BEFORE THE BOARD OF INQUIRY
TAMARIND DEVELOPMENT DRILLING APPLICATIONS

EEZ100016

IN THE MATTER	of the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012
AND	
IN THE MATTER	of a Board of Inquiry appointed under s52 of the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 to decide on Tamarind Taranaki Limited's marine consent and marine discharge consent applications

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STATEMENT OF EXPERT EVIDENCE OF SIMON JOHN CHILDERHOUSE FOR TAMARIND TARANAKI LIMITED

Dated: 20 July 2018

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THE LAWYERS

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MAY IT PLEASE THE COMMITTEE

1. EXECUTIVE SUMMARY

1.1. Tamarind Taranaki Limited ("**Tamarind**") are applying for a Marine Consent and Marine Discharge Consent for activities associated with an existing petroleum mining activity in the Tui field. Tamarind's application is to enable the drilling of up to five side-track development wells from up to four existing wells, including associated logistic and environmental monitoring activities. The activity will take place within the area of interest, permit area PMP 38158 (the "**AOI**"), which is operated by Tamarind. The focus of this evidence is to provide a review and assessment of the potential impacts of the activity on marine mammals.

1.2. There is a reasonable amount of information available about marine mammals in the greater Taranaki region, although little specific information available about the AOI. Overall, over forty different marine mammals have been reported from the greater Taranaki region (including seven listed as threatened) while only two species have been reported from the AOI. The summaries provided in the Impact Assessment ("**IA"**) for Tamarind's application and additional material I have considered, provide a description of marine mammals that may potentially be found in the greater Taranaki region. Overall, the AOI is not thought to represent an important feeding or breeding area for any marine mammal species. However, blue whales have been reported as feeding in the broader Taranaki bight area and some parts of the South Taranaki Bight are recognised as important feeding areas for them.

1.3. The IA for the application identifies a range of activities that have the potential to impact on marine mammals, including both planned (e.g., underwater noise and vibration, turbidity, seabed deposition, artificial light, physical disturbance) and unplanned (e.g., accidental spills, loss of well control, dropped objects, vessel incidents) aspects. In addition, potential deck discharges are also considered, as are cumulative impacts.

1.4. The IA provides an assessment of the impact of a range of activities on marine mammals with residual impact assessments (i.e., incorporating appropriate mitigation and management) ranging from negligible to minor. These assessments are reasonable given the available information, our understanding of marine mammals and their ecology within the region, and the nature of the activity.

2. INTRODUCTION

2.1. My full name is Simon John Childerhouse.

2.2. I hold the following qualifications:

2.2.1. PhD in Marine Science, University of Otago (2009; Thesis – Conservation Biology of New Zealand sea lions);

2.2.2. Post Graduate Diploma in Wildlife Management, University of Otago (1993; Thesis – Individual photographic identification and population size estimates for sperm whales at Kaikoura, New Zealand); and

2.2.3. BSc in Zoology, University of Auckland (1991).

2.3. I am currently employed as a Senior Research Scientist at Blue Planet Marine, an environmental consultancy company based in Nelson, and have been employed there since 2012. Previously, I worked as a Marine Mammal Scientist for 11 years at the Department of Conservation (DOC) and a further three and a half years at the Australian Government's Marine Mammal Centre. I have been a member of the Scientific Committee of the International Whaling Commission from 1998 until 2013 during which time I held the positions of Head of the New Zealand delegation for eight years, Chair of the Southern Ocean Whales sub-committee for three years and a member of the Australian delegation for three years. I am also an Executive Officer of the South Pacific Whale Research Consortium, a member of the Convention on Migratory Species Scientific Council's Aquatic Mammals Working Group and a member of the New Zealand Threat Classification System team for marine mammals managed by DOC.

2.4. I have more than 25 years' experience working as a marine mammal scientist in New Zealand, Australia, Antarctica, USA, Canada and the South Pacific. My work has included pure and applied marine research, leading and project managing large scale, international research projects, publication across a broad range of marine research, lecturing and teaching at various universities, representation of both Australian and New Zealand Governments at international meetings, development of national and international policy and strategic documents, and delivering applied and practical solutions to challenging marine conservation and resource-utilisation issues. I have considerable experience in the ecology and behaviour of marine mammals and the identification and mitigation of impacts of anthropogenic activities, including noise, on marine mammals.

2.5. I have more than 50 peer-reviewed research papers (including three book chapters) published in the international scientific literature. These include papers on nine different New Zealand marine mammal species, namely New Zealand sea lions, whales (sperm, humpback, southern right and blue) and dolphins (Hector's, Māui, dusky and bottlenose). I have also authored more than 80 unpublished research reports.

2.6. I have appeared as an expert witness on marine mammal ecology and/or potential impacts on marine mammals for the following consent applications:

2.6.1. On behalf of Trans-Tasman Resources Limited (TTRL) for both its 2014 and 2016 marine mining consent applications to the New Zealand Environmental Protection Authority (EPA);

2.6.2. On behalf of DOC in regard to the 2014 Chatham Rock Phosphate (CRP) marine mining consent application to the EPA;

2.6.3. On behalf of OMV New Zealand Limited (OMV) for its 2014 marine consent application to the EPA for the Maari Field Development drilling programme;

2.6.4. On behalf of Environment Canterbury for its review of RMA consent applications for Lyttelton Harbour Channel Deepening and Reclamation projects, both in 2017; and

2.6.5. On behalf of Shell Taranaki Ltd (Shell) for both its 2015 and 2016 marine consent application to the EPA for Māui Field activities and drilling operations.

2.7. I have read the following information in preparation of my evidence:

2.7.1. The Marine Consent Application and Marine Discharge Consent Application (the "**Applications**") and the Impact Assessment and Annexures, which accompanied the Applications (the "**IA**"), in particular, the sections that relate to the description of the activity and marine mammals:

2.7.2. The statements of evidence by:

a) Mr Jason Peacock;
b) Mr Iain McCallum;
c) Dr. Brian King;
d) Dr. Sharon de Luca;
e) Ms Nicola Gibbs;
f) Dr. David Thompson;
g) Dr. Alison Lane;
h) Dr. Alison MacDiarmid; and
i) Mr Fraser Colegrave;

2.7.3. Submissions on the application provided to the EPA;

2.7.4. Proposed consent conditions provided by Tamarind;

2.7.5. EPA Key Issues Report dated July 2018;

2.7.6. The following independent reviews commissioned by the EPA (the "Technical Reviews"):

a) *Technical Review of Oil Spill Modelling*, prepared by Coffey Services (NZ) Limited, dated 26 June 2018 (the "**Coffey Report**");

b) *Technical Review and Analysis of Operational Activities associated with Sidetrack Development Drilling and Marine Discharge Consent - Assessment Report*, prepared by Oil and Gas Solutions Pty Limited, dated 22 May 2018 (the "**OGS Report**");

c) *Review of Marine Environmental Impact Assessment*, prepared by SEAPEN Marine Environmental Services, dated 26 May 2018 (the "**SEAPEN Report**"); and

2.7.7. Tamarind's '*Response to the Board's Request for Further Information under section 54 EEZ Act and Other Further Information Report*', dated July 2018 ("**RFI Response**").

2.8. My role in relation to Tamarind's application has been to undertake an independent review of the IA as it relates to marine mammals and to consider and assess any potential impacts of the proposed activities on marine mammals, to prepare expert evidence and to respond to any questions raised by the Board, EPA and/or submitters on this topic.

Code of Conduct

2.9. I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court of New Zealand Practice Note 2014 and that I have complied with it when preparing my evidence. Other than when I state I am relying on the advice of another person, this evidence is entirely within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

2.10. My qualifications as an expert witness are set out above. The issues addressed in this brief relate to the application for a marine consent and marine discharge consent and are matters within my area of expertise.

3. SCOPE OF EVIDENCE

3.1. In this evidence, I will discuss the following:

3.1.1. The existing environment, including marine mammal status, distribution and abundance in the Taranaki region and the AOI;

3.1.2. Potential impacts on marine mammals from the proposed activities, including: the proposed activities; the impact assessment methodology; the potential impacts from planned and unplanned activities, deck drain discharges and cumulative effects; and a review of scientific evidence;

3.1.3. Response to issues raised by the EPA Key Issues Report and technical reviews, where these are relevant to my evidence; and

3.1.4. Response to issues raised by submitters about marine mammals and potential impacts of noise.

4. EXISTING ENVIRONMENT

Marine Mammals potentially found in the Taranaki Region

4.1. A summary of marine mammals potentially found in the AOI and greater Taranaki area is provided in Section 4.3.7 of the IA. A large part of the information provided in the IA is drawn from a summary that I provided as part of previous application for the nearby Māui field by Shell Taranaki Ltd in 2017 (e.g., Childerhouse 2017), supplemented by additional material. Given the limited amount of specific information available about marine mammals in the AOI and their generally wide-ranging behaviour, it is appropriate to draw on information about marine mammals from the wider Taranaki area in assessing what may be present in the AOI.

4.2. Overall, the information provided in Section 4.3.7 of the IA provides reasonable but brief summaries of most of the marine mammal species likely to be found in the AOI. However, there are a few key species which are not listed in this section, including New Zealand fur seals, common dolphins and dusky dolphins, although I note that some of these are mentioned in subsequent sections (e.g., 6.2.2, 6.2.4). The likely reason that these species were missed is that Table 4.6 of the IA outlines the marine mammal species listed as “of concern” in the Department of Conservation’s 2013 Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations. Fur seals, common dolphins and dusky dolphins

do not appear on that list as they are not species of concern for seismic surveys.

4.3. The summary information in Section 4.3.7 is primarily a high-level overview, which is generally appropriate for most species given that there is little or no specific information available for most species. However, there are some recent pieces of research that are important to consider when reviewing what is known about marine mammals in the greater Taranaki area. I have provided some additional comments on some species in **Appendix A** and referenced new or updated information available at this time on blue whales, Hector's dolphins, Māui dolphins, common dolphins and dusky dolphins.

4.4. There has been a considerable body of work undertaken over the last few years in describing the marine mammal species that are likely to be present in the Taranaki region, and therefore by implication, potentially within the AOI. In addition to the information provided in the IA, I also reviewed previous marine mammal information provided to the EPA during earlier consent applications for projects in the Taranaki region (i.e., TTRL applications in 2014 and 2016; OMV application in 2014; Shell applications in 2015 and 2017).

4.5. Overall, over forty different marine mammals have been reported from the greater Taranaki region but only two species (i.e., blue whale, pilot whale) have been reported from the AOI. This conclusion comes from my review of 2,503 sightings, strandings and incidents provided to me by DOC and other sources up until November 2016. There are at least seven threatened[1] marine mammal species occurring in the greater Taranaki region including Antarctic blue whale, killer whale, Māui dolphin, Hector's dolphin, bottlenose dolphin, southern right whale and Bryde's whale. I have summarised the available marine mammal information from the DOC database in **Appendix B** and **Appendix C**.

4.6. It is important to note that there has been little systematic survey effort for marine mammals in the AOI, with the possible exception of some dedicated

[1] Based on Baker et al. (2016) Conservation Status of New Zealand Marine Mammals 2013.

marine mammal sighting effort on seismic surveys. The fact that only two different marine mammal species have been confirmed with the AOI is unlikely to be truly reflective of actual marine mammal diversity in the area and therefore, all the combined records from the Taranaki region are likely to provide a better overview of potential marine mammal diversity within the AOI.

4.7. There have been two acoustic recorders deployed approximately 25km north (Barlow et al. 2018) and 90km south-east (Goetz and Hupman 2017) of the AOI which provide some information about marine mammals within the region. The following species were detected at one or both of these locations: Antarctic blue whales, pygmy blue whales, pilot whales, sei whales, Antarctic minke whales, humpback whales and various dolphin species. All of these species have also been recorded visually (e.g., **Appendix B**, **Appendix C**).

4.8. While all the records provide an insight into the importance of the greater Taranaki region, it is important to recognise that these records are a summary of marine mammal records collected over 20 years from an area in excess of 30,000 km^2. There is unlikely to be any single place where all of these species occur together as they occupy different depths, ecosystems and even seasons. Furthermore, the AOI covers a very small part of this greater region and it is highly likely that many of the species present in the region are never or rarely found in the AOI. For example, Māui dolphins which are inshore, coastal dolphins, and beaked whales which are predominantly found in deep water (e.g., deeper than 200 m) are unlikely to be present within the AOI. While it is appropriate to consider which species are found in the wider region (so that information about which species may occur in the AOI is also considered), it is important to make the distinction clear that the AOI only represents a small subset of the wider region. Therefore, the identification of the greater Taranaki region as an important area for marine mammals, does not necessarily mean that each small part of that larger area (including the AOI) is also important to marine mammals.

4.9. Overall, the AOI is not thought to represent an important feeding or breeding area for any marine mammal species. However, blue whales have been

reported as feeding within the AOI. In addition, parts of the South Taranaki Bight are recognised as important feeding areas for blue whales, but these locations are likely to be highly variable in both location and extent due to natural variability in the Kahurangi upwelling system which drives localised productivity in the area. However, these feeding areas are generally considered to be further south and west of the AOI. The nearest Hector's/Māui dolphin sighting to the AOI is approximately 12 km to the south-east and it is assumed that these sub-species very rarely occur within the AOI given their low numbers and the distance of the AOI offshore. Further discussion of this is provided in **Appendix A**.

5. POTENTIAL IMPACTS ON MARINE MAMMALS FROM THE PROPOSED ACTIVITIES

A. Proposed Activities

5.1. Section 3 of the IA provides a description of the proposed activities for which marine consent is sought. These activities are identified under four categories:

5.1.1. Installation, operation and removal of a moored semi-submersible drilling rig, including placement of all equipment, well drilling and well commissioning activities, rig removal, and contingent activities;
5.1.2. Logistic support activities;
5.1.3. Environmental monitoring activities; and
5.1.4. Discharges from drilling rig deck drains.

5.2. The IA provides a review and assessment of the potential impacts of these activities from a semi-submersible rig in the AOI. I have followed the same format as the IA when undertaking my review of this application.

Installation, operation and removal of a moored semi-submersible drilling rig, including well intervention, drilling and contingent operations

5.3. The Applications seek consent for the use of a semi-submersible drilling rig. The key aspects of the operation of a semi-submersible rig that may potentially impact on marine mammals include:

5.3.1. Noise from general machinery (e.g., pumps, motors, etc.), dynamic positioning system, and drilling;
5.3.2. Drilling discharges; and
5.3.3. Anchoring.

5.4. Details of activities related to the semi-submersible operation include:

5.4.1. Maximum work programme of 9 months of operation with up to five wells being drilled for 40-45 days each. These times are all maximums and advice from Tamarind is that the total duration is likely to be shorter than these estimates;
5.4.2. No new wells will be drilled into the sea floor and all drilling will be undertaken from side-tracking of existing wells using existing subsea wellheads;
5.4.3. Most machinery, pumps, etc. will be above the water level of the semi-submersible rig during operations;
5.4.4. Side tracking will occur at depths of approximately 1,400-3,600m below the seabed;
5.4.5. Eight rig anchors will be spread over a diameter of approximately 1.5 to 2.5km around each wellhead and four anchors will be used to anchor the Blow-Out Preventers;
5.4.6. The potential use of explosives may be required to free stuck drilling equipment within the well, but any explosions will occur at least 1400m below the seabed;
5.4.7. Dynamic positioning systems of the rig will be used in combination with anchors to maintain the location of the rig; and
5.4.8. Any structures placed on the sea floor as part of this drilling programme will be fully removed at the completion of each well.

Logistic support activities

5.5. This mainly covers supply and support vessels and helicopter operations. Some details relevant to potential impacts on marine mammals include:

5.5.1. Supply and support vessels will not be moored or anchored during operations, but they may use dynamic positioning systems when manoeuvring. As noted in section 3.4 of the IA, vibrations from dynamic positioning systems on the support vessels are considered to be vibrations associated with the propulsion of a ship and therefore do not require consent under the EEZ Act; and

5.5.2. Additional vessel traffic will occur in the AOI in support of drilling operations.

Environmental monitoring activities

5.6. There are no aspects of environmental activities that may potentially impact on marine mammals with the possible exception of additional vessel traffic in the AOI.

Discharges from drilling rig deck drains

5.7. The discharges from drilling rig deck drains include the discharge of potentially hazardous substances that may impact on marine mammals.

B. Impact assessment methodology

5.8. The impact assessment methodology applied in the IA is appropriate for use with this application. However, there are some issues specific to marine mammals that should be considered when assessing impact:

5.8.1. In the column relating to Ecology in the Criteria for Assessing Magnitude of an Impact Table (Table 5.1 of the IA, page 103), there is reference to potential effects over *a short time period (one generation or less)*. While I appreciate that it is challenging to

develop meaningful criteria that covers all species, it is important to recognise that when considering long lived marine mammals, generation times can be as long as 20-30 years. Accordingly, any impact over this kind of time frame on marine mammals is unlikely to be insignificant; and

5.8.2. In the Ecology column in the Criteria for Assessing Sensitivity of a Seabed, Seawater Quality, Ecological and Social Values Table (Table 5.2 of the IA, page 104), key criteria include whether a species is endemic, endangered or protected. While these criteria are broadly useful, across the more than 40 marine mammal species found in Taranaki, the threat status ranges from *non-threatened* through to *nationally critical*. When lumping all marine mammals together, it is important to consider the different status levels especially for the highly threatened species which may occur in the AOI. I note that the SEAPEN report makes a similar comment and I provide some specific comment on this issue in section 6 of this evidence.

5.9. Section 5.6.1 of the IA deals with the confidence of the data used in the impact assessment process. The confidence of data used to assess potential impacts on marine mammals from:

5.9.1. offshore infrastructure was assessed as *reasonable*;
5.9.2. noise impacts were assessed as *high*;
5.9.3. vessel activities were assessed as *reasonable*; and
5.9.4. collisions were assessed as *reasonable*
5.9.5. loss of well control and loss from small accidental spills were assessed as *reasonable*.

5.10. These assessments are reasonable with respect to marine mammals, subject to the following qualifications:

5.10.1. There is no dedicated and systematic information available about marine mammals that may occupy the AOI and so our

understanding is based on what species we expect to find in the wider Taranaki region; and

5.10.2. With respect to potential noise from the semi-submersible rig, we can estimate the likely noise profile from overseas rigs and studies, but we do not know the exact noise profile produced by the rig that is to be used in New Zealand and how comparable it is with international studies.

C. Potential Impacts on Marine Mammals

5.11. Tables 6.7[2], 7.16[3] and 8.18[4] of the IA provide a summary of the potential impacts from planned and unplanned activities on marine mammals. The following paragraphs provide some additional discussion of these assessments, consistent with the three sections of the IA.

Planned activities

5.12. A description of planned activities is provided in Table 6.1 of the IA[5]. I believe that this table has identified all of the potential impacts that require review. The only activities identified as potentially having a significant interaction with marine mammals are noise and physical disturbance, as set out in Table 6.2 of the IA[6]. I agree with these assessments and review each of the assessments below.

Underwater Noise and Vibration

5.13. The most significant sources of noise from the proposed activities are associated with operation of the semi-submersible rig, including:

5.13.1. Use of the dynamic positioning system;
5.13.2. General machinery noise (e.g.; pumps, motors, etc.); and

[2] Refer to the IA, page 119
[3] Refer to the IA, page 169
[4] Refer to the IA, page 179
[5] Refer to the IA, page 110
[6] Refer to the IA, page 112

5.13.3. Drilling activities.

5.14. While noise may also be generated from the supply and/or support vessels, as noted above, the use of dynamic positioning systems by these vessels does not require consent and is outside the scope of this application. As such, I have not assessed or considered these aspects of the proposed activities further.

5.15. I been unable to find any published or unpublished literature on the actual noise generated by semi-submersible platforms and associated activities in New Zealand waters and so have reviewed data from the international literature for reference and context.

5.16. Underwater sound is generated from drilling and production platforms through the transmission of the vibrations of the machinery and drilling equipment such as pumps, compressors and generators that are operating on the platform (GOAG 2011). The main sound source from production and drilling comes from machinery itself (Richardson et al. 1995). The underwater noise depends strongly on the design of the structure that connects the machinery with the water. Hence, the relative scale of drilling noise, from quietest to loudest are: natural islands, platforms, semi-submersibles, drill ships (Richardson et al. 1995).

5.17. There is relatively little noise generated from the drilling head itself which is underground, generally thousands of metres below the sea floor. Additionally, with semi-submersibles, machinery is raised above the sea surface on risers supported by submerged flotation chambers, with sound primarily transmitted to water via air or through the risers rather than directly through the hull. This transmission through air leads to a reduced sound profile.

5.18. Data on underwater noise emitted from semi-submersibles is relatively limited (OSPAR 2009). Some examples of the noise from semi-submersible rigs overseas include:

5.18.1. Gales (1982) – Estimated levels of 125 dB re1µPa at frequencies of 29-70 Hz at distances of 13-15m with lower infrasonic tones a 7-14 Hz;

5.18.2. Green (1986) – The drilling source level was estimated to be 154 dB re1µPa@1m in the broadband frequency levels of 10 - 500 Hz and 80 - 400 Hz. At a distance of 1 km away from the drilling location, the broadband noise did not exceed ambient noise, although some weak tones were detected to a distance of 18 km away;

5.18.3. API (1986) – Estimates of a broadband source levels of 117 dB re1µPa@1m with the majority of energy occurring below 2000 Hz;

5.18.4. McCauley (1998) - During non-drilling periods the typical broadband level encountered was ~113 dB (*RMS*) re 1µPa@125m with various tones from the machinery observable in the noise spectra. During drilling periods, the broadband noise level increased to the order of 117 dB (*RMS*) re1µPa@125m;

5.18.5. Statoil (2012) – Drilling from a semi-submersible estimated at 154-160 dB (peak to peak) dB re 1µPa@1m with dominant frequencies at 100-500 Hz. While using dynamic positioning, noise was estimated at 170-180 dB (peak to peak) re 1µPa@1m with dominant frequencies of 500-1,000 Hz. Overall noise while undertaking drilling operations was estimated at 170 dB (*RMS*) re 1µPa@1m with the received level of noise reaching 105 dB (*RMS*) re 1µPa at 500m and 100 dB (*RMS*) re 1µPa at 1,000m from the source.

5.19. Based on the estimates provided above, there are a wide range of potential noise levels from a semi-submersible rig ranging from a low of 117 dB (RMS) re1µPa@1m though to a high of 170 dB (*RMS*) re 1µPa@1m. Given that we do not know what the source level of the rig to be used by Tamarind will be, it is appropriate to use the highest reported noise level when assessing impact. Therefore, I have used 170 dB (*RMS*) re 1µPa@1m in my

evaluations. I have not used the maximum of 180 dB (peak to peak) re 1µPa@1m as:

5.19.1. it is a *peak to peak* value rather than an *RMS* level[7]; and

5.19.2. based on advice from Tamarind, the dynamic positioning system won't be used very frequently as the position of the rig will primarily be maintained by the anchoring system.

5.20. Southall et al. (2007) is the most widely used refence material internationally for assessing impacts from noise on marine mammals. I have applied the thresholds indicated in Southall et al. (2007) to assess impacts from this activity. I have used Sound Pressure Level (SPL) values to assess marine mammal behavioural response thresholds (**Appendix D**). Sound exposure over time can lead to hearing damage, and Sound Exposure Levels (SEL) values were used to assess Permanent Threshold Shifts (PTS) and Temporary Threshold Shifts (TTS) in hearing. The sensitivity of an animal to a particular sound will depend on its functional hearing range and frequency-weighting functions can be applied to correct for that frequency-dependent hearing range. I took a conservative approach and compared non-frequency weighted SPL and SEL values for the drilling operation with the corresponding thresholds for behavioural response, TTS, and PTS.

5.21. A spherical spreading model was used to estimate the propagation and transmission loss of sound away from the source out to 100m (based on the approximate water depth of 100m in the AOI) and a cylindrical spreading model for distances greater than that (**Appendix D**). Sound propagation through water is a complex mechanism and the approach taken is a simple way of estimating energy loss as the sound travels further from the source. This simple model is useful for exploring SPLs and SELs.

[7] *peak to peak* is the part of the frequency bandwidth with the highest intensity/pressure levels. It can also be thought of as essentially the maximum level produced over a set period. *RMS* (Root Mean Square) is the mean variance of continuous waveforms (often loosely referred to as the "mean power") of continuous noise. This is the generally accepted metric in describing sound from a continuous sound source and is the most appropriate metric for the operation of the semi-submersible rig and associated activities.

5.22. Results from this model are shown in **Table D-1** in **Appendix D** and demonstrate that SPL (or noise intensity) declines with distance from the source. SEL (or total noise exposure) by comparison is a combination of noise intensity and exposure time as can be seen by the increasing estimates of SEL as exposure time increases. The conclusions of my modelling are:

5.22.1. Behavioural disturbance is possible out to 1250m from the rig;
5.22.2. There is no evidence of PTS at any distance from the rig; and
5.22.3. TTS is possible within 50m distance of the rig but individuals must remain within this area for 10 minutes or more to potentially be affected.

5.23. It is important to consider the likely reality of these estimated exposure times by distance. For example, it seems extremely unlikely that an animal could get within 1m of the sound source as the total noise source is from dispersed sources (i.e., noise energy from the drilling operation, pumps and machinery is dispersed over a large area from beneath the seabed, on the seabed, in the water column, and above the surface). For an animal to reach 1m from the source, it would have to swim through a steadily increasing sound field until the noise is uncomfortable, which seems unlikely.

5.24. Furthermore, it seems unlikely that a marine mammal would stay in the vicinity of an intense noise source for any length of time, particularly as no marine mammal species appears dependent on habitat in the immediate vicinity of the drilling operation.

5.25. The estimates above identify the possibility of significant behavioural responses and TTS in marine mammals but only within the immediate vicinity of the drilling operation. However, it is important to note the uncertainties associated with these estimates including, but not restricted to:

5.25.1. A lack of accurate estimation of the actual source level of the drilling;
5.25.2. The use of a simple propagation model; and
5.25.3. The use of generic, non-weighted threshold levels based on limited data.

5.26. Given that effects for marine mammals are only likely in the immediate vicinity of the rig, the overall impact of noise from operational and drilling noise on marine mammals is likely to represent a minor risk and that minor risk will be restricted to the immediate area around the rig.

5.27. There have been a range of reviews about the potential impacts of noise on marine mammals from semi-submersible operations. The conclusions from these reviews are consistent with my findings that any impacts will be minor and will only occur within the immediate vicinity of the rig. Specifically:

5.27.1. The sound levels produced by drilling rigs are relatively low (Gales 1982, Richardson et al. 1995);

5.27.2. The effects on marine mammals from drilling noise [*from semi-submersible rigs*] are expected to be restricted to minor, temporary (less than 1-hour) disturbances within approximately 100m of the drilling rigs. These impacts are considered to be negligible (US Minerals Management Service 2001);

5.27.3. GOAG (2011) found that sound levels from semi-submersible rigs were all below the threshold levels for PTS and TTS in hearing in cetaceans and pinnipeds according to the internationally recognised Southall et al. (2007) criteria[8]; and

5.27.4. The threshold for physical injury from Southall et al. (2007) was not exceeded under any circumstances during semi-submersible operations. The maximum distance over which behavioural disturbance was estimated to occur during drilling operations from the semi-submersible was 48m (Statoil 2012).

5.28. Section 6.2.3 of the IA[9] identifies mitigation measures that will be implemented by Tamarind to reduce, avoid and/or minimise potential impacts of noise from the operation. The following measures will significantly reduce the noise profile if implemented:

[8] Southall et al. (2007) is generally considered to be the definitive work for the assessment of acoustic impacts on marine mammals and is widely referred to in the international literature. This work also describes and defines noise threshold levels at which marine mammals are likely to show behavioural or physiological effects.
[9] Refer to the IA, page 116

5.28.1. Side-tracking instead of drilling new wells;

5.28.2. Not undertaking Vertical Seismic Profiling; and

5.28.3. The rig and support vessels only using dynamic positioning systems as required for safe operations.

5.29. The IA identifies the sensitivity of marine mammals to noise as *medium* (Table 6.4[10]) and the magnitude of the impact as *small* (Table 6.6[11]). These assessments combine to give a significance of the overall impact of noise as *minor* (Table 6.7[12]). I agree with these assessments.

Turbidity

5.30. Turbidity is unlikely to have a direct impact on marine mammals but may have an indirect impact through effects on their prey. However, given that no cuttings are being discharged, any increases in turbidity are expected to rapidly return to its pre-impact state, and as there are unlikely to be any significant impacts to plankton or fish[13], then there is little likelihood of any impact on marine mammal prey.

Deposition of equipment or material on the seabed

5.31. As with turbidity, seabed deposition is unlikely to have a direct impact on marine mammals but may have an indirect impact through effects on their prey. However, given the nature and amount of the deposited material plus the sparse benthic communities present in the area of effect, there is little likelihood of any impact on any marine mammal prey.

Artificial lighting

5.32. There will be no direct or indirect impact on marine mammals from artificial light.

[10] Refer to the IA, page 116
[11] Refer to the IA, page 119
[12] Refer to the IA, page 119
[13] Refer to the Evidence of Alison MacDiarmid

Physical disturbance

5.33. The physical presence of the rig and associated support vessels has the potential to impact marine mammals. The key mechanism of disturbance is likely to be through noise which is covered previously in this evidence. Other potential impacts include vessel strike and entanglement in anchor lines. I consider that the likelihood of either of these impacts to be extremely low. Any vessels operating around the rig will be moving at slow speeds which significantly reduces the chance of vessel strike for marine mammals and at other times, operational vessels will have the same risk profile as any other vessel transiting the Taranaki area.

5.34. The risk of entanglement wasn't identified in the IA but represents a very low risk given that all anchor lines will be kept as tight as possible at all times to maintain the location of the rig. Historically, marine mammal entanglements around New Zealand are typically associated with unattended fishing gear, with no specific records of marine mammal entanglement in mooring lines being listed in either the DOC stranding or sighting databases (DOC 2016). The entanglement of humpback whales in lobster pot mooring lines (Laverick et al. 2017) does however provide evidence to suggest that lines do pose some risk to marine mammals. This risk can be appropriately reduced though the use of thick, high tension mooring lines (Boehlert et al. 2007). Based on technical advice provided by Tamarind, the configuration of the mooring lines will comprise 90mm wire and 200mm chain which, given its very large size, will pose no risk of entanglement to marine mammals.

5.35. The key mitigation actions identified in IA Section 6.6.3[14] that can reduce the risk of physical disturbance of marine mammals include:

5.35.1. No anchoring of supply or support vessels during operations;

5.35.2. Vessels operating in the field will at all times travel at slow speeds and lookout will be kept on all vessels and at all times; and

[14] Refer to the IA, page 138

5.35.3. No direct approaches to marine mammals by vessels and avoidance action taken where possible when a marine mammal is observed in the operational area.

5.36. I do not recommend any additional mitigation for marine mammals given the low risk posed by the operation.

5.37. The IA identifies physical disturbance as having a *medium* sensitivity (IA Table 6.30) and *small* magnitude (IA Table 6.36) for marine mammals. These assessments combine to provide an overall assessment of the significance of impacts from physical disturbance on marine mammals as *minor* (IA Table 6.37). I agree with these assessments.

Unplanned activities

5.38. Section 7 of the IA considers a range of unplanned events that have the potential to impact on marine mammals. While there is little specific consideration of marine mammals under this section, some of the events considered could lead to impacts on them.

5.39. While I am not an expert in the assessment of the likelihood of these events, the generic coverage of them in the IA broadly includes marine mammals and, therefore, the assessments of the severity of impact appear reasonable for marine mammals. The residual potential impact of accidental spills other than a loss of well control is considered minor and the overall impact significance of a hydrocarbon release resulting from a loss of well control is considered as low as is reasonably practicable. I concur with the IA assessment that the severity of impact would be high, and in particular in specific circumstances where marine mammals would be affected (e.g., if a spill reaches an area where Māui dolphins may occur).

Deck drain discharges

5.40. The IA identifies localised discharges of harmful substances as having a *medium* sensitivity (Table 8.2[15]) and *negligible* magnitude (Table 8.8[16]) for marine mammals. These assessments combine to provide an overall assessment of the significance of impacts from deck discharges on marine mammals as *negligible* (Table 8.9[17]). I agree with these assessments.

5.41. Given that only small amounts of any harmful substance may be discharged via the rig deck drains and, that these discharges will be subject to high levels of dilution immediately upon entering the ocean, any potential impact on marine mammals is likely to be extremely small. Marine mammals range and forage over large areas so any local exposure to any harmful substance is likely to be extremely short in duration and unlikely to be repeated. In my opinion, the mitigation measures identified in the IA are appropriate to reduce the risk of discharges and the potential impacts on marine mammals.

Cumulative Effects

5.42. Section 10 of the IA addresses cumulative impacts. The only events that have been identified as potentially having a significant negative impact on marine mammals are noise and physical disturbance with both being assessed as *minor*. Given the even lower level of risk from the other potential impacts considered in the IA, no cumulative effects are expected from these.

5.43. With respect to noise, given that disturbance from this activity will only potentially impact marine mammals up to 1,250m from the rig (and most likely less than this), it is highly unlikely that any cumulative impacts from noise will occur. While other activities in the greater Taranaki area also generate noise from their operations (e.g., Māui and Maari fields, TTRL sand mining (if consent is approved), general vessel traffic), acoustic disturbance from these activities (with the notable exception of seismic surveys) has a similar or smaller area of effect as for this operation. Therefore, while noise

[15] Refer to the IA, page 170
[16] Refer to the IA, page 175
[17] Refer to the IA, page 176

from these activities will be potentially audible to marine mammals over a wide area, impacts such as disturbance and/or displacement will be restricted to the immediate area around each activity.

5.44. Furthermore, given that the maximum length of time for this operation is 9 months, no cumulative impacts are likely after the conclusion of this activity.

6. RESPONSE TO ISSUES RAISED BY THE EPA KEY ISSUES REPORT AND TECHNICAL REVIEWS

6.1. I note that section 4.3 of the SEAPEN report provides some alternative assessments for the sensitivity of marine mammals to various potential impacts. Specifically, that some sensitivities should be assigned as *high* rather than *medium* given that some species are listed as endangered or protected. This raises the significance designation for some residual impacts from *minor* to *moderate* although the author notes that this higher designation still doesn't require the need for any further mitigation. This is one of the major issues with lumping all marine mammals into a single group for assessment as I noted in section 5.8.2 of this Evidence.

6.2. I would note that only 7 of the more than 40 marine mammal species potentially found in the AOI are listed as threatened and so this increased designation would not apply to the other 33+ non-threatened species. With respect to the 7 threatened species, in my opinion, it is highly unlikely that most of these species will be found in the AOI, and even if they are, it will be extremely rarely (e.g., Hector's, Māui and bottlenose dolphins are primarily inshore, coastal dolphins; southern right whales are rarely seen on the west coast of New Zealand; the AOI is at the extreme southern range of Bryde's whales). Blue whales are known from the AOI and killer whales could be found there.

6.3. While the approach outlined in the SEAPEN Report is strictly correct given the assessment criteria as specified, I believe that these higher residual impacts are not biologically plausible, given what we know about the species themselves and the nature of the impacts. For example, my noise modelling

has indicated that there will be no behavioural impact on marine mammals further than 1,350m from the rig. To designate this as a moderate impact for blue whales which forage over hundreds, if not thousands of square kilometres, is overly precautionary and simply isn't a sensible designation. If the area over which the disturbance or impact is occurring represented a large part of a significance breeding or feeding area, then such a residual impact could be warranted but I do not believe that is the case in this example.

7. RESPONSE TO ISSUES RAISED BY SUBMITTERS

7.1. A number of submissions raised general concerns around a lack or inadequacy of information provided in the IA on potential impacts on marine mammals. I will specifically address some of those issues here but consider most of the issues have already been addressed in the body of my evidence.

7.2. *Cumulative impacts* – A number of submissions express concern about unacceptable risks from cumulative impacts on threatened marine mammals. I addressed this issue specifically in my paragraphs 6.42 – 6.44 but, in essence, the IA assessed all potential impacts individually as *minor* or *negligible* for all issues considered. I agree with these assessments and note that even the minor impacts identified (i.e., noise, physical disturbance) are localised in the immediate area around the operation and so any cumulative impacts are unlikely. In my opinion, any potential cumulative effects resulting from the proposed activity will not pose unacceptable risks to marine mammals.

7.3. *Blue whales* – Concerns were raised about the potential impacts on blue whales[18]. I provide some additional information about this species in **Appendix A**. New Zealand blue whales have been reported in the outer waters of the Taranaki region with two sightings recorded within the AOI. Given that there have been no systematic surveys of the AOI, it is difficult to establish the significance of the AOI for blue whales but the South Taranaki Bight is recognised as an important feeding area (one of several such sites

[18] For example, refer to the submissions of Climate Change Taranaki Incorporated and Oil Free Wellington

in New Zealand). However, blue whales are known to occur in much of the outer waters of the Taranaki region including being seen as far north as off the coast of Auckland and down the west coast as far south as Westport. Most of the sightings of blue whales in the Taranaki region are well to the south and west of the AOI.

7.4. It is important to note that while blue whales are listed as *endangered* internationally, they are listed as *migrants* and *not threatened* under New Zealand's domestic threat ranking criteria (Baker et al. 2016). Many submissions commented that they believe that the proposed drilling programme will threaten blue whales. My conclusions with respect to noise and other potential impacts are that any impacts from the drilling will be minor and those will be restricted to the immediate vicinity of the rig as discussed above.

7.5. Furthermore, I would note that there has been significant oil and gas development (including drilling) in the Taranaki region for several decades and therefore any marine mammals present in the area may be habituated to any noise or other impacts as has been speculated for sperm whales in the Gulf of Mexico (Jochens et al. 2008).

7.6. *Impacts of noise* – I have reviewed and expanded considerably on the information on noise provided in the original IA (e.g., in my paragraphs 6.13 – 6.29). This includes a detailed explanation of the potential impacts of noise from semi-submersible drilling operations and a quantitative assessment of the impacts of noise on marine mammals. Given that noise impacts for marine mammals are only likely in the immediate vicinity (i.e., < 1,250m) of the rig, the overall impact of noise on marine mammals represents a minor impact and that minor risk will be restricted to the immediate area around the rig.

7.7. *Sperm whales near Kaupokonui river mouth* – Climate Justice Taranaki Incorporated and Lydon DeVantier's submissions express concerns about eight sperm whales that washed up dead in May in South Taranaki and further about the impact of seismic surveying on cetaceans. While the reason for this stranding remains unknown, it is certain that it is unrelated to any

drilling activity as there has been no drilling in Taranaki waters for more than a year. Sperm whales are also reasonably regularly reported as stranding around the New Zealand coastline, including in areas where there is no oil and gas activity. The proposed activities do not include any seismic surveying.

7.8. *Loss of marine habitat* – Te Korowai o Ngaruahine's submission expresses concern about loss of marine habitats due to extensive drilling activities. Based on my assessment of the potential impacts of the activity all being low risk, I do not believe that there will be any significant marine mammal habitat lost. The largest potential impact for marine mammals is noise and the minor impacts that are possible will be limited to the area immediately around the areas where the rig is operating.

8. PROPOSED CONDITIONS AND MITIGATION MEASURES

8.1. I reviewed the proposed consent conditions dated 4 April 2018 proffered by Tamarind as part of the Applications. Given the assessment of minor or negligible residual risk posed by all the potential impacts assessed, the conditions and mitigation measures discussed in section 11 of the IA are adequate given the level of risk to marine mammals from the operation.

8.2. Notwithstanding this conclusion, I would recommend some amendments and additional conditions to aid in understanding and clarifying the nature of the potential impacts on marine mammals. Specifically:

8.2.1. Marine Consent – Amend Proposed Condition 12 – this provides for the collection and reporting of data on marine mammals (except for fur seals) from any vessel authorised by this consent. I recommend an addition to this condition in that the collection and provision of photos should be provided where practically possible and that these photos should be submitted to DOC and EPA along with the data from marine mammal sightings;

8.2.2. Marine Consent – Amend Proposed Condition 13 – this specifies the provision of a marine mammal identification guide for all

offshore personnel. I would recommend that a copy of such a guide is made available on each vessel authorised by this consent, i.e. the drilling rig and support vessels.

8.2.3. Marine Consent – Additional condition – the assessment of the potential impact of noise from the proposed activities in the IA and my own review are based on studies from overseas and from different rigs and, therefore, the actual noise produced by this operation is unknown. A short study near the start of the activity and covering the full range of activities that generate noise could be undertaken to empirically measure the actual noise during normal operating conditions to confirm that it is within the range of noise levels that have been assumed for this assessment of potential impacts[19]; and

8.2.4. Marine Consent – Additional condition – an additional condition could be included in the marine consent to ensure all personnel are aware of their responsibilities under the Marine Mammals Protection Act 1978 as follows:

> *All personnel undertaking airborne, seagoing and watch-keeping duties are informed of their obligations under the Marine Mammals Protection Act 1978 and Marine Mammals Protection Regulations 1992 or any subsequent Regulations.*

9. CONCLUSION

9.1. The IA provides an assessment of the impact of a range of activities on marine mammals with residual impact assessments (i.e., incorporating appropriate mitigation and management) ranging from negligible to minor. These assessments are reasonable given the available information, my understanding of marine mammals and their ecology within the region, and the nature of the activity.

[19] Potential text for such a condition could be drawn from parts of Condition 12 Underwater noise from the TTRL Sand Mining consent approved in 2017 by the EPA.

9.2. Overall, I consider the likely impact on marine mammals from the proposed activity as set out in Tamarind's marine consent applications and IA to be negligible to minor.

Dr. SIMON JOHN CHILDERHOUSE
20 July 2018

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APPENDIX A: ADDITIONAL INFORMATION ABOUT MARINE MAMMALS IN THE TARANAKI REGION

Blue whales

There has been some new information become recently available about blue whales in the Taranaki region including Barlow et al. (2018), Torres et al. (2017), Goetz and Hupman (2017) and Goetz et al. (2017). The new key pieces of information include:

- The blue whales regularly seen in the Taranaki region are most likely pygmy blue whales, a sub-species of blue whales but calls from Antarctic blue whales, a different sub-species, have also been detected occasionally in Taranaki;
- Genetic and other information suggest that there is a high degree of isolation of blue whales in New Zealand from their nearest neighbours in Australia;
- A conservative, abundance estimate of blue whales in New Zealand was provided of 718 (95% CI = 279-1926) individuals. No local abundance estimate was available for Taranaki;
- During the collection of acoustic recordings over a full year in Taranaki, blue whales were heard on 99.7% of days. An acoustic recorder deployed approximately 25 km north of the Tui field recorded blue whale calls on 96% of days. While these data provide good evidence that blue whales are present in the region year round, their calls are potentially detectable over ranges of tens of kilometres and therefore the exact location of these calling whales is unknown. Both Antarctic blue and pygmy blue whales were detected on an acoustic recorder approximately 90km to the south-east of the permit area confirming the presence of both sub-species within the region;
- Blue whales change habitat use patterns across the Taranaki region relative to oceanographic patterns;
- Feeding has been regularly reported in the Taranaki region. Cow-calf pairs have also been reported including nursing behaviour; and
- Satellite tracking of two blue whales demonstrated large scale movements (e.g., circumnavigation of the South Island) potentially indicative of large foraging areas, although given such a small sample size and an unusual year with respect to oceanography and productivity, it is unclear how representative these two tracks are.

Overall, the Taranaki region represents an important feeding area for blue whales in New Zealand with other feeding areas recognised off Westport, Kaikoura and Oamaru. The relative importance of the Taranaki area for feeding is also likely to fluctuate from year to year as a result of variation in the Kahurangi upwelling. Most of the sightings of blue whales and blue whale feeding are south of the AOI but feeding has been observed inside the AOI.

Figure A-1 provides some details of blue whale sightings and movements around New Zealand. Both panels in the Figure have significant qualifiers associated with them. Specifically, while the left-hand panel shows all sightings, it is not possible to adjust these density estimates for the amount of search effort in each cell and, given that the vast majority of dedicated marine mammal sighting effort has come from the Taranaki area, it is not clear how representative these data of are actual relative densities around New Zealand. The right-hand panel only represents data from two individual whales and therefore it is unclear how representative these two tracks are for all whales and years given the small sample size and the unusual year that it was tracked in.

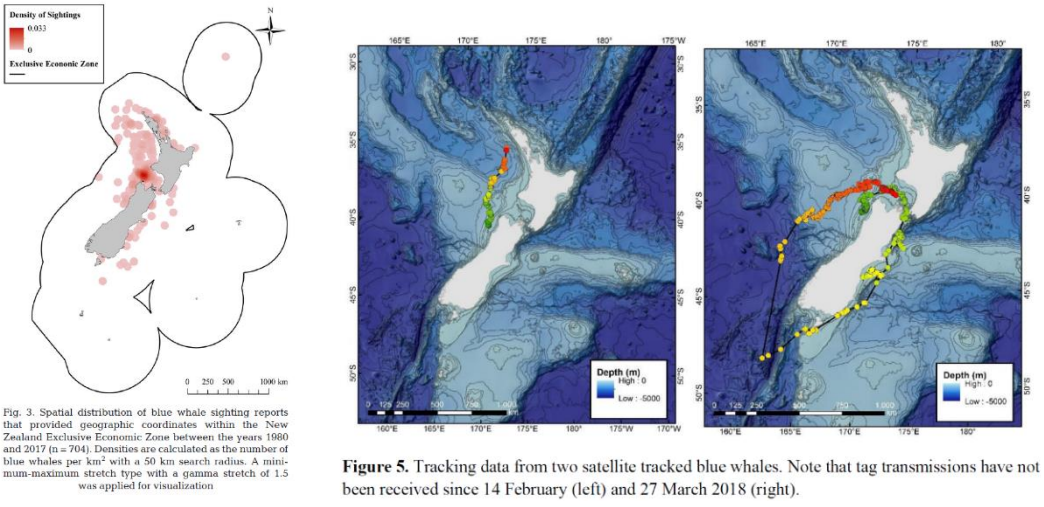

Fig. 3. Spatial distribution of blue whale sighting reports that provided geographic coordinates within the New Zealand Exclusive Economic Zone between the years 1980 and 2017 (n = 704). Densities are calculated as the number of blue whales per km² with a 50 km search radius. A minimum-maximum stretch type with a gamma stretch of 1.5 was applied for visualization

Figure 5. Tracking data from two satellite tracked blue whales. Note that tag transmissions have not been received since 14 February (left) and 27 March 2018 (right).

Figure A-1 - Distribution and satellite tracking data from blue whales in New Zealand. *Left hand panel – Spatial distribution of blue whale sighting reports from 1980-2017 (n=704) from Barlow et al. (2018). Right hand panel – Tracking data from two blue whales satellite tagged in 2018 from Goetz et al. (2017).*

Hector's and Māui dolphins

There is presently a completely new risk assessment being undertaken by DOC and MPI for both Māui and Hector's dolphins which includes the development of a new

spatial explicit, habitat model for both sub-species. While preliminary results from this work have been presented, the final outcomes and models were not yet available at the time of the development of this evidence. While it is premature to speculate about the final outcome of that assessment, it is clear from all the preliminary habitat modelling undertaken to date, that both Hector's and Māui dolphins are highly unlikely to be found in the AOI but that the area is still within the potential range of both sub-species. This is consistent with four opportunistic (but unconfirmed) sightings of Hector's or Māui dolphins reported from the Māui Field (McConnell 2015). The outcomes from this recent assessment are likely to be available in time for the hearing later in the year, at which time I will provide an update of the relevant results.

Common dolphins

A short summary about Common dolphins in Taranaki was provided by Helen McConnell in the statement of evidence she prepared for the Shell Māui Field consent in 2015. McConnell (2015) summarised the available knowledge at that time:

> *Common dolphins have been recorded from waters spanning all regions of New Zealand (Berkenbusch et al. 2013) and often occur in very large pods (up to several thousand individuals; Baker, 1999). Despite few sightings being specific to the Māui Field, numerous sightings in nearby waters have occurred, indicating that this is possibly the most frequently encountered cetacean species in the region (Torres, 2012). The majority of sightings reported are from summer months; however observational bias may be somewhat responsible for this apparent seasonality. Eighteen stranding events have been reported for this species in the Taranaki region (Appendix 1). Based on this it is clear that common dolphins could be frequently present in the Māui Field.*

While this statement was prepared for the Māui Field, given that it is immediately to east and south of the AOI, the summary is likely to hold equally for the AOI. There is no new information since that time that would change or amend this view.

Dusky dolphins

A short summary about Dusky dolphins in Taranaki was provided by Helen McConnell in the statement of evidence she prepared for the Shell Māui Field consent in 2015. McConnell (2015) summarised the available knowledge at that time:

> *Dusky dolphins prefer cooler waters around the South Island of New Zealand and the lower North Island (Wursig et al. 2007). Whilst typically considered a coastal species; sightings frequently occur in deep offshore waters, particularly during winter and individuals can travel up to 100km between locations (Wursig et al. 2007). From April to July a population of dusky dolphins utilises Admiralty Bay (in the Marlborough Sounds) as specific foraging habitat. Torres (2012) reported one sighting of dusky dolphins in the Māui Field in December and four stranding have occurred on the Taranaki coast (Appendix 1). This information suggests that dusky dolphins are more frequently seen around the South Island, but occasionally utilise waters in the Taranaki region.*

While this statement was prepared for the Māui Field, given that it is immediately to east and south of the AOI, the summary is likely to hold equally for the AOI. There is no new information since that time that would change or amend this view.

APPENDIX B: SUMMARY OF ALL MARINE MAMMAL SIGHTING AND STRANDING DATA FOR TARANAKI FROM THE DEPARTMENT OF CONSERVATION MARINE MAMMAL DATABASE TO NOVEMBER 2016 WITH ADDITIONAL SIGHTINGS OF BLUE WHALES PROVIDED BY DR LEIGH TORRES.

Figure B-1 is all marine mammal events for the Taranaki Region and Figure B-2 is the same data but zoomed in to petroleum permit 38158 area.

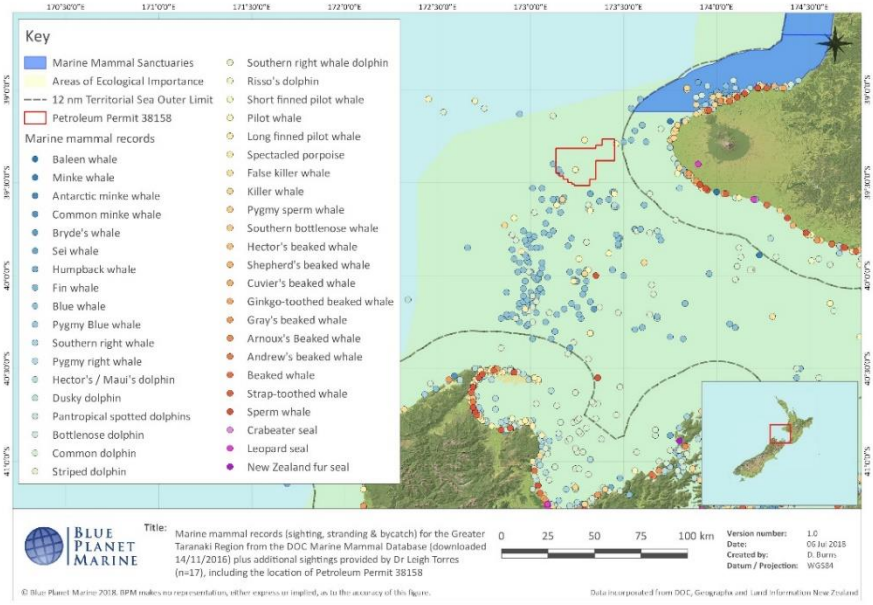

Figure B-1

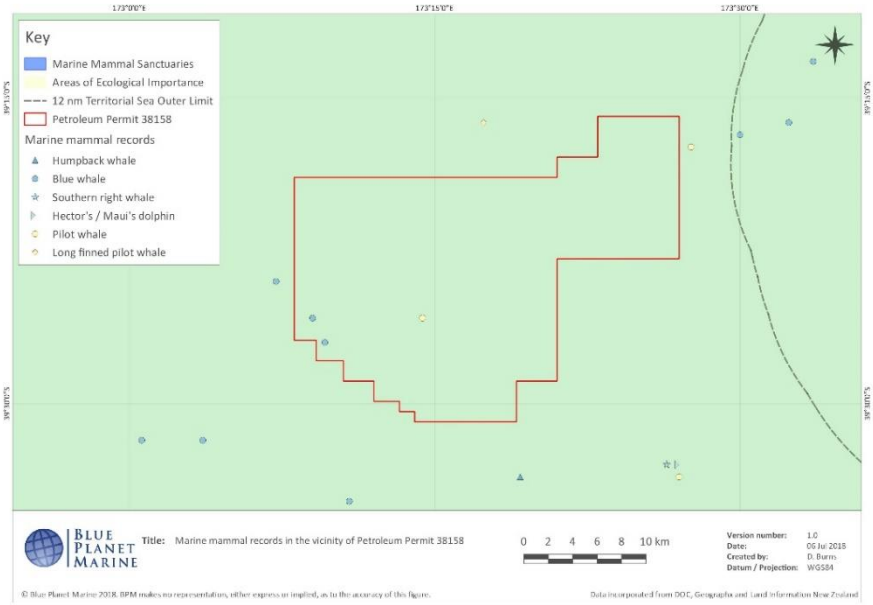

Figure B-2

APPENDIX C: SUMMARY OF ALL MARINE MAMMAL SIGHTING, STRANDING AND INCIDENT DATA FOR TARANAKI FROM THE DEPARTMENT OF CONSERVATION MARINE MAMMAL DATABASE TO NOVEMBER 2016 WITH ADDITIONAL SIGHTINGS OF BLUE WHALES PROVIDED BY DR LEIGH TORRES[23]

Species or group	Number of sightings
Andrew's beaked whale	4
Antarctic minke whale	6
Arnoux's Beaked whale	2
Baleen whale	12
Beaked Whale	31
Blue Whale	180[24]
Bottlenose dolphin	52
Bryde's whale	6
Common Dolphin	628
Common minke whale	21
Crabeater seal	1
Cuvier's beaked whale	39
Dusky Dolphin	102
False killer whale	8
Fin whale	8
Ginkgo-toothed beaked whale	3
Gray's beaked whale	63
Hector's/Māui dolphin	423
Hector's beaked whale	3
Humpback whale	156
Killer whale	188
Leopard seal	16
Long finned pilot whale	132
Minke whale	4

[23] Blue whale sighting data was provided to me and the Decision Making Committee by Dr Leigh Torres during the 2016 TTRL consent process. These data are summarised in Dr Torres' evidence titled Further Evidence of Leigh Torres on behalf of Kiwis Against Seabed Mining Incorporated. Dated 21 March 2017

[24] Including the additional blue whale sightings from Dr Torres provided to the Decision Making Committee during the 2016 TTRL consent process.

Species or group	Number of sightings
New Zealand fur seal	3
Pantropical spotted dolphins	1
Pilot whale	49
Pygmy blue whale	4
Pygmy right whale	22
Pygmy sperm whale	47
Risso's dolphin	10
Rough toothed dolphin	1
Sei whale	6
Shepherd's beaked whale	8
Short finned pilot whale	2
Southern bottlenose whale	2
Southern elephant seal	2
Southern right whale	116
Southern right whale dolphin	8
Spectacled porpoise	1
Sperm whale	103
Strap-toothed whale	27
Striped dolphin	3
Total	2,503

APPENDIX D: MAXIMUM SOUND PRESSURE LEVELS (SPLS) AND SOUND EXPOSURE LEVELS (SELS) ESTIMATED FOR A SEMI-SUBMERSIBLE RIG DURING DRILLING INCLUDING THRESHOLDS FOR PHYSICAL IMPACTS.

	Sound Pressure Level (dB re 1µPa)	**SEL (Broadband SPL) [dB re 1µPa]**					
Distance from source (m)	Spherical ≤ 100m; Cylindrical >100m	1sec	10sec	10min	0.5hrs	1hr	3hr
1	170	170	180	198	203	206	210
50	136	136	146	164	169	172	176
100	130	130	140	158	163	166	170
200	127	127	137	155	160	163	167
500	124	124	134	152	157	160	164
1000	121	121	131	149	154	157	161
2000	118	118	128	146	151	154	158
4000	115	115	125	143	148	151	155
1250	120						

Table D-1 - Estimated impacts on cetaceans from noise from semi-submersible operations during drilling including behavioural (green), Temporary Threshold Shift (orange) and Permanent Threshold Shift (red).

Notes:

- SPL (Sound Pressure Level) is defined as the physical intensity or 'loudness' of sound at a specific point
- SEL (Sound Exposure Level) is the total noise energy produced from a noise event over the duration of that event, which includes the effect of the exposure duration.
- Impact criteria follow Southall et al. (2007). Specifically, behavioural disturbance at an SPL of 120 dB re: 1 µPa2, TTS at an SEL of 195 dB re: 1 μPa^2-s and PTS at an SEL of 215 dB re: 1 μPa^2-s for continuous noise sources such as drilling operations.
- A simple acoustic propagation model is used to estimate sound transmission loss over distance from the source. Based on an estimated water depth of approximately 100m, a spherical spreading model is used out to 100m from

the source followed by a cylindrical spreading model at distances greater than 100m.

- The sensitivity of an animal to a particular sound will depend on its functional hearing range and frequency-weighting functions can be applied to correct for that frequency-dependent hearing range. A conservative approach was taken and compared non-frequency weighted SPL and SEL values.