predicted that the maximum SELs in the sanctuary for a source at the **S2** location were 144.0 dB re 1 µPa^2.s (Figure 31).

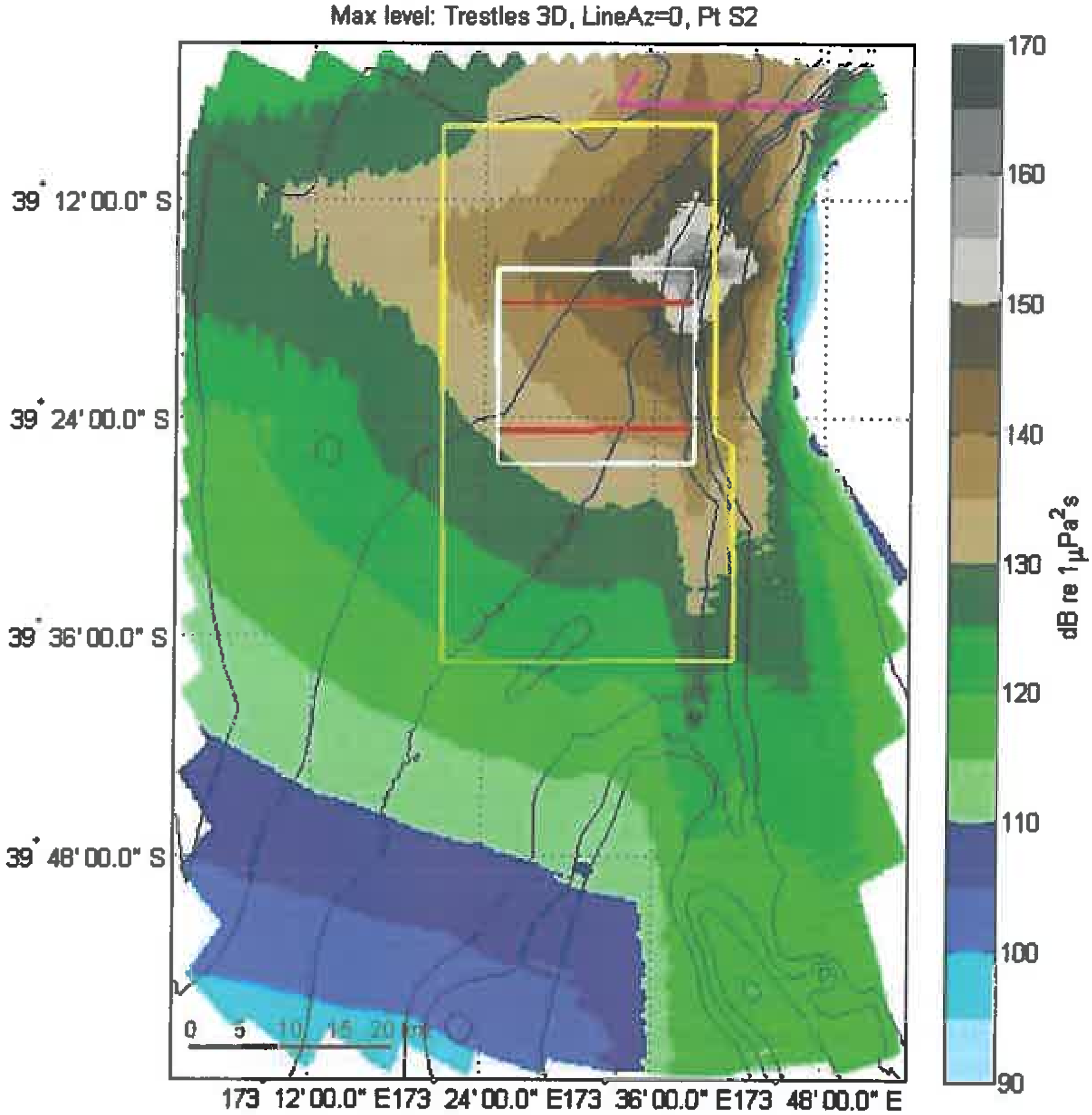

Figure 31: Long range geographical distribution of modelled SEL

(for a source at location S2, and showing the boundary of the West Coast North Island Marine Mammal Sanctuary in magenta)

The strong and complicated directionality in this plot is due to a combination of the directionality of the acoustic array, which produces maxima in the in-line and cross-line directions and the effects of bathymetry: whereby rapid attenuation occurred upslope from the source and enhances propagation downslope.

Physical effects

Marine mammals that are exposed at close range to high intensity underwater noise (or the associated pressure effects) could potentially suffer trauma or auditory damage (DOC, 2013). However, the sound intensity (energy levels, frequencies and duration) required to produce these physiological effects is unknown for most marine fauna, and what is known is based on a limited number of studies.

Auditory damage is referred to by way of threshold shifts, whereby an elevation of the lower limit of auditory sensitivity occurs (i.e. hearing loss). Threshold shifts can either be temporary or permanent (Temporary Threshold Shift, TTS; or Permanent Threshold Shift, PTS). In most cases threshold shifts will be temporary i.e. a temporary loss of hearing sensitivity following exposure to high intensity sound; and most mobile species, if given the opportunity, are thought to avoid the range in which physical effects occur.

For marine mammals, the sound exposure level (SEL) required to elicit a threshold shift varies with species. For example, captive bottlenose dolphins exhibit TTS at 190 – 192 dB re 1 μPa^2-s (Schlundt *et al.* 2000, Finneran *et al.* 2005), whereas captive harbour porpoises have shown that TTS occurred at SEL 164 dB re 1 μPa^2-s (Lucke *et al.* 2009). PTS in marine mammals typically occurs between 218 – 230 dB re 1 μPa^2-s (Southall *et al.* 2007). Captive studies are important as quantifying physiological change in free-ranging marine mammals is virtually impossible; however it is noteworthy that there are remarkably few reported incidents of obvious and sustained marine mammal surface distress behaviours in the immediate vicinity of seismic surveys, and no marine mammal standings' have to date been linked to marine seismic surveys.

The Code uses the SEL criteria set out by Southall *et al.* (2007) to predict thresholds for physiological changes. This threshold is referred to as the 'injury threshold' and is defined to be 186 dB re 1 μPa^2-s (DOC, 2013). The mitigation measures outlined in the Code are designed specifically to address this threshold by protecting marine mammals from physiological damage (temporary and permanent). As outlined earlier in this section, sound transmission loss modelling has confirmed that the standard mitigation measures in the Code should sufficiently protect marine mammals from auditory injury during the Trestles 3D Seismic Survey. Indeed, the modelling predicts that SELs capable of causing PTS only occur right at source itself and decrease rapidly with distance from the source (Figure 29). The mitigation measures that will be employed during the Trestles 3D Seismic Survey ensure that species of concern are fully protected from such sound levels as the acoustic source must be shut down if species of concern approach to within 200 m of the source. In addition, soft starts (a gradual increase in the acoustic power level) will ensure marine mammals in the immediate vicinity of the survey will be given adequate opportunity to leave the area before full power operations get underway.

As with marine mammals, fish can also suffer from to auditory damage or threshold shifts. Damage to auditory hair cells has been documented in a number of species and is believed to contribute to threshold shifts; for example: Atlantic cod (Enger 1981, as cited in Hastings and Popper, 2005) and pink snapper (McCauley *et al.* 2003). These physiological changes are generally thought to be limited to fish in the immediate vicinity of the acoustic source (Popper and Hastings, 2009); however, the available studies that document effects on marine fish are scarce, meaning that assumptions of effects between species (particularly freshwater species and marine species) are common and often unsubstantiated. Addison *et al.* (2004) conclude that mortality of teleost fish in very close proximity to an airgun could occur on account of sudden pressure changes and consequences on the swim bladder.

Of all the groups of marine fauna, the least information is available for invertebrates. For plankton, mortality has been observed at close range (within 5 m) of an active acoustic source (DIR, 2007; Addison *et al.* 2004). However, most studies suggest that seismic effects on benthic macro-invertebrates are minor and occur primarily in shallow water (< 20 m) (Addison *et al.* 2004). Data on the impacts of seismic sound on macro-invertebrates (scallop, sea urchins, mussels, periwinkles, crustaceans, shrimp, gastropods, and squid) show that little mortality occurs below sound levels of 220 dB re 1µPa@1m (Addison *et al.* 2004). Based on the sound transmission loss modelling, these effects are not predicted to occur with the acoustic source intended for this survey.

Seismic surveys could presumably have physiological effects on deep diving seabirds, but little information is available to suggest the mechanisms and likelihood of impacts (Addison *et al.* 2004).

Marine fauna that are unable to avoid the acoustic source (because of behavioural or physical constraints) are more at risk of physiological effects than highly mobile organisms that can detect and respond to an approaching seismic survey. Fauna that may not be capable of eliciting an avoidance response include plankton, fish eggs, some species of fish and sessile or slow moving benthic organisms.

Mitigation measures to address acoustic disturbance are outlined in Section 6.3.3.

Auditory Masking

Many different marine organisms use sound for various functions in the marine environment. Sound travels efficiently underwater and, in an environment where light often limits the suitability of visual communication, communication by sound has obvious benefits (DOSITS, 2014).

Marine mammals use sound extensively for communication. Many marine mammal species are social animals that live in groups, whereby group cohesion is maintained by short-range vocalisations between individuals. Bottlenose dolphins are a good example of this where each individual has a 'signature' whistle for recognition. Short-range vocalisations are particularly important for mother/calf pairs. Some marine mammal species also reserve a specific range of communication vocalisations for reproductive behaviours (e.g. humpback whale song). Whilst aggression is displayed by another range of vocalisations or sound producing behaviours (e.g. tail slapping).

Marine mammals produce sound not only for communication with conspecifics, but also for navigation and foraging. Toothed whales and dolphins use echolocation to forage and navigate, whilst all marine mammals are believed to use passive listening to gather useful navigational cues (e.g. the sound of waves breaking on coastline etc.).

Fish also use sound to communicate with one another with sounds typically being associated with reproductive activities or stressful situations (DOSITS, 2014). Many fish species also produce sounds while feeding, and these sounds may attract other individuals to a food source. Little is known about NZ fish species, but a recent study documented red gurnard to produce vocalisations in the 100 – 500 Hz range (Ghazali, 2011). Information also suggests that sound may also be important for components of invertebrate ecology with crustaceans commonly producing sounds (DOSITS, 2014) and larval coral and larval reef fishes using sound to detect suitable settling locations (Simpson *et al.* 2004; Vermeij *et al.* 2010).

Sound producing animals in the marine environment must be able to perceive and effectively respond to biologically important sounds. Underwater noise generated by human activity can interfere with the perception of these sounds. Such interference is referred to as 'masking'. The following examples demonstrate the potential for masking in both marine mammals and fish:

- The noise from an ice-breaker ship was predicted to mask beluga whale communication signals (Erbe and Farmer, 2000); and
- Boat noise was found to mask acoustic communications in three vocalising fish species in the Adriatic Sea (Codarin *et al.* 2009).

Masking can occur at received levels less than those which would elicit an observable behavioural response. In situations when masking occurs, evidence suggests that adaptive shifting in vocalisation can result (McGregor *et al.* 2013). This is when animals change their vocalisation behaviour in an attempt to overcome a masking effect. Examples of this adaptive behaviour are:

- Di Lorio & Clark (2009) investigated changes in blue whale vocal behaviour during a low-medium power seismic survey (mean seismic source = 131 dB re 1μPa at 30 – 500 Hz; mean SEL = 114 dB re 1μPa^{2}s). Results showed that blue whales called consistently more on days when the seismic source was active than on days when it was not. It is believed that an increase in calling rate increased the probability of blue whale signals being successfully received by conspecifics; and
- Foote *et al.* (2004) demonstrated that killer whales increased the duration of their calls in response to high levels of boat traffic.

Based on the information above it is clear that seismic surveys could have impacts on marine fauna acoustics. This may be particularly the case for marine mammals when the sounds generated by the survey overlap with the frequency range used by animals (Richardson *et al.* 1995).

Table 9 summarises the known frequencies of echolocation and communication calls for selected species of toothed whales and dolphins. These species could be present in the Operational Area at the time of the survey. For the most part the echolocation frequencies for those species listed are much higher than the Trestles 3D Seismic Survey acoustic source (5 - 200 Hz). There is however the potential for the seismic source to interfere with lower frequency marine mammal communications; e.g. for blue whales a small overlap occurs at the highest end of the seismic spectrum and the lowest end of the vocalisation spectrum.

Mitigation measures to address acoustic disturbance are outlined in Section 6.3.3.

Table 9: Frequencies of Cetacean Vocalisations

(Summarised from Simmonds *et al.* 2004)

Species	Vocal component	Frequency range (kHz)
Humpback whale	Grunts	0.025-1.9
	Horn blasts	0.41-0.42
	Moans	0.02-1.8
	Pulse trains	0.025-1.25
	Songs	0.03-8
	Social calls	0.05-10
	Shrieks	0.75-1.8
	Slaps	0.03-1.2
Blue whale	Moans	0.012-0.4
Bryde's whale	-	No data available
Fin whale	Clicks	16-28
	Constant call	0.02-0.04
	Moans	0.016-0.75
	Down sweeps	0.014-0.118
	Up sweeps	0.03-0.075
	Pulses	0.018-0.075
	Ragged pulses	<0.03
	Rumble	0.01-0.03
	Whistles and chirps	1.5-5
Minke whale	Down sweeps	0.06-0.13
	Moans, grunts	0.06-0.14
	Ratchet	0.85-6
	Sweeps, moans	0.06-0.14
	Thump trains	0.1-2
Sei whale	Sweeps	1.5-3.5
Southern Right whale	Pulsive calls	0.03-2.2
	Tonal calls	0.03-1.25

Beaked whales*	Whistles Clicks	3-16 2-26
Sperm whale	Clicks	0.1-30
Common dolphin	Whistles Chirps Barks Clicks	2-18 8-14 <0.5-3 0.2-150
Killer whale	Whistles Clicks Scream Pulse calls Echolocation clicks	1.5-18 0.1-35 2 0.5-25 12-25
Bottlenose dolphin	Whistles Clicks Barks Low frequency calls Echolocation clicks	0.8-24 0.2-150 0.2-16 0.05-0.9 110-130
Māui/Hector's dolphin	Echolocation clicks	129**
Pilot whale	Whistles Clicks Echolocation clicks	1-8 1-18 6-11
Dusky dolphin	Echolocation clicks	40-50 and 80-110 (2 peaks)***
False killer whales	Whistles Echolocation clicks	1.87-18.1 25-130
Striped dolphin	Whistles	1.1-24+
Pygmy sperm whale	Clicks	60-200
Pygmy right whale	-	No data available

** The bottlenose whale is used as a beaked whale example; frequency ranges are likely to vary with species*
*** Kyhn et al (2009)*
**** Au and Wursig (2004)*

Interruption of Behavioural Patterns and Displacement from Habitat

Behavioural changes of marine mammals are readily documented in response to seismic surveys. Responses include:

- Avoidance: change in travel direction away from seismic source and/or lower density than expected in area affected by seismic surveys (e.g. Johnson *et al.* 2007, Potter *et al.* 2007, Koski *et al.* 2009, Stone and Tasker 2006; Weir, 2008);
- Changes in vocal behaviour (e.g. Di Lorio and Clark 2010; IWC, 2007, as cited in Weilgart 2007; Bowles *et al.* 1994; Cerchio *et al.* 2014); and
- Changes in dive behaviour (e.g. Gailey *et al.* 2007).

Temporary avoidance is the most commonly reported response by marine mammals in the vicinity of strong acoustic sources (Hammond *et al.* 2002); although some species appear to be attracted to low/medium power acoustic sources (e.g. Wursig *et al.* 1998, Simmonds *et al.* 2004). Other changes in localised movements in marine mammals include: swimming away from the source, rapid swimming at the surface, and breaching (McCauley *et al.* 1998; McCauley *et al.* 2003). However, McCauley *et al.* (2003) concluded that acoustic disturbance did not cause changes in the regional migration patterns of cetaceans.

Avoidance behaviours may culminate in marine fauna being displaced from habitat. Detrimental effects can be expected if this displacement occurs from optimal habitat into suboptimal alternatives; particularly if such displacement persists in the long-term. Consequences of displacement are poorly understood, and are likely to have the greatest adverse effect on those species with relatively restricted home ranges (Forney *et al.* 2013).

However, despite temporary avoidance responses being common some authors have concluded that longer term population level impacts are unlikely (Johnson *et al.* 2007; Thompson *et al.* 2014). Thompson *et al.* (2014) documented that during a 2D seismic survey (SEL 145 – 151 dB re 1 $\mu Pa^2 s^{-1}$) in Scotland harbour porpoises showed an initial avoidance response, but were typically detected again within a few hours; indicating that short-term disturbance may not necessarily lead to long-term displacement from habitat.

Most free-swimming animals have been observed avoiding the range at which negative effects may occur; diving seabirds, marine mammals and many fish species are highly mobile and can be expected to temporarily avoid acoustic disturbances.

Changes in vocalisations (that are not considered to be a masking response) have also been documented. Examples of such changes are:

- Sperm whales reportedly decrease their vocalisations in response to seismic surveys (IWC, 2007, as cited in Weilgart, 2007; Bowles *et al.* 1994). A decrease in vocalisations associated with foraging behaviour (IWC, 2007, as cited in Weilgart, 2007) is particularly noteworthy as it may indicate a disruption to feeding behaviour or success;
- Fin whales stopped vocalising in the presence of a seismic survey (IWC, 2007, as cited in Weilgart, 2007); and
- The number of 'singers' in a humpback whale population off Northern Angola significantly decreased with increasing exposure to seismic surveys (Cerchio *et al.* 2014). This indicates potential disruption to breeding behaviours.

Changes in dive behaviour are less well documented, but Gailey *et al.* (2007) found that dive time in grey whales increased in response to seismic noise.

The Code uses the SEL criteria set out by Southall *et al.* (2007) to predict thresholds for behavioural changes. This threshold is referred to as the 'behaviour threshold' and is defined to be 171 dB re 1 μPa^2-s (DOC, 2013). The mitigation measures outlined in the Code are designed specifically to address this threshold by protecting marine mammals from acoustic disturbance that could elicit behavioural change. As outlined earlier in this section, sound transmission loss modelling has confirmed that the standard mitigation measures in the Code should sufficiently protect marine mammals from behavioural impacts during the Trestles 3D Seismic Survey.

Less information is available on the behavioural responses of other marine fauna, but a captive exposure study on pink snapper demonstrated minor behavioural responses to air gun signals ranging from startle to alarm responses (McCauley *et al.* 2003). This study also suggested that fish numbers decrease with habituation, and that fish may avoid seismic surveys in the wild. Fish species have also been observed to dive deeper and tightening of the school structure (in schooling species) has been observed (McCauley *et al.* 2000). Controlled exposure experiments were conducted to examine the effect of underwater noise on sole and cod which showed an increase in swimming speed during exposure periods; however, there was a high variability between individuals and a decrease in response indicated that habituation occurred through time (Mueller-Blenkle *et al.* 2010).

Little information exists about the behavioural effects of underwater noise on sea birds, but Turnpenny and Nedwell (1994) found no obvious response from diving birds in the presence of a seismic vessel.

A full description of mitigation measures to address acoustic disturbance are outlined in Section 6.3.3.

Indirect Effects

Seismic data acquisition is known to alter the behavioural patterns of some marine organisms. Behavioural changes that lead to displacement could result in changes in the abundance, distribution or behaviour of pelagic fish species that are targeted either by fisheries or marine predators. Such indirect effects could be expected to occur in the immediate vicinity of the survey vessel, with baseline conditions resuming quickly after the vessel passes.

6.3.3 Acoustic Disturbance – Mitigations

The following mitigation measures will be employed during the Trestles 3D Seismic Survey in order to minimise acoustic disturbance to the marine ecosystem and existing interests:

- The Trestles 3D Seismic Survey will strictly adhere to the mitigation requirements as prescribed by the Code and outlined in Section 3.3.1 of this MMIA;
- A detailed Marine Mammal Mitigation Plan (MMMP) for the Trestles 3D Seismic Survey is presented in Appendix 6. This MMMP shall be used by observers and crew to guide operations in relation to marine mammal encounters at sea;
- Sound transmission loss modelling has been undertaken to predict the suitability of the mitigation zones required by the Code. The modelling verifies that the intended source array to be used will comply with the code during the Trestles 3D Seismic Survey, and should sufficiently protect marine mammals from both physiological and behavioural impacts;
- Ground-truthing of the modelled results for sound transmission loss will be undertaken during the Trestles 3D Seismic Survey according to the methodology outlined in Appendix 7;
- In addition to the operational requirements of the Code and in an attempt to further reduce acoustic disturbance during the Trestles 3D Seismic Survey, where possible Todd Energy will avoid acoustic source testing in waters < 100 m deep;
- Seismic survey operations will occur 24 hours a day, 7 days a week (weather permitting) to minimise the overall duration of the survey;
- Whilst transiting to and from the Operational Area, and during daylights hours and if sighting conditions are good, a MMO will be on watch and recording marine mammal sightings. Any observations outside of the Operational Area will be reported in the DOC 'Off Survey' forms;
- If any strandings occur in the North or South Taranaki Bights, that result in mortality during the Trestles 3D Seismic Survey or within 14 days of the survey completion date, Todd Energy will, on a case-by-case basis, consider covering the costs of undertaking a necropsy in an attempt to determine the cause of death. Those strandings that occur in the coastal area between New Plymouth and Hawera will be obvious candidates for necropsy. It is likely that only a subsample of animals would be subject to necropsy during any mass stranding event;
- Weekly MMO reports will be provided to DOC and the Environmental Protection Authority;
- In accordance with the Code, DOC will be notified immediately in the following circumstances:
  - For any instances of non-compliance with the Code and/or the additional mitigation measures identified in this MMIA;
  - Should high numbers of a species of concern be observed within the survey area; and
  - If ground-truthing results indicate the mitigation zones are insufficient for providing protection to marine mammals from physiological or behavioural impacts.
- DOC will also be notified immediately of any sightings of Māui or Hector's dolphins.

With these mitigation measures in place, the residual impacts associated with acoustic disturbance are minimised. Assessments of significance for the residual impacts of acoustic disturbance are presented in Table 10.

Table 10: Predicted residual impacts of acoustic disturbance.

Residual Impacts	Comment	Significance
Physiological	The sound transmission loss modelling predicts that SELS greater than 186 dB re 1 μPa^2-s (the physiological injury threshold) will be restricted to within 200 m of the acoustic source. The delayed start and shut down mitigations outlined in the Code serve to limit marine mammal exposure to injurious SELs; i.e. 'species of concern' will not be exposed to these levels and all other marine mammals will only be exposed to these levels if they chose to approach closer than 200 m after the full power operations have commenced.	**Minor** (for 'species of concern') **Moderate** (for 'other marine mammals')
Masking	Despite mitigations being in place, there is the potential for masking of low frequency marine mammal vocalisations to occur. This residual impact would be limited to the survey duration and would cease immediately at the completion of the survey.	**Minor**
Interruption of behaviour/ Displacement	The sound transmission loss modelling predicts that SELS greater than 171 dB re 1 μPa^2-s (the behavioural threshold) will be restricted to within 1 km of the acoustic source. The delayed start and shut down mitigations outlined in the Code serve to limit marine mammal exposure to these SELs; i.e. 'species of concern' will not be exposed to these levels and all other marine mammals will only be exposed to these levels if they chose to approach closer than 1 km after the full power operations have commenced. The Operational Area has not been documented as critical habitat for any species of marine fauna. For those species that could potentially be present, no lasting impacts on feeding, breeding, migrating or resting behaviours are expected.	**Minor** (for 'species of concern') **Moderate** (for 'other marine mammals')
Indirect effects	Despite mitigations being in place some indirect impacts could occur. These impacts (i.e. a localised change in distribution or abundance of prey species or quota species) would be temporary and localised. Any such impacts are expected to return to baseline conditions rapidly.	**Minor**

6.3.4 Solid and Liquid Waste Discharges

The discharge of waste overboard may contribute a number of potentially harmful pollutants to the marine environment and would reduce habitat quality. This is particularly so for sewage and non-biodegradable garbage. The discharge of waste at sea is regulated in NZ by the Resource Management (Marine Pollution) Regulations 1998 within the territorial sea and MARPOL requirements as enacted by Marine Protection Rules under the Maritime Transport Act 1994 within the EEZ.

The resultant impact of waste discharge depends on the type of waste and the flow characteristics of the water body into which the waste is discharged and the proximity to sensitive marine environments.

Biodegradable waste at sea results in an increased biochemical oxygen demand. This means that as the organic substances are decomposed by bacteria in the water column, dissolved oxygen levels are depleted. A reduction in dissolved oxygen levels can have significant consequences for marine fauna. This can be a particular problem in low flow areas where water circulates only slowly.

Biodegradable wastes can also contain the nutrients phosphorus and nitrogen. When these nutrients are present in excessive quantities they can cause patches of artificial enrichment which in severe cases can trigger algal 'blooms'.

Non-biodegradable garbage at sea can cause problems for marine fauna including entanglement, injury and ingestion of foreign objects.

Table 11 summarises the relevant legislation and the appropriate disposal routes for various common waste types within the EEZ and the territorial sea.

Table 11: Waste Disposal – Relevant Legislation and Requirements

Waste Type	Relevant National Legislation	Appropriate Disposal within Territorial Sea (within 12 Nm)	Relevant MARPOL Annex	Appropriate Disposal within EEZ (beyond 12 Nm)
Non-Biodegradable Garbage	Marine Protection Rules Part 170 Resource Management (Marine Pollution) Regulations 1998	Must be stored onboard until disposal onshore is possible.	Annex V	Generally must be stored onboard until disposal onshore is possible, however some exceptions may apply as detailed in MARPOL Annex 5.
Biodegradable Food Waste	Marine Protection Rules Part 170 Resource Management (Marine Pollution) Regulations 1998	Comminuted food waste (ground to <25 mm particle size) can be discharged beyond 3 Nm.	Annex V	Non-comminuted food waste can be discharged
Sewage	Resource Management (Marine Pollution) Regulations 1998	Treated sewage (comminuted and disinfected) can be discharged beyond 3 Nm	Annex IV	Untreated sewage can be discharged
Grey water	NA	Permitted discharge	NA	Permitted discharge

Mitigations:

- The 3D seismic source vessel and the support vessels will have an approved International Sewage Pollution Prevention Certificate as per the regulations of MARPOL Annex IV;
- Only treated sewage which meets the requirements of the Resource Management (Marine Pollution) Regulations 1998 will be discharged;
- Over and above the requirements of the Resource Management (Marine Pollution) Regulations 1998, biodegradable galley waste may be incinerated onboard to dissuade potential shark attraction and subsequent damage to streamers;
- All other solid and non-biodegradable liquid wastes will be retained aboard for subsequent disposal to managed facilities ashore;
- The *MV Polar Duke* will comply with a comprehensive Garbage Management Plan as per the '2012 guidelines for the development of Garbage Management Plans' with regard to Regulation 10 of the revised MARPOL Annex V;
- Garbage Management Plans will detail procedures for minimising, collecting, sorting, processing and disposing of all garbage and designate the crew responsible for garbage management;
- Garbage record books will be kept to enable operators and officials to audit all garbage discharges; and
- All wastes returned to shore will be disposed of in strict adherence to local waste management requirements, with all chain of custody records retained by the *MV Polar Duke*.

With these mitigation measures in place, it is considered that there will be no residual impacts from the discharge of waste during the Trestles 3D Seismic Survey. Therefore waste discharges are considered to be **negligible**.

6.4 Sources of Impact - Unplanned Events

Unplanned events are rare during marine seismic operations. However, they do pose a small potential risk and hence for completeness they are considered below.

Table 12 outlines the unplanned events which could occur in association with the Trestles 3D Seismic Survey and that have the potential to impact the baseline environment.

Table 12: Sources of impact and associated potential impacts – unplanned events

Fuel oil spill
Potential Impacts: • Toxic effects on marine fauna • External contamination of wildlife • Indirect effects on environment and existing interests
Loss of towed gear
Potential Impacts: • Introduction of marine debris
Vessel collision
Potential Impacts: • Introduction of marine debris • Accidental release of hazardous substances
Biosecurity Incursion
Potential Impacts: • Introduction of marine pests

6.5 Potential Impacts and Mitigation Measures – Unplanned Events

6.5.1 Fuel Oil Spill

A fuel oil spill (marine diesel) from the 3D seismic vessel or support vessels during the Trestles 3D Seismic Survey could occur on account of:

- Leaking equipment/storage containers;
- Accidental releases from fuel containers;
- Hull/fuel tank failure due to collisions/sinking; and
- Accidental spill during a refuelling operation.

A fuel tank rupture poses the largest potential risk of environmental impact. Other potential spills are more readily contained on board and are generally only small volumes.

The potential impacts associated with a fuel oil spill are summarised in Table 13.

Table 13: Potential worst case environmental effects of a marine diesel spill

Environmental Receptor	Description of potential effects
Pelagic ecosystems	• Toxicity effects on organisms: mortality (direct and indirect), sub-lethal population effects (e.g. organ damage, immunosuppression, impaired reproduction).
Marine mammals and sea birds	• External contamination of marine mammals. This is particularly detrimental to New Zealand fur seals which rely on their dense fur for insulation; • External contamination of pelagic seabirds. This is extremely detrimental to seabirds which rely on 100% waterproofing to survive in the cold marine environment. Even a small patch of diesel on plumage will result in a loss of waterproofing, leading to a loss of buoyancy and insulation; • Due to the lower viscosity of diesel, affected individuals are more likely to be able to remove the product through grooming; • Loss of thermoregulatory abilities in heavily diesel affected wildlife leads to severe flow-on effects for foraging and survival at sea; • Toxicity effects via internal contamination from ingested/inhaled diesel. Contaminated marine mammals and sea birds will groom/preen to clear contamination from fur and feathers, in doing so they are likely to ingest diesel which is highly toxic and highly bioavailable; • Mortality of protected species and the associated conservation implications; and • Mortality of any animal and the associated animal welfare implications.
Cultural	• Short-term contamination of sites of cultural significance
Commercial fishing	• Reduction in fish stocks through mortality of fish eggs
Social	• Effects will occur only if diesel impacts the coast, whereby a short-term contamination of sites of social significance could occur.

The worst-case scenario for a fuel oil spill during the Trestles 3D Seismic Survey would be the complete loss of fuel from the 3D seismic vessel following a collision. The *MV Polar Duke* has a fuel capacity of 1810 m^3. However, this size of spill would only occur as a result of complete failure of the vessel's internal fuel containment system or catastrophic hull damage. The likelihood of such an incident is considered to be extremely low due to the sophisticated navigational systems on board to minimise the chance of collisions and compliance with the COLREGS.

During the Trestles 3D Seismic Survey, refuelling of the 3D seismic vessel will be required only once, if at all. Refuelling will preferably occur at sea. A smaller refuelling spill is more likely than a spill that eventuates following a collision, but is also a highly unlikely event.

__Mitigations:__

- The 3D seismic vessel and support vessels involved in the Trestles 3D Seismic Survey have an approved and certified Shipboard Oil Pollution Emergency Plan and International Oil Pollution Prevention Certificate as per MARPOL and the Marine

Protection Rules Part 130A and 123A respectively. These will be kept onboard for the duration of the survey;

- Sophisticated navigational systems on board and compliance with the COLREGS will minimise the likelihood of collision;
- Should a spill occur and if response assistance is required, the location of the spill will dictate the response management regime implemented. If inside the territorial sea the response will be led by the Taranaki Regional Council as a Tier 2 response. However, a spill in the EEZ would be managed as a Tier 3 response led by Maritime New Zealand;
- Refuelling is carried out using standard industry practices and several standard safety procedures will be implemented to minimise the risk of an accidental spill. These include:
  - Refuelling operations are undertaken only in suitable weather conditions, and only during daylight hours;
  - During refuelling an observer is present to check for leaks;
  - Wire-reinforced transfer hoses will be used during refuelling;
  - Transfer hoses will be fitted with 'dry break' couplings. These are advanced fluid handling systems that ensure safe, spill-free transfer of hazardous substances;
  - An on-board spill contingency plan will be implemented promptly in the event of a refuelling incident; and
  - Any spill will be reported as an environmental incident.

The mitigation measures outlined above are considered to sufficiently minimise the risk of fuel oil spills associated with the Trestles 3D Seismic Survey. The actual environmental impacts of an oil spill would be determined by the exact spill scenario: i.e. spill volume, location in relation to sensitive sites, and specific characteristics of spilled hydrocarbons. The most likely spill scenario associated with the Trestles 3D Seismic Survey is a refuelling spill. Such a spill would result in a relatively small volume of fuel oil being discharged into a high energy marine environment, resulting in rapid evaporation and dispersion. For these reasons the potential impacts of a spill of this nature are considered to be **minor** as effects are predicted to be short-term and very localised.

6.5.2 Loss of Towed Gear

During marine seismic surveys it is possible that one or multiple components of towed gear could be lost to sea. The breakage of a streamer cable carries the highest potential risk and could occur on account of 1) severe weather, 2) snagging on marine debris, 3) shark bite, or 4) being severed by the propeller of another vessel.

Gear that is lost and cannot be retrieved at sea could contribute to the broader issue of marine pollution. Towed gear for seismic surveys is typically negatively buoyant so would sink to the seafloor if lost. Potential impacts are therefore limited to benthic ecosystems and would be highly localised, e.g. crushing on individual macro-benthic organisms as gear settles onto the seabed. However the mitigations below reduce the likelihood of gear being lost to the sea bed.

Mitigations:

- The Trestles 3D Seismic Survey will use negatively buoyant solid streamers, likely with 'self-recovery devices' (e.g. the GeoSpace SRD-500S). This means that any severed streamer would most likely be recovered before it settled onto the seafloor; and
- The Trestles 3D Seismic Survey will adhere to international best practise with regard to gear deployment and retrieval and these operations will be managed by experienced personnel.

The likelihood of loss of towed gear at sea is low during a marine seismic survey, and given the mitigations in place any impact associated with gear loss is considered to be **minor**.

6.5.3 Vessel Collision and/or Sinking

The most significant environmental impacts associated with a vessel collision or sinking is 1) the potential for the discharge of hazardous substances (including fuel oil, lubricants, and other chemicals) and, 2) disturbance to the benthic ecosystem as the vessel hits the sea floor.

The discharge of oil has largely been addressed in Section 6.5.1; hence, the focus here is on disturbance to the seafloor and the introduction of debris pollution into the marine environment.

Large pieces of wreckage from a sinking or collision event are likely to descend and settle onto the sea floor. This has the potential to damage benthic habitat and crush individual animals (e.g. demersal fish and epibenthic organisms).

The introduction of debris into the marine environment could result in:

- The entanglement of marine fauna in debris;
- The ingestion of manmade objects by marine mammals, seabirds and marine reptiles which can lead to health issues from gastric impactions; and
- A reduction in habitat quality for marine fauna.

Floating or semi-submerged debris may also create navigational hazards.

Mitigations:

- A Notice to Mariners will be issued and a vigilant watch will be maintained throughout the survey;
- The survey operations will comply with the COLREGS, in terms of obligatory radio communications, navigation lights, day shapes, and appropriate navigational practices;
- During the survey, support vessels will assist with navigation safety (particularly with regard to alerting other marine users to the approaching seismic survey vessel) and the implementation of any non-interference zone;
- Tail buoys will mark the end of each streamer which will also have radar reflectors and lights fitted to assist with navigation; and
- The Operational Area lies within the Taranaki Offshore Precautionary Area which requires all ships to navigate with particular caution in order to reduce the risk of maritime casualty and resulting marine pollution.

The likelihood of a collision or sinking is considered to be very low, and the risks are considered to be fully managed through the mitigations listed above. Therefore, no residual impact is expected and the significance of this unplanned event is **negligible**.

6.5.4 Biosecurity Incursion

International vessel traffic is the primary pathway for the transportation and introduction of potentially harmful marine organisms into NZ waters primarily through biofouling, ballast water discharges and associated sediments. The results from the introduction of exotic species could have a serious impact on the NZ seafood industries and on the biodiversity of coastal marine life. A chain of events must occur in order for pest establishment to take place, starting with the infection of a vessel by a non-indigenous species in its source region, followed by the survival of that species during transit to the recipient region, and finally the subsequent release and establishment of that species within NZ waters.

Mitigations:

- The seismic 3D seismic vessel and both support vessels will have been working in New Zealand waters for one month prior to commencing the Trestles 3D Seismic Survey
- The Ministry for Primary Industries border standards are required to be met by all incoming vessels into NZ waters. These border standards are in the form of the 'Import Heath Standard for Ships' Ballast Water from all Countries', and the 'Craft Risk Management Standard – Biofouling on Vessels Arriving to New Zealand' (in which compliance isn't mandatory until 2018). All vessels used by Todd Energy during this marine seismic survey were in compliance with these border standards on entry to New Zealand waters.
- The 'Import Heath Standard for Ships' Ballast Water from all Countries' prohibits the discharging of ballast water loaded in another country's water inside NZ territorial waters without permission. Before arriving in NZ, a vessel must show that its ballast water was, or will, be exchanged adequately with mid-ocean water in order to gain permission from the Ministry for Primary Industries to enter NZ territorial waters. All vessels used by Todd Energy during this marine seismic survey were in compliance with the 'Import Heath Standard for Ships' Ballast Water from all Countries' on entry to New Zealand waters.
- The 'Craft Risk Management Standard – Biofouling on Vessels Arriving to New Zealand' comes into force on 15 May 2018 and requires all vessels to arrive in NZ territorial waters with 'clean hulls'. This Craft Risk Management Standard has been developed in line with the 2011 International Maritime Organisation Guidelines for Biofouling Management. The Craft Risk Management Standard includes measures to be used by vessels in order to comply with the Standard, and the Ministry for Primary Industries will work with operators to help decide which measures are most suitable for them. Todd Energy will encourage the vessels contracted to complete this marine seismic survey to comply with the 'Craft Risk Management Standard – Biofouling on Vessels Arriving to New Zealand' even though it is voluntary through to May 2018.

Based on the mitigations outlined above, it is considered that the risk of a biosecurity incursion from the Trestles 3D Seismic Survey is **negligible**.

6.6 Cumulative Effects

Cumulative effects result when the effects of an activity are added to or interact with other effects in a particular place and within a particular time. In accordance with the 'Cumulative Effects Assessment Practitioner Guide' (CEA, 1999) the following conditions must be met in order for a cumulative effect to occur in relation to an activity:

- There must first be an environmental effect from the singular activity; and
- That effect must be demonstrated to operate cumulatively with the environmental effects from other activities, either past, existing or those planned for the future.

Because low frequency acoustic energy from seismic surveys travel large distances underwater the zone of influence associated with a seismic survey is typically extensive (see Figure 31).

Based on the sound transmission loss modelling we know that physiological and behavioural impacts will most likely be limited to the immediate 1 km surrounding the air gun array. However, the long-range modelling predicts that the seismic source will be audible underwater for tens of kilometres. Without knowing the background underwater noise levels in the Taranaki there is no way of knowing at what distance the propagating seismic sound matches that of background levels, but it is fair to predict that a degree of masking could occur outside the Operational Area during the survey.

To assess the cumulative effects of the Trestles 3D Seismic Survey, other marine activities that might also have an impact on environmental receptors in the zone of influence also need to be identified in order to ascertain any potential for impact overlap.

The following activities have been identified which could, or will, occur in the vicinity of the Operational Area:

- Oil and gas related operations (production, drilling, seismic);
- Commercial fishing; and
- Commercial shipping.

Each of these activities is described briefly below. As acoustic disturbance is unequivocally the most significant impact of the Trestles 3D Seismic Survey, the discussions below focus on the acoustic characteristics of the concurrent activities.

Oil and Gas Related Operations

The Taranaki Basin is the only producing basin in NZ and therefore is a primary focus of oil and gas related activity. A number of different operations will potentially overlap with the Trestles 3D Seismic Survey. The Māui A and B Platforms are located within the Operational Area and produce natural gas and condensate around the clock. The noise produced by the platforms has not been specifically characterised, but during standard day to day production activities this noise is most likely characterised by the movements of support vessels and machinery noise associated with pumping.

OMV NZ Limited is currently conducting development drilling in the southern Taranaki Basin from the jack-up drilling rig the ENSCO 107. This drilling activity is predicted to continue until mid-2015 (OMV, 2014). Once again, the noise produced by the development drilling has not been specifically characterised, but based on international literature Childerhouse (2014) predicted that the main frequencies emitted from this drilling programme will be less than 1 kHz (i.e. low frequency).

In addition to the production and drilling activities discussed above, Todd Energy is aware of a number of other seismic surveys which are scheduled in NZ waters during the 2014/15 seismic season. These other seismic surveys are summarised in Table 14.

Table 14: Other seismic surveys scheduled to occur during 2014/15

Location	Indicative Timeframe
New Caledonia Basin (Permit 55377)	December 2014
Northland, New Caledonia, and Taranaki Basins (Permit 56377)	December 2014
East Coast North Island and East Coast South Island including Cook Strait (PEP 56365)	May 2015
Taranaki Basin (PEP 55793)	January 2015
Great South Basin (PEP 55794)	Mid-February 2015
Canterbury Basin (PEP 38264)	April 2015
Canterbury Basin, Western Southland Basin, Great South Basin and Bounty Trough	mid-December 2014

Without knowing the exact acoustic parameters or the exact timing of the seismic surveys outlined in Table 14, it is difficult to predict the potential cumulative effects with any certainty. However, the only other survey scheduled for the Taranaki Basin in early 2015 is the Woodside Energy Ltd. survey which will occur in PEP 55793. Todd Energy has a timeshare arrangement with Woodside Energy Ltd. for use of the *MV Polar Duke*, with this vessel scheduled to complete the Woodside Energy Ltd. Survey first before commencing the Trestles 3D Seismic Survey. For this reason we predict no acoustic interaction between seismic surveys in the Taranaki Basin at the time of the Trestles 3D Seismic Survey. Therefore the probability of marine mammal vocalisations being masked by attenuating noise from multiple seismic surveys in this general marine region is unlikely.

Commercial Fishing

Commercial fishing activities in the offshore Taranaki were discussed in Section 5.4.2. The act of fishing itself will not contribute significantly to the noise profile in the area and the movement of fishing vessels is considered along with other commercial shipping traffic below.

Cumulative effects of fishing (the removal of fish stocks) and the potential for fish to be displaced from habitat during seismic operations (see Section 5.4.2 and Section 6.3.2) could result in an overall decrease in the density of some fish species in offshore Taranaki. Any cumulative effects of this nature would be limited to those fish species targeted by commercial fisheries, e.g. jack mackerel and barracouta.

Commercial Shipping

The low frequency nature of shipping noise, like seismic operational noise, means that it travels long distances underwater. Many vessels use the Taranaki offshore area regularly and hence it is likely that background shipping noise is virtually constant in this region. The low intensity/low frequency background noise generated by shipping could mask some low frequency cetacean calls in the area. This coupled with the potential masking effects of the Trestles 3D Seismic Survey (see Section 6.3.2) most likely increases the likelihood of masking in the offshore Taranaki for the duration of the seismic survey.

No quantitative information is available to assess how marine mammal behaviour and sound perception is affected by multiple sources of underwater noise. However anthropogenic noises originating from multiple directions at once could exacerbate the degree of masking, by reducing the chances of an individual compensating through reorientation in relation to important biological sounds.

Despite this potential increased risk of masking, there is growing evidence to suggest that in the presence of consistent noise, marine mammals can change their vocalisations (intensity/frequency) so that their calls are less likely to be masked showing some adaptation to increased noise levels (McGregor *et al.* 2013); however energetic costs to individuals that compensate in this manner are unknown.

Mitigations

The primary mitigations associated with acoustic disturbance for the Trestles 3D Seismic Survey are outlined in Section 6.3.3. No additional mitigations are recommended to address the potential cumulative effects outlined above although Todd Energy has arranged to timeshare the *MV Polar Duke* with Woodside Energy which by nature eliminates the temporal overlap between the surveys planed for PEPs 55793 and 53374.

Despite the proposed mitigations, some additional masking of marine fauna calls can be expected on account of potential cumulative effects. The cumulative masking potential associated with the interaction of the Trestles 3D Seismic Survey with other marine activities is predicted to cease immediately at the completion of the survey; hence, is considered to have **a minor** residual impact.

6.7 Summary

Table 15 provides a summary of the potential impacts associated with the Trestles 3D Seismic Survey and the predicted significance of residual impacts as per the criteria presented in Table 6. Note that the significance of residual impacts describes the significance of any predicted impacts assuming all mitigation actions are actively in place.

Table 15: Summary of Potential Residual Impacts and Significance

	Potential Residual Impacts	**Significance**
Planned Activities	Physical Presence of Seismic Vessel, Towed Gear and Support Vessels	
	Ship strike - marine mammals	Negligible
	Collision – sea birds	Negligible
	Displacement of marine fauna from Operational Area	Minor
	Displacement of existing interests from Operational Area	Minor
	Indirect effects	Minor
	Acoustic Disturbance	
	Physiological injury for Species of Concern	Minor
	Physiological injury for Other Marine Mammals	Moderate
	Masking	Minor
	Behavioural impacts for Species of Concern	Minor
	Behavioural impacts for Other Marine Mammals	Moderate
	Indirect effects	Minor
	Solid and liquid waste discharges	
	Sewage, greywater, galley waste & garbage	Negligible
Unplanned Events	Fuel oil spill	Minor
	Loss of towed gear	Minor
	Vessel collision or sinking	Negligible
	Biosecurity incursion	Negligible
	Cumulative effects	
	Interaction - impacts of seismic and unrelated activities	Minor

7 Monitoring and Reporting

7.1 Marine Mammal Mitigation Plan

Under the Code and as part of this MMIA a MMMP is required for proposed Level 1 seismic surveys in New Zealand fisheries waters. An MMMP has been developed for the Trestles 3D Seismic Survey and is included as Appendix 5. The MMMP becomes the standard operating procedure to be followed at sea during seismic survey operations and guides crew and MMOs of their duties and obligations in accordance with the Code and any additional mitigation measures outlined in the MMIA.

Monitoring and reporting are key components of the MMMP, whereby:

- All sightings of marine mammals during the survey period will be recorded in a standardised format;
- A written trip report shall be submitted to DOC within 60 days of the survey completion date;
- MMO raw datasheets will be submitted directly to DOC within 14 days of the survey completion; and
- The voluntary provision of weekly reports to DOC and EPA outlining 1) monitoring effort (visual and PAM); 2) source operations and mitigation actions; and 3) a summary of marine mammal detections.

7.2 Research

Once lodged with DOC, MMO data resulting from the Trestles 3D Seismic Survey is available at the discretion of DOC for the purposes of research. This research may be undertaken by DOC or other research groups and may assist with both understanding of distributional patterns of marine mammals in New Zealand and the behaviour of marine mammals in relation to active seismic operations. Todd Energy recognises and supports this commitment to increase the understanding of these topics.

8 Stakeholder Engagement

During the preparation of this MMIA an assessment was undertaken to identify interested parties within the Trestles Operational Area. These interested parties have been engaged by Todd Energy through a robust consultation process in the lead up to the Trestles 3D Seismic Survey.

Consultation has involved five specific focal groups:

- Local and national government regulatory agencies: e.g. Department of Conservation, the Environmental Protection Authority and Taranaki Regional Council;
- Iwi groups: Todd Energy acknowledges that Taranaki Iwi has existing interests through their exercise of mana whenua and mana moana of this area. Ongoing discussions will continue with the Taranaki Iwi Trust throughout the Trestles 3D Seismic Survey. Notification to Nga Ruahine also occurred as part of the consultation process;
- Fisheries interest groups: both commercial and recreational fishers that frequent marine waters of the Taranaki Basin for the purpose of fishing;
- Technical experts: the Code requires that the consultation provides an opportunity for expert technical advice to be considered. In the case of the Trestles 3D survey a number of marine mammal experts were contacted and given the opportunity to comment of the proposed operations and their potential effects on marine mammals; and

- Other potential interested parties.

For past surveys, the request for submissions was cast further afield than for this effort, and results showed that some groups with little or no active involvement in the survey area – many of these received no reply to the request for submissions. Consequently consultation for the Trestles 3D has been focused only on those groups who have a vested interest in the area of operations or the marine environment – many of the stakeholders approached for submissions were identified as correspondents from consultation related to Todd's previous marine seismic operations in Taranaki.

Consultation for the Trestles 3D Seismic Survey was initiated during January 2015 with those parties listed in the consultation register included as Appendix 1. An information sheet (Appendix 1) was provided with all engagements and stakeholders were encouraged to contact Todd Energy at any time with further questions, concerns or for more information. Consultation related correspondence and material is also included in Appendix 1.

The following points of note arose during the consultation process:

- DOC comments have been received and incorporated into this MMIA;
- A pre-survey vessel audit has been arranged with the EPA;
- The Taranaki Regional Council is happy that DOC take the lead on the assessment of this MMIA and the development of mitigation measures;
- Port Taranaki does not anticipate that the Trestles 3D Seismic Survey will have any significant impacts on their activities;
- Communications occurred with Taranaki Iwi during the consultation process, but to date no feedback has been received;
- The Trestles 3D Seismic Survey will overlap temporally and spatially with the jack mackerel fishing fleet. Todd Energy has committed to liaise closely with affected parties throughout the survey to mitigate against any potential problems; and
- One technical expert has reservations about the protection that the Code affords to marine mammals and believes that the only way to effectively protect threatened species is to not operate in areas that overlap with their distribution. This person also suggests that there is a lack of robust industry led research into the effects of seismic surveys on marine mammals.

Todd Energy is committed to maintaining ongoing communications with these parties throughout the duration of the Trestles 3D Seismic Survey.

9 Conclusion

Marine seismic surveys are considered routine activities within the oil and gas sector with well-established standard procedures to mitigate the associated potential impacts. In accordance with the EEZ Act – Permitted Activities, Todd Energy will comply with the mitigation actions described in the Code to manage both behavioural and physiological impacts to marine mammals during the Trestles 3D Seismic Survey.

Sound transmission loss modelling has been conducted and predicts that the mitigation measures outlined in the Code will appropriately mitigate adverse effects in light of the specific acoustic parameters and oceanographic environment associated with this survey. In addition to those measures described in the Code, Todd Energy proposes to implement a number of additional mitigation measures to further reduce potential environmental effects.

During the planning phase of this survey considerable attention was given to survey design to ensure acoustic input would be minimised in waters less than 100 m deep and in waters abutting the West Coast North Island Marine Mammal Sanctuary.

The potential environmental effects and the associated mitigation measures which Todd Energy will implement to minimise such effects have been thoroughly described in this MMIA. In summary, the potential impacts of the Trestles 3D Seismic Survey are considered in the most part to be negligible or minor, with moderate effects potentially occurring for other marine mammal species (i.e. those not considered to be species of concern) that approach the acoustic source to within 200 m during full seismic operations. These moderate effects may cause temporary behavioural changes, but physiological changes are unlikely as highly mobile marine mammals can be expected to largely avoid the immediate vicinity of the acoustic source. It is envisaged that the use of delayed starts and soft starts will minimise the occurrence of moderate effects which is indeed their intended purpose under the Code.

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Appendices

These following appendices accompany this report.

Number	Title
1	Consultation Register and Relevant Correspondence
2	Specifications for 3D Seismic Survey Vessel
3	Passive Acoustic Monitoring Specifications
4	Summary of NZ Threat Classification System (Threatened Species)
5	Sound Transmission Loss Modelling Results
6	Marine Mammal Mitigation Plan
7	Ground-truthing Methodology for Sound Transmission Loss Modelling

APPENDIX 1

Consultation Register and Relevant Correspondence

CONSULTATION REGISTER

Party	Contact Info	Record of Communications	Information sheet sent
Taranaki Iwi	Pouwhakahaere/General Manager	Phone message left on 13.01.15. Phone message left on 19.01.15. Phone message left on 23.01.15. Advised to try contacting on 23.01.15. Information sheet resent ... new email address on 23.01.15. advised that next Taranaki Iwi Trust Hui is next Monday (26th) and the Trestles survey is on the agenda for discussion at this hui. To date no feedback has been received, despite a follow up email enquiry on 30.01.15. Any feedback will be forwarded to DOC once received.	13.01.15
Nga Ruahine		Phone message left on 13.01.15. Message left with colleague on 19.01.15. Phone conversation on 20.01.15; she advised that Taranaki iwi have primary interest over the Operational Area and that therefore Taranaki Iwi would represent iwi opinion and if Nga Ruahine have any concerns they will raise them via Taranaki Iwi. However asked that Todd Energy keep Nga Ruahine in the loop so they can support their neighbouring iwi.	13.01.15
Department of Conservation Taranaki		6.1.15 Phone call , to notify of Trestles survey and to advise him of my earlier discussi TRC. works wit during the MMIA review, so will be kept part of the loop through DOC. He stressed the importance of early engagement with Iwi and I informed that we were working with STOS to coordinate timing of engagement. Notification of STOS survey postponement should occur before notification of Trestles.	15.01.15
Department of Conservation Head Office		6.1.15 Phone call followed up with a letter of notification (amendment to STOS earlier notification), and array parameters. to advise re STLM requirements. Also confirmed that Sunset Survey will not proceed this summer. 7.1.15 Email correspondence whereby DOC confirmed that they will require the STLM to be re-run for the new array. 13.01.15 phone call and email correspondence re timing of submission of the MMMP - ideally on Friday 16th with MMIA, but a few days late would be ok. Also discussed consultation timeframe and have consent to not rush this through for the 16th submission date. Draft MMIA was submitted on 16.01.15, comments received on 29.01.15. Final draft resubmitted with revisions on 30.01.15.	na
Taranaki Regional Council		6.1.15 Phone call , confirmed that seismic is permitted activity under RCP and that they have no problems with the survey as long as DOC is happy.	15.01.15
Environmental Protection Authority		6.1.15 Phone call Advised that once details are confirmed the EPA will send through a formal request for weekly survey reports. They also asked about the Sunset survey and were informed that it will not proceed this summer. 7.1.15 Email correspondence inviting to tour the MV Polar Duke on 21 January to conduct audit	7.1.15
Deepwater Group		Email requesting coordinates of the Operational Area was received on 13.01.15. Coordinates provided. A further email was received on 26.01.15 stating that the jack mackerel fleet will be operating in the area of the Trestles survey. DWG requested that Todd provide as much warning as possible about their activities to a number of listed affected fishing vessel operators. Subsequently, Todd has committed to provide affected parties with information about the radio frequencies that the MV Polar Duke will use during the survey; and also will ensure that the skipper of the MV Polar Duke will liaise frequently with affected parties during the survey. Confirmation was received on 27.01.15 that this approach sufficiently allayed the concerns of the DWG	13.01.15

Southern Inshore Fisheries			No feedback received to date	13.01.15
Cape Egmont Boat Club			No feedback received to date	13.01.15
Egmont Seafoods			No feedback received to date	13.01.15
Taranaki Commercial Fishing Federation			Email received on 13.01.15 stating that 'this survey will have no impact on myself or the Taranaki fishermen'	13.01.15
NZ Federation of Commercial Fishermen			No feedback received to date	13.01.15
Taranaki Recreational Fishing Council			No feedback received to date	13.01.15
Port Taranaki + harbour master	Chief Executive Harbour Master Manager Offshore Contracts (Oil & Gas) Commercial Manager		Email received on 16.01.15 stating that 'As far as Port Taranaki is concerned there will be no impact upon the Port and therefore no concerns raised from our end'	13.01.15
Massey University			No feedback received to date	13.01.15
Auckland University			No feedback received to date	13.01.15
University of Otago			Email received on 13.01.15 stating that 1) has reservations about the protection that the DOC Code of Conduct affords to marine mammals; 2) thinks MMO data sets are biased towards tolerant species; 3) disagrees that the survey has been planned to avoid effects on marine mammal sanctuary, as the only way to avoid effects is not to survey here; 4) implies a lack of knowledge on cetacean distribution in the area; 5) suggests that the industry should be conducting robust research to detect effects of seismic on marine mammals; 6) Does not want the industry to use consultation as a means of association with the University particularly with regard to any potential reputational advantage that association would confer to the industry. Response email sent on 14.01.15 thanking for feedback and informing him that Todd is investigating moored hydrophones in MMS.	13.01.15

REM Resource and Environmental Management Ltd

TODD ENERGY

Todd Energy

Trestles 3D Marine Seismic Survey, Taranaki Basin
Information Sheet

Resource and Environmental Management Limited (REM) has been engaged by Todd Energy to conduct a Marine Mammal Impact Assessment for a 3D Marine Seismic Survey in the Taranaki Basin. The 388 km^2 Trestles 3D Seismic Survey will be located approximately 8 km west of Cape Egmont (Figure 1) within Petroleum Exploration Permit (PEP) 53374. The objective of the survey is to obtain 3D seismic data to assess the potential hydrocarbon prospectivity within the survey area. The proposed survey is to commence in mid-February 2015 and is likely to run for 3 to 4 weeks in total.

Todd Energy intends to undertake the survey with a dedicated seismic survey vessel (the *MV Polar Duke*), which will tow 12 streamers that extend 7 km behind the vessel. The streamers will have an overall spread of 1100 m. The streamers have hydrophones positioned along them to record the reflected signal from the acoustic sources that are located immediately behind the vessel. Tail buoys (with lights and radar reflectors) will mark the end of each streamer.

During the survey, the vessel will be travelling at a relatively slow speed (4 – 5 knots) and will have limited manoeuvrability on account of the extent of towed gear. One or more support vessels will be used to scout the survey area for navigational hazards and to inform other marine users of the oncoming seismic survey vessel.

Todd Energy will operate to the requirements of a Level 1 seismic survey as defined by the Department of Conservations '2013 Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations'. Compliance with the mitigation measures prescribed in the Code of Conduct will provide protection to marine mammals which may be in the area at the time of the survey. These mitigation measures include: the presence of independent marine mammal observers onboard the seismic survey vessel, a period of pre-start observations for marine mammals before activating the acoustic source in a graduated manner (soft-start), and shutting down the acoustic source if marine mammals approach during operations. DOC approval of the Marine Mammal Impact Assessment is required before the survey can proceed.

Please contact Helen McConnell at REM or Hamish McHaffie at Todd Energy if you have any questions.

Helen McConnell
Environmental Consultant
REM Ltd

Hamish McHaffie
Community Relations Manager
Todd Energy

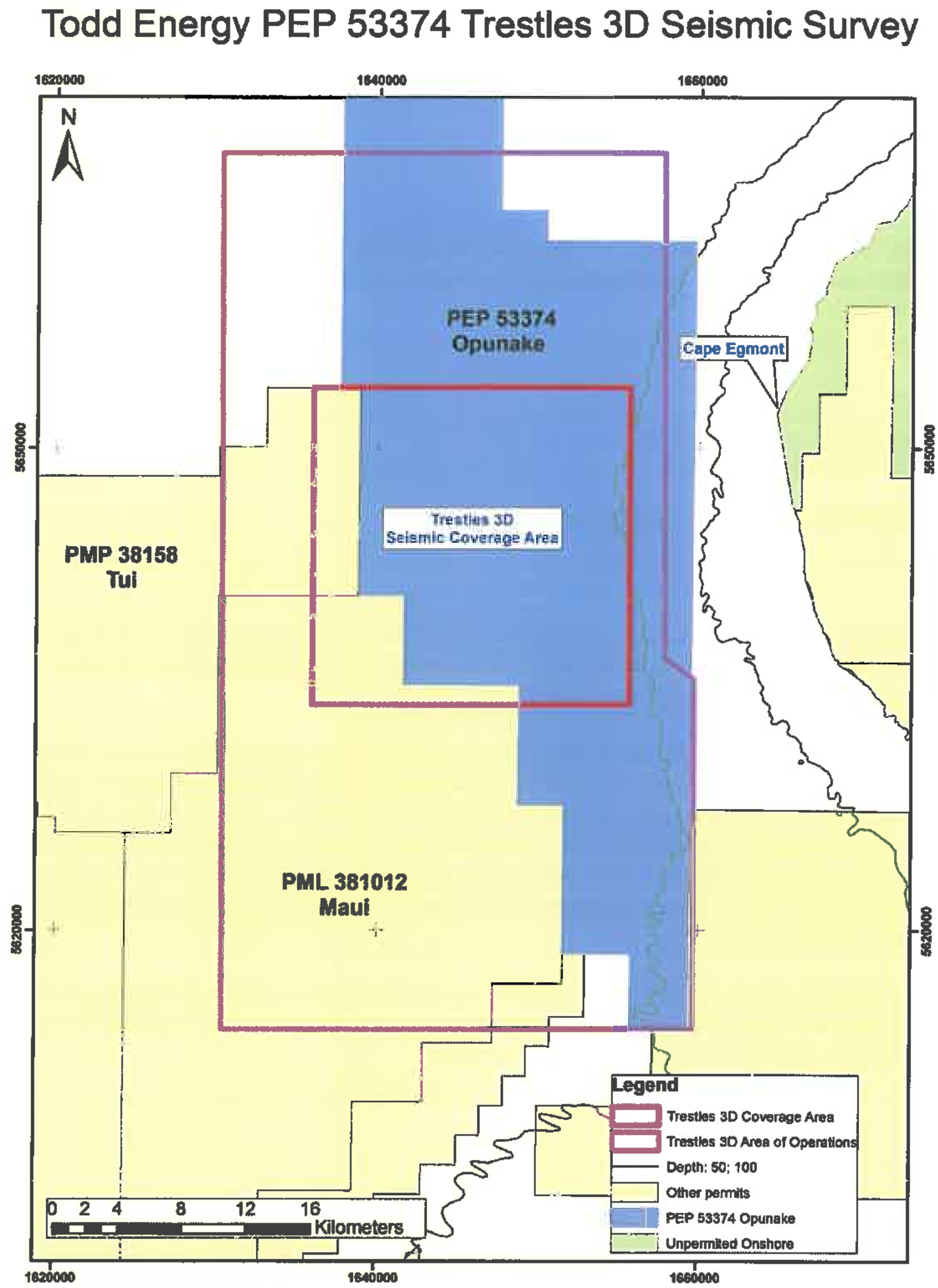

Figure 1: Trestles 3D Seismic Survey Area

Helen McConnell

From:
Sent: Friday, 23 January 2015 2:40 p.m.
To: 'Helen McConnell'
Subject: RE: Proposed Trestles 3D Marine Seismic Survey

Kia Ora Helen

Thank you for the information. We have our monthly Taranaki Iwi Trust hui next Monday 26th January and this is on our agenda for discussion. I will be in touch and provide you with some feedback on the proposed Trestles 3D Marine Seismic Survey.

Nga Mihi

From: Helen McConnell [
Sent: Friday, 23 January 2015 2:22 p.m.
To:
Subject: Proposed Trestles 3D Marine Seismic Survey

Tena koe

I have been engaged by Todd Energy Limited to prepare a Marine Mammal Impact Assessment for a proposed marine seismic survey 'the Trestles 3D Seismic Survey' off Cape Egmont in Taranaki waters. The proposed survey is due to commence on about the 20th of February 2015.

The attached information sheet is designed to inform you of the upcoming survey details and to provide additional background information about mitigations that will be implemented during the survey to minimise environmental impacts; particularly, any potential impacts on marine mammals. The primary mitigation measure that will be used throughout the survey will be compliance with the Department of Conservation's 'Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations'. Please note that the survey has been carefully planned in order to reduce acoustic impacts in the West Coast North Island Marine Mammal Sanctuary and in shallow coastal waters.

Todd Energy would like to invite your feedback on their proposed operations and would be happy to discuss any concerns or questions you may have. Feedback and discussion is welcome at any time, however if I could receive any feedback as soon as possible it would be most appreciated.

Kind regards,
Helen

Resource and Environmental Management Limited

Helen McConnell **BSc (Zoology), MSc (Marine Science)**
Marine Ecologist

Helen McConnell

From: Helen McConnell
Sent: Wednesday, 14 January 2015 8:29 a.m.
To:
Cc:
Subject: RE: Proposed Trestles 3D Marine Seismic Survey

Hi

Thanks for your response. I appreciate your feedback and will pass it on to Todd Energy. I'll also ensure that your feedback is included in the Marine Mammal Impact Assessment process which requires all consultation communications to be provided to DOC.

You may also be interested to hear that Todd Energy is investigating the use of moored hydrophones in the southern portion of the Marine Mammal Sanctuary to ground-truth their Sound Transmission Loss Modelling and to better quantify the received sound levels from the survey in the protected area.

Kind regards,
Helen

Resource and Environmental Management Limited

Helen McConnell BSc (Zoology), MSc (Marine Science)
Marine Ecologist

Sent: Tuesday, 13 January 2015 3:20 p.m.
To: Helen McConnell
Subject: Re: Proposed Trestles 3D Marine Seismic Survey

Hi Helen,

Thanks for this. I fully understand that you are highly constrained. But here's what I think.

On 13/01/2015, at 12:13 pm, Helen McConnell <helen@remltd.co.nz> wrote:

I have been engaged by Todd Energy Limited to prepare a Marine Mammal Impact Assessment for a proposed marine seismic survey 'the Trestles 3D Seismic Survey' off Cape Egmont in Taranaki waters. The proposed survey is due to commence on about the 20th of February 2015.

The attached information sheet is designed to inform you of the upcoming survey details and to provide additional background information about mitigations that will be implemented during the survey to minimise environmental impacts; particularly, any potential impacts on marine mammals. The primary mitigation measure that will be used throughout the survey will be compliance with the Department of Conservation's 'Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations'.

Frankly, I'm not convinced that following the DOC code is very useful. I don't think it provides effective protection. And, because the highly sensitive animals will have reacted well before they could be seen by observers on the seismic vessels, the data produced are potentially highly misleading. Observers are likely to see only the reasonably tolerant species. Collecting observations from them creates a highly biased dataset - suggesting much higher tolerance than would likely be the case if the observers were not on the vessel causing the disturbance.

Further, following the DOC code gives the impression that the industry is doing something meaningful to minimise its effects. I do not think that this is an accurate impression.

> Please note that the survey has been carefully planned in order to reduce acoustic impacts in the West Coast North Island Marine Mammal Sanctuary and in shallow coastal waters.

With all respect (and a good deal of affection), I don't believe that is true. If the industry really cared about it they would not survey in areas with sensitive or endangered marine mammals, and would actively promote research to study cetacean distributions. It's not like they can't afford it.

> The Trestles 3D survey was initially included as part of the Shell Todd Oil Services Maui 3D/4D survey which I contacted you about in late-November 2014. However, the Maui 3D/4D survey will no longer be going ahead this summer, and instead Todd Energy will be independently conducting only the Trestles component of this original survey.

If the industry was remotely serious about quantifying impacts on marine mammals, it would facilitate research that has a decent chance of detecting effects. To my way of thinking, that means robust before and after surveys, and moored acoustic recorders in place well before the survey, during and after.

Personally, I will not participate in any research on this issue unless there is decent statistical power to detect effects. Lack of clear differences will likely be used by the industry to argue that effects are minor at worst. As you know, statistically and logically this is unjustifiable. Also, if I got involved, the industry is likely to publicise that they are "working closely with Otago University experts to minimise impacts". I will not let my good reputation be used to improve their bad one, unless there is a real chance of change.

Cheers,

Professor
Dept of Marine Science

University of Otago

Helen McConnell

From:
Sent: Thursday, 8 January 2015 9:35 a.m.
To:
Cc:
Subject: RE: Todd Energy proposed seismic surveys

Hi

Ok – sounds like you're all sorted for a check on the CoC compliance on the vessel so I'm happy to leave you in Woodside's hands for that. I'll look out for you when the vessel is in port though, in case we cross paths.

NZP&M are aware of our intentions with PEP 54865.

Cheers

TODD
ENERGY

Rick Henderson
Senior Geophysicist

www.toddenergy.co.nz
I 15, 95 Customhouse Quay| PO Box 3141|Wellington 6140 New Zealand

---

Sent: Thursday, 8 January 2015 8:49 a.m.

Subject: RE: Todd Energy proposed seismic surveys

Thanks for the email. called me the other day and gave me a run-down on your plans. I understand that your other survey ('Sunset') has been postponed until next season? Have you spoken with NZP&M about the change in plans?

Thank you for extending the invitation to join your party for a tour of the vessel. At this stage, the EPA (myself and my manager) is already planning on visiting Polar Duke on 23 January. According to the advice we received from Woodside (earlier this week), the vessel is arriving in port late 21st/early 22nd. Late last year we notified Woodside of our intention to do a short inspection on board (with respect to the Seismic Code of Conduct), and given the current timeline has suggested that the 23rd would be the best day, just prior to their departure from port. We've booked flights but of course will be flexible around the changing schedule of the vessel. It would be great of our visits could coincide, but let's just see how that one plays out.

Stay in touch.

Regards,

Senior Advisor, EEZ Enforcement & Compliance

Sent: Wednesday, 7 January, 2015 9:52 AM

Subject: RE: Todd Energy proposed seismic surveys

Happy New Year. Thanks to recent developments, Todd will be acquiring a standalone 3D seismic survey in PEP 53374 instead of one combined with the Maui 3D/4D survey that the Maui JV were planning on acquiring – I at REM may have alerted you to this already, however in case she hasn't, please refer to the attached information sheet for details.

The vessel we intend to use is the Dolphin Polar Duke, which will be also working for Woodside this summer. It is unlikely that it will make a port call immediately prior to our survey start as it will steam directly from Woodside's Taranaki survey to our area, however it is apparently making a port call in New Plymouth on about 21 January for gyro calibration. I have asked Dolphin's sales manager if a small party could take a tour of the ship and if this is possible, you would be welcome to come along as our guest, assuming you are available. I will let you know if this likely to be possible when I hear back from Dolphin.

Cheers

TODD
ENERGY

Rick Henderson
Senior Geophysicist

www.toddenergy.co.nz
|15-55 Customhouse Quay PO Box 3141|Wellington 6140 New Zealand

---

Sent: Tuesday, 25 November 2014 4:22 p.m.

Subject: Todd Energy proposed seismic surveys

I was given your contact details by Department of Conservation. I understand that Todd Energy will be undertaking some 3D seismic surveys in the Taranaki region.

As you may be aware, the Environmental Protection Authority plays a regulatory role in offshore activities within the EEZ (12 – 200 n.mi.). Under the EEZ Permitted Activities Regulations, seismic surveying is a permitted activity provided the survey complies with the 2013 DOC Code of Conduct for seismic surveys; EPA therefore works closely with DOC to provide compliance oversight of seismic surveys. The EPA is expecting a very busy seismic season coming up, and as such we are in the process of finalising our seismic survey monitoring plans, which will combine desktop monitoring with some vessel-based inspections (while the vessel is in port).

As such, I thought it would be useful for us to establish contact, and hopefully you may be able to provide us with some planning updates as and when these become available, so we can better plan our monitoring activities around your schedule. For example, we may wish to carry out a short, 2 – 3 hour inspection on the vessel during a port call.

The EPA is a relatively new player in the area of seismic surveying, so you may have some questions about our role and how we interact with DOC. I'm happy to discuss this with you over the phone, or in person if you are based in Wellington, or passing through. You can also find some useful information on the EPA website.

If there is someone else in Todd Energy better placed to deal with this, please feel free to forward this directly, or send alternative contact details through to me. I look forward to hearing from you.

Kind regards

Senior Advisor, EEZ Enforcement & Compliance
ENFORCEMENT & COMPLIANCE

Helen McConnell

From:
Sent: Wednesday, 14 January 2015 8:26 a.m.
To:
Cc:
Subject: RE: Proposed Trestles 3D Marine Seismic Survey

I have converted the coordinates into WGS84 lat/long below.

39° 08' 00.223" S	173° 21' 02.192" E
39° 07' 54.612" S	173° 40' 04.885" E
39° 24' 51.067" S	173° 40' 15.441" E
39° 25' 33.917" S	173° 41' 30.771" E
39° 37' 18.572" S	173° 41' 38.250" E
39° 37' 24.534" S	173° 21' 12.366" E

Let me know if there is anything else you need.

Cheers,

Sent: Wednesday, 14 January 2015 8:17 a.m.

Subject: FW: Proposed Trestles 3D Marine Seismic Survey

Could you please convert these coordinates and send back to Richard.

Thanks,

Sent: Tuesday, 13 January 2015 8:41 p.m.

Subject: RE: Proposed Trestles 3D Marine Seismic Survey

Really need in lat and long please

Regards,

Sent: Tuesday, 13 January 2015 2:51 p.m.

Subject: RE: Proposed Trestles 3D Marine Seismic Survey

Happy New Year! I hope you had a nice holiday.

The NZTM coordinates for the Trestles Operational Area are:

1630302.79	5668361.7
1657738.10	5668380.75
1657759.25	5637044.45
1659550.46	5635709.87
1659561.83	5613985.04
1630334.19	5613971.62

Let me know if you need them in a different format.

Kind regards,

Sent: Tuesday, 13 January 2015 1:12 p.m.

Subject: RE: Proposed Trestles 3D Marine Seismic Survey

Hi

Age old question....can you please provide the co-ordinates of the outer corners of the area?

Thanks

Regards,

deepwater group

Deepwater Group Ltd

W www.deepwatergroup.org

This email is intended solely for the use of the addressee and may contain information that is confidential or subject to legal professional privilege. If you are an unintended recipient of this email please immediately notify the sender and delete the email.

Sent: Tuesday, 13 January 2015 12:11 p.m.

Subject: Proposed Trestles 3D Marine Seismic Survey

Good afternoon

I have been engaged by Todd Energy Limited to prepare a Marine Mammal Impact Assessment for a proposed marine seismic survey 'the Trestles 3D Seismic Survey' off Cape Egmont in Taranaki waters. The proposed survey is due to commence on about the 20th of February 2015.

The attached information sheet is designed to inform you of the upcoming survey details and to provide additional background information about mitigations that will be implemented during the survey to minimise environmental impacts; particularly, any potential impacts on marine mammals. The primary mitigation measure that will be used throughout the survey will be compliance with the Department of Conservation's 'Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations'. Please note that the survey has been carefully planned in order to reduce acoustic impacts in the West Coast North Island Marine Mammal Sanctuary and in shallow coastal waters.

Todd Energy would like to invite your feedback on their proposed operations and would be happy to discuss any concerns or questions you may have. Feedback and discussion is welcome at any time, however responses by Friday the 23rd of January would be appreciated where possible.

Kind regards,

Resource and Environmental Management Limited

Helen McConnell BSc (Zoology), MSc (Marine Science)

Marine Ecologist

Helen McConnell

From:
Sent: Tuesday, 27 January 2015 7:39 a.m.
To:
Subject: RE: Proposed Trestles 3D Marine Seismic Survey

Yes thx

Regards,

Sent: Monday, 26 January 2015 4:56 p.m.

Subject: RE: Proposed Trestles 3D Marine Seismic Survey

Thanks for your message.

I've discussed your request with Todd Energy who have offered to provide you with further information regarding the radio frequencies that the seismic survey vessel (*MV Polar Duke*) will be using during the survey. They will also ask the seismic vessel to liaise with the JMA operators throughout the survey. As usual a Notice to Mariners will also be broadcast via the RCCNZ.

Will these actions sufficiently allay your concerns?

Kind regards,

F
Sent: Monday, 26 January 2015 1:12 p.m.

Subject: RE: Proposed Trestles 3D Marine Seismic Survey

There will be JMA fishing operations in the region in the time period proposed.

The vessel operator needs to be aware of that and provide as much advance warning regarding their activities as possible.

Affected operators are listed in the CC to this email.

I have added co-ords below again for their benefit:

I have converted the coordinates into WGS84 lat/long below.

39° 08' 00.223" S	173 ° 21' 02.192" E
39° 07' 54.612" S	173 ° 40' 04.885" E
39° 24' 51.067" S	173 ° 40' 15.441" E
39° 25' 33.917" S	173 ° 41' 30.771" E
39° 37' 18.572" S	173 ° 41' 38.250" E
39° 37' 24.534" S	173 ° 21' 12.366" E

Regards,

Fisheries Specialist

Deepwater Group Ltd

W www.deepwatergroup.org

Sent: Tuesdav. 13 January 2015 12:11 p.m.

Subject: Proposed Trestles 3D Marine Seismic Survey

Good afternoo

I have been engaged by Todd Energy Limited to prepare a Marine Mammal Impact Assessment for a proposed marine seismic survey 'the Trestles 3D Seismic Survey' off Cape Egmont in Taranaki waters. The proposed survey is due to commence on about the 20th of February 2015.

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Kind regards,

Resource and Environmental Management Limited

Helen McConnell **BSc (Zoology), MSc (Marine Science)**
Marine Ecologist

Helen McConnell

From:
Sent: Friday, 16 January 2015 9:04 a.m.
To:
Cc:
Subject: RE: Proposed Trestles 3D Marine Seismic Survey

As far as Port Taranaki is concerned there will be no impact upon the Port and therefore no concerns raised from our end.

Kind Regards

Offshore Manager/Executive Pilot
Port Taranaki Limited

www.porttaranaki.co.nz

F

Sent: Tuesday, 13 January 2015 12:13 p.m.

Good afternoon,

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Todd Energy would like to invite your feedback on their proposed operations and would be happy to discuss any concerns or questions you may have. Feedback and discussion is welcome at any time, however responses by Friday the 23rd of January would be appreciated where possible.

Kind regards,

REM Resource and Environmental Management Limited

Helen McConnell BSc (Zoology), MSc (Marine Science)
Marine Ecologist

Helen McConnell

From:
Sent: Tuesday, 13 January 2015 4:04 p.m.
To:
Subject: RE: Proposed Trestles 3D Marine Seismic Survey

Many thanks for your response. It's certainly good to receive your feedback.

Kind regards,

Sent: Tuesday, 13 January 2015 3:36 p.m.

Subject: Re: Proposed Trestles 3D Marine Seismic Survey

Hello

Thanks for your information. This will have no impact on myself or the Taranaki fishermen

Regards

Compass Rose Fishing Ltd.

On Tuesday, 13 January 2015 12:11 PM, Helen McConnell <helen@remltd.co.nz> wrote:

Good afternoon

I have been engaged by Todd Energy Limited to prepare a Marine Mammal Impact Assessment for a proposed marine seismic survey 'the Trestles 3D Seismic Survey' off Cape Egmont in Taranaki waters. The proposed survey is due to commence on about the 20th of February 2015.

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Todd Energy would like to invite your feedback on their proposed operations and would be happy to discuss any concerns or questions you may have. Feedback and discussion is welcome at any time, however responses by Friday the 23rd of January would be appreciated where possible.

Kind regards,

REM Resource and Environmental Management Limited

Helen McConnell **BSc (Zoology), MSc (Marine Science)**
Marine Ecologist

APPENDIX 2

Specifications for 3D Seismic Survey Vessel

Polar Duke
Overview

Polar Duke

Dolphin has the newest and most powerful fleet in the industry today.

The Dolphin high capacity vessels deliver ultra-wide tow, deep tow and long offset configurations ideal for today's frontier exploration needs, with full configuration flexibility to service any 2D, 3D and 4D requirements. Dolphin is also able to offer same fleet advantage for undershoot and multi-vessel operations.

Highest levels of operational performance and production since the launch of each vessel, proving the design of the vessels and the experience of the seismic crews.

Industry standard equipment and dedication to the highest levels of QHSE and now Dolphin is fully ISO 9001:2008 certified. Dolphin is now pre-qualified with most E&P companies and has already worked in most of the major exploration provinces across the world.

Built	2010
Seismic Configuration	Max 12 x 10000m
Bollard Pull	Approx. 210 Tonnes

Superior high capacity vessel with class-leading bollard pull and preferred client choice for large scale and frontier exploration 3D surveys.

General	Polar Duke
Owner / Manager	GC Rieber
Port of Registry	Limassol
Flag	Cyprus
IMO Number	9378204
Classification	DNV
Built	2010
Fuel Capacity	1820 cu.m
Length	106.8m
Beam	19.2m at waterline/22m Max
Draft	6.5m
Gross Tonnage	7689 tons
Total Propulsion	2 x 7100kW
Azimuth Thruster	1 x Rolls Royce - UL 2001 CP - 2100kW
Cruising Speed	17 knots
Berths	60 bunks
Helideck	Up to S92
Bollard Pull	Approx. 210 Tonnes

Communications

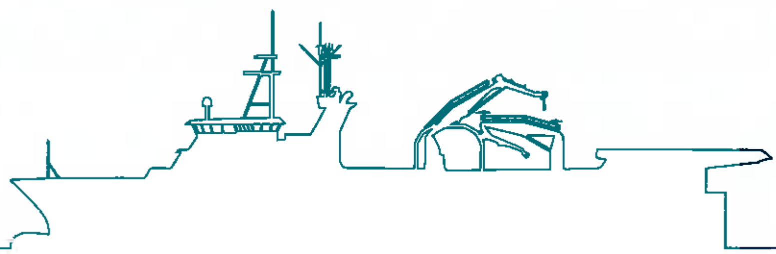
Primary	VSAT
Auto Pilot	Navitron NT999G
Communications	GMDSS JRC

Seismic Source

Airguns	Bolt LL up to 10,000 cu. in @2000 psi
Gun Control System	Seamap Gunlink 4000
Compressors	3 x LMF 1695 SCFM
Operating Pressure	2000 psi

Seismic System

Streamer Type	Sercel Sentinel
Seismic Cable Configurations	Max 12 x 10000m
Navigation System	Orca
Streamer Positioning & Steering	Nautilus



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#06-06 North Wing
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E: info@dolphingeo.com

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Dolphin Geofisica do Brasil Ltda
Av. Nilo Pecanha, 50 / Suite 1309
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Brockbourne House,
77 Mount Ephraim,
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TN4 8GN, UK
T: +44 (0) 1892 701000
E: info@dolphingeo.com

APPENDIX 3

Passive Acoustic Monitoring Specifications

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

Seiche Measurements LLC
10801 Hammerly Boulevard
Suite 114, Houston
Texas TX77043
USA
Cell: +1 (713) 201 5726
Fax: +1 (713) 984 9628
Email: bpadovani@seiche.eu.com
Web: www.seiche.eu.com

11 November 2014

250m Array System and 230m tow with 20m detachable array System Specifications

Commercial in Confidence

Contents

1)Towed PAM

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.

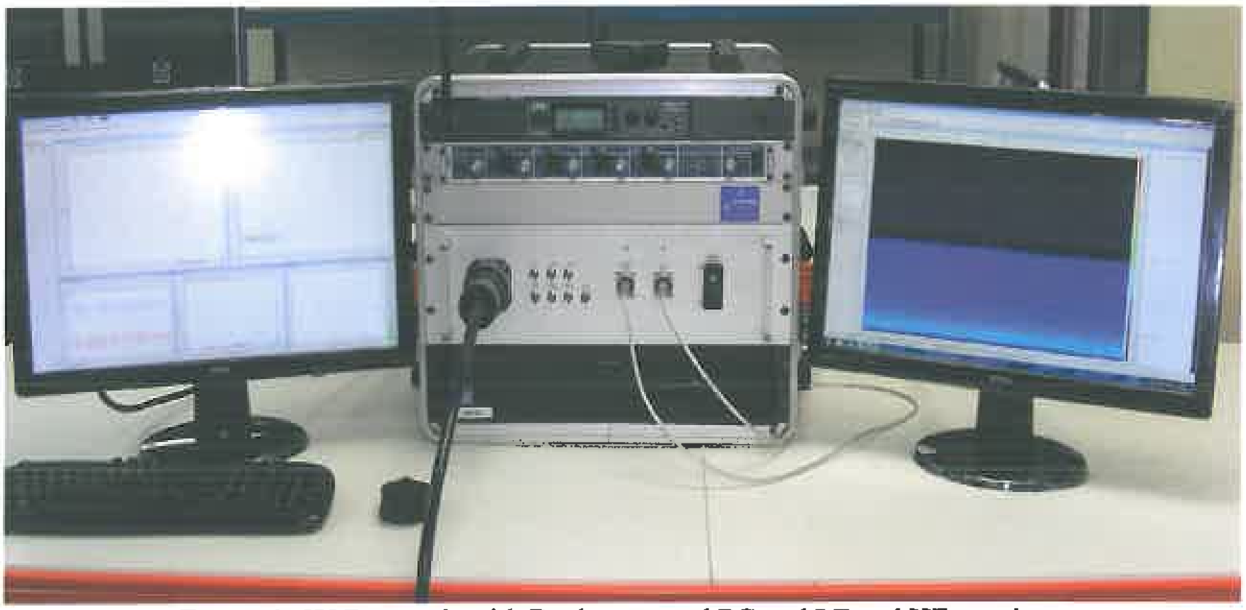


Figure 1: 8U Base unit with Rack-mounted PC and LF and HF monitors

Remote Monitoring Station

Figure 2: Remote station on bridge and set up screen for Rack mounted base unit

The remote monitoring station enables the base unit to be rack-mounted with other ship based computer equipment and by using the ships internal ethernet system, link to screens in an alternative location on the vessel.

Electronics Monitoring Base Unit

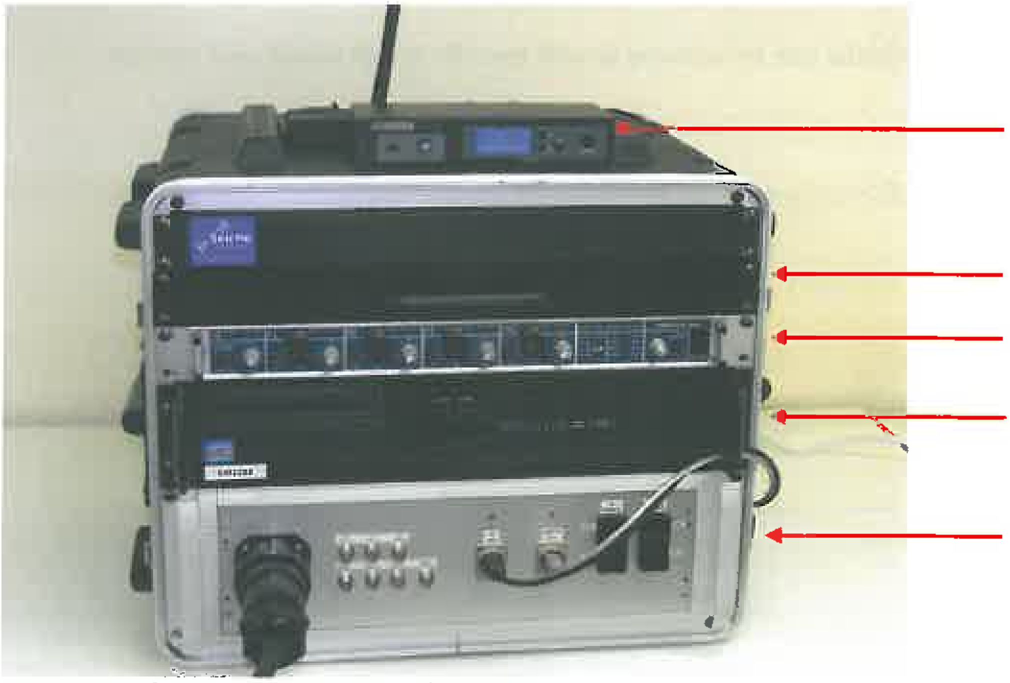


Figure 3: Electronics monitoring base unit

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.

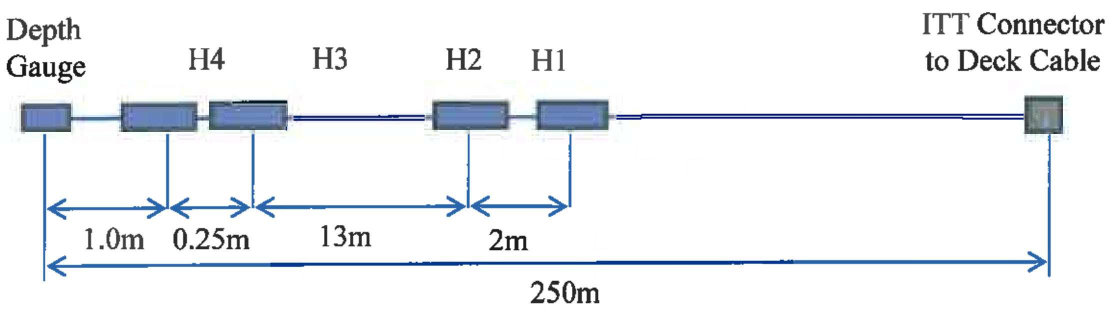
Rack-mounted PC
The rack-mounted PC system has an Intel quad core i5 processor with 8 GB of RAM. This custom built PC system has enough power to run both high and low frequency audio data through Pamguard simultaneously from up to 4 hydrophones.

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

Note that frequency bandwidths can be tailored to suit specific applications and country requirements.

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

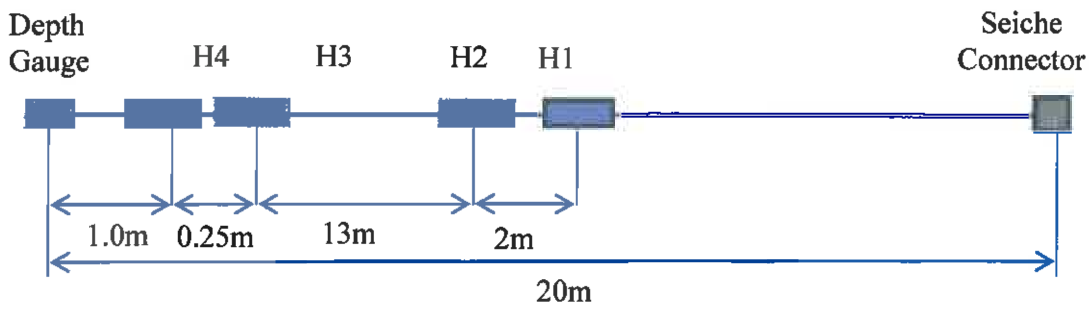
Hydrophone elements

H1	Broadband	10 Hz to 200 kHz (3dB points)
H2	Broadband	10 Hz to 200 kHz (3dB points)
H3	Wideband	2 kHz to 200 kHz (3dB points)
H4	Wideband	2 kHz to 200 kHz (3dB points)

Spacing H1 - H2 (HF detection)	2.00m	1.28mSecs
Spacing H2 - H3 (HF detection)	13.00m	8.32mSecs
Spacing H3 - H4 (LF detection)	0.25m	0.16mSecs

20m Towed array

The sensor array comprises a 20m detachable array section with a 230m heavy tow cable. The connectors are designed in house and are fully waterproof. Longer array sections can be provided to improve detections of low frequency vocalising marine mammals.



Mechanical Information

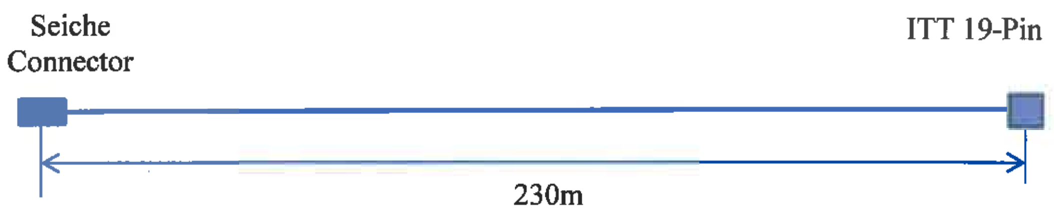
Length:	20m
Depth Rating:	100m (not connector)
Diameter:	14mm over cable, 32mm over mouldings, 45mm over connectors
Weight:	60kg
Connector:	Seiche
BS	500 kg

Hydrophone elements

H1	Broadband	10 Hz to 200 kHz (3dB points)
H2	Broadband	10 Hz to 200 kHz (3dB points)
H3	Wideband	2 kHz to 200 kHz (3dB points)
H4	Wideband	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

230m Tow cable

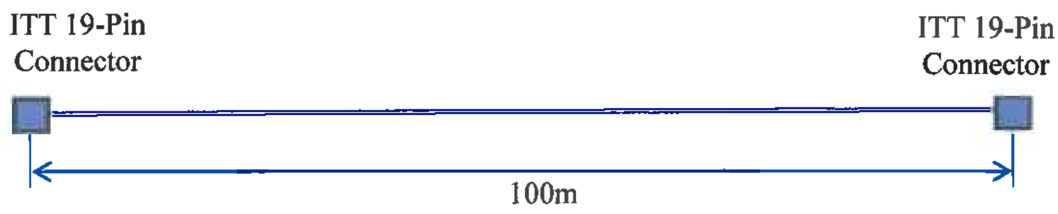


Mechanical Information

Length	230m	
Diameter	17mm over cable	
Connector	Seiche 36-pin	45mm over connectors
	ITT 19-pin	65mm over connectors
Weight	95 kg	
BS	960 kg	

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

2)System Sensitivity

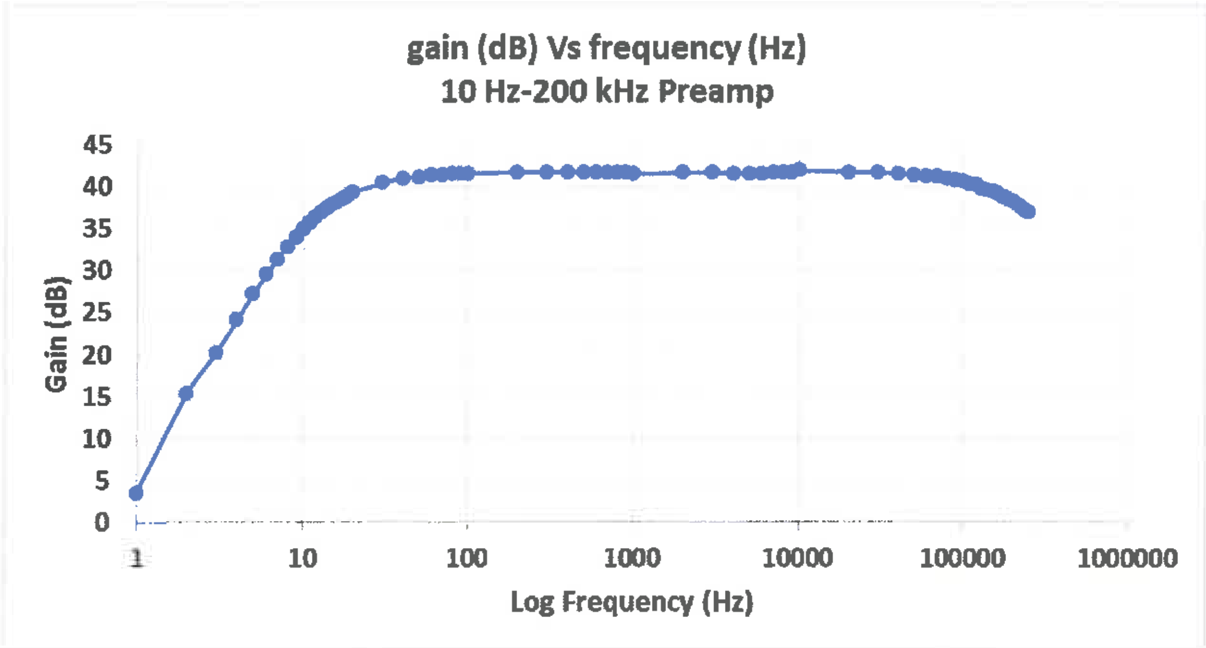


Figure 4: Hydrophone Sensitivity

The array sections consist of four hydrophones.
Two are set with a bandwidth of 10 Hz to 200 kHz, per Figure 4 above, which demonstrates that the sensitivity of the hydrophone starts to roll off at 10 Hz, but remains sensitive down to 1 Hz where it will still register 4 dB

The second pair of hydrophones is set to a bandwidth of 2 kHz to 200 kHz sensitivity. This will ensure that if the lower frequency pair of hydrophones is saturated by vessel noise, the system will still be capable of detecting vocalising marine mammals.

APPENDIX 4

Summary of NZ Threat Classification System (Threatened Species)

Criteria for Threatened Taxa as described by the New Zealand Threat Classification System (following Townsend et al. 2008) and as applied to marine mammals (see Baker et al. 2010).

Classification		Criteria
Nationally Critical	A	**Very small population (natural or unnatural)** • There are fewer than 250 mature individuals; or • There are ≤ 2 sub-populations *and* ≤ 200 mature individuals in the largest sub-population; or • The total area of occupancy is ≤ 1 ha (0.01 km2).
	B	**Small population (natural or unnatural) with a high ongoing or predicted decline** • There is an ongoing or predicted decline of 50–70% in the total population due to existing threats, taken over the next 10 years or three generations, whichever is longer; and • The population comprises 250–1000 mature individuals; or • There are ≤ 5 sub-populations *and* ≤ 300 mature individuals in the largest sub-population; or • The total area of occupancy is ≤ 10 ha (0.1 km2).
	C	**Population (irrespective of size or number of sub-populations) with a very high ongoing or predicted decline (> 70%)** • A taxon is 'Nationally Critical' when the population has an ongoing trend or predicted decline of > 70% in the total population due to existing threats taken over the next 10 years or three generations, whichever is longer.
Nationally Endangered	A	**Small population (natural or unnatural) that has a low to high ongoing or predicted decline** • There is an ongoing or predicted decline of 10–50% in the total population due to existing threats, taken over the next 10 years or three generations, whichever is longer; and • The total population size is 250–1000 mature individuals; or • There are ≤ 5 sub-populations *and* ≤ 300 mature individuals in the largest sub-population; or • The total area of occupancy is ≤ 10 ha (0.1 km2).
	B	**Small stable population (unnatural)** • The population is stable (± 10%) and is predicted to remain stable over the next 10 years or three generations, whichever is longer; and • The total population size is 250–1000 mature individuals; or • There are ≤ 5 sub-populations *and* ≤ 300 mature individuals in the largest sub-population; or • The total area of occupancy is ≤ 10 ha (0.1 km2).
	C	**Moderate population and high ongoing or predicted decline** • There is an ongoing or predicted decline of 50–70% in the total population due to existing threats, taken over the next 10 years or three generations, whichever is longer; and • The total population size is 1000–5000 mature individuals; or • There are ≤ 15 sub-populations *and* ≤ 500 mature individuals in the largest sub-population; or • The total area of occupancy is ≤ 100 ha (1 km2).

Nationally Vulnerable	A	**Small, increasing population (unnatural)** The population is increasing (> 10%) and is predicted to continue to increase over the next 10 years or three generations, whichever is longer; and The total population size is 250–1000 mature individuals; or There are ≤ 5 sub-populations *and* ≤ 300 mature individuals in the largest sub-population; or The total area of occupancy is ≤ 10 ha (0.1 km2).
	B	**Moderate, stable population (unnatural)** • The population is stable (± 10%) and is predicted to remain stable over the next 10 years or three generations, whichever is longer; and • The total population size is 1000–5000 mature individuals; or • There are ≤ 15 sub-populations *and* ≤ 500 mature individuals in the largest sub-population; or • The total area of occupancy is ≤ 100 ha (1 km2).
	C	**Moderate population, with population trend that is declining** • There is an ongoing or predicted decline of 10–50% in the total population due to existing threats, taken over the next 10 years or three generations, whichever is longer; and • The total population size is 1000–5000 mature individuals; or • There are ≤ 15 sub-populations *and* ≤ 500 mature individuals in the largest sub-population; or • The total area of occupancy is ≤ 100 ha (1 km2).
	D	**Moderate to large population and moderate to high ongoing or predicted decline** • There is an ongoing or predicted decline of 30–70% in the total population due to existing threats, taken over the next 10 years or three generations, whichever is longer; and • The total population size is 5000–20 000 mature individuals; or • There are ≤ 15 sub-populations *and* ≤ 1000 mature individuals in the largest sub-population; or • The total area of occupancy is ≤ 1000 ha (10 km2).
	E	**Large population and high ongoing or predicted decline** • There is an ongoing or predicted decline of 50–70% in the total population or area of occupancy due to existing threats, taken over the next 10 years or three generations, whichever is longer; and • The total population size is 20 000–100 000 mature individuals; or • The total area of occupancy is ≤ 10 000 ha (100 km2).

APPENDIX 5

Sound Transmission Loss Modelling Results

Curtin University

Centre for Marine Science and Technology

Received underwater sound level modelling for the Trestles 3D seismic survey

Prepared for:

Todd Exploration Ltd

Prepared by: Marta Galindo-Romero and Alec Duncan

PROJECT CMST 1385
REPORT 2015-04

30th January 2015

Summary

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

Both short range and long range modelling were carried out. The modelling method used to produce the short range results accurately deals with both the horizontal and vertical directionality of the seismic source. The method used for computing the long range results only considers the horizontal directionality of the seismic source but accounts for water column and seabed variations in depth and range.

The modelled seismic source was a 3460 cubic-inch acoustic source at a depth of 7 m.

The short range modelling predicted that the maximum sound exposure levels would be below the Code of Conduct thresholds of 186 dB re 1 $\mu Pa^2.s$ at 200 m and 171 dB re 1 $\mu Pa^2.s$ at 1 and 1.5 km.

The long range modelling results were highly directional due to the combined effects of seismic source directionality and bathymetry. Levels showed high attenuation inshore of the source towards the east, and slow attenuation offshore. The maximum sound exposure level in the West Coast North Island Marine Mammal Sanctuary due to a source in the survey area was predicted to be 144.0 dB re 1 $\mu Pa^2.s$.

Contents

List of Figures

1 Introduction

This report describes acoustic propagation modelling which was carried out to predict the underwater sound levels that are likely to be produced by the Trestles 3D seismic survey which will be carried out in waters off Cape Egmont, New Zealand (see Figure 1). The aims of the modelling were to establish whether the survey will meet 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, and to predict the maximum sound exposure levels in the West Coast North Island Marine Mammal Sanctuary. 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.

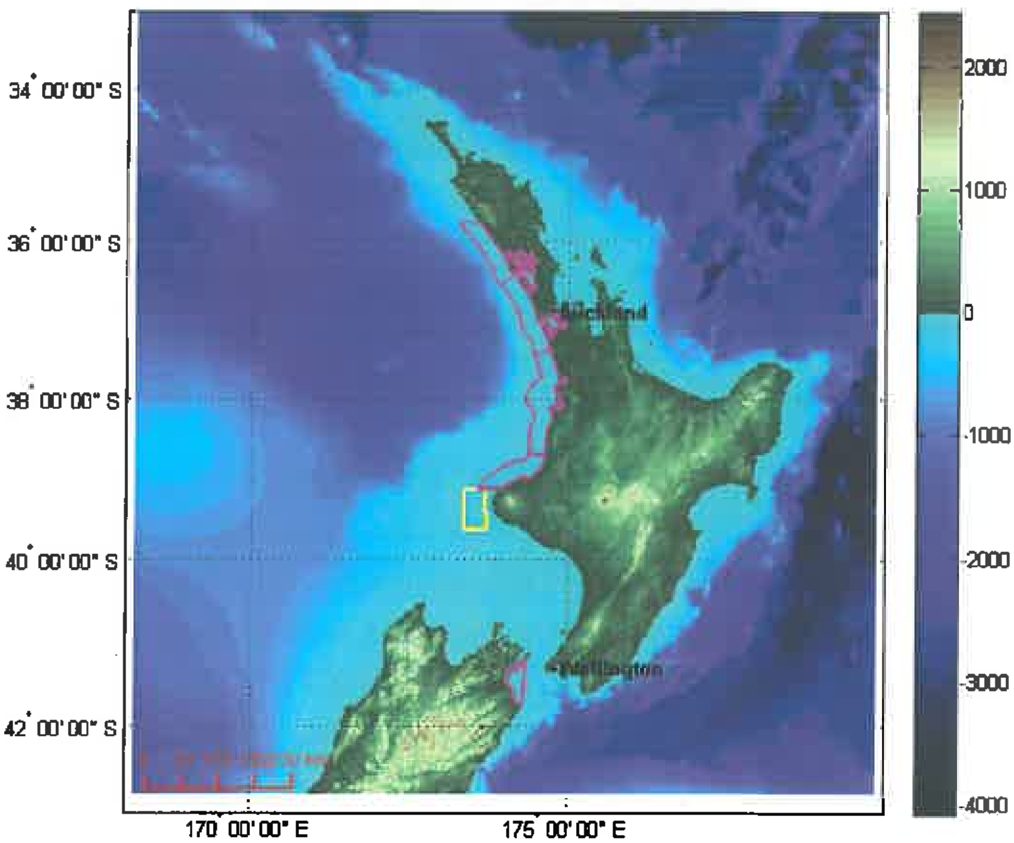


Figure 1. Map of the New Zealand's North Island showing the survey area. The yellow polygon represents the boundary of the operational area. The boundaries of the Marine Mammal Sanctuary are plotted in magenta.

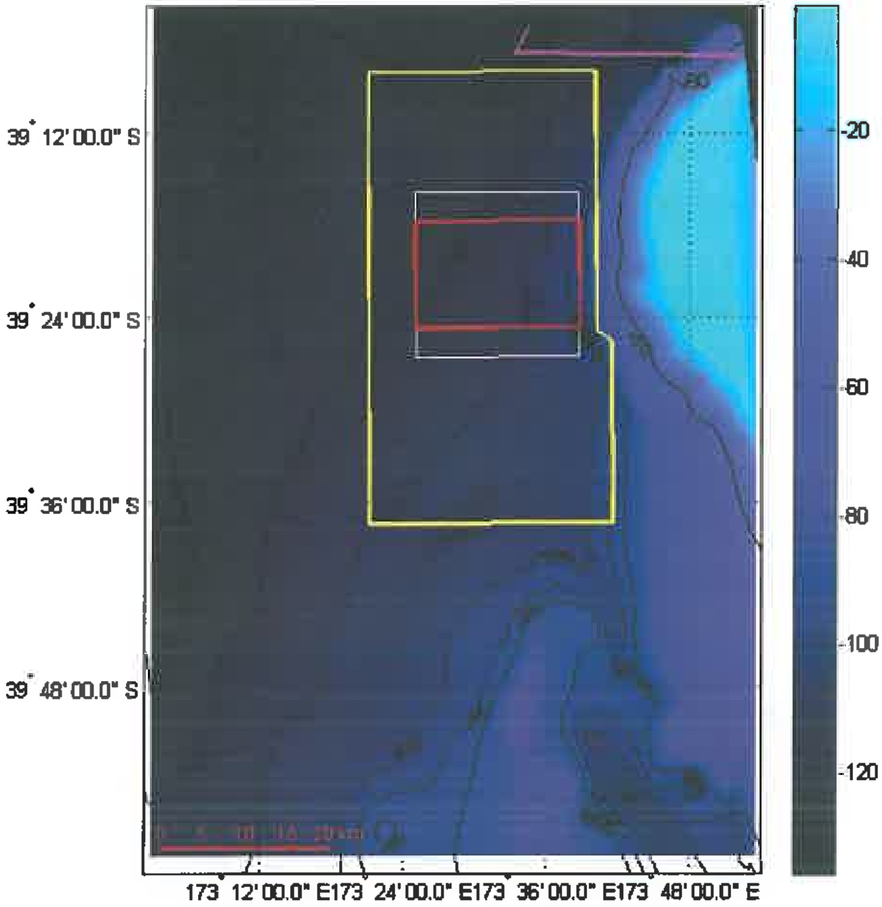


Figure 2. Map of the operational area. The white polygon is the boundary of the Trestles 3D Dolphin Fold Taper area (survey area), the red polygon is the Trestles 3D FF Dolphin Polar Duke area, and the yellow polygon is the Trestles 3D Area of Operations. The southern boundary of the North Island Marine Mammal Sanctuary area is plotted in magenta.

The general location of the survey operational area is displayed in Figure 1. The shaded bathymetry shown was obtained from the NIWA elevation and bathymetry grid (CANZ, 2008). Figure 2 shows a closer view of the area of interest. Here, the white polygon is the boundary of the Trestles 3D Dolphin Fold Taper area, in which the source could be operated at full power, the red polygon is the Trestles 3D FF Dolphin Polar Duke area, and the yellow polygon is the Trestles 3D Area of Operations. The southern boundary of the North Island Marine Mammal Sanctuary is also plotted in magenta. The bathymetry data shown in Figure 2 was provided by Shell Todd Oil Services Ltd (STOS) with infill from Land Information New Zealand (LINZ) hydrographic data where required. Water depth soundings from previous seismic surveys carried out in this area varied significantly from the NIWA elevation and bathymetry grid, and furthermore, smooth contours in the

NIWA data indicated high levels of extrapolation. Hence the STOS/LINZ bathymetry data was used for modelling as it was considered to be more accurate than the NIWA data for this area.

This survey covers a small geographic footprint between North and South Taranaki Bight, close to Cape Egmont. However, the offshore environment transitions from the continental shelf through the continental slope to benthic regions, and the active geologic regime around New Zealand introduces some major geographic and geological features into the environment.

This report is organised as follows: Section 2 describes the methods used to carry out the modelling, and the results are presented in Section 3. Major conclusions are summarised in Section 4.

2 Methods

2.1.1 Source modelling

The seismic source proposed for this survey is the 3460 cubic-inch airgun array shown in Figure 3. Modelling has been carried out for a source depth of 7 m.

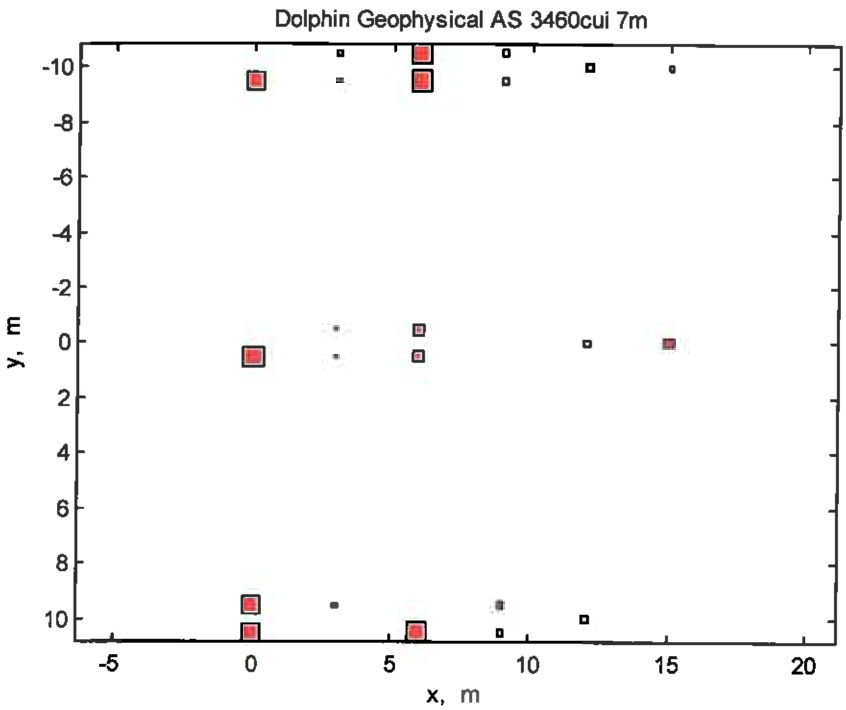


Figure 3. Plan view of the 3460 cubic-inch acoustic source. Source elements are shown much larger than actual size but are scaled proportional to the cube root of their volume.

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 source elements in the array and from the surface ghosts of all the source elements. 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 seismic source. These parameters have also been checked against several waveforms from larger seismic sources 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 seismic source signals' amplitudes are scaled to match the signal energy for a far-field waveform for the entire array computed for the 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

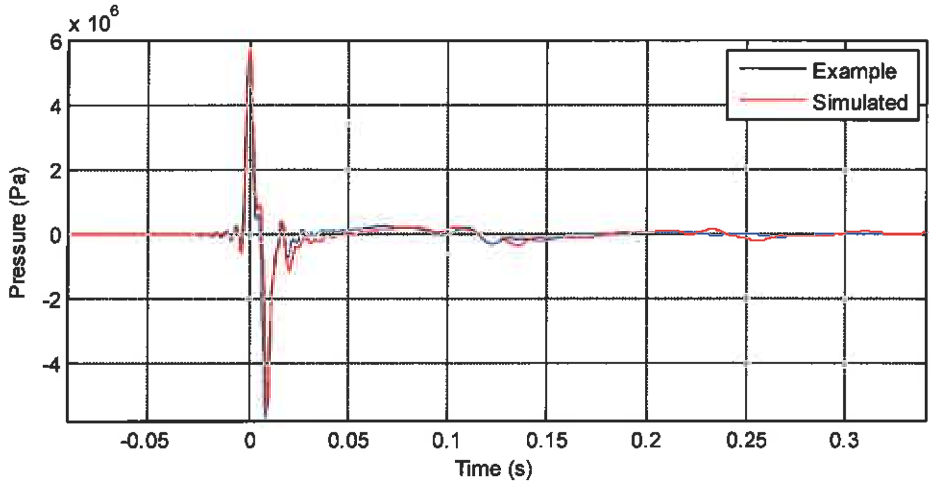
similar to that used by the seismic contractor in generating their sample, or additional filtering is applied to both data sets to emphasise a section of the bandwidth of the supplied data which CMST regards as being most reliable.

Beam patterns for the calibrated array were built up one azimuth at a time as follows:

- The distances from each seismic source element to a point in the far-field along the required azimuth were calculated. (The far-field is the region sufficiently far from the seismic source 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 seismic source element were delayed by the appropriate time, and then these delayed signals were summed over the seismic source elements;
- 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 comparisons between the example waveforms and spectra 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 between the simulated waveforms and the example waveforms is very good. In this case the provided example waveforms were for an array depth of 7 m, the same as the expected operational depth.



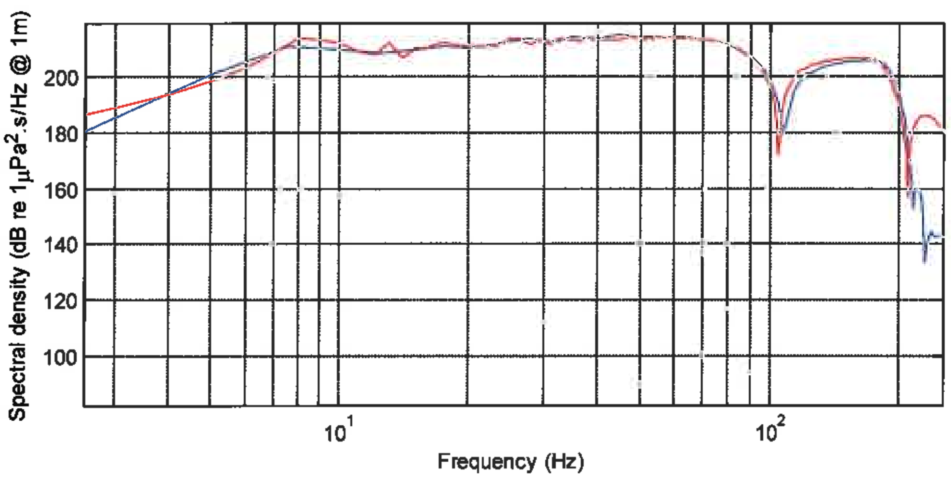


Figure 4. Comparison between the waveforms (top) and spectra (bottom) for the 3460 cubic-inch acoustic source. The example signal for the vertically downward direction provided by the client is represented in blue and the signal produced by CMST's acoustic source model is represented in red.

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 seismic source. The horizontal beam pattern shows that in the horizontal plane a large amount of the high frequency energy is radiated in the cross-line direction, whereas at frequencies below 100 Hz there is more energy radiated in the in-line direction.

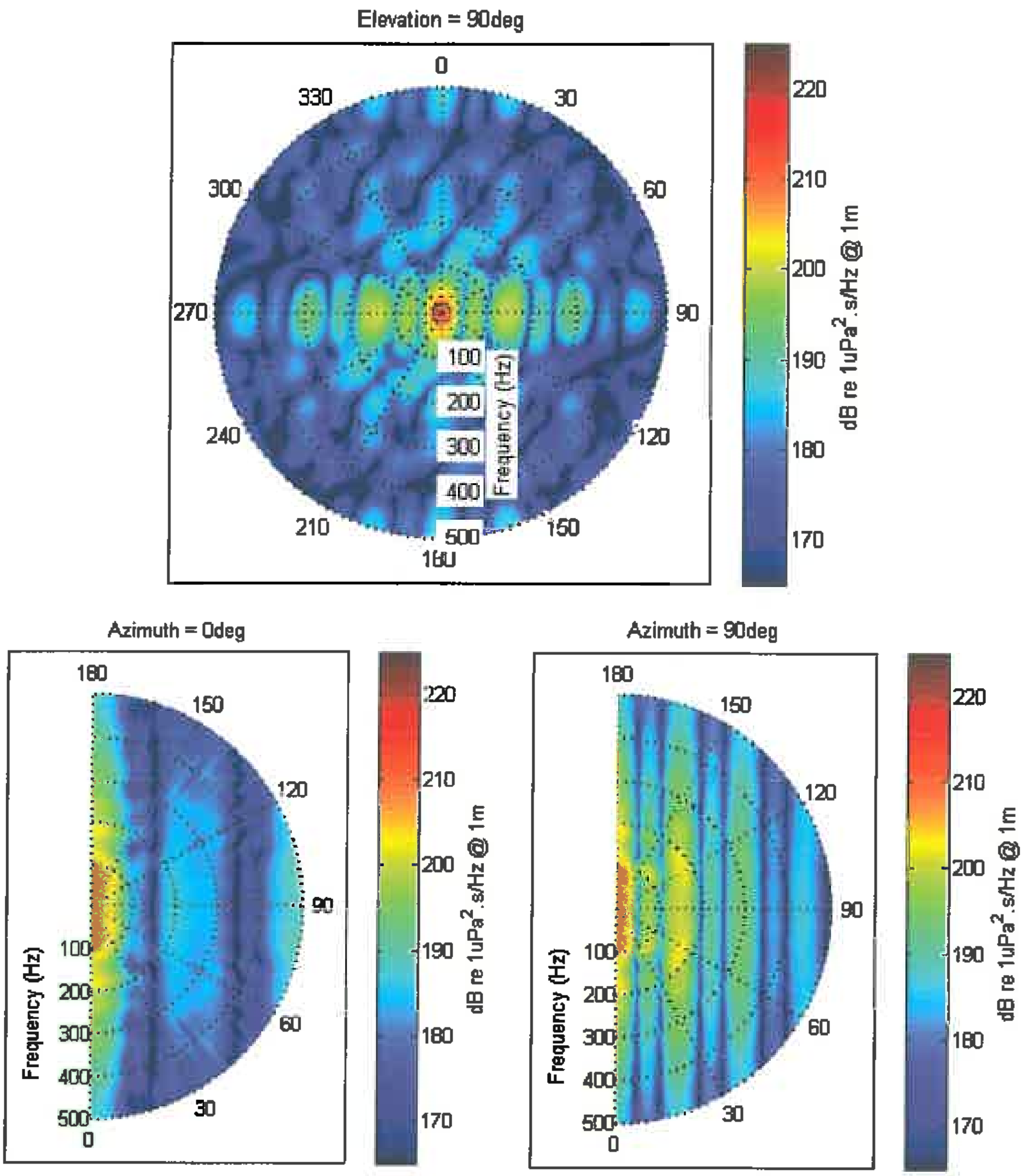


Figure 5. Array far-field beam patterns as a function of orientation and frequency. The top plot is for the horizontal plane with 0 degrees azimuth corresponding to the in-line direction. The bottom two plots are for the vertical plane for the in-line direction (left) and cross-line direction (right).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

2.1.4 Propagation modelling

2.1.4.1 Water-column properties

The appropriate Autumn (April to June) sound speed profiles from the World Ocean Atlas (Locarnini et al., 2006) (Antonov, Locarnini, Boyer, Mishonov, & Garcia, 2006) was chosen for this modelling work in order to capture the worst-case conditions that could be encountered during the survey. Full water depth sound speed profiles for the two geoacoustic regions defined for this survey (see next section) are shown in Figure 6. The sound speed profiles show a pronounced positive sound speed gradient in the upper 40 m of the water column that would act as a surface duct.

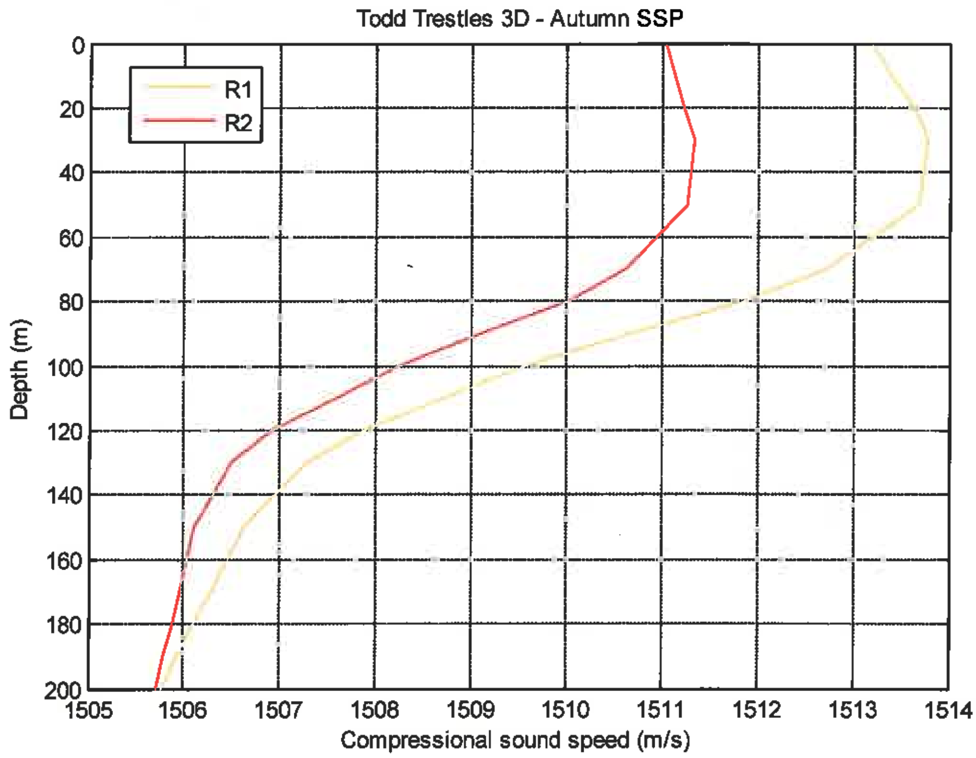


Figure 6. Sound velocity profiles obtained from NOAA World Ocean Atlas.

2.1.4.2 Regional geoacoustic models & bathymetry

Two geoacoustic regions are defined to represent different bottoms in the area of interest. These regions are shown in Figure 7. The regions were chosen to represent the probable bottom sediment compositions and sub-bottom layering. The bottom models for each region were based on information from published literature on New Zealand regional seabed geology and the acoustic properties of marine sediments. For both regions R1 and R2, elastic propagation parameters were ignored. When limited information is known about sediments and the average sediment composition consists of sand, silt, and clay, neglecting elastic effects is a reasonable approximation (Jensen, Kuperman, Porter, & Schmidt, 2011). The resulting seabed properties for each geoacoustic region are tabulated below in Table 1.

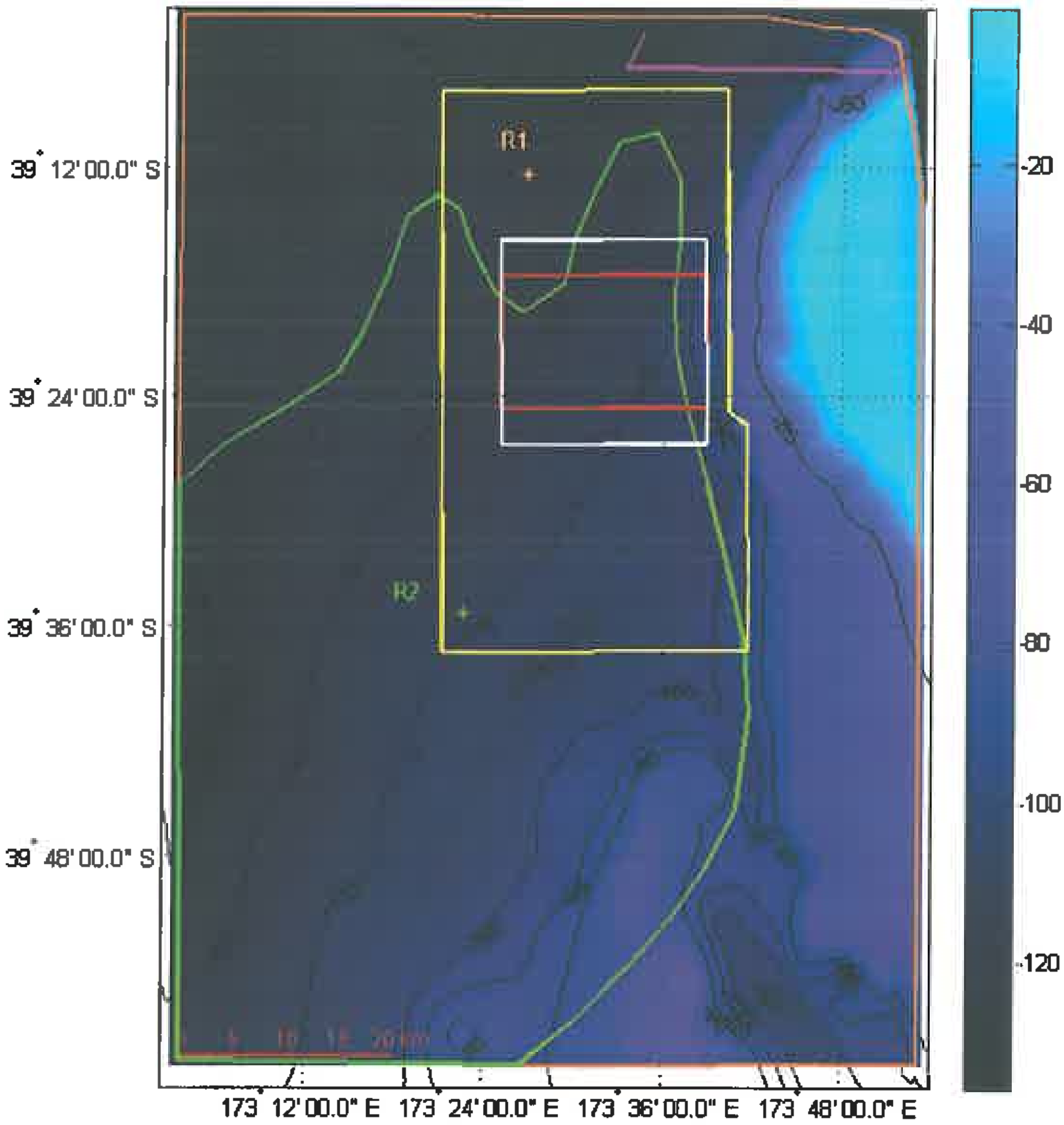


Figure 7. The green curve is the boundary between the two geoacoustic regions defined for the survey region, R1 and R2. The white polygon is the boundary of the Trestles 3D Dolphin Fold Taper area (survey area), the red polygon is the Trestles 3D FF Dolphin Polar Duke area, and the yellow polygon is the Trestles 3D Area of Operations. The southern boundary of the North Island Marine Mammal Sanctuary area is plotted in magenta.

Table 1: Geoacoustic Properties for the regions defined in Figure 7.

Layer Sediment Description	**Thickness (m)**	**ρ ($kg.m^{-3}$)**	**c_p ($m.s^{-1}$)**	**α_p (dB/λ)**
R1: NE corner Taranaki Bight – Sandy Mud				
Sandy Mud	**150**	**1760**	**1621**	**0.5**
		1896	**1677**	
Very Fine Sand Half Space	**N/A**	**1896**	**1677**	**0.5**
R2: SW corner Taranaki Bight - Mud				
Mud (Silty Clay) Layer	**150**	**1432**	**1514**	**0.1**
		1719	**1606**	
Silt Half-Space	**N/A**	**1719**	**1606**	**0.1**

Symbol key for Table 1:
ρ = density, c_p = compressional wave speed, c_s = shear wave speed, α_p = compressional wave attenuation, α_s = shear wave attenuation, λ = wavelength

The Trestles 3D survey area is situated in the Cape Egmont Fault Zone (CEFZ), located between the Western Platform and the Taranaki Graben. This has historically been an active seismic area, as reflected in events observed in different periods (Anderson & Webb, 1994). During the late Quaternary, the motion of the Cape Egmont Fault (CEF), particularly close to the surface, has been normal, with the hanging wall thrown downward to the southeast (Nodder, 1993).

The onshore area toward the north of the North Island is composed of a shelf-slope system with varied amounts of terrestrial sediments (Lionel Carter, 1975; Griffiths & Glasby, 1985).

The bottom sediments of the continental shelf and continental slope within the Northland-Waikato-Taranaki regions consist of detrital terrigenous sediment (Lionel Carter, 1975, 1980). On this section of the continental shelf, the sediment types can range from coarse siliceous sand near shore, and fine sand at the shelf break (Lionel Carter, 1980). The detrital sediments are further transported down the continental slope. Silts and clays that grade to mud are predominantly deposited on the continental slope.

The sediment thickness of continental shelf and slope of the South Taranaki basin has been estimated at an average thickness of 150 m by Nodder (1995). This thickness was assumed to continue northward.

Mud covers the entire core succession close to Cape Egmont succession (Lionel Carter, 1980), with different percentages of sand. Waves off Cape Egmont generate bottom speeds that will move sand in shallow areas (L. Carter & Heath, 1975).

Regions R1 and R2 were defined based on the distribution of main sediment textural types according to (Lionel Carter, 1980) after (Folk, 1974). R1, covering the NE corner, is situated in an area of sandy mud, with a content of sand between 10-50%. R2, covering the SW corner, is more dominated by mud, with a small content of sand.

With the likely bottom sediment types defined for the offshore area, the geoacoustic parameters for the regions R1 and R2 were taken from Hamilton (1980). Both the compressional wave speed (Hamilton, 1979) and density (Hamilton, 1976) were increased linearly with depth within these layers to account for the effects of increased sediment compaction with depth into the seabed.

2.1.4.3 Short Range Modelling

2.1.4.3.1 Choice of propagation modelling codes

The short ranges involved in this component of the modelling made it possible to use the range independent propagation modelling code SCOOTER (Michael B. Porter, 2007) for this work. 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, and is therefore considered a range independent model, but that is unimportant in this particular application.

2.1.4.3.2 Source Locations

One source location, S1 was used for the modelling of sound propagation at short ranges (Figure 8).

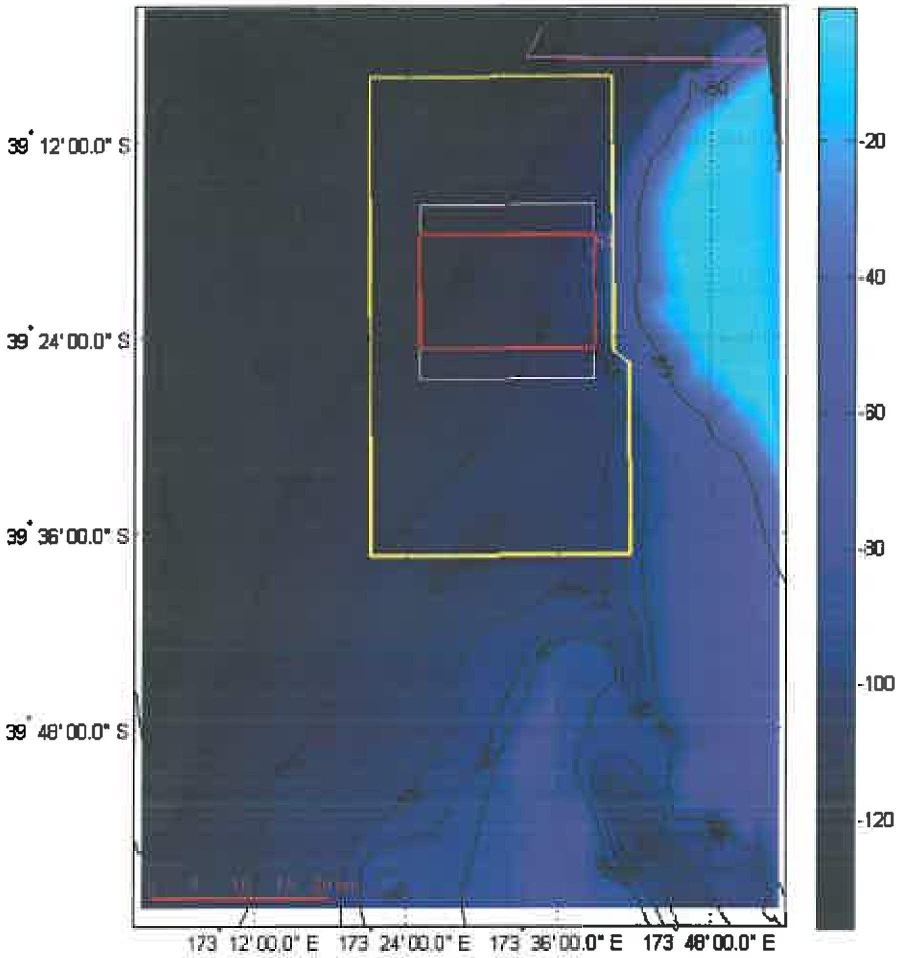


Figure 8. The magenta dot S1 is the source locations chosen for short range modelling. The white polygon is the boundary of the Trestles 3D Dolphin Fold Taper area (survey area), the red polygon is the Trestles 3D FF Dolphin Polar Duke area, and the yellow polygon is the Trestles 3D Area of Operations. The southern boundary of the North Island Marine Mammal Sanctuary area is plotted in magenta.

The location chosen was the shallowest area, 94.12 m depth, and was chosen for modelling as a source in this location will produce the highest sound levels due to the contribution of seabed reflections.

2.1.4.4 Long Range Modelling

2.1.4.4.1 Choice of propagation modelling codes

For longer ranges the effects of varying water depth are important and it was necessary to use a range dependent model. In this case the parabolic equation code RAMGeo (Collins, 1993) was used. This code is well tested and reliable but can only deal with fluid seabeds.

2.1.4.4.2 Long Range Source Location

A single source location was chosen to model long range sound propagation. This source location is labelled S2 and is shown in Figure 9. It was chosen as being the locations likely to produce the highest sound levels within the West Coast North Island Marine Mammal Sanctuary.

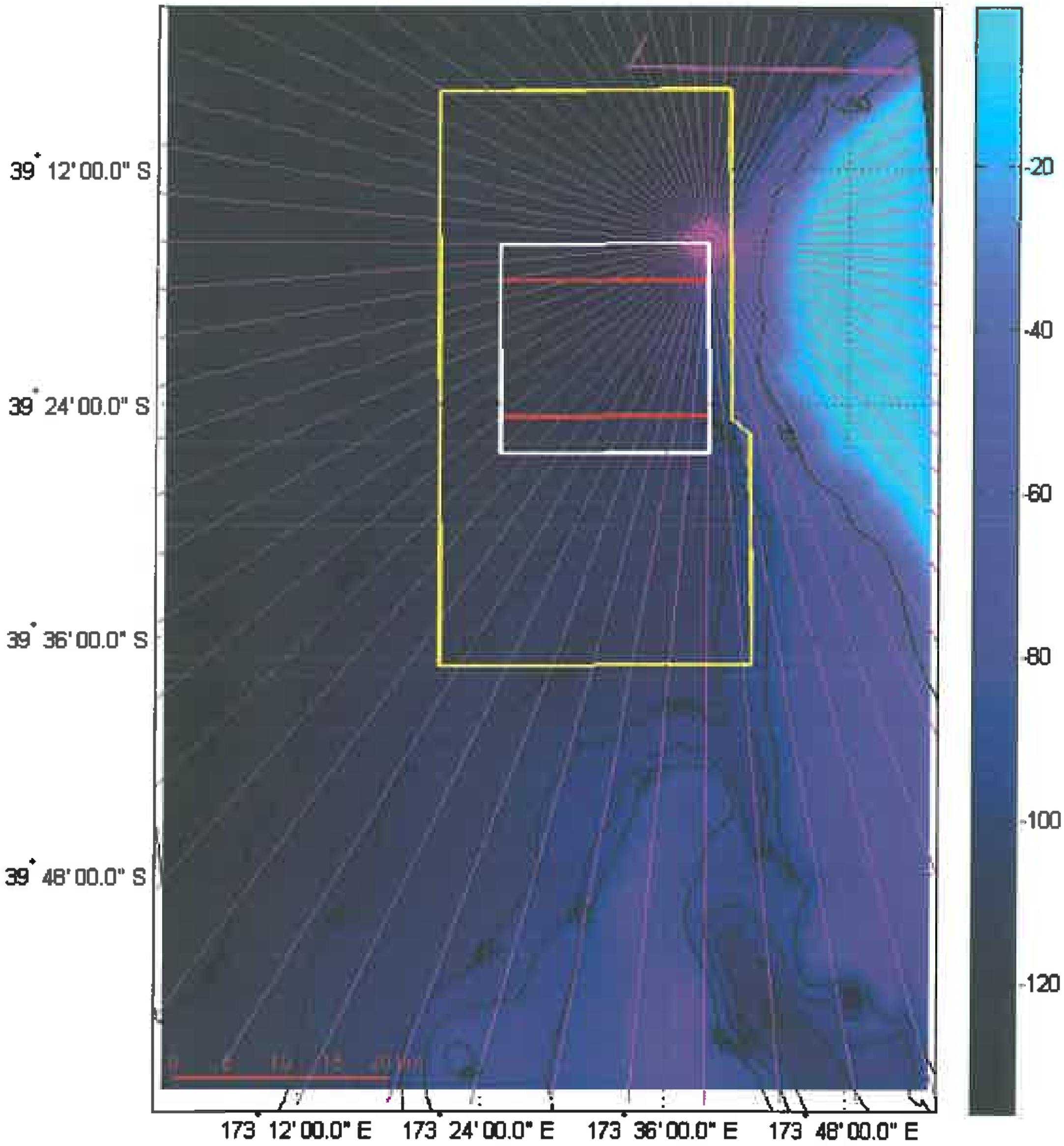


Figure 9. Source location S2 used for long-range modelling and the set of azimuths lines spaced 5 degrees. The white polygon is the boundary of the Trestles 3D Dolphin Fold Taper area (survey area), the red polygon is the Trestles 3D FF Dolphin Polar Duke area, and the yellow polygon is the Trestles 3D Area of Operations. The southern boundary of the West Coast North Island Marine Mammal Sanctuary is plotted in magenta.

2.1.5 Sound exposure level (SEL) calculations

2.1.5.1 Short Range Modelling

At short ranges it is important to include both the horizontal and vertical directionalities of the seismic source, which requires summing the signals from the individual seismic source elements 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 seismic source (7m). 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 seismic source element 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 - seismic source element 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 seismic source element to give a received signal due to that seismic source element.
    c. The received signals from all seismic source elements 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.

2.1.5.2 Long Range Modelling

For longer ranges the short-range modelling procedure described above was too computationally intensive to be feasible and instead SELs were calculated as a function of range, depth and azimuth from each source location as follows:

- Transmission loss was modelled at 5° azimuth increments out to 90 km maximum range using RAMGeo (fluid Parabolic Equation model) for a set of discrete (bin-centre) frequencies at one-third octave intervals from 8 Hz to 1000 Hz. The bathymetry along the track was interpolated from the STOS/LINZ dataset, and the local acoustic environment was as described previously.
- Frequency-dependent source level was obtained by integrating the horizontal plane source spectrum for the appropriate (relative) azimuth over each frequency band. (Band edges were chosen as the geometric means of adjacent frequencies.) Relative azimuths were calculated based on a survey line direction North-South.
- Source level and transmission loss were then combined to compute the received level as a function of range, depth and frequency. This calculation was carried out at the same azimuth increments. Corresponding transmission loss data were extracted from the closest available transect (in azimuth) used in the propagation modelling.
- Integrated squared acoustic pressure was calculated for each 1/3rd-octave spectral bin. These values were summed and converted to decibels to yield SEL.

3 Results

3.1.1 Short Range Modelling Results

Maximum received sound exposure levels at any depth are plotted as a function of range and azimuth from the source at S1 in Figure 10. The directionality of received levels in the horizontal plane is due to the directionality of the seismic source, which produces its highest levels in the cross-line and in-line directions.

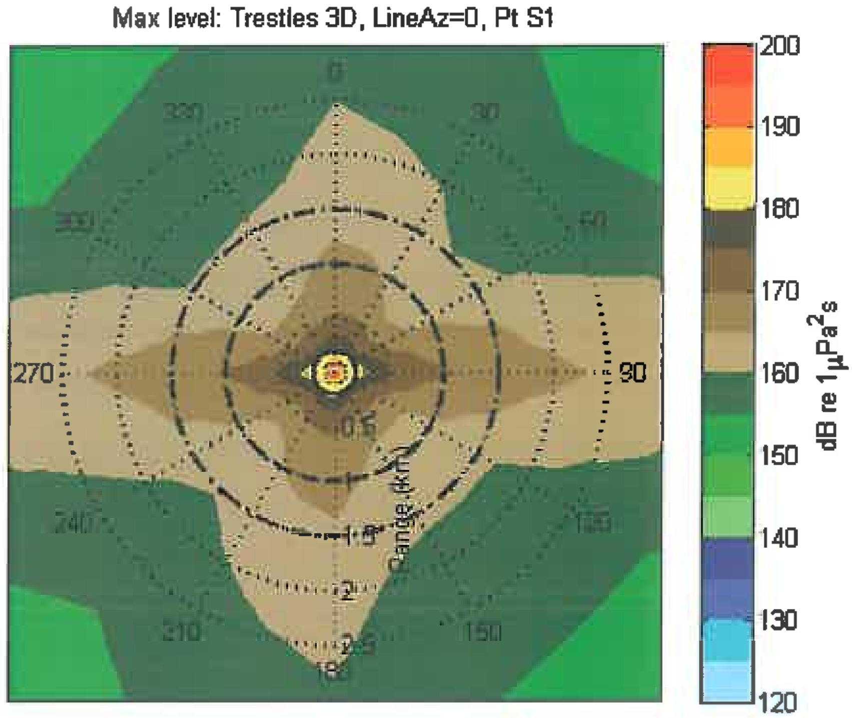


Figure 10. Predicted maximum received SEL at any depth produced as a function of azimuth and range from the source (spring sound speed profile). An azimuth of 0° (up) corresponds to the in-line direction. The thick black circle corresponds to mitigation ranges of 200m (solid), 1km (dash), and 1.5km (dash-dot).

Figure 11 shows a scatter plot that displays the sound exposure levels produced by the array at S1 as a function of range. The maximum predicted sound exposure levels at the specified mitigation ranges are listed in Table 2.

Figure 12 shows the percentage of levels not exceeding two thresholds as a function of range. The thresholds are limits imposed by the New Zealand Department of Conservation 2013 Code of Conduct, 171 dB re 1 μPa^2.s and 186 dB re 1 μPa^2.s. It can be seen that 100 % of the levels lie below the threshold of 186 dB re 1 μPa^2.s at distances equal or greater than 150 m. From 1 km from the source all of them lie below 171 dB re 1 μPa^2.s.

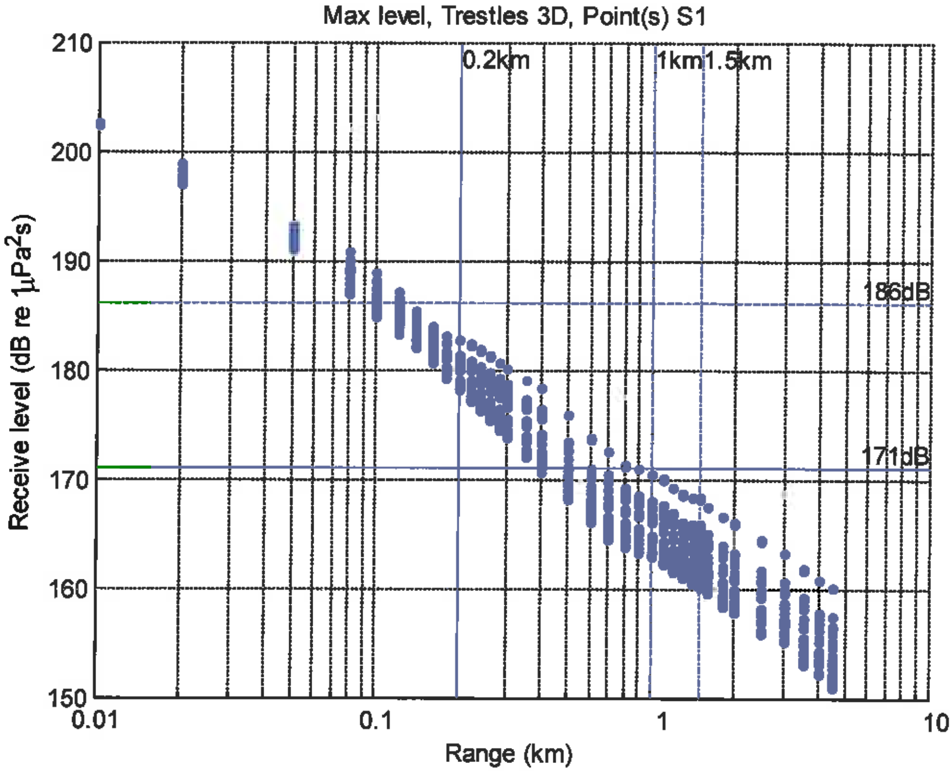


Figure 11. Scatter plot of maximum SEL at the source location S1. Points are maximum predicted received levels at any depth as a function of range, plotted for all azimuths. Vertical magenta lines show mitigation ranges of 200m (solid), 1km (broken), and 1.5km (dash-dot). Horizontal green lines show mitigation thresholds of 171 dB re 1 μPa2.s (solid) and 186 dB re 1 μPa2.s (broken).

Table 2. Maximum sound exposure levels as a function of range from source location S1

Range	Maximum Sound Exposure Level (dB re 1 μPa^2.s)
200m	182.7
1.0 km	170.5
1.5 km	168.3

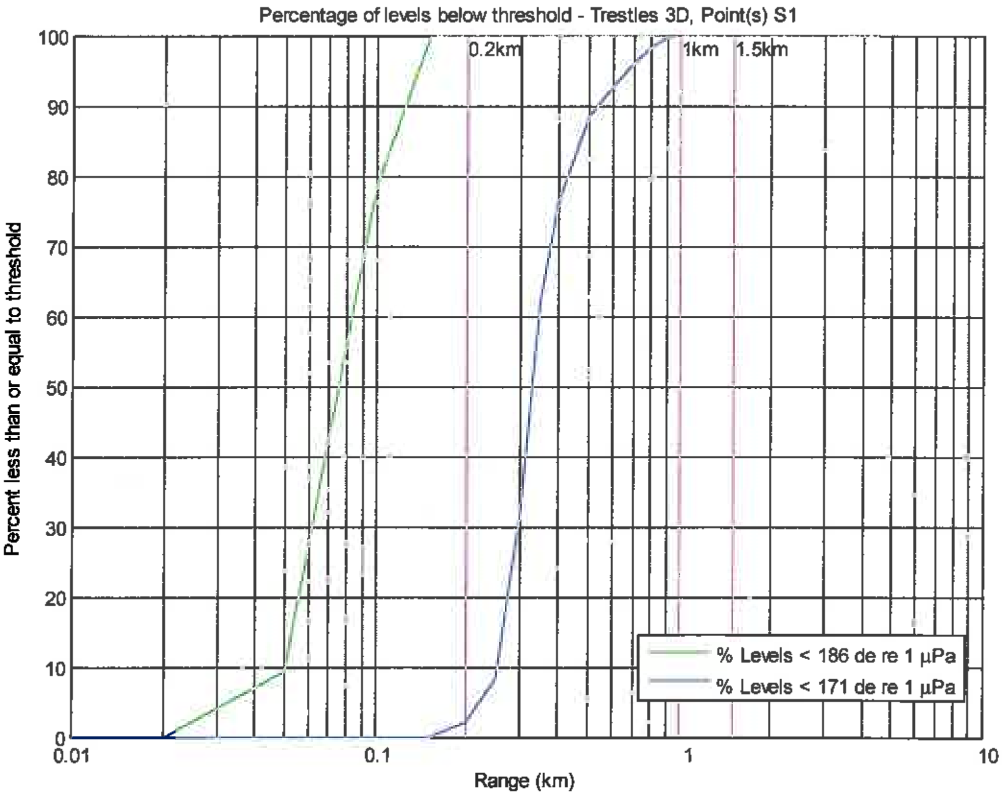


Figure 12. Percentage of levels not exceeding thresholds of 171 dB re 1 µPa2.s and 186 dB re 1 µPa2.s as a function of range.

3.1.2 Long Range Modelling Results

Figure 13 shows the geographical distribution of received sound exposure levels out to a maximum range of 90 km from source location S2, which is in 102.6 m of water. Note that in order to illustrate the lower sound levels that occur at longer ranges a different colour scale has been used for these plots than for the short range results given in the previous section. Maximum levels in the West Coast North Island Marine Mammal Sanctuary for a source at S2 are predicted to be 144.0 dB re 1 µPa2.s.

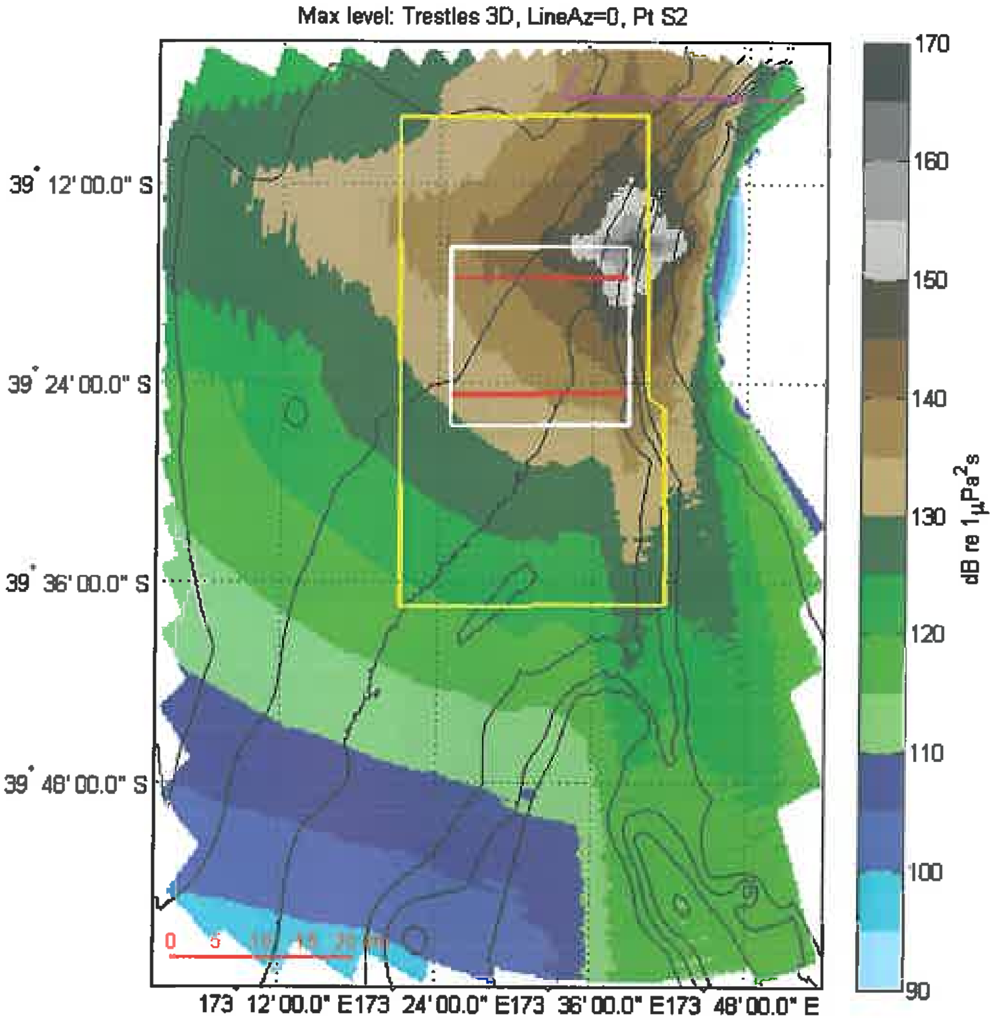


Figure 13. Geographical distribution of modelled sound exposure level for a source at S2 to a maximum range of 90km - autumn sound speed profile (Maximum level at any depth). Survey line azimuth is 0°T. The boundary of the West Coast North Island Marine Mammal Sanctuary is plotted in magenta.

The strong and complicated directionality apparent in these plots is due to a combination of the directionality of the array, which produces maxima in the in-line and cross-line directions and the effects of bathymetry. The effect of variable bathymetry causes rapid attenuation upslope from the source and enhances propagation downslope.

These effects are illustrated in Figure 14 and Figure 15, which show vertical cross-sections through the sound field produced by a source at S2 in the in-line and cross-line directions respectively. The highest levels are transmitted vertically downward into the seabed, however acoustic energy is also trapped in the ocean interior.

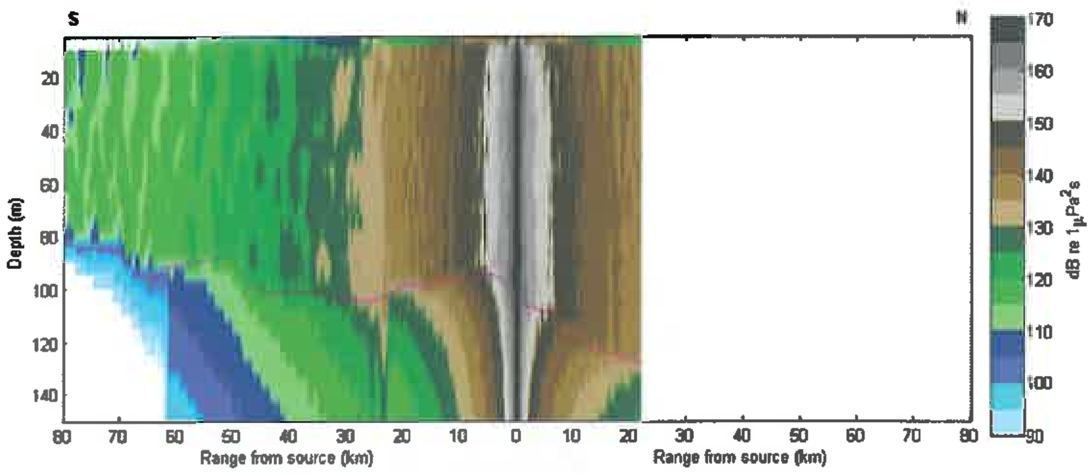


Figure 14. Vertical cross-section through the sound field in the in-line direction (0°T - 180°T), centred on S2, the magenta line is the seabed.

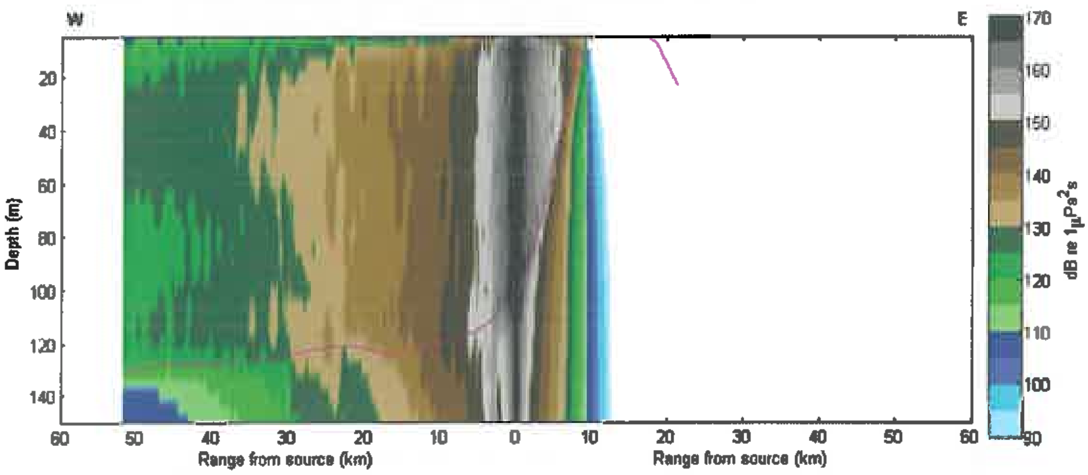


Figure 15. Vertical cross-section through the sound field in the cross-line direction (90°T - 270°T), centred on S2, the magenta line is the seabed.

Figures 16 and 17 show a scatter plot that displays the sound exposure levels produced by the array at S2 as a function of range. The former shows the total scatter of levels for all azimuths, while the latter shows the levels along the two cross-line and two in-line azimuths.

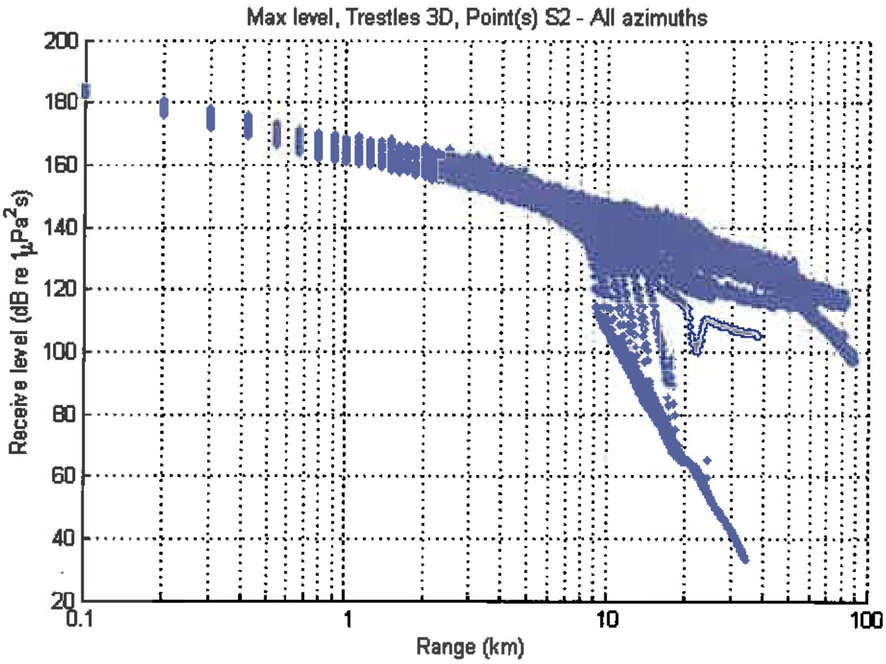


Figure 16. Scatter plot of maximum SEL at the source location S2. Points are maximum predicted received levels at any depth as a function of range, plotted for all azimuths.

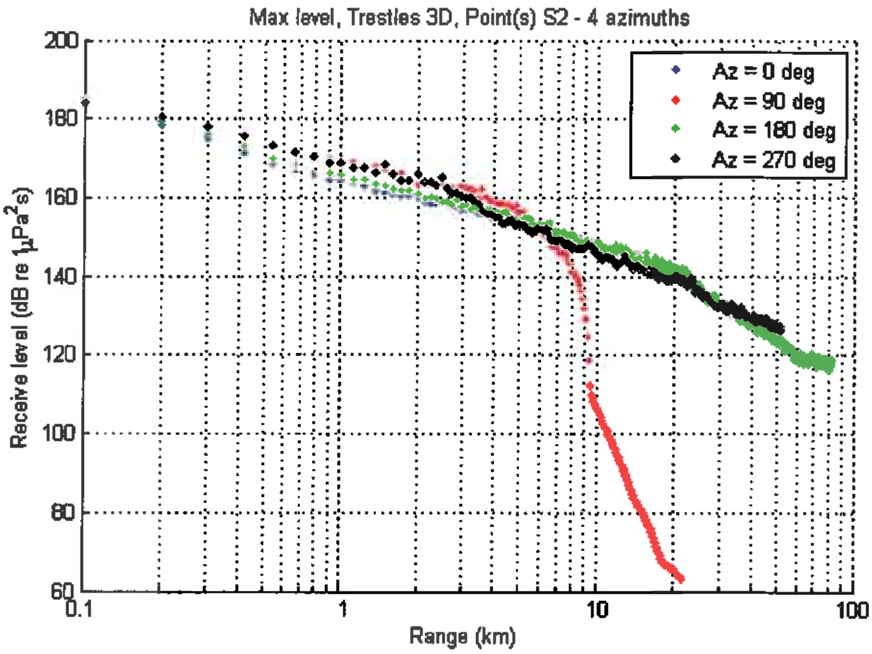


Figure 17. Scatter plot of maximum SEL at the source location S2. Points are maximum predicted received levels at any depth as a function of range, plotted for the four main directions.

4 Conclusions

The Trestles 3D survey covers a small geographic footprint between North and South Taranaki Bight, close to Cape Egmont. However, the offshore environment transitions from the continental shelf through the continental slope to benthic regions, and the active geologic regime around New Zealand introduces some major geographic and geological features into the environment. Bottom reflectivity associated with seafloor sediment type was chosen by conducting a literature review of New Zealand's offshore sedimentology and geology.

Two source points representing the worst-case scenario for received SELs were considered, one for the short range modelling and one for the long range modelling.

The modelling method used to produce the short range results is very computationally intensive but accurately deals with both the horizontal and vertical directionality of the seismic source and with variations in water depth. The majority of the sound energy is transmitted downward and is absorbed by the seabed, but some energy is trapped and propagates within the ocean interior. This modelling predicted that the maximum sound exposure levels from the 3460 cubic-inch acoustic source would be below the threshold of 186 dB re 1 μPa^2.s at 200 m and below 171 dB re 1 μPa^2.s at 1 and 1.5 km.

The long range modelling results were significantly directional due to the combined effects of seismic source directionality and bathymetry. Levels showed rapid attenuation upslope from the source and enhanced propagation downslope.

The maximum sound exposure level in the West Coast North Island Marine Mammal Sanctuary for a source at S2 in a water depth of 102.6 m was predicted to be 144.0 dB re 1 µPa2.s. This is expected to be the highest level produced in the sanctuary by this survey.

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APPENDIX 6

Marine Mammal Mitigation Plan

Marine Mammal Mitigation Plan:

Todd Energy Limited – Trestles 3D Marine Seismic Survey

BPM-Todd-Trestles 3D MSS-MMMP-v1.3

29/01/2015

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		5
		6

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Prepared by:

Last updated: 30 January 2015

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1. Introduction

This document has been developed by Blue Planet Marine (BPM) for Todd Energy Limited (Todd Energy) in order to meet the requirements for a Marine Mammal Mitigation Plan (MMMP) for the Trestles 3D Marine Seismic Survey (the survey).

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

2. The Todd Energy Limited – Trestles 3D Marine Seismic Survey

Information provided in the MMIA for the survey has been used by BPM in the development of this MMMP. REM was engaged by Todd Energy to prepare a MMIA for an approximate 388 km^2 survey in the Taranaki Basin, scheduled to commence in mid February 2015. The Survey Area will be located largely within PEP 53374 with extensions into Petroleum Mining Licence (PML) 381012 and PEP 38158. The Survey Area will be bound by an Operational Area, which is all encompassing and provides a buffer (4 – 20 km) for run in/out, line turns, acoustic source testing and soft start source initiation (Figure 1).

The primary objective of this survey is to provide quality, modern 3D seismic coverage over the area north of the Māui Field in order to establish the key characteristics of the petroleum system in that area, particularly those related to the Miocene "Vulcan" Prospect and deeper targets in Eocene and Palaeocene aged rocks. The planned seismic survey will record data with sufficient offsets to allow for Quantitative Interpretation of the prospectivity in the area. It is anticipated that the survey will take approximately 3-4 weeks to complete, depending on weather constraints and marine mammal encounters. Operations will be conducted 24 hours per day, 7 days per week; also subject to suitable weather conditions and marine mammal encounters.

2.1 Seismic vessel and acoustic source

The survey will use the seismic vessel *MV Polar Duke* and will tow 12 solid streamers, 7 km in length and 100 m apart. The acoustic source will have an effective volume of 3,460 in^3 and will be comprised of three sub-arrays with seven acoustic sources on all but one of the sub-arrays, which has nine. The acoustic array will be located at a depth of 7 m below the sea surface and approximately 130 m behind the survey vessel.

The acoustic source will have an operating pressure of 2,000 psi and will be fired at a sourcepoint interval of 18.75 m apart. For a typical boat speed of 4 knots (kts), this equates to a sourcepoint activation every 9 seconds. Given the volume of the acoustic source being used, the survey is classified as a **Level 1** survey under the Code. The mitigation procedures set out in this MMMP will adhere to the requirements of a Level 1 survey as stipulated in the Code and any additional mitigation measures determined via the MMIA process and outlined in Section 5 of this document.

Two support vessels, the *MV Sanco Sky* and *MV Guru* will accompany the 3D seismic vessel to provide supplies and scout the area ahead for obstructions.

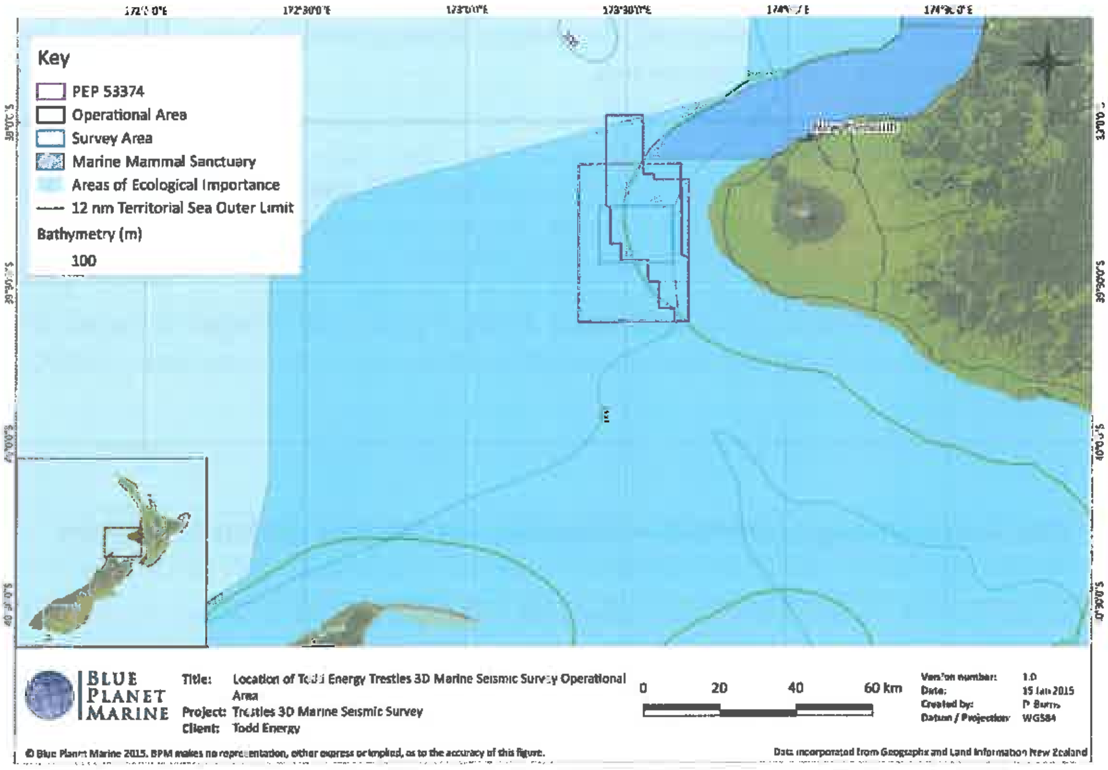

Figure 1: Location of the Todd Energy Trestles 3D Marine Seismic Survey.

(Observers to refer to the VADAR system for the coordinates of the Operational Area.)

2.2 Operational Area

The Operational Area for the survey is located off Cape Egmont and in waters to the southwest (Figure 1). All seismic operations will be restricted to waters beyond 7 km from shore (primarily in water depths greater than 100 m). The Operational Area occurs within the 12 nautical mile territorial sea and the New Zealand Exclusive Economic Zone. Amongst other legislation, the survey is required to comply with the Exclusive Economic Zone (EEZ) and Continental Shelf (Environmental Effects – Permitted Activities) Act and the Code. In the territorial sea, compliance with the Code is voluntary. Todd Energy will voluntarily comply with the Code within the territorial sea for the survey.

When a survey is proposed within Areas of Ecological Importance (AEI), the Code requires Sound Transmission Loss Modelling (STLM) to be undertaken in order to validate the standard mitigation zones specified in the Code. The Operational Area for this survey is located within AEI and so STLM is required (Figure 1).

Todd Energy's STLM was based upon the specific configuration of the acoustic array deployed from the *MV Polar Duke* and the environmental conditions within the Operational Area. The STLM predicted that the standard mitigation zones described in the Code will be adequate for the protection of marine mammals and that Sound Exposure Levels (SEL) will be equal to or below the behaviour and injury criteria thresholds specified for mitigation in the Code. There is no need, therefore, to either extend the radius of the mitigation zones or limit acoustic source power.

There is one Marine Mammal Sanctuary (MMS) in the vicinity of the survey. The West Coast North Island MMS extends from Maunganui Bluff in Northland to Oakura Beach in the south ranging 12 Nm offshore and was established in 2008 for the protection of the Māui dolphin. The Operational Area of the survey lies outside, to the south and west of this MMS, at a distance of 1.5 km from the southern boundary of the sanctuary (Figure 1).

3. Record Keeping and Reporting

The observers (MMOs and PAMOs) are responsible for maintaining records of all marine mammal sightings/detections and mitigation measures taken throughout the survey. Observers are also required to monitor and record seismic operations, the power output of the acoustic source while in operation, observer effort and sighting conditions. These and other reporting requirements are detailed in Appendix 2 of the Code. Section 5.3.5 of the MMIA presents a summary of the most commonly occurring or protected marine mammal species known to occur in the Operational Area.

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

The operator will ensure that information relating to the activation of an acoustic source and the power output levels employed throughout survey operations is readily available (e.g. in a place of convenience for the qualified observers while conducting their normal duties) to support the activities of the qualified observers in real time by providing a display screen for acoustic source operations.

> Please review Appendix 2 of the Code carefully. Note that you are required to record the power levels (and timing) of at least one random soft start per swing[1].
>
> Note: the Code is mandatory within the NZ EEZ, as such record keeping should be of a high standard as it may form the basis of compliance or enforcement action by the authorities.

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

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

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

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

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

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

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

In addition to the recording and reporting requirements of the Code, Todd Energy has committed to the following:

• Whilst transiting to and from the Operational Area, and during daylight hours and good sighting conditions, a MMO will be on watch and recording marine mammal sightings;

• Weekly MMO reports will be provided to DOC and the Environmental Protection Authority;

• DOC will be notified immediately of any sightings of Māui or Hector's dolphins; and

• If any strandings occur in the North and South Taranaki Bights that result in mortality during the survey or within 14 days of the survey completion date, Todd Energy will, on a case-by-case basis, consider covering the costs of undertaking a necropsy in an attempt to determine the cause of death.

3.1 Māui and Hector's dolphin sightings

The survey is being acquired in waters near the West Coast North Island MMS. The northern boundary of the Operational Area has a buffer of at least 1.5 km between it and the MMS. It is possible that Māui (and Hector's) dolphins may be sighted within the Operational Area and during transit. If either species of dolphin is sighted during the survey, DOC should be notified as per the instructions in Section 6 of this MMMP.

3.2 Validation of Sound Transmission Loss Modelling (STLM)

As outlined in Section 2, Todd Energy have undertaken STLM and will ground-truth the results during the survey (as per the methodology outlined in Appendix 7 of the MMIA). Representative data recorded on the seismic streamers during the seismic survey will be used to compare actual water column sound exposure levels with pre-survey modelled predictions. The results of ground-truthing will be verified in order to ensure the mitigation zones are appropriate. The validation results and report will be provided to DOC by Todd Energy.

It is recommended that the MMO Team Leader undertake early communications with the relevant personnel in order to be aware of the timing of the ground-truthing exercise. The Observer team is not responsible for collecting, analysis or reporting of ground-truthing data.

Refer to Section 6.3.2 and Appendix 5 of the MMIA for details of the STLM.

3.3 Contact details for the Department of Conservation

During the survey, the first point of contact within DOC is Ian Angus (If a response is required urgently then telephone communications are recommended but in all other circumstances email correspondence should suffice. Should Ian Angus be unavailable, please phone 0800DOCHOT (0800-362-468) and state the following:

1) You wish to provide information to the Marine Species and Threats Team, National Office;
2) The name of the MMO/PAMO, the seismic survey and boat you are currently on;
3) The time and date;

4) The issue/enquiry they wish to pass on to Ian Angus; and
5) Where you can be contacted with a reply (if appropriate).

3.3.1 Communication protocol

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

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

- MMO Team Leader to contact BPM Project Manager ashore ,
- BPM to contact Todd Energy (Rick Henderson); and
- Todd Energy to contact DOC (Ian Angus or other).

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

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

4. Mitigation Measures Required Under the Code

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

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

4.1 Dedicated observers (MMOs and PAMOs)

As this is a Level 1 survey, there will be two MMOs and two PAMOs on board the seismic survey vessel for the duration of the survey[2]. The training and experience of the observers will meet the requirements stipulated in Section 3.4 of the Code. **There will be at least one MMO (during daylight hours) and one PAMO on watch at all times while the acoustic source is in the water in the Operational Area.**

If the acoustic source is in the water but inactive, such as while waiting for bad weather conditions to pass, the qualified observers have the discretion to stand down from active observational duties and resume at an appropriate time prior to recommencing seismic operations. This strictly limited

[2] During the survey, an additional iwi Trainee MMO may also be onboard. This will bring the observer team to a total of five individuals: three MMOs and two PAMOs.

exception must only be used for necessary meal or refreshment breaks or to attend to other duties directly tied to their observer role on board the vessel, such as adjusting or maintaining PAM or other equipment, or to attend mandatory safety drills.

It is recommended that:

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

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

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

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

It is recommended that:

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

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

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

• The observers provide posters detailing mitigation procedures and communications protocols and display these in the instrument room, at the PAM station and on the Bridge (refer Addenda 1, and Addenda 2).

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

4.1.1 Safety drills

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

4.1.2 PAM not operational

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

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

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

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

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

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

4.2 Crew observations

As per Section 3.8.6 of the Code:

"If a crew member on board any vessel involved in survey operations (including chase or support vessels) observes what may be a marine mammal, he or she will promptly report the sighting to the qualified MMO, and the MMO will try to identify what was seen and determine their distance from the acoustic source.

In the event that the MMO is not able to view the animal, they will provide a sighting form to the crew member and instruct on how to complete the form. Vessel crew can relay either the form or basic information to the MMO. If the sighting was within the mitigation zones, it is at the discretion of the MMO whether to initiate mitigation action based on the information available. Sightings made by members of the crew will be differentiated from those made by MMOs."

4.3 Mitigation procedures

The proponent will observe the following mitigation practices:

4.3.1 Operational Area

Under the Code, an Operational Area must be designated outside of which the acoustic source will not be activated. This includes testing of the acoustic source and soft starts. The Operational Area is defined by the coordinates provided in Addenda 3. These have been loaded into VADAR for real time monitoring of vessel location and marine mammal detections relative to the Operational Area.

4.3.2 Operational capacity

The operational capacity of the acoustic source is notified in the MMIA and outlined in Section 2.1 of this MMMP. This operational capacity should not be exceeded during the survey, except where unavoidable for source testing and calibration purposes only[3]. All occasions where activated source volume exceeds notified operational capacity must be fully documented in observer reports. It is the responsibility of the operator to immediately notify the qualified observers if operational capacity is exceeded at any stage[4].

4.3.3 Sighting conditions

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

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

Beaufort 3

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

BEAUFORT FORCE 3
WIND SPEED: 7-10 KNOTS

SEA: WAVE HEIGHT .5-1M (2-3FT), LARGE WAVELETS, CRESTS BEGIN TO BREAK, ANY FOAM HAS GLASSY APPEARANCE, SCATTERED WHITECAPS

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

Beaufort 4

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

BEAUFORT FORCE 4
WIND SPEED: 11-16 KNOTS

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

4.3.4 Transit

Though not required by the Code it is encouraged that a MMO be on watch while the seismic survey vessel is in transit to and from the Operational Area. If a marine mammal is sighted during transit, the sighting must be recorded in the standardised DOC Off Survey Reporting Form.

Todd Energy has committed to a MMO being on watch and recording marine mammal sightings during daylight hours and good weather during transit to and from the Operational Area.

4.3.5 Outline of mitigation procedure

A diagram outlining the general components of the mitigation procedure is shown in Figure 2. Addenda 4 outlines a checklist to be completed by the MMO and/or PAMO on watch prior to the acoustic source being put into the water.

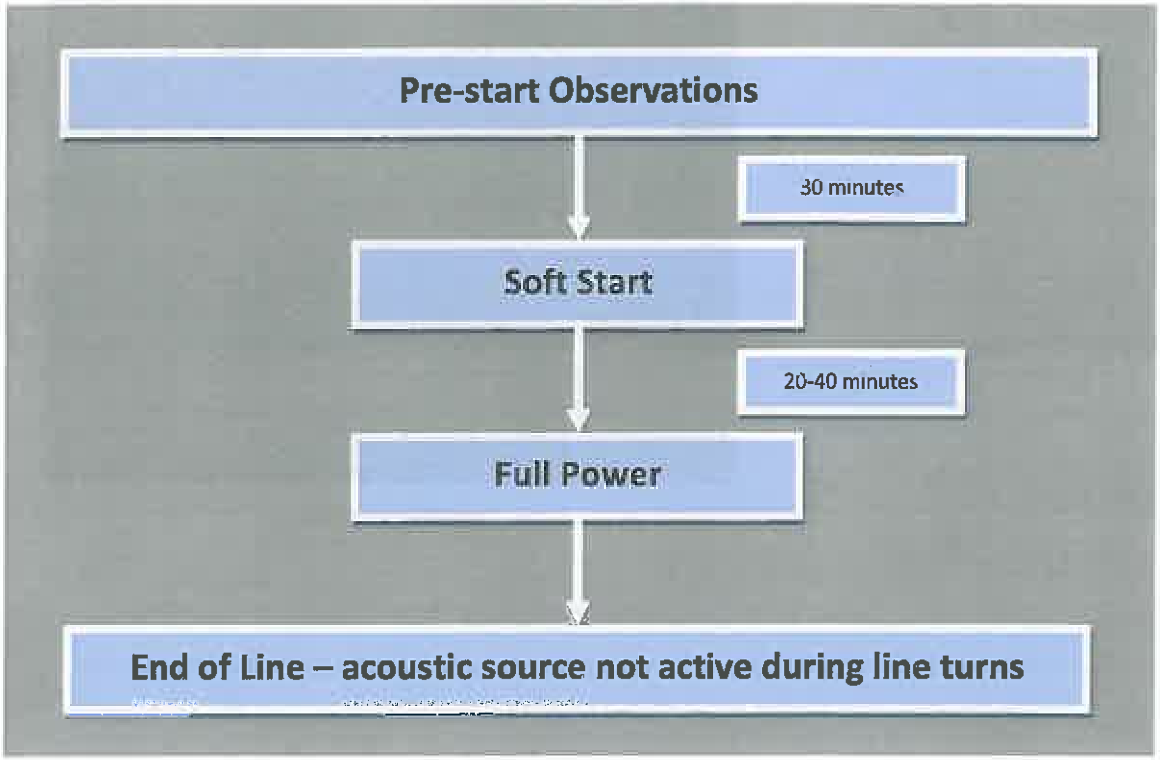

Figure 2: Seismic operations mitigation procedure.

4.3.6 Pre-start observations

A Level 1 acoustic source can only be activated if it is within the specified Operational Area, and no marine mammals have been observed or detected in the relevant mitigation zones as outlined in Section 4.5.

The source cannot be activated during daylight hours unless:

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

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

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

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

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

Another update to the Code in 2013 relates to commencement of operations in a new location in the survey programme for the first time (Section 4.1.3). When arriving at a new location 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 of the planned start up position for at least the last 2 hours of good sighting conditions preceding proposed operations, and no marine mammals have been detected; or
- Where there have been less than 2 hours of good sighting conditions preceding proposed operations (within 20 nautical miles of the planned start up position), the source may be activated if[5]:
    - PAM monitoring has been conducted for 2 hours immediately preceding proposed operations, and
    - Two MMOs have conducted visual monitoring in the 2 hours immediately preceding proposed operations[6], and
    - No Species of Concern have been sighted during visual monitoring or detected during acoustic monitoring in the relevant mitigation zones in the 2 hours immediately preceding proposed operations, and
    - No fur seals have been sighted during visual monitoring in the relevant mitigation zone in the 10 minutes immediately preceding proposed operations, and
    - No other marine mammals have been sighted during visual monitoring or detected during acoustic monitoring in the relevant mitigation zones in the 30 minutes immediately preceding proposed operations.

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

Todd Energy will adhere to the requirements of Section 4.1.3. This includes when the seismic vessel leaves and returns to the Operational Area following a crew change or port call.

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

[6] DOC (3 November 2014): "... this requirement means that night time starts are not allowed, since visual observation cannot be undertaken immediately prior to start-up."

4.3.7 Soft starts

The soft start procedure will be followed every time the source is activated. That is: the gradual increase of the source's power to the operational power requirement over a period of at least 20 minutes and no more than 40 minutes, starting with the lowest power acoustic source in the array.

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

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

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

4.3.8 Acoustic source testing

The Code requires that all testing of the acoustic source occurs within the Operational Area. Notified operational capacity should not be exceeded during the survey, except where unavoidable for source testing and calibration purposes only.

Seismic source tests are subject to soft start procedures (Section 4.3.7), though the 20-minute minimum duration does not apply. Where possible, power should be built up gradually to the required test level at a rate not exceeding that of a normal soft start. Acoustic source tests cannot be used for mitigation purposes, or to avoid implementation of soft start procedures.

4.3.9 Line turns

There will be no acquisition during line turns and the acoustic source will not be active (unless soft start procedures or testing are in effect).

4.4 Species of Concern

The full list of Species of Concern (SOC) as defined by the Code is shown in Addenda 5 below.

4.5 Mitigation zones

The Code stipulates standard mitigation zones for Level 1 surveys. These will be applied during the survey and are outlined below:

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

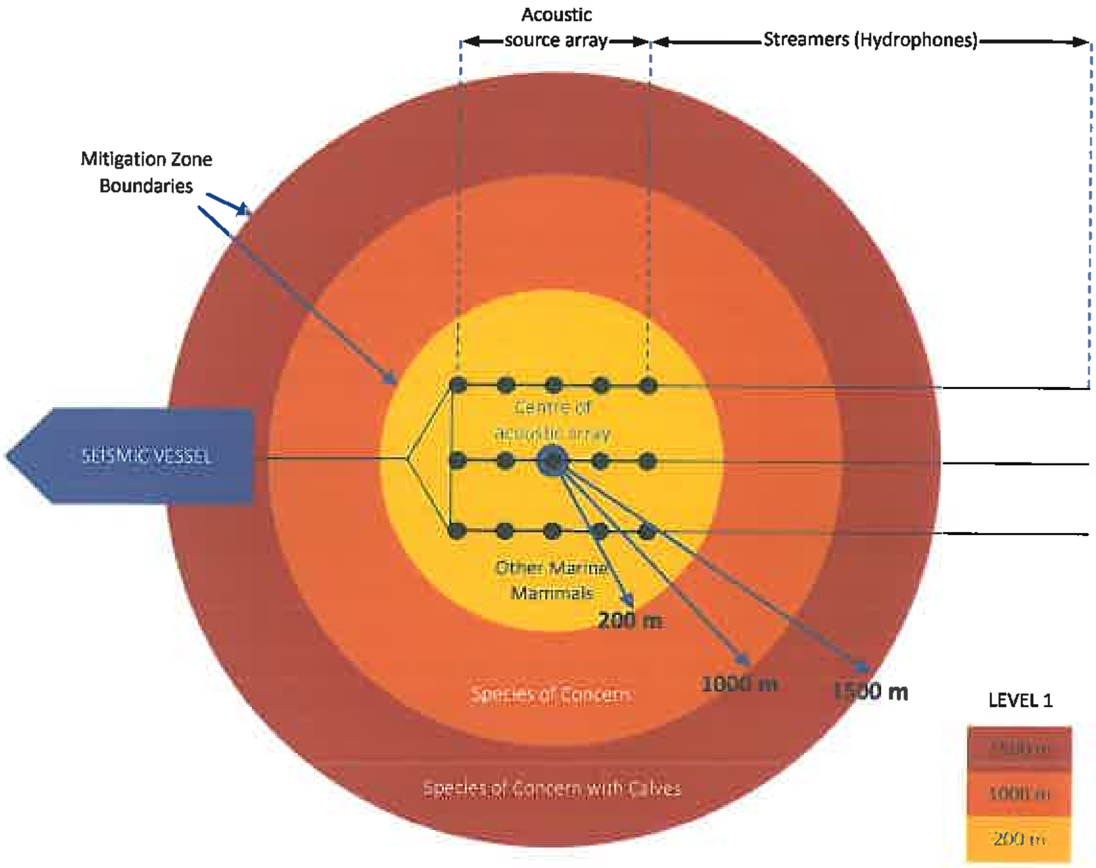

Figure 3: Mitigation Zone Boundaries for the survey as outlined in the Code.

4.5.1 PAM and calves

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

PAMOs must be familiar with this requirement.

4.6 Mitigation actions

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

4.6.1 Species of Concern with calves

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

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

In regard to cetacean SOC with a calf note that the requirements above apply to the entire group containing that calf. An explanatory note from DOC[7]: " *Yes, whole group has to be seen to move beyond zone, or not be seen for 30 mins*", and "*The intent of this provision is that since a group of marine mammals containing one calf has potential to contain more (and at distance it may be hard to follow movement of the cow/calf pair), the same precaution should apply to all the individuals*".

Due to the limited detection range of current PAM technology for ultra-high frequency cetaceans[8] (<300 m), any such bioacoustic detections will require an immediate shutdown of an active survey or will delay the start of operations, regardless of signal strength, or whether distance or bearing from the acoustic source has been determined. Shutdown of an activated acoustic source will not be required if visual observations by a qualified MMO confirm that the acoustic detection was of a species falling into the category of 'Other Marine Mammals'.

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

4.6.2 Species of Concern without calves

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

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

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

4.6.3 Other Marine Mammals

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

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

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

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[7] Email to BPM from DOC Senior Adviser - International and Marine; 17 December 2012.

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

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

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

4.6.4 Mitigation posters and summary

Refer to Addenda 1 of this MMMP for posters detailing mitigation action procedures.

5. Further Mitigation and Reporting Measures

In addition to the standard reporting and mitigation measures outlined in Sections 3 and 4 respectively, the following will be implemented during this survey and are over and above that identified in the Code. They have been agreed by DOC following discussions between Todd Energy and DOC.

1) **Minimise duration of survey**

   Seismic survey operations will occur 24 hours a day, 7 days a week (weather permitting) to minimise the overall duration of the survey.

2) **Additional marine mammal observations outside Operational Area**

   Whilst transiting to and from the Operational Area, and during daylight hours and good sighting conditions, a MMO will be on watch and recording marine mammal sightings marine mammal sightings outside the Operational Area will be recorded in the standardised DOC Off Survey Reporting form.

3) **Acoustic source testing**

   In addition to the operational requirements of the Code and in an attempt to further reduce acoustic disturbance during the survey, where possible Todd Energy will avoid acoustic source testing in waters < 100 m deep.

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

   Todd Energy will adhere to the requirements of Section 4.1.3 of the Code. This includes when the seismic vessel leaves and returns to the Operational Area following a crew change or port call.

5) **Additional reporting**

   Weekly MMO reports will be provided to DOC and the EPA.

6) **Immediate notification – Māui and Hector's dolphin sightings**

   DOC will be notified immediately of any sightings of Māui or Hector's dolphins.

7) **Necropsy of stranded marine mammals**

   If any strandings occur in the North and South Taranaki Bights that result in mortality during the survey or within 14 days of the survey completion date, Todd Energy will, on a case-by-case basis, consider covering the costs of undertaking a necropsy in an attempt to determine the cause of death.

6. Notifications to DOC

If a situation arises that requires a more direct line of communication from the observers to DOC, then the MMO Team Leader is to first inform the Party Chief of the issue and intended action. The following table summarises the situations when DOC (in effect, the Director-General) should be notified immediately. During this survey, the first point of contact within DOC is Ian Angus). If a response is required urgently then telephone, but in all other circumstances use email. Should Ian Angus be unavailable, please phone 0800DOCHOT and state the information as outlined in Section 3.3.

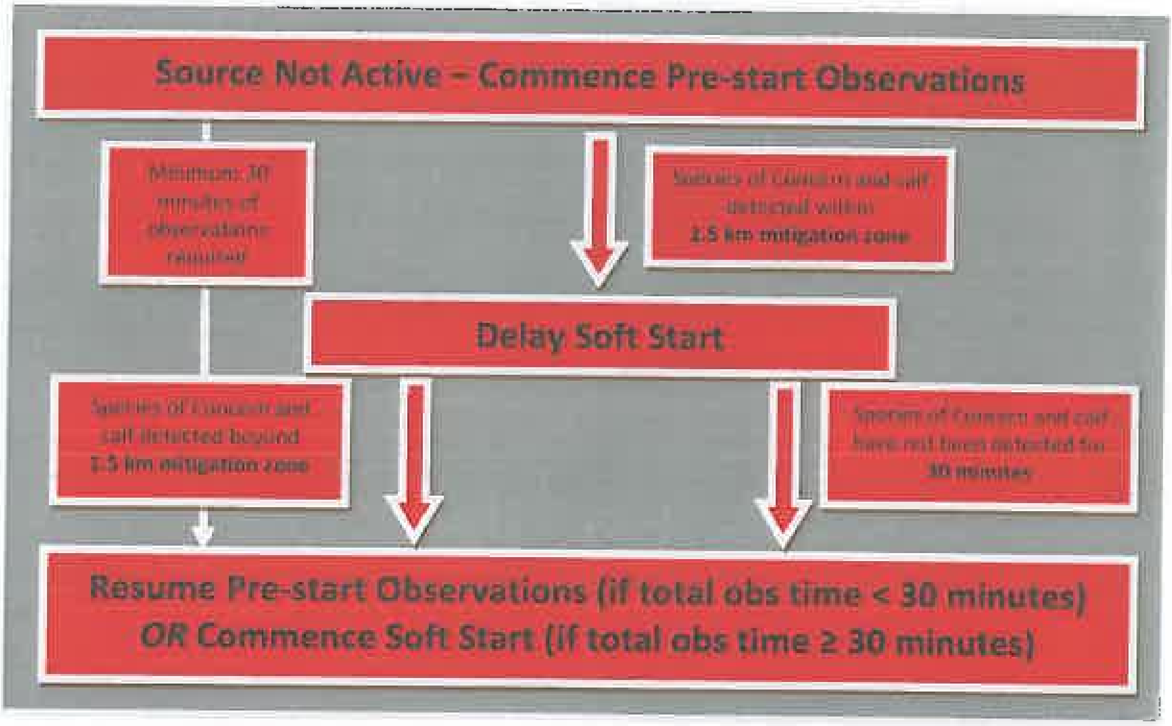
Table 1: Events that require DOC to be notified.

Situation	Timing of notification	Comments
The PAM system becomes non-operational	Immediate	This refers to when both primary and backup systems are non-operational
Any instances of non-compliance with the Code	Immediate	This is a standard requirement under the Code and includes instances where the operational capacity notified in the MMIA is exceeded – refer Section 4.3.2 of this MMMP
MMOs consider that there are higher numbers of marine mammals encountered than what was summarised in the MMIA, including large numbers of migratory whales	Immediate	MMO Team Leader should report to DOC immediately if there appears to be a higher number of marine mammals encountered than summarised in the MMIA. This includes large numbers of whales on northward migration
Sighting of Māui or Hector's dolphin	Immediate	DOC notified immediately. In these instances contact should be via: Ian Angus, National Office,
If ground-truthing results indicate the mitigation zones are insufficient for providing protection to marine mammals from physiological or behavioural impacts	As soon as practicable	DOC is notified via email as soon as practicable with details of the ground-truthing results
If PAM is being repaired, and operations continue without active PAM for maximum of 2 hours 20 mins per event	As soon as practicable	DOC is notified via email as soon as practicable with the time and location in which operations began without an active PAM system (Code 4.1.2)

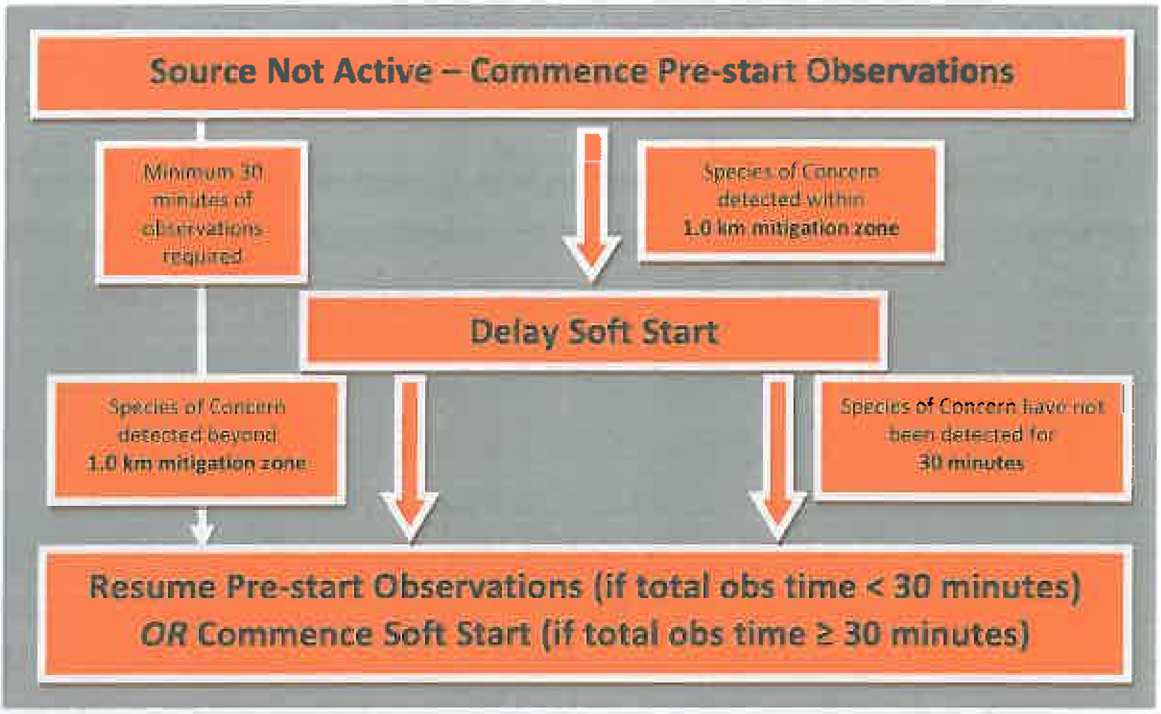
Addenda 1: Standard Mitigation Procedures – Good Sighting Conditions (poster format)

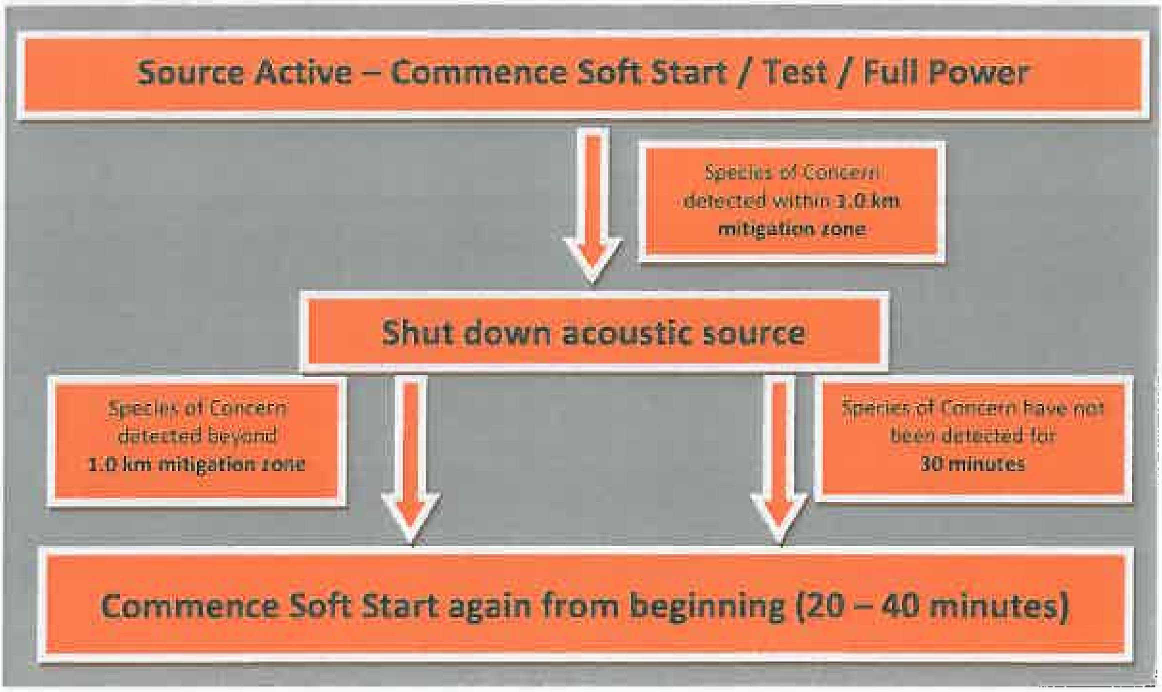
The following posters depict mitigation procedures. It is recommended they be posted in the instrument room, the PAM station and on the bridge. Operational flowcharts are also found in Appendix 4 of the Code.

Species of Concern with Calves within 1.5 km of Acoustic Source

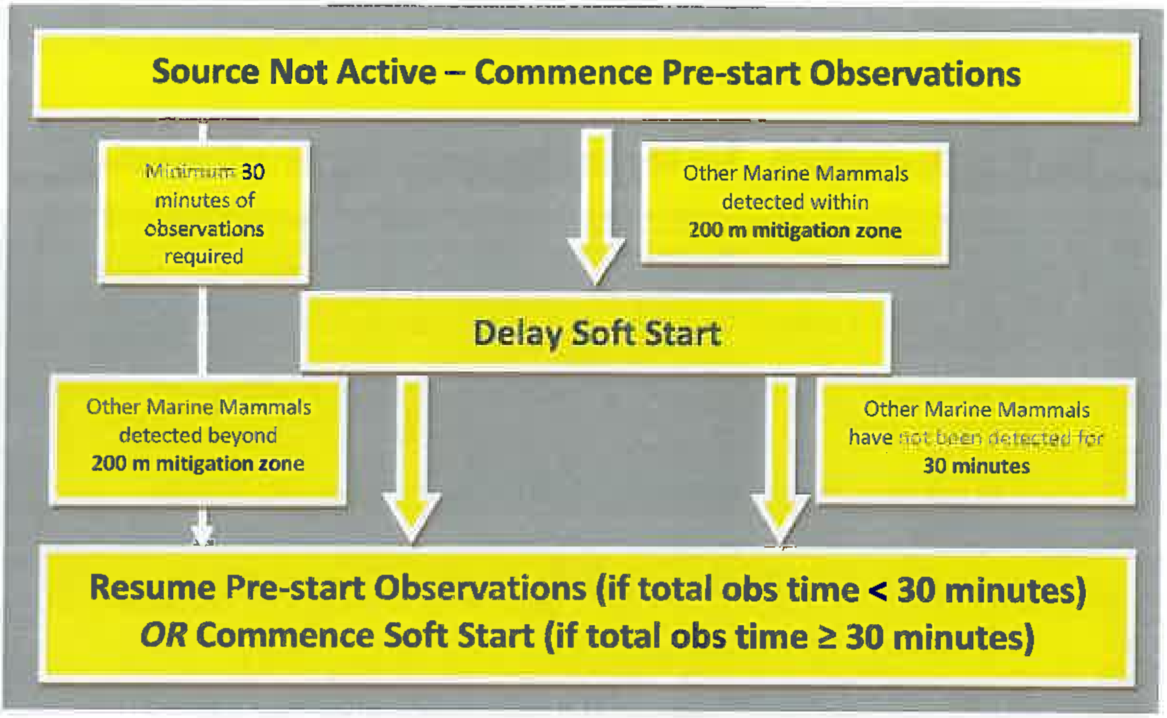


STANDARD MITIGATION ZONES
Species of Concern (no Calves) within 1.0 km of Acoustic Source

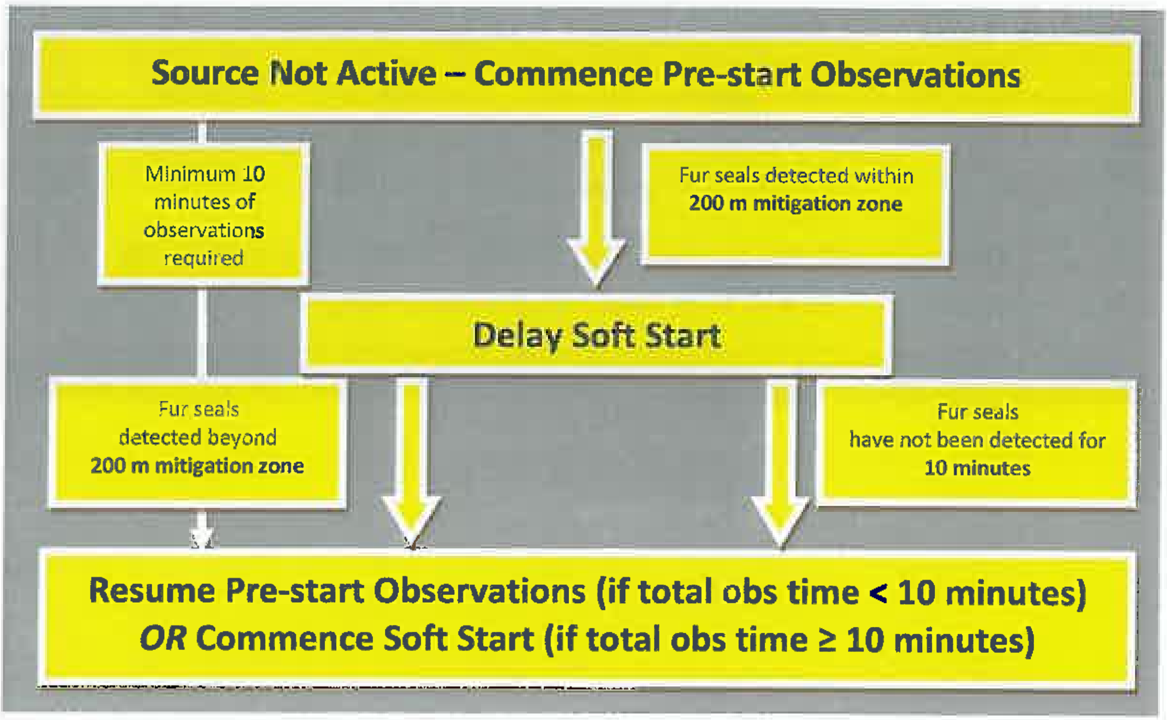




Other Marine Mammals within 200 m of Acoustic Source (excluding fur seals)



Fur seals within 200 m of Acoustic Source



BLUE PLANET MARINE

Addenda 2: Recommended Communication Protocols (poster format)

Note: Seismic control room to immediately notify observers (MMO and PAMO) of any changes in the status of acoustic source.

Normal Operations - No Marine Mammal Sighting/Detection

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

↓

Prior to soft start, seismic call observers for ALL CLEAR

↓

Seismic notify observers time of soft start

↓

Seismic call observers to confirm time of full power

↓

Seismic notify observers time of end of acoustic source shutdown

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

Blue Planet Marine

Delayed Soft Start or Shutdown – Marine Mammal Sighting/Detection

Pre-start observations | Soft Start | Full power acquisition

↓

Observers detect:

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

↓

Observers notify seismic to go on standby

↓

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

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

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

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

↓

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

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

↓

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

Addenda 3: Operational Area coordinates

These coordinates have been loaded into VADAR for real time monitoring of vessel location and marine mammal detections relative to the Operational Area.

Operational Area (WGS84)	
Longitude (decimal degrees West)	Latitude (decimal degrees South)
173.418003	-39.44270147
173.4168113	-39.26486874
173.6452872	-39.2637161
173.647065	-39.44164721
173.418003	-39.44270147

Addenda 4: Checklist for MMOs and PAMOs before acoustic source is put into water

MMOs and PAMOs to complete this checklist prior to the acoustic source being put into the water. MMO on watch to complete checklist during daylight hours, PAMO on watch to complete during hours of darkness.

There will be at least one MMO (during daylight hours) and one PAMO on watch <u>at all times while the acoustic source is in the water in the Operational Area</u>.

	Task	Confirmed by? (MMO &/or PAMO)
1	Establish communications protocol with seismic control room and between MMO and/or PAMO on watch and ensure these are functioning	
2	Ensure MMOs, PAMOs and seismic control room are aware that the acoustic source must not enter the water within the Operational Area without MMO (daylight hours) and PAMO (24 hours) on watch	
3	Is seismic control room aware that they need to inform MMO and/or PAMO at what time they intend to place seismic source into the water?	
4	MMO (daylight hours) informs PAMO that they are on watch prior to acoustic source being placed in water and endorses go ahead for acoustic source to be placed in water PAMO has acknowledged this?	
5	PAMO (24 hours) informs MMO that they are on watch prior to acoustic source being placed in water and endorses go ahead for acoustic source to be placed in water MMO has acknowledged this?	
6	MMO (during daylight hours) informs seismic control room that MMO and PAMO are on watch and that acoustic source can be placed in water. Seismic control room acknowledged this? If during hours of darkness, PAMO undertakes this task	
7	Seismic control room informs MMO and/or PAMO when the acoustic source enters the water	

Addenda 5: Species of Concern as defined in the Code

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

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

APPENDIX 7

Ground-truthing Methodology for Sound Transmission Loss Modelling

Ground-truthing Methodology for the Trestles 3D Seismic Survey

For surveys taking place in an AEI where sound transmission loss modelling is required, Appendix 1 of the Code requires that this modelling is ground-truthed during the survey by appropriate means.

Short-range modelling

During the Trestles 3D Seismic Survey the sort-range sound transmission loss modelling will be ground-truthed by isolating the acoustic sound trace received from the streamer hydrophones at the mitigation distances relevant to the Code (200 m, 1000 m and 1500 m). The streamer hydrophones record across the frequency range 1 – 250 Hz.

It is proposed that this ground-truthing will occur once at each of the following water depths:

- 90 – 99 m
- 100 – 109 m
- 110 – 119 m
- 120 – 129 m

By conducting this monitoring over varying water depths it is possible to investigate how predicted sound exposure levels vary across the bathymetry of the Operational Area.

Long-range modelling

In addition, the long-range modelling results will be ground-truthed by the placement of hydrophones into the southern reaches of the West Coast North Island Marine Mammal Sanctuary.

It is proposed that the hydrophones will be placed in two mooring locations:

The first location will represent the location within the sanctuary that is predicted to receive the highest sound exposure levels; and

The second location will be in the vicinity of the 100 m bathymetry contour to approximate the maximum sound exposure level that Maui dolphins in the area could typically be exposed to (the 100 m isobath defines the typical offshore range of this dolphin).