Title of Proposal - Effect of marine seismic sounds to demersal fish and pearl oysters

Section 1 - Summary of your proposed action

Provide a summary of your proposed action, including any consultations undertaken.

1.1 Project Industry Type

Science and Research

1.2 Provide a detailed description of the proposed action, including all proposed activities.

The search for, and exploitation of, oil and gas reserves in the offshore waters of Australia largely focuses on the continental shelf, which is also the region of the nation's most productive fisheries. The exploration process involves the use of seismic surveys, which can be a major source of underwater noise that produces high intensity, low frequency impulsive sounds at regular intervals. The effects of this noise pollution on commercial fisheries is controversial (Carroll et al. 2017), with claims that seismic surveys reduce catch rates. However few experimental studies have been conducted in "real-world" situations that can be used to determine the size and extent of actual impacts. If changes in catch rates do indeed occur, it seems likely that these have a behavioural basis, since it is generally agreed that there is no obvious or scientific evidence of mortality of fishes in the short-term during surveys and only limited and contradictory evidence for physiological impacts (Carroll et al. 2017).

The Australian Institute of Marine Science (AIMS) is undertaking a large-scale three year study to better understand the effect of marine seismic surveys on important commercial fisheries of Western Australia.

Assessing the extent of these potential impacts requires field experiments that occur in real-world situations over scales of time and space relevant to the activities of industry and the life cycles of the organisms concerned. The key objective of these studies is to ascribe threshold levels of sound that can be imposed on organisms that minimise potential impacts of noise on population fitness. We propose to use industry-standard seismic survey equipment in field situations that replicate actual activities, taking into account issues such as water depth and substrate type that might affect the propagation of sound, and occurring over a sufficient time scale to assess behavioural (e.g. fish displacement through species/assemblage distribution and composition) and physiological (e.g. pearl oyster sublethal impacts and mortality) responses to high intensity impulsive sounds. The aim of this work aligns with the key AIMS research goal of 'developing risk assessments and models of impacts for coastal developments'.

This project will provide information that will enable improved environmental management of marine seismic surveys by industry and government regulators by providing evidence-based data regarding the effect of marine seismic surveys on:
1. behaviour of fish, and

2. physiology of pearl oysters and their ability to produce market quality pearls

To achieve these, it is proposed to conduct a seismic source exposure experiment in September/October 2018. The seismic source exposure experiment will occur at each of the two study areas (described further in the following sections), these being;
1. Fish study area, offshore from Karratha Western Australia
2. Pearl study area, offshore from Broome Western Australia
At each study area a commercial seismic vessel towing sound source arrays, the same as those typically used in a 3D marine seismic survey, will complete a predetermined series of lines to replicate the exposure that may would occur in an actual marine seismic survey.

The seismic source experiment, which will replicate in a controlled manner the sound exposure from a seismic survey, will occur in late September / early October 2018 (the exact date depends on vessel availability) over a four day period at each of pearl and fish study locations. It should be noted that the survey will only involve the transit of the vessel and the firing of seismic airgun array, there will be be no hydrophones (commonly referred to as streamers) deployed for recording of returned seismic signals as would occur in a typical seismic survey.

The seismic source array details are summarised in the following Table.

Number of Sound Source Arrays (airguns): 2 - 3
Airgun array total volume: ~0.04 m3 (3200 cubic inch)
Operating pressure: ~13 500 kPa (2,000 psi)
Source depth: 7 m
Shot point interval: ~12.5 m (5 seconds)
Shots per line: 860 - 1700
Time per line: 2.4 hours (fish), 1.2 hours (pearl)
Line separation (time): 24 hours(pearl), 12 hours (fish)
Line separation (space): 500 m

A seismic source array contains a number of airguns each of which is fed compressed air that is rapidly released to produce an impulse signal. The individual airguns are sized, calibrated and oriented to optimise efficiency in directing the sound waves towards the sea floor. The airgun array operating pressure will be approximately 13,500 kPa (2,000 psi) and a volume in the order of 0.04 m3 (3,200 cubic inches). Airguns of this size are known to produce sound pulses within a few meters in the order of 220 to 260 dB re 1uPa-m at frequencies extending up to approximately 130 Hz.

Marine seismic survey vessels are specialised purpose built ships and normally carry a complement of 40 to 45 crew members. Additional vessels will be at each location prior to, during, and after the seismic vessel conducts the survey work in order to deploy and recover experimental equipment.

1.3 What is the extent and location of your proposed action? Use the polygon tool on the map below to mark the location of your proposed action.

Area	Point	Latitude	Longitude
Fish site	1	-20.136472543282	117.28417500816
Fish site	2	-19.986836626852	117.2786818441
Fish site	3	-19.790546764668	117.69616231285
Fish site	4	-20.012646097652	117.7181349691
Fish site	5	-20.131315062122	117.48742207847
Fish site	6	-20.126157410776	117.28966817222
Fish site	7	-20.136472543282	117.28417500816
Pearl study area	1	-18.085747249265	121.83663472496
Pearl study area	2	-18.087052685214	121.83663472496
Pearl study area	3	-18.060942121356	121.84762105308
Pearl study area	4	-18.067470126334	121.8668471273
Pearl study area	5	-18.131431723652	121.840754598
Pearl study area	6	-18.123600945667	121.82152852379
Pearl study area	7	-18.085747249265	121.83663472496

1.5 Provide a brief physical description of the property on which the proposed action will take place and the location of the proposed action (e.g. proximity to major towns, or for off-shore actions, shortest distance to mainland).

The proposed action will occur at two locations, referred to as the pearl study area and the fish study area. The pearl study area is located approximately 30 km from the nearest coastline and 45 km west-southwest from Broome Western Australia. The fish study area is located approximately 75 km from the northern extremities of the Dampier Archipelago 80 km from the nearest mainland coastline and 110 km north east of Karratha.

1.6 What is the size of the proposed action area development footprint (or work area) including disturbance footprint and avoidance footprint (if relevant)?

The proposed survey will cover approximately 75 km2 at the pearl study area and approximately 100 km2 at the fish study area

1.7 Is the proposed action a street address or lot?

Lot

1.7.2 Describe the lot number and title.not applicable

1.8 Primary Jurisdiction.

Commonwealth Marine

1.9 Has the person proposing to take the action received any Australian Government grant funding to undertake this project?

Yes

1.9.1 Please provide details.

As an Australian Government listed entity, funding provided to AIMS through the Department of Industry Innovation and Science has been used to co-invest, with industry funding sources, to facilitate the execution of the proposed scientific studies.

1.10 Is the proposed action subject to local government planning approval?

No

1.11 Provide an estimated start and estimated end date for the proposed action.

Start date 09/2018

End date 10/2018

1.12 Provide details of the context, planning framework and State and/or Local government requirements.

The proposed action does not fall under any planning framework at State or Local government level. Nor is it subject to the O*ffshore Petroleum and Greenhouse Gas Storage Act 2006* because it is for scientific research purposes and no return seismic signals will be recorded. The *Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act)* is the sole Commonwealth legislation under which approval is being sought.

The proposed action will comply with the Objects of the EPBC Act, including the principles of ecologically sustainable development. Furthermore it will provide information to enhance ecologically sustainable development specifically through improved knowledge of the effect of marine seismic surveys on the marine environment and more generally improved understanding of the effects of anthropogenic noise inthe marine envionment.

1.13 Describe any public consultation that has been, is being or will be undertaken, including with Indigenous stakeholders.

Consultation with stakeholders has commenced. This includes consultation with fishing industry representative bodies as well as individual organisations, relevant government

agencies and other research organisations. Stakeholders were initially identified by AIMS, based on knowledge of industry and marine science, and further stakeholders were subsequently identified through discussions.

A workshop was convened in January 2018 to review and finalise the experimental design for both the fish study and the pearl study. This workshop included representatives from WA Fisheries, the WA Fishing Industry Council, fishers, the Pearl Producer's Association, pearl farmers and the seismic survey industry.

A public consultation program is planned to be implemented, commencing in April 2018, which will involve local residents and indigenous groups in and around Broome. No public consultation is planned to be conducted in Karratha, beyond this referral, due to the remoteness of the fish study area, it being approximately 110 km offshore from Karratha.

1.14 Describe any environmental impact assessments that have been or will be carried out under Commonwealth, State or Territory legislation including relevant impacts of the project.

Refer to 1.2 above

1.15 Is this action part of a staged development (or a component of a larger project)?

No

1.16 Is the proposed action related to other actions or proposals in the region?

No

Section 2 - Matters of National Environmental Significance

Describe the affected area and the likely impacts of the proposal, emphasising the relevant matters protected by the EPBC Act. Refer to relevant maps as appropriate. The interactive map tool can help determine whether matters of national environmental significance or other matters protected by the EPBC Act are likely to occur in your area of interest. Consideration of likely impacts should include both direct and indirect impacts.

Your assessment of likely impacts should consider whether a bioregional plan is relevant to your proposal. The following resources can assist you in your assessment of likely impacts:

• Profiles of relevant species/communities (where available), that will assist in the identification of whether there is likely to be a significant impact on them if the proposal proceeds;

• Significant Impact Guidelines 1.1 – Matters of National Environmental Significance;

• Significant Impact Guideline 1.2 – Actions on, or impacting upon, Commonwealth land and Actions by Commonwealth Agencies.

2.1 Is the proposed action likely to have ANY direct or indirect impact on the values of any World Heritage properties?

No

2.2 Is the proposed action likely to have ANY direct or indirect impact on the values of any National Heritage places?

No

2.3 Is the proposed action likely to have ANY direct or indirect impact on the ecological character of a Ramsar wetland?

No

2.4 Is the proposed action likely to have ANY direct or indirect impact on the members of any listed species or any threatened ecological community, or their habitat?

Yes

2.4.1 Impact table

Species	Impact
We have developed a considered response	Given the short duration of actual seismic

Species	Impact
regarding impacts on listed migratory species based on a thorough review of relevant species profiles and Significant Impacts Guidelines. Refer to Section 2.6.2	survey activity, the movement of the vessel and the control measures to be adopted during the study activities (refer Section 4), the proposed action is unlikely to have a significant effect on any listed species or any threatened ecological community as identified in the EPBC Act protected matters search (Attachments A and B); or on their habitat. The proposed study is therefore unlikely to cause any of the significant impacts described within the Significant Impact Guidelines 1.1, Matters of National Environmental Significance

2.4.2 Do you consider this impact to be significant?

No

2.5 Is the proposed action likely to have ANY direct or indirect impact on the members of any listed migratory species, or their habitat?

Yes

2.5.1 Impact table

Species	Impact
We have developed a considered response regarding impacts on listed migratory species based on a thorough review of relevant species profiles and Significant Impacts Guidelines. Refer to Section 2.6.2	Given the short duration of actual seismic survey activity, the movement of the vessel and the control measures to be adopted during the study activities (refer Section 4), the proposed action is unlikely to have a significant effect on any listed migratory species as identified in the EPBC Act protected matters search (Attachments A and B); or on their habitat. The proposed study is therefore unlikely to cause any of the significant impacts described within the Significant Impact Guidelines 1.1, Matters of National Environmental Significance

2.5.2 Do you consider this impact to be significant?

No

2.6 Is the proposed action to be undertaken in a marine environment (outside Commonwealth marine areas)?

Yes

2.6.1 Is the proposed action likely to have ANY direct or indirect impact on the Commonwealth marine environment?

Yes

2.6.2 Describe the nature and extent of the likely impact on the whole of the environment.

Potential effects of the proposed survey have been assessed by way of literature review, comparison to outcomes of previous surveys, and industry benchmark information. The factors that may lead to potential significant impacts are considered to be:

1. Underwater noise from the acoustic energy source

2. Routine discharges associated with maritime activities

3. Accidental (non-intended activities) including fuel spills and introduction of invasive species

These potential impacts also relate to migratory species, cetaceans and marine listed species (referred to in Sections 2.4 and 2.5). Therefore to avoid repetition the potential impacts to threatened species, cetaceans, migratory species and marine listed species are addressed together in the following text.

1.Underwater Noise

There are a range of potential impacts to marine animals from sounds emanating from a seismic survey. These impacts vary with seismic discharge intensity, distance from the source, species and mitigation measures. The predicted levels of underwater noise from the acoustic energy source have previously been described in Section 1.2. Preliminary modelling of sound transmisison from an airgun array of the expected capacity has been completed. The estimated transmission fof a signal from a 3,130 cubic inch airgun array at each of the fish study and the pearl study areas is presented in **Attachment E**. This indicates that the the received sound levels decrease rapidly over the first 1 km. The receved sound sound exposure level is reduced to less than 185 dB re1uPa2.s within a distance of approximately 100 m and less than 160 dB re1uPa2.s after approximatley 1.5 km.

1.1 Baleen Whales

Baleen whales produce a rich and complex range of underwater sounds ranging from about 12 Hz to 8 kHz but with the most common frequencies below 1 kHz (McCauley, 1994). This combined with studies of their hearing apparatus suggests that their hearing is also best adapted for low frequency sound (McCauley, 1994; Richardson et al., 1995). Baleen whales make individual sounds that last for up to 16 seconds (Richardson et al., 1995) and can “sing” for long periods. These sounds are thought to be used in social interaction and communication between individuals and pods. Potential significant impacts of underwater noise relate to potential physiological effects, behavioural response leading to secondary effects and masking of communications leading to secondary effects.

Humpback whales are the baleeen whales most likley to be encountered at the study areas (refer to Section 3) as the areas are withn the normal migratory route for these animals. The timing of the mapping exercise (April) is outside of the migratory season for humpback whales in the region. Humpback whales do not feed, nor are they known to mate in the study areas. It is probable that humpbacks will be encountered in the study areas on their southwards migration at the time of the proposed survey experiments (September /October). Because they are migraaitng it is highly unlikely that they would be exposed to seismic noise on more than one occasion. The maximum time for which an indivdiual whale may be exposed to seismic noise is in the order of 3 hours.

Physiological Effects: No definitive values are available to predict the precise nature of, and potential for, injury from underwater noise due to variations between species, between individuals of the same species and even the same individual as it ages. To further complicate assessment, a broad range of variables relating to bathymetry, environmental conditions, and vessel position affect transmission of underwater noise. This uncertainty has been addressed by firstly by applying precautionary conservative assumptions regarding the level of sensitivity of the species to noise impacts, and secondly by assuming worst case noise exposure levels.

For marine mammals a panel of international experts in acoustics and marine mammal science Southall et al. (2007) developed conservative exposure criteria for cetaceans (and pinnipeds) drawn from the most current research and analysis, amassed experience, and contemporary policy and regulatory objectives and practices. The exposure criteria are based primarily on the levels at which Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS) have been found to occur. Induced PTS represents tissue injury, but TTS does not. Although TTS involves reduced hearing sensitivity following exposure, it results primarily from the fatigue (as opposed to loss) of cochlear hair cells and supporting structures and is, by definition, reversible (Nordmann et al, 2000).

The conservative criteria arrived at by Southall et al (2007) for TTS onset levels from exposure to a single pulse are: In terms of sound exposure level (SEL): mid frequency weighted 183 dB re 1 uPa2.s.

The conservative criteria arrived at by Southall et al (2007) for injury from exposure to a single pulse are: In terms of sound exposure level (SEL): mid frequency weighted 198 dB re 1 uPa2.s.

Behavioural Effects*:* For a change in behaviour to be considered biologically significant should have an effect on one or more life functions affecting individual vital rates (such as

maturation or reproduction) and ultimately leading to population effects (National Research Council, 2005). The level of noise at which response is elicited varies between species and even between individuals within a species (Richardson et al., 1995). Dunlop et al (2017) have reported on the results of the behavioural response of Australian humpbacks to seismic sounds (BRAHSS) studies that specifically investigated the behavioural response of humpback whales, the whale most likely to be encountered in the course of this research experiment. Their study quantified and interpreted the response of southward migrating humpback whales that were deliberately exposed to a 3,130 cubic inch commercial airgun array. Their reported findings included the discussion statement;

"***In this study, no abnormal behaviours, such as instances of a female separating form her calf or sustained bouts of high energy surface behaviours (which are considered abnormal behaviour indicative of a stress response in humpback whales) , were observed. We also continued to observe typical behaviours including singing, socialising with conspecifics, using social signals, such as surface slapping, and general migratory travels southwards. Given the lack of abnormal behaviour and the continued prevalence of typical behaviours we found no evidence that they were under significant additional stress during the experimental trials. Put another way, the behaviour of whales appeared to be driven primarily by other whales and the need to socialise and migrate, and the addition of a seismic vessel and airguns had little impact on that***."

Masking of vocalisations*:* Masking of vocalisations may occur when the frequency of sound generated by the seismic survey coincides with the frequency of vocalisations at sufficient intensity to 'mask' the calls. As noted earlier, baleen whales emit calls that overlap the frequency range of seismic shots. It is considered unlikely that masking of baleen whale communications would occur to any substantive degree due to the transient nature of the seismic survey and the transient nature of any whales in the study area. Hence it is considered very unlikely that masking would have any significant adverse effect at either the individual or species level.

1.2 Toothed whales and dolphins

Toothed whales produce a wide range of whistles, clicks, pulsed sounds and echolocation clicks. The frequency range of toothed whale sounds, excluding echo location clicks, are mostly <20 kHz with most of the energy typically around 10 kHz, although some calls may be as low as 100 to 900 Hz with source levels ranging from 100 to 180 dB re 1 µPa, (Richardson et al, 1995). There is little systematic data on the response of toothed whales to seismic surveys. Richardson et al (1995) reports that sperm whales appeared to react by moving away from survey and ceasing to call even at great distances from a survey. However in a study supported by the US Minerals Management Service (Jochens and Biggs, 2003) two controlled exposure experiments were carried out (including one with three simultaneously tagged whales) to monitor the response of sperm whales to seismic source. The whales were exposed to a maximum received level of 148 dB re 1µPa. There was no indication that the whales showed horizontal avoidance of the seismic vessel nor was any there any detected change in feeding rates of the tagged sperm whales.

Smaller toothed cetaceans have poor hearing in the low frequency range of air-gun array noise (10-300 Hz), so may be able to approach operating seismic vessels closely without adverse behavioural or pathological effects (McCauley, 1994). Goold (1996) studied the effects of 2D seismic survey on common dolphins (*Delphinus delphis*) in the Irish Sea. The results indicated that there was a statistically detectable level of local displacement of dolphins around the seismic operation out to about 1 km radius from the airguns.

The hearing capability of larger toothed whales (such as the killer whale) is unknown, but it is possible that they can hear better in the lower frequencies than the smaller toothed cetaceans. If this is the case, in lieu of any other information, their reactions to seismic survey vessels may be akin to those of the baleen whales.

Disturbances associated with the proposed seismic programme are likely to be temporary, infrequent, outside of peak migratory periods and very localised. In addition, the location of the survey areas is remote from any critical areas for whale feeding and calving therefore, effects on marine mammals are expected to be minimal.

1.3 Turtles

The sea turtle's auditory canal consists of cutaneous plates underlain by fatty material at the side of the head which serves the same function as the tympanic membrane in the human ear. From previous research it is evident that sea turtles can detect sound, and that their hearing is confined to lower frequencies, mainly below 1000 Hz (Bartol, Musick & Lenhardt 1999). Studies using auditory brainstem responses of juvenile green and Ridley's turtles and subadult green turtles showed that juvenile turtles have a 100 to 800 Hz bandwidth, with best sensitivity between 600 and 700 Hz, while adults can hear over a bandwidth of 100 to 500 Hz, with the greatest sensitivity between 200 and 400 Hz (Piniak et al 2016; Ketten & Bartol 2005). Similarly loggerhead turtles are considered to be low frequency specialists with a hearing range of 50 -1100HZ (Lavender *et al.,* 2014).

***Physiological Effects**:* Little is known about the source levels and associated frequencies that will cause physical injury to turtles. Studies by Keevin and Hempen (1997) on the effects of explosions on turtles recommend that an empirically based safety range developed by Young (1991) be used for guidance. Using Young's safety range formula and converting back to sound pressure levels, a conservative value of 240 dB re 1uPa is obtained for adult turtles. This equates to the theoretical potential for physical damage if the turtle is within a few metres of the airgun array.

The only known data addressing threshold shift in turtles are from a study conducted by Eckert *et al.* (2006) on leatherback turtles. This study demonstrated that when exposed to repetitive high-level acoustic energy impulses greater than 185 dB re 1 uPa the tested turtles suffered temporary threshold shift and eventually permanent threshold shift. However in adopting 185 dB re 1 uPa as the threshold level for temporary threshold shift in turtles it needs to be recognised that the study was based on a small sample of leatherback turtles, the results are based on airborne noise (not underwater noise), and it is unlikely that a turtle would (in an uncontrolled

situation) be exposed to multiple high intensity seismic impulses.

Behavioural Effects: Sea turtles have been recorded as demonstrating a startle response to sudden noises (Lenhardt et al. 1983). McCauley et al (2000) conducted controlled exposure experiments on a loggerhead turtle and a green turtle to monitor behavioural response to approach by an airgun. They found two types of response:

1. Above a received airgun level of approximately 155 dB re 1 uPa2.s the turtles began to noticeably increase their swimming speed.

2. Above a received airgun level of approximately 164 dB re 1 uPa2.s the turtles began to show more erratic swimming pattern, possibly indicative of them being in a distressed state.

Eckart *et al.* (2004) used GPS and Time Depth Recorders to track movement and behaviour of two unconstrainedleatherback turtles exposed to seismic survey noise. They found no change in behaviour or movement from these turtles exposed to seismic survey noise. However the authors caution that the sample size (two turtles) meant that quantitative analysis was not possible.

1.4 Crocodiles

Species of crocodile that have been tested indicate a wide range of hearing ability with best sensitivity in the region from about 150 to 3000 Hz (Wever, 1971). The saltwater crocodile is considered common and locally abundant in Western Australia however there is no information as to the likely threshold levels for adverse effect from underwater noise. In the absence of data it should be assumed that crocodiles display greater sensitivity to noise disturbance than turtles.

1.5 Fish

Physiological Effects*:* There is a wide range of susceptibility to noise pulses among fish. The primary factor likely to influence susceptibility is the presence or absence of a swim bladder. Generally fishes with a swim bladder will be more susceptible than those without this organ. Many adult fishes, including the elasmobranchs (sharks, rays and sawfish) do not possess a swim bladder and so are not susceptible to swim bladder-induced trauma.

Only a limited number of studies have been done to establish the threshold criteria for injury to fish from underwater noise. Hastings and Popper (2005) reviewed the available literature to establish threshold underwater noise criteria for impacts from pile driving. They reasoned that if transient sounds could be characterized using a waveform similar to the impulse, then effects of pile driving on fish could be extrapolated from the larger field of data based on effects observed from exposure to blasts. Based on this and extrapolating from Yelverton et al. (1975, in Hastings and Popper 2005), they derived preliminary guidance SEL for protection of fish from underwater noise. The waveform characteristics of piling and seismic are reasonably similar

(but with key differences of peak intensity, spatial scale and the interval period, piling typically has sound pulses with peak intensity in the order of 180 dB re 1uPa at 1 second intervals compared to peak intensity of up to about 240 dB re 1uPa at 8 second intervals for seismic).

Using a similar approach to the EPBC Policy Statement 2.1, and the derived relationship of Hastings and Popper (2005), the continuous SEL value at which the fish would have to be exposed for 10 minutes to reach threshold criteria of Hastings and Popper (2005) has been calculated to be:

For a 0.1 kg fish: single exposure of 199 dB re 1 uPa2.s or 10 minute exposure of 180 dB re 1 uPa2.s

For a 1 kg fish: single exposure of 200 dB re 1 uPa2.s or 10 minute exposure of 181 dB re 1 uPa2.s

These single sound exposure levels would only occur within less than 30 m of the sound source and the 10 minute exposure would only occur if the fish was within less than 100 m range and swimming parallel to the noise source for 10 minutes.

Behavioural Effects: Most pelagic fish are expected to exhibit avoidance behaviour and swim away when seismic noise reaches levels at which it might cause physiological effects. A primary objective of this proposed study is to elucidate the behavioural response of fish to seismic survey sounds.

EPBC Act protected marine species that may be present in the study areas include 31 species of seahorses and pipe fish, Family Syngnathidae. Syngnathids species are ‘hearing generalists’ with hearing best in the low frequencies (Anderson and Mann 2011). The capacity for hearing in Syngnathids, and hence the potential for behavioural impacts, is not well understood. Many Syngnathids have been documented to produce sound (loud clicks), suggesting that sound is important for communication in the aquatic environment (Bergert and Wainwright 1997). Anderson and Mann (2011) conducted evoked potential audiograms of the lined seahorse, a species potentially present at the pearl study area, they found maximum broadband hearing sensitivity at, and around, 200Hz. Therefore there is considered that there is the potential for behavioural response to the seismic survey in syngnathid species, however there is limited informaiton on whcih we are able to predict the range of response. A key objective of this experiment is to improve our understanding of the response of generalist hearing fish to marine seimsic surveys.

1.7 Seasnakes

Other EPBC Act protected marine species that may be present in the study areas include 18 species of seasnakes. Seasnakes are frequently observed in coastal areas, around offshore islands and the waters of the shelf generally. There is no information on their frequency of occurrence in deeper offshore waters such as the fish study area, though individuals are often observed at the surface. Little is known about the effects of seismic surveys on sea snakes.

However, it is feasible that they will respond in a similar way to turtles such as exhibiting behavioural change to an approaching sound source.

1.8 Seabirds

Birds use the survey area for foraging, so the effect of the seismic survey on birds would be limited to disturbance of foraging behaviour. The seismic survey has a theoretical potential to affect the short term distribution of prey species (such as fish and squid) in the immediate vicinity of the vessels while they are operating. The extent of this potential impact is localised and, for both study areas, of a short duration and unlikely to impact on the food source of foraging seabirds.

2. Routine Discharges

2.1 Sewage and Putrescible Wastes

The risk of damage to sensitive marine resources from discharge of sewage and putrescible wastes from the survey vessel or support vessels is similar to the risk associated normal maritime activities in the areas. Small volumes of discharge to sea, the localised area of impact combined with high rapid dilution (allowing high biodegradability and low persistence) in deep waters means the potential for toxic effects on the marine environment from such wastes is extremely low. Disposal of sewage and putrescible wastes will be managed according to the requirements of the Navigation Act (Cth) and Marine Order 96 (Marine pollution prevention — sewage) 2013 [https://www.legislation.gov.au/Details/F2016C01070] .

Marine Order 96 (Marine pollution prevention — sewage) 2013 provides information on the prevention of marine pollution by sewage from ships including:

* equipment certification requirements

* discharge restrictions

2.2 Garbage

All solid wastes from the survey vessel or support vessels will be stored on board and returned to shore for disposal in accordance with local regulatory requirements.There will beno disposal of garbage at sea.

3 Accidental Events

3.1 Fuel Spills

Risk of oil spill from the survey vessel is similar to that for other vessels operating in the Australian waters and will be managed by application of MARPOL 73/78 as implemented in Australia under the *Protection of the Sea (Prevention of Pollution from Ships) Act* 1983 and the Navigation Act 2012.

3.2 Introduction of Marine Pest Species

Introduction of marine pest species will be unlikely as any vessels mobilised to site from overseas will be required to comply with the AQIS *Australian Ballast Water Guidelines* to minimise the potential for any introduction of exotic marine organisms.

SUMMARY

The proposed action is not likely to:
* to have a significant impact on a critically endangered, endangered or vulnerable species

* result in a known or potential pest species becoming established in the Commonwealth marine area

* substantially modify, destroy or isolate an area of important habitat for a migratory species

* seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species

* modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area results

* result in a substantial change in air quality or water quality (including temperature) which may adversely impact on biodiversity, ecological integrity; social amenity or human health

* result in persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment such that biodiversity, ecological integrity, social amenity or human health may be adversely affected, or

• have a substantial adverse impact on heritage values of the Commonwealth marine area, including damage or destruction of an historic shipwreck.

2.6.3 Do you consider this impact to be significant?

No

2.7 Is the proposed action to be taken on or near Commonwealth land?

No

2.8 Is the proposed action taking place in the Great Barrier Reef Marine Park?

No

2.9 Is the proposed action likely to have ANY direct or indirect impact on a water resource related to coal/gas/mining?

No

2.10 Is the proposed action a nuclear action?

No

2.11 Is the proposed action to be taken by the Commonwealth agency?

Yes

2.11.1 Describe the nature and extent of the likely impact on the whole of the environment.

The Australian Institute of Marine Science is a Commonwealth government entity established to (among other matters duties) carry out research and development in relation to:

* marine science and marine technology; and

* the application and use of marine science and marine technology.

Refer to Section 2.6.2 above for a description of likely impact on the whole of the environment.

2.11.2 Do you consider this impact to be significant?

No

2.12 Is the proposed action to be undertaken in a Commonwealth Heritage Place Overseas?

No

2.13 Is the proposed action likely to have ANY direct or indirect impact on a water resource related to coal/gas/mining?

No

Section 3 - Description of the project area

Provide a description of the project area and the affected area, including information about the following features (where relevant to the project area and/or affected area, and to the extent not otherwise addressed in Section 2).

3.1 Describe the flora and fauna relevant to the project area.

1. Threatened and Migratory Species

Neither the fish study area nor the pearl study area are considered habitat that is critical to the survival of any listed threatened or migratory species. Similarly, there are no EPBC Act-listed threatened ecological communities in the vicinity of either study area.

Attachments B and C provide copy of the Protected Matters Search conducted for the fish survey area and hte pearl survey area.

Table 1, Attachment D presents a compiled list of EPBC Act Listed Threatened Species and Listed Migratory Species that may occur in, or around the study areas. It can be seen from this Table that a diverse range of marine fauna are known to occur, or may occur, in and around the study areas. All listed species are protected under the EPBC Act. The likelihood of their presence in the study areas is described in the following sections.

1.1 Cetaceans

1.1.1 Humpback Whale

The humpback whale is the most commonly sighted whale in north Western Australian waters. The species has been observed seasonally to complete their northern migration in the Camden Sound area of the west Kimberley (Jenner *et al*. 2001), after feeding in Antarctic waters during the summer months (Bannister and Hedley 2001). The whales follow a predictable migratory path and migrate both north and south within the continental shelf boundary (200 m bathymetry). However, on the southbound migration it is likely that most individuals, and particularly cow/calf pairs, will stay closer to the coast than the northern migratory path. This is confirmed by recent satellite tracking of southbound female humpback whales in the Kimberley region (Double *et al*. 2010; see **Figure 3, Attachment D**).

The timing and duration of the proposed study occurs at a time that coincides with the latter part of the southwards migration period for humpback whales in the region. It is expected that migrating humpback whales will be moving southwards through both the pearl and fish study areas at the time of the proposed studies.

1.1.2 Pygmy Blue Whale

Pygmy blue whales are widely distributed throughout the world's oceans. This species has been recorded offshore in all states excluding the Northern Territory. Their migration paths appear to be widespread and do not clearly follow coastlines or particular oceanographic features. AIMS has a research program underway to elucidate the migratory paths of pygmy blue whales through the region and to identify any biologically important areas. This work is due to be completed in 2020.

The pygmy blue whale is rarely present in large numbers outside recognised aggregation areas. Pygmy blue whales are believed to calve in tropical waters in winter and births peak in May to June, however the exact breeding grounds of this species are unknown (Bannister *et al*. 1996).

The study areas and adjacent waters do not include any known pygmy blue whale feeding, breeding or resting areas. In the region pygmy blue whales (*Balaenoptera musculus brevicauda*) generally migrate along the 500 m to 1,000 m depth contour on the edge of the slope. The northward component of this migration takes place from May to mid-August, with a peak in July-August, and the southward component occurs from late October to November-December, with a few isolated individuals moving south in January. The migration appears to be centred on the 500 m depth contour, and consequently it is unlikely that they will occur in either of the study areas.

1.1.3 Sei Whale

Sei whales have been infrequently recorded in Australian waters (Bannister et al. 1996). The similarity in appearance of sei whales and Bryde's whales (Balaenoptera edeni) has resulted in confusion about distributional limits and frequency of occurrence, particularly in warmer waters (>20 °C) where Bryde's whales are more common. Sei whales are considered a cosmopolitan species, ranging from polar to tropical waters, but tend to be found more offshore than other species of large whales. They show well defined migratory movements between polar, temperate and tropical waters (Mackintosh 1965). Migratory movements are essentially north-south with little longitudinal dispersion.

1.1.4 Bryde's Whale

Bryde's Whale is found in tropical and warm temperate waters exceeding 16.3 °C, but generally in the 20 °C isotherm, between 40° N and 40° S. The coastal form of Bryde's Whale appears to be limited to the 200 m depth isobar, moving along the coast in response to availability of suitable prey while the offshore form is found in deeper water, 500 m to 1000 m (DoEE 2018c).

1.2 Other Listed Cetaceans

In addition to the listed threatened and listed migratory species of cetaceans other species whose broad distributions cover the region include whales that are infrequently observed as they are usually restricted to cooler or deeper waters (e.g. killer whales) and consequently

individuals of these species may pass through the area, although probably not in significant numbers (refer to **Table 2, Attachment D**).

1.3 Marine Turtles

Five marine turtle species may occur in the operational area and adjacent waters - the green turtle, leatherback turtle, loggerhead, hawksbill turtle, and the flatback turtle (**Table 1, Attachment D**). AIMS has an ongoing research program to investigate the biologically important areas for green turtles and hawksbill turtles.

Green turtles feed on macroalgae and are by far the most common turtle seen in nearshore waters. Loggerhead turtles are carnivorous, feeding mainly on molluscs and crustaceans. hawksbill turtles feed mainly on sponges and are more often found in deeper waters of the rregion. Flatback turtles are carnivorous, feeding principally on soft-bodied invertebrates including soft corals, sea pens, holothurians, and jellyfish.

Green, flatback and loggerhead turtles all breed from September to March, while the hawksbill turtle breeds from July to March. Reefal habitats in the photic zone are key feeding habitats for green and hawksbill turtles, while flatback turtles forage in both sub-tidal and open ocean soft bottomed habitats

The leatherback turtle is a pelagic feeder, found in tropical, subtropical and temperate waters throughout the world. Nesting is mainly confined to tropical beaches although some nesting occurs on subtropical beaches. No major nesting has been recorded in Australia, although scattered isolated nesting (1-3 nests per annum) occurs in southern Queensland and the Northern Territory.

Nesting distribution analysis pesented by Waayers et al (2014) shows some clear latitudinal delineation between species:

*Loggerhead turtles nesting in the southern latitudes (25.857 – 22.698°S) between Dirk Hartog island and Muiron Islands

* Green turtles in the southern (22.730 – 20.386°S) and northern latitudes (16.873 – 13.960°S) with presence in the northern offshore island (Ashmore, Browse and Scott reefs)

* Flatback turtles covered most of the Western Australia coast (21.689 – 13.963°S), which have been divided into southern (southern Pilbara region), mid (Mundabullanga to Lacepede Islands) and northern (Bonaparte Archipelago) nesting sites.

* Hawksbill turtles mostly concentrated in the southern Pilbara region (21.847 – 20.469°S) with some nesting recorded in the northern Kimberley region

1.4 Crocodile

The salt-water crocodile occurs in the broader region. Its primary habitat is coastal areas and in rivers, although it can travel long distances by sea and occasionally be found some distance from their usual range (Britton, 2001). The likelihood that saltwater crocodiles would occur or pass within or near the the pearl study area is very small and very unlikely that any would pass by the fish study area.

1.5 Sharks and Ray-finned Fishes

1.5.1 Whale Shark

The whale shark (*Rhincodon typus*) is listed as Vulnerable and Migratory under the EPBC Act (see **Table 1, Attachment D**). The whale shark is the world's largest fish, growing to lengths of up to 12 m. Whale sharks are found worldwide in all tropical and warm temperate seas, except the Mediterranean. In Australia, whale sharks are regularly observed in Queensland, the Northern Territory and Western Australia, and have also been occasionally recorded in New South Wales, South Australia and Victoria.

AIMS has a long-term research project that examines the ecology of whale sharks. A central aim of this project is to determine regional long-term movement patterns. The tracks of 15 whale sharks tagged at Ningaloo Reef in 2005 to 2008 passed seaward of the study areas (Meekan and Radford 2010; see **Figure 4, Attachment D**). Although whale sharks have been observed near to the fish study area, it is unlikely that they would be encountered during the proposed studies.

1.5.2 Sawfish

Sawfish are typically found in shallow waters inhabiting muddy bottom habitat and estuaries although there are records of the green sawfish being found in waters of more than 70 m depth (Stevens et al. 2005). Bycatch of sawfish is known to occur in both the Pilbara Trawl Fishery and the Northern Prawn Fishery. Studies of shark and ray bycatch in the Northern Prawn Fishery have identified the green sawfish as a species that is particularly susceptible to capture, based on the species' behaviour and habitat preferences (DSEWPaC 2011b).

Green sawfish have historically been recorded in the coastal waters off Broome, in very shallow water (<1 m) to offshore trawl grounds in over 70 m of water (Stevens et al. 2005), so there is the potential for green sawfish to be present in the study areas, particularly in the pearl study area.

The dwarf sawfish usually inhabits shallow (2–3 m) coastal waters and estuarine habitats (DSEWPaC 201b). A study in north-western Western Australia found that estuarine habitats are used as nursery areas by dwarf sawfish, with immature juveniles remaining in these areas up until three years of age (Thorburn et al. 2007). Adults are known to seasonally migrate back into inshore waters (Peverell 2007), although it is unclear how far offshore the adults travel, as

captures in offshore surveys are very uncommon.

1.5.3 White Shark

The white shark is listed as Vulnerable and Migratory under the EPBC Act. In Australia, the white shark has a range extending from central Queensland, around the southern coastline, and up to the North West Cape in Western Australia. It is not likely to occur in either of the study areas.

1.6 Seabirds and Shorebirds

Eighty Mile Beach and Roebuck Bay, approximately 50 km from the pearl study area, is an important feeding and resting site for birds using the East Asian-Australasian Flyway. Migratory shorebirds are listed as Migratory and Marine species under the EPBC Act and all are also listed under the Convention on Migratory Species (CMS). Additionally, some species are listed on the China-Australia Migratory Bird Agreement (CAMBA), the Japan-Australia Migratory Bird Agreement (JAMBA), or the Republic of Korea Australia Migratory Bird Agreement (ROKAMBA). Migratory shorebirds are likely to be present in the region between July and October and again between March and April.

1.6.1 Curlew Sandpiper

In Australia, curlew sandpipers occur around the coasts and are also quite widespread inland, though in smaller numbers. Curlew sandpipers mainly occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast. They occur in large numbers, in thousands to tens of thousands, at Port Hedland Saltworks, 80 Mile Beach, Roebuck Bay and Lake Macleod. The global population has been estimated at 1,850,000 individuals, of which about 180,000 are found in the East Asian – Australasian Flyway (Bamford *et al*., 2008). It is likely that the curlew sandpiper may overfly the pearl study area, however this area is not habitat for the animal. It is very unlikely that any would overfly the fish study area.

1.6.2 Eastern Curlew

The eastern curlew is the largest migratory shorebird in the world. They have a continuous distribution from Barrow Island and Dampier Archipelago, Western Australia, through the Kimberley and along the Northern Territory, Queensland, and NSW coasts and the islands of Torres Strait. They are patchily distributed elsewhere. During the non-breeding season in Australia, the eastern curlew is most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, The birds arrive in north-west and eastern Australia as early as July (Lane, 1987). In north-west Australia, the maximum arrival was recorded between mid-August and the end of August. It is possible that the eastern curlew would overfly both the pearl study area and fish study area, however neither area is considered to be habitat for the animal.

2 Other Listed Marine Species

2.1 Fish

Other EPBC Act protected marine fish species that may occur within the study areas, these are listed in **Table 3, Attachment D**. They include various species of pipefishes and seahorses (Family Syngnathidae). There is little knowledge on the distribution, abundance and ecology of syngnathids in the region. Syngnathids generally have diverse characteristics ranging from apparently rare and localised species, to widely distributed and very common species. Most syngnathids are usually found in shallow, coastal tropical and temperate waters living among seagrasses, mangroves, coral reefs, macroalgae-dominated reefs, and sand/rubble habitats. It is unlikely, therefore, that significant populations of these species will occur in the deeper waters of the fish study area, they may however occur in low numbers at the pearl study area.

2.2 Seasnakes

The *EPBC Act* protected matters search tool also identified 18 species of seasnake that may occur within the study areas, these are listed in **Table 4, Attachment D**. Seasnakes are frequently observed in and around offshore islands and the waters of the shelf generally. There is no information on their frequency of occurrence in deeper offshore waters, though individuals are often observed at the surface.

3.2 Describe the hydrology relevant to the project area (including water flows).

The large-scale ocean circulation of the region is primarily influenced by the Indonesian Throughflow (ITF) and the Leeuwin Current. The ITF and the Leeuwin Current are strongest during late summer and winter with flow reversals occurring when associated with strong south-westerly winds. These flow reversal events may be associated with weak, shelf upwellings.

Tides in the region are semi-diurnal have a pronounced spring-neap cycle, with tidal currents flooding towards the southeast and ebbing towards the north-west

3.3 Describe the soil and vegetation characteristics relevant to the project area.

There is limited data on seafloor characteristics at the fish study site, however discussions with a local fishing operator and WA Fisheries representatives indicates that the seabed is relatively flat with no obvious topographic features and mostly comprised of thin layer of coarse sand overlying limestone pavement.

The pearl study site is situated within an area that has previously been used as a resting area for pearl oysters that have been fished but not yet transferred to a farm. The seabed is mostly fine sand with areas of coarser sand and exposed limestone pavement.

3.4 Describe any outstanding natural features and/or any other important or unique values relevant to the project area.

There are no known outstanding natural features or any other important or uniques vales relevant to the proposed study areas.

3.5 Describe the status of native vegetation relevant to the project area.

Not applicable

3.6 Describe the gradient (or depth range if action is to be taken in a marine area) relevant to the project area.

The water depth at the pearl study area varies between 20 m and 30 m depth generally sloping downwards towards the west.

The water depth at the fish study area varies between 55 m and 65 m depth generally sloping downwards from south-west to north-east.

3.7 Describe the current condition of the environment relevant to the project area.

Both the fish study area and the pearl study area are in good to near pristine condition.

3.8 Describe any Commonwealth Heritage Places or other places recognised as having heritage values relevant to the project area.

The pearl study area is approximately 5 km from the seaward boundary of the Roebuck Commonwealth Marine Park. The Roebuck Marine Park abuts, on the most landward boundary, the Nagulagun Roebuck Bay Marine Park and forms a continous marine protected area encompassing and extending out from Roebuck Bay. The Marine Park is assigned IUCN category VI and, under the Draft North-West Commonwealth Marine Reserves Network Management Plan has one zone, this being Multiple Use Zone (VI)

There are no Commonwealth Heritage Places within or in close proximity to either of the proposed study sites.

A search of the Australian national shipwrecks database found several wrecks reported to have occurred in and around Gantheaume Point, which is approximately 35km from the pearl study

area, mostly vessels that foundered in storms or cyclones at the entrance to Roebuck Bay. There are no known shipwrecks in or around the fish study area.

3.9 Describe any Indigenous heritage values relevant to the project area.

There are no known sites of Indigenous heritage values within the vicinity of the fish study area

The pearl study area is approximately 20 km from the most seaward boundary of the Yawuru Indigenous Protected Area (IPA) which was accepted by the Federal government in February 2017. The Yawuru IPA covers the significant wetlands and springs on Roebuck Plains station. It joins with and overlaps large portions of the Yawuru conservation estate, including the Roebuck Bay intertidal zone and the Nagulagun Roebuck Bay Marine Park.

3.10 Describe the tenure of the action area (e.g. freehold, leasehold) relevant to the project area.

Not applicable

3.11 Describe any existing or any proposed uses relevant to the project area.

Commonwealth fisheries operating in the region include the North West Slope Trawl Fishery, Western Tuna and Billfish Fishery, Southern Bluefin Tuna Fishery and the Western Skipjack Tuna Fishery. These fisheries mostly operate near the shelf edge, well offshore of the proposed study areas.

State fisheries that may operate near to the study areas are the North Coast Demersal Scalefish Fisheries (comprised of the Pilbara Trawl, Trap and Line Fisheries) and the Broome Prawn Managed Fishery.

The fish study area is located within ‘Area 3’ of the North Coast Demersal Scalefish Fisheries. Area 3 is a managed area that has been closed to fishing since 1998. Therefore, no impact is expected to fishing activity in the area.

The pearl study area is located within an area utilised for pearl oyster fishery and is encompassed within the Broome Prawn Managed Fishery although not a part where prawn trawling is currently allowed to occur. Therefore no impact is is expected to prawn fishing activity in the area.

The Western Australian pearl oyster fishery is the only remaining significant wild-stock fishery for pearl oysters in the world. It is a quota-based, dive fishery, operating in shallow coastal waters along the north coast bioregion and targets the silver lipped pearl oyster (*Pinctada maxima*). This fishery has been accredited for export under the EPBC Act for a period of ten years (reassessment in 2025) and has recently obtained MSC certification. There are multiple pearl leases in the areas surrounding the pearl study site. The proposed study has been

devised in response to concerns expressed by the pearl industry regarding marine noise impacts. AIMS has engaged in consultation with the Pearl Producers Association and individual pearl farming operators from the region during development of the study experimental design. The implementation of the pearl study relies heavily on the ongoing cooperation and assistance from the pearling industry.

The fish study area is partially contained with the Petroleum Permit Area WA-472-P. The permit area is operated by Woodside Energy Limited.

Section 4 - Measures to avoid or reduce impacts

Provide a description of measures that will be implemented to avoid, reduce, manage or offset any relevant impacts of the action. Include, if appropriate, any relevant reports or technical advice relating to the feasibility and effectiveness of the proposed measures.

Examples of relevant measures to avoid or reduce impacts may include the timing of works, avoidance of important habitat, specific design measures, or adoption of specific work practices.

4.1 Describe the measures you will undertake to avoid or reduce impact from your proposed action.

1.Alternatives Considered

1.1 No Study

The planned studies will provide valuable information for the management of seismic operations in areas of demersal fish and pearl oyster fisheries and advance our understanding of the nature of seismic survey impacts on the marine environment. This action is to conduct research on how fish and pearl oysters are effected by and respond to sounds so that better models can be developed to manage the interaction of seismic surveys on fisheries. It is not possible to investigate the effect of seismic surveys in real world conditions without actually conducting an experimentally controlled seismic survey.

1.2 Change of Timing

The timing of the studies is constrained by the biology of the pearl oysters and potential for cyclones.

Pearl oysters are collected May to August, seeding of pearl oysters is then carried out in the cooler months before onset of gametogenesis which is triggered by warming water temperatures. The study has been ‘pushed back’ as far as practicable to late September. This timing avoids the northwards migration and the peak of the southwards humpback migration. It is expected that the majority of southward migrating humpbacks will have passed the study sites by late September. However there remains a moderate to high likelihood of encountering humpback whales.

Cyclones are known to occur in the region from November through to April, being most common December to March. Because the study sites are located in exposed water the work needs to be conducted outside of cyclone season.

2 Mitigation measures

2.1 Management to mitigate effect of seismic source sounds on whales during seismic survey studies

In terms of sound exposure level (SEL) the conservative criteria arrived at by Southall et al (2007) for temporary theshold shift (TTS) onset in low frequency cetaceans from exposure to a single pulse is a M-weighted SEL exposure of 183 dB re 1 uPa2.s. The conservative criteria arrived at for TTS from the cumulative effect of exposure to multiple pulses is M-weighted cumulative SEL exposure 198 dB re 1 uPa2.s. Note 'M-weighting' places an emphasis (i.e greater weighting) on the level of sound in the mid-hearing range of the animals (refer to Southall et al (2007) p.434 to p.436 for detailed description).

It is noted that the *EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales* applies criteria based on TTS onset; limiting exposure to an SEL of 183 dB re 1 uPa2-s for protection of great whales. The *EPBC Act Policy Statement 2.1* then goes on to back-calculate the cumulative SEL that, in a conservative worst-case 30 minute period of constant exposure, would lead to received cumulative SEL of 183 dB re 1 uPa2.s. This conservative worst-case SEL is 160 re 1 uPa2.s. Hence the Policy Statement (and associated Guidelines) in establishing the threshold criteria of SEL 160 re 1 uPa2.s have incorporated three levels of conservativeness, these being:

1. Use of onset of TTS as an indication of injury leading to significant impacts

2. Conservative SEL threshold criteria for onset of TTS.

3. Conservative assumption of 30 minutes continuous exposure

We propose to implement a two-tiered mitigation strategy to protect whales from harm. These mitigation measures are based on:

1. Ensuring that we avoid, by a wide margin, exposing whales to received sound levels that could cause a Permanent Threshold Shift (PTS) by setting criteria that avoids onset of TTS.

2. Consistency with the concept behind the Australian *EPBC Act Policy Statement 2.1*. i.e use of TTS as conservative measure to protect against PTS for single shot exxposure, use of cumulative SEL theshold for TTS as conservative measure to protect against TTS for mulitple exposures.

3. Conformity with the mitigation measures applied by the BRAHSS studies (behavioural responses of Australian humpbacks to seismic surveys) conducted in 2011 and 2014 (Cetacean permit C2014-0002) which found nbo significant behavioural effect of exposure.

The first tier is to have a shut-down zone, the radius of which will prevent the whales being exposed to single seismic source shots greater than 183 dB re 1 uPa2.s (SEL).

The second tier will be involve tracking all whales within 3km of the seismic source and calculating their cumulative exposure in real time and ensuring that the cumulative exposure does not exceed 198 dB re 1 uPa2.s. Should a whale reach the cumulative exposure, the seismic source will be shut down even if it has not been exposed to a single shot greater than 183 dB re 1 uPa2.s (SEL).

AIMS propose to use a dynamic approach to prevent any individual whale receiving a cumulative dose of more than 198 dB re 1uPa2.s. This is an additional measure because it includes the accumulated exposure before the individual reaches shut down range. Using the positions determined for each whale (obtained in real time from tracking on the seismic vessel), the source level of the array and the known propagation loss as a function of distance, it is possible to calculate the received SEL at a whale within 3000 m of the source (using a software program that incorporates visual detecting and ranging at sea with sound propogation model). Using this software we propose to a running total of the cumulative SEL of whales entering the detection zone (3km radius). If the cumulative SEL reaches 195 dB re 1 uPa2.s, a level 3 dB lower than the single shot shut down criterion to add an additional margin of safety, the airgun source will be shut down.

The impact on whales from our experiment will be substantially lower than for a typical seismic array and our much higher resolution and accuracy in determining actual noise exposure levels allows us to use mitigation measures more targeted to the specific conditions. The impact differs from that of a seismic survey in a number of ways:

1. Individual whales would be exposed to the air gun array for very short periods, whereas whales could be exposed to a seismic survey for days at a time.

2. AIMS will have three observers on the seismic vessel whereas most seismic vessels only have one or two MMOs.

3. AIMS will track the positions of each whale within three kilometres of the seismic vessel to obtain an accurate plot of the distance of each individual from the source in real time.

4. Sound exposure will be modelled based on site investigations of seabed and sound propagation characteristics carried out in advance of the study. Received levels as a function of distance can be modelled for seismic surveys but are usually not done due to the large areas being traversed.

5. AIMS will measure the cumulative exposure *before* an individual reaches the shutdown range and shut down when this reaches the cumulative exposure limit, even if the whale is still beyond the single shot shutdown range. Mitigation for seismic survey has to rely on the shutdown range only so this range has to be significantly larger than AIMS are proposing as a precaution.

Start-ups will be managed in accordance with the *EPBC Act Policy Statement 2.1*. That is:

1. Pre-start observations will be carried out for at least 30 minutes prior to a soft start.

2. Soft start will only occur if no whales have been sighted within the area wherein the received sound level is likely to be greater than 160 dB re 1uPa2.s

3. Soft start: the acoustic source will gradually increase power over a 30-minute period.

Night time operations will be managed in accordance with the *EPBC Act Policy Statement 2.1*. That is, start up will not be commenced if there has been three or more whale instigated power-down or shut-down situations during the preceding 24 hour period.

2.2 Management Measures to mitigate physical interference to whale movements

The following mitigation measures will be implemented to control impacts associated with normal vessel operations (ie for vessesl other than the seismic vessel or the seismic vessel when the seismic source is not firing).

The interaction of the survey vessel, and other vessels associated with the studies, will adhere to the Australian National Guidelines for Whale and Dolphin Watching (DoEE, 2017) and be consistent with Part 8 of the EPBC Regulations (2000) which requires, among other matters, that a vessel will not travel greater than 6 knots within 300 m of a whale (caution zone) and not allow the vessel to approach closer than 100m of a whale.

All members of the study team and vessel crew will be briefed on environmental requirements and particularly crew responsible for vessel operation and navigation will be aware of cetacean interaction regulations and guidelines.

2.4 Management Measures to prevent interference to turtles and whale sharks

For both the mapping activities and the experimental seismic survey the MMOs will (during daylight hours), in conjunction with the whale mitigation measures;

1. undertake visual observations for marine turtles and whale sharks for at least 30 minutes prior to the commencement of soft start, focusing on a 500 m horizontal radius of the source vessel.

2. ensure that if marine turtles and whale sharks are sighted within 50 m horizontal radius of source vessel, the acoustic source will be shut down.

3. maintain continuous visual observations for marine turtles and whale sharks within a 300 m horizontal radius of the source vessel, whilst the seismic survey operaitons are underway (note, 300 m is the practical limit at which turtles can be observed).

3 Routine Discharges

3.1 Sewage and Putrescible Wastes

Risk of damage to sensitive marine resources from discharge of sewage and putrescible wastes from the survey vessels is similar to normal maritime activities in the areas. Disposal of sewage and putrescible wastes will be managed according to the Navigation Act 2012 which requires:

1. Sewage treatment plant on survey vessel is to comply with MARPOL requirements

2.Sewage and putrescible wastes will not be discharged within 12 nautical miles of land

3.2 Garbage

No wastes wil be disposed of overboard. All solid wastes will be returned to shore for disposal in accordance with local regulatory requirements.

4. Accidental Events

4.1 Fuel Spills

Risk of oil spill from the survey vessel is similar to that for other vessels operating in the Australian waters and will be managed by application of MARPOL 73/78 as implemented in Australia under the *Protection of the Sea (Prevention of Pollution from Ships) Act* 1983 and Marine Orders issued unde the Navigation Act 2012.

4.2 Introduction of Marine Pest Species

Introduction of marine pest species will be unlikely as any vessels mobilised to site from overseas will be required to comply with the AQIS *Australian Ballast Water Guidelines* to minimise the potential for any introduction of exotic marine organisms.

4.2 For matters protected by the EPBC Act that may be affected by the proposed action, describe the proposed environmental outcomes to be achieved.

The proposed studies into the effect of marine noise on fish and pearl oysters poses potential risks to threatened, migratory and marine listed species. A range of measures, based on best available methods, will be put in place to either avoid risks or mitigate the potential impacts associated with the risks. The result of these avoidance and mitigation measures is that no significant impact will occur, nor is it likely to occur, to any matter of national environmental significance.

The components of the proposed action that involve interactions with whales will only have a minor behavioural effect, of a temporary nature, on the individuals exposed, and the numbers of individuals affected will be small compared to the size of the population (in the order of ~30,000 whales). All other potential impacts can be managed through routine operational procedures.

Section 5 – Conclusion on the likelihood of significant impacts

A checkbox tick identifies each of the matters of National Environmental Significance you identified in section 2 of this application as likely to be a significant impact.

Review the matters you have identified below. If a matter ticked below has been incorrectly identified you will need to return to Section 2 to edit.

5.1.1 World Heritage Properties

No

5.1.2 National Heritage Places

No

5.1.3 Wetlands of International Importance (declared Ramsar Wetlands)

No

5.1.4 Listed threatened species or any threatened ecological community

No

5.1.5 Listed migratory species

No

5.1.6 Commonwealth marine environment

No

5.1.7 Protection of the environment from actions involving Commonwealth land

No

5.1.8 Great Barrier Reef Marine Park

No

5.1.9 A water resource, in relation to coal/gas/mining

No

5.1.10 Protection of the environment from nuclear actions

No

5.1.11 Protection of the environment from Commonwealth actions

No

5.1.12 Commonwealth Heritage places overseas

No

5.2 If no significant matters are identified, provide the key reasons why you think the proposed action is not likely to have a significant impact on a matter protected under the EPBC Act and therefore not a controlled action.

The Australian Government Significant Impact Guidelines have been reviewed in the preparation of this referral and compared to the outcomes on the whole of the environment that would, or is likely to occur with the nominated mitigation measures in place. It is concluded that the project is **not a Controlled Action.** The rationale for this is set out below.

For listed critically endangered and endangered species the proposed studies will not:

• lead to a long-term decrease in the size of a population

• reduce the area of occupancy of the species

• fragment an existing population into two or more populations

• adversely affect habitat critical to the survival of a species

• disrupt the breeding cycle of a population

• modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

• result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

• introduce disease that may cause the species to decline, or

• interfere with the recovery of the species.

For vulnerable species the proposed studies will not:

• lead to a long-term decrease in the size of an important population of a species

• reduce the area of occupancy of an important population

• fragment an existing important population into two or more populations

• adversely affect habitat critical to the survival of a species

• disrupt the breeding cycle of an important population

• modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

• result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

• introduce disease that may cause the species to decline, or

• interfere substantially with the recovery of the species.

For listed migratory species the proposed studies will not:

• substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species

• result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or

• seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

For the marine enviornment, the proposed studies will not:

• result in a known or potential pest species becoming established in the Commonwealth marine area

• modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area results

• have a substantial adverse effect on a population of a marine species or cetacean including its life cycle (for example, breeding, feeding, migration behaviour, life expectancy) and spatial distribution

• result in a substantial change in air quality or water quality (including temperature) which may adversely impact on biodiversity, ecological integrity; social amenity or human health

• result in persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment such that biodiversity, ecological integrity, social amenity or human health may be adversely affected, or

• have a substantial adverse impact on heritage values of the Commonwealth marine area, including damage or destruction of an historic shipwreck.

Section 6 – Environmental record of the person proposing to take the action

Provide details of any proceedings under Commonwealth, State or Territory law against the person proposing to take the action that pertain to the protection of the environment or the conservation and sustainable use of natural resources.

6.1 Does the person taking the action have a satisfactory record of responsible environmental management? Please explain in further detail.

Yes.

The Australian Institute of Marine Science is Commonwealth entity established under the *Australian Institute of Marine Science Act 1972* to (inter alia) to carry out research and development in relation to:

(i) marine science and marine technology; and

(ii) the application and use of marine science and marine technology.

We play a pivotal role in providing large-scale, long-term and world-class research that helps governments, industry and the wider community to make informed decisions about the management of Australia's marine estate. Our commitment is to undertake research that addresses real needs and provides impartial, authoritative advice, and that supports both the protection and sustainable use of our marine heritage, now and into the future.

6.2 Provide details of any past or present proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against either (a) the person proposing to take the action or, (b) if a permit has been applied for in relation to the action – the person making the application.

None

6.3 If it is a corporation undertaking the action will the action be taken in accordance with the corporation's environmental policy and framework?

Yes

6.3.1 If the person taking the action is a corporation, please provide details of the

corporation's environmental policy and planning framework.

AIMS is committed to protecting the environment and consequently has a written Environment Policy (see **Attachment A**) that provides a public statement of our commitment to protecting the environment during marine research activities.

6.4 Has the person taking the action previously referred an action under the EPBC Act, or been responsible for undertaking an action referred under the EPBC Act?

No

Section 7 – Information sources

You are required to provide the references used in preparing the referral including the reliability of the source.

7.1 List references used in preparing the referral (please provide the reference source reliability and any uncertainties of source).

Reference Source	Reliability	Uncertainties
Anderson PA. and Mann DA. (2011). Evoked potential audiogram of the lined sea horse Hippocampus erectus(Perry), in terms of sound pressure and particle acceleration. Environ. Biol. Fishes 91, 251-259.	All reference source material is considered to be very reliable. References have been drawn from peer reviewed scientific journals or published reviews of studies.	Minimal uncertainty because of high reliability of the source material.
Bamford M, Watkins D, Bancroft W, Tischler G and Wahl J (2008). Migratory Shorebirds of the East Asian - Australasian Flyway: Population estimates and internationally important sites. Canberra, ACT: Department of the Environment, Water, Heritage and the Arts, Wetlands International-Oceania.	Peer reviewed.	Minimal
Bannister JL, and Hedley SL (2001). Southern hemisphere Group IV Humpback whales: their status from recent aerial survey. Memoirs of the Queensland Museum, 47 (2): 587-598.	Peer reviewed.	Minimal
Bannister JL, Kemper CM and Warneke RM (1996). The Action Plan for Australian Cetaceans. Wildlife Australia, Endangered Species Program, Project No. 380. Australian Nature Conservation Agency, Canberra, Australia. 272 pp.	n/a	Minimal
Bartol SM, Musick JA and	Peer reviewed.	Minimal

Reference Source	Reliability	Uncertainties
Lenhardt ML (1999). Auditory evoked potentials of the loggerhead sea turtle (Caretta caretta). Copeia 3: 836–840.		
Berget B, Wainwright PC (1997). Morphology and kinematics of prey capture in the syngnathid fishes Hippocampus erectus and Syngnathus floridae. Marine Biology 127: 563-570.	Peer reviewed.	Minimal
Best, PB, Butterworth DS and Rickett RH (1984). An assessment cruise for the South African inshore stock of Bryde's Whales (Balaenoptera edeni). Report of the International Whaling Commission. 34:403-423. In Species Profile and Threats Database Balaenoptera edeni — Bryde's Whale. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=35	Peer reviewed.	Minimal
Carroll AG, Przeslawski R, Duncan A, Gunning M and Bruce B (2017). A critical review of the potential impacts of marine seismic surveys on fish and invertebrates. Marine Pollution Bulletin 114: 9 – 24.	Peer reviewed.	Minimal
DEWHA (2008a). Policy Statement 2.1 – Interaction between offshore seismic exploration and whales, 2008. (http://www.environment.gov.au/epbc/publications/pubs/seismic-whales.pdf)	n/a	n/a
DEWHA (2008b). Background Paper to EPBC Act Policy Statement 2.1 – interaction between offshore seismic exploration and whales, http://www.environment.gov.au/epbc/publications/pubs/seismic-	n/a	n/a

Reference Source	Reliability	Uncertainties
whales-background.pdf		
DEWHA (2013). Matters of National Environmental Significance Significant impact guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999. http://www.environment.gov.au/epbc/publications/significant-impact-guidelines-11-matters-national-environmental-significance	n/a	n/a
DEWHA (2013). Matters of National Environmental Significance Significant impact guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999. http://www.environment.gov.au/epbc/publications/significant-impact-guidelines-11-matters-national-environmental-significance	n/a	n/a
DoEE (2017). Australian National Guidelines for Whale and Dolphin Watching. http://www.environment.gov.au/marine/publications/australian-national-guidelines-whale-and-dolphin-watching-2017	n/a	n/a
DoEE (2018a). Conservation Advice Numenius madagascariensis eastern curlew. http://www.environment.gov.au/biodiversity/threatened/species/pubs/847-conservation-advice.pdf	n/a	n/a
DoEE (2018b). Sawfish data fact sheet Species Profile and Threats Database, http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=68447	n/a	n/a
DoEE (2018c). Species Profile and Threats Database: Balaenoptera edeni — Bryde's Whale. http://www.environment.gov.au/cgi-bin/sprat/public/publi	n/a	n/a

Reference Source	Reliability	Uncertainties
cspecies.pl?taxon_id=35		
Double MC, Gales N, Jenner KCS and Jenner MN (2010). Satellite tracking of south-bound female humpback whales in the Kimberley region of Western Australia – Final Report. Report produced for Woodside Energy Limited. 30 pp.	Peer-reviewed	Limitations relate to accuracy of satellite tracker devices and representativeness of the whales tracked.
Dunlop RA, Noad MJ, McCauley RD, Kneist E, Slade R, Paton D, and Cato DH (2017). The behavioural response of migrating humpback whales to a full seismic airgun array. Proc R. Soc B 284: 2017.1901	Peer reviewed and highly relevant study	Minimal
Eckert S, Levenson DH and Crognale MA (2006). The sensory biology of sea turtles: what can they see, and how can this help them avoid fishing gear?. in Swimmer Y and Brill R (eds) Sea Turtle and Pelagic Fish Sensory Biology: Developing Techniques to Reduce Sea Turtle Bycatch in Longline Fisheries, NOAA Technical Memorandum NMFS-PIFSC-7.	Peer reviewed.	Minimal
Eckert SA, Bowles A and Berg E (1998). The effect of seismic airgun surveys on leatherback sea turtles (Dermochelys coriacea) during the nesting season. Technical report to BHP (Petroleum) Trinidad Ltd.	Peer reviewed.	Limitations relate to accuracy of satellite tracker devices and representativeness of the turtles tracked
Goold JC (1996). Acoustic assessment of populations of common dolphin Delphinus delphis in conjunction with seismic surveying. Journal of the Marine Biological Association UK, 76: 811-820.	Peer reviewed.	Minimal
Hastings M.C. and Popper A.N.	Peer reviewed.	Minimal

Reference Source	Reliability	Uncertainties
2005. Effects of sound on fish. Subconsultants to Jones & Stokes Under California Department of Transportation Contract No. 43A0139. Report. Pp 82. http://www.dot.ca.gov/hq/env/bio/files/Effects_of_Sound_on_Fish23Aug05.pdf		
Jenner C, Jenner M and McCabe K (2001). Geographical and temporal movements of humpback whales in Western Australian Waters. APPEA Journal 2001. 749-765.	Peer reviewed.	Minimal
Jochens AE and Biggs DC (2003). Sperm Whale Seismic Study in the Gulf of Mexico. US Minerals Management Service OCS Study 2003-069. Report published by US Department of Minerals Management Service OCS Region, New Orleans.	Peer reviewed.	Minimal
Keevin TM and Hempen GL (1997). The environmental effects of underwater explosions with methods to mitigate impacts. US Army Corps of Engineers, St. Louis District, St. Louis.	Peer reviewed literature review of publications	Minimal
Ketten DR and Bartol SM (2005). Functional Measures of Sea Turtle Hearing. Woods Hole Oceanographic Institute, MA, USA.	Peer reviewed.	Minimal
Lane BA (1987). Shorebirds in Australia. Sydney, NSW: Reed. In DoEE (2018). Conservation Advice Numenius madagascariensis eastern curlew. http://www.environment.gov.au/biodiversity/threatened/species/pubs/847-conservation-advice.pdf	n/a	n/a
Lavender AL, Bartol SM, Bartol IK (2014). Ontogenetic	Peer reviewed.	Minimal

Reference Source	Reliability	Uncertainties
investigation of underwater hearing capabilities in loggerhead sea turtles (Caretta caretta) using a dual testing approach. J Exp Biol 217:2580–2589.		
Lenhardt ML, Bellmund S, Byles RA, Harkins SW and Musick JA (1983). Marine Turtle reception of bone conducted sound. Journal of Auditory Research 23: 119–1125.	Peer reviewed	Minimal
Mackintosh NA (1965). The stocks of whales. London: Fishing News (Books) Ltd .In. DOEE (2018) Species Profile and Threats Database Balaenoptera borealis — Sei Whale. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=34	Original document not sighted	unknown
McCauley RD (1994). The environmental implications of offshore oil and gas development in Australia – seismic surveys. In Swan, JM, Neff JM and Young PC (eds.), “Environmental Implications of Offshore Oil and Gas Development in Australia - The Findings of an Independent Scientific Review”, pp. 19-122. Australian Petroleum Exploration Association, Sydney	Peer reviewed.	Minimal
McCauley RD, Fewtrell J, Duncan AJ, Jenner C, Jenner MN, Penrose JD, Prince R, Adhitya A, Murdoch J and McCabe, K (2000). Marine seismic surveys: Analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fish and squid. In: Environmental implications of	Peer reviewed.	Minimal

Reference Source	Reliability	Uncertainties
offshore oil and gas development in Australia: further research. Australian Petroleum Production and Exploration Association Limited.		
Meekan MG and Radford B (2010). Migration patterns of Whale Sharks: A summary of 15 satellite tag tracks from 2005 to 2008. Report produced for Woodside Energy Ltd. Australian Institute of Marine Science, Perth.	Peer reviewed.	Limitations relate to accuracy of satellite tracker devices and representativeness of the whale sharks tracked
National Research Council, (2005). Marine mammal populations and ocean noise: determining when noise causes biologically significant effects. Washington DC, National Academy Presses.	Peer-reviewed literature review of publications	Minimal
Nordmann AS, Bohne BA, Harding GW (2000). Histopathological differences between temporary and permanent threshold shift. Hearing Research. 139:13–30. Cited In Southall et al (2007)	Peer-reviewed	Minimal
Peverell S (2007). Dwarf Sawfish Pristis clavata. Queensland Department of Primary Industries and Fisheries Fact Sheet, viewed online April 2011 at http://www.mesa.edu.au/seaweek2008/info_sheet05.pdf	n/a	n/a
Piniak WED, Mann DA, Harms CA, Jones TT and Eckart AE. 2016. Hearing in the juvenile green sea turtle (Chelonia mydas): a comparison of underwater and aerial hearing using auditory evoked potentials. PLoS ONE 11(10):e0159711.	Peer-reviewed	Minimal
Popper AN and Hastings MC (2009). The effects of	Peer-reviewed	Minimal

Reference Source	Reliability	Uncertainties
anthropogenic sources of sound on fishes. J. Fish Biol. 75,455-489.		
Popper AN, Smith ME, Cott PA, Hanna BW, MacGillivray AO, Austin ME and Mann DA (2005). Effects of exposure to seismic airgun use on hearing of three fish species. J. Acoust. Soc. Am. 117, 3958-3971	Peer-reviewed	Minimal
Richardson WJ, Greene Jr CR, Malme CI and Thomson DH (1995), Marine mammals and Noise. Academic Press, San Diego	Peer-reviewed	Minimal
Southall BL, Bowles AE, Ellison WT, Finneran JJ, Gentry RL, Greene Jr CR, Kastak D, Ketten DR, Miller JH, Nachtingall PE, Richardson WJ, Thomas JA and Tyack PL (2007). Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals 33: 411 509.	Peer-reviewed results from expert group review of available data, including published peer-reviewed documents and company reports. The most extensive and comprehensive analysis of marine mammal noise exposure criteria.	minimal uncertainties, where uncertainties exist they are addressed by conservative assessment
Stevens JD, Pillans RD and Salini J. (2005). Conservation Assessment of Glyphis sp. A (Speartooth Shark), Glyphis sp. C (Northern River Shark), Pristis microdon (Freshwater Sawfish) and Pristis zijsron (Green Sawfish). Report Prepared for Department of Environment and Heritage by CSIRO Marine Research Hobart, Tasmania, http://www.environment.gov.au/coasts/publications/pubs/assessment-glyphis.pdf	n/a	n/a
Stone CJ (2003). The Effects of Seismic Activity on Marine Mammals in UK Waters. JNCC Report No. 323. Joint Nature Conservation Committee, Aberdeen	Peer-reviewed	Minimal

Reference Source	Reliability	Uncertainties
Thorburn DC, Morgan DL, Rowland AJ, Gill HS and Paling E (2007). Life history notes of the critically endangered dwarf sawfish, Pristis clavata, Garman 1906 from the Kimberley region of Western Australia.	n/a	n/a
Waayers D, Mau R, Mueller A, Smith J and Pet-Soede L. (2014). A Review of the Spatial Distribution of Marine Turtle Nesting and Foraging Areas in Western Australia. In Whiting, S. D., Tucker, A. (Compilers) (2015). Proceedings of the Second Australian and Second Western Australian Marine Turtle Symposia, Perth 25-27 August 2014	Peer-reviewed	Minimal
Wever EG (1971). Hearing in the crocodilia, Proc. Nat. Acad. Sci. USA 68 (7) 1498-1500.	Peer-reviewed	Minimal
Young GA (1991). Concise methods for predicting the effects of underwater explosions on marine life. NAVSWC No. 91-22. Naval Surface Warfare Centre, Silverspring, Maryland, USA.	Physics based technical report.	Minimal

Section 8 – Proposed alternatives

You are required to complete this section if you have any feasible alternatives to taking the proposed action (including not taking the action) that were considered but not proposed.

8.0 Provide a description of the feasible alternative?

n/a

8.1 Select the relevant alternatives related to your proposed action.

8.27 Do you have another alternative?

No

Section 9 – Contacts, signatures and declarations

Where applicable, you must provide the contact details of each of the following entities: Person Proposing the Action; Proposed Designated Proponent and; Person Preparing the Referral. You will also be required to provide signed declarations from each of the identified entities.

9.0 Is the person proposing to take the action an Organisation or an Individual?

Organisation

9.2 Organisation

9.2.1 Job Title

Chief Executive Officer

9.2.2 First Name

Paul

9.2.3 Last Name

Hardisty

9.2.4 E-mail

p.hardisty@aims.gov.au

9.2.5 Postal Address

1526

Cape Cleveland Road
Cape Cleveland QLD 4810
Australia

9.2.6 ABN/ACN

ABN

78961616230 - THE AUSTRALIAN INSTITUTE OF MARINE SCIENCE

9.2.7 Organisation Telephone

(07) 4753 4444

9.2.8 Organisation E-mail

j.rasmussen@aims.gov.au

9.2.9 I qualify for exemption from fees under section 520(4C)(e)(v) of the EPBC Act because I am:

Not applicable

Small Business Declaration

I have read the Department of the Environment and Energy's guidance in the online form concerning the definition of a small a business entity and confirm that I qualify for a small business exemption.

Signature:..... Date: .....

9.2.9.2 I would like to apply for a waiver of full or partial fees under Schedule 1, 5.21A of the EPBC Regulations

Yes

9.2.9.3 Under sub regulation 5.21A(5), you must include information about the applicant (if not you) the grounds on which the waiver is sought and the reasons why it should be made

The proposed activity is for environmental research to be conducted by AIMS in accordance with the statutory function of AIMS, as defined within the Australian Institute of Marine Science Act 1972.

As AIMS is a Commonwealth funded entity, and the research proposed is for the benefit of environmental management of Australia's marine estate, it is in the best interest of the public that the fees for this referral are waived.

Person proposing the action - Declaration

I, PAUL EDWARD HARDISTY, declare that to the best of my knowledge the information I have given on, or attached to the EPBC Act Referral is complete, current and correct. I understand that giving false or misleading information is a serious offence. I declare that I am not taking the action on behalf of or for the benefit of any other person or entity.

Signature:..... Date: 21/03/18

I, PAUL EDWARD HARDISTY, the person proposing the action, consent to the designation of MICHAELA DOMMISSE as the proponent of the purposes of the action describe in this EPBC Act Referral.

Signature:..... Date: 21/3/18

9.3 Is the Proposed Designated Proponent an Organisation or Individual?

Organisation

9.5 Organisation

9.5.1 Job Title

Program Leader Western Australia

9.5.2 First Name

Michaela

9.5.3 Last Name

Dommisse

9.5.4 E-mail

m.dommisse@aims.gov.au

9.5.5 Postal Address

Indian Ocean Marine Research Cen

Level 3 Fairway
Crawley WA 6009
Australia

9.5.6 ABN/ACN

ABN

78961616230 - THE AUSTRALIAN INSTITUTE OF MARINE SCIENCE

9.5.7 Organisation Telephone

(08) 6369 4000

9.5.8 Organisation E-mail

waadmin@aims.gov.au

Proposed designated proponent - Declaration

I, MICHAELA DOMMISSE, the proposed designated proponent, consent to the designation of myself as the proponent for the purposes of the action described in this EPBC Act Referral.

Signature:..... Date: 21/03/18

9.6 Is the Referring Party an Organisation or Individual?

Organisation

9.8 Organisation

9.8.1 Job Title

Program Manager NWSS Research Program

9.8.2 First Name

Peter

9.8.3 Last Name

Farrell

9.8.4 E-mail

p.farrell@aims.gov.au

9.8.5 Postal Address

Indian Ocean Marine Research Cen

Level 3 Fairway Entry 4
Crawley WA 6009
Australia

9.8.6 ABN/ACN

ABN

78961616230 - THE AUSTRALIAN INSTITUTE OF MARINE SCIENCE

9.8.7 Organisation Telephone

(08) 6369 4000

9.8.8 Organisation E-mail

waadmin@aims.gov.au

Referring Party - Declaration

I, Peter Farrell, I declare that to the best of my knowledge the information I have given on, or attached to this EPBC Act Referral is complete, current and correct. I understand that giving false or misleading information is a serious offence.

Signature: ..... Date: 21 March 2018

Appendix A - Attachments

The following attachments have been supplied with this EPBC Act Referral:

1. attachment_b_protected_matters_search_fish_study_area.pdf
2. attachment_c_protected_matters_search_pearl_study_area.pdf
3. attachment_d_figures_and_compiled_tables.pdf
4. attachment_e_sound_transmission_forecast_and_calculation_methods.pdf
5. environment_policy_1.pdf